Series : R5QPS

SET~1

प्रश्न-पत्र कोड
Q.P. Code **55/5/1**

रोल नं.
Roll No.

परीक्षार्थी प्रश्न-पत्र कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें।
Candidates must write the Q.P. Code on the title page of the answer-book.

भौतिक विज्ञान (सैद्धान्तिक)

PHYSICS (Theory)

*निर्धारित समय : **3** घण्टे* | *अधिकतम अंक : **70***

*Time allowed : **3** hours* | *Maximum Marks : **70***

नोट

(I) *कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **31** हैं।*

(II) *प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें।*

(III) *कृपया जाँच कर लें कि इस प्रश्न-पत्र में **33** प्रश्न हैं।*

(IV) ***कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में यथा स्थान पर प्रश्न का क्रमांक अवश्य लिखें।***

(V) *इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है। प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जाएगा। 10.15 बजे से 10.30 बजे तक परीक्षार्थी केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे।* []

NOTE

(I) *Please check that this question paper contains **31** printed pages.*

(II) *Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.*

(III) *Please check that this question paper contains **33** questions.*

(IV) *Please write down the Serial Number of the question in the answer-book at the given place before attempting it.*

(V) *15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the candidates will read the question paper only and will not write any answer on the answer-book during this period.*

सामान्य निर्देश :

निम्नलिखित निर्देशों को ध्यानपूर्वक पढ़िए और उनका पालन कीजिए :

(i) *इस प्रश्न-पत्र में **33** प्रश्न हैं। **सभी** प्रश्न **अनिवार्य** हैं।*

(ii) *यह प्रश्न-पत्र **पाँच** खण्डों में विभाजित है – **खण्ड क, ख, ग, घ** एवं **ङ**।*

(iii) ***खण्ड क** में – प्रश्न संख्या **1** से **16** तक बहुविकल्पीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न **1** अंक का है।*

(iv) ***खण्ड ख** में – प्रश्न संख्या **17** से **21** तक अति लघु-उत्तरीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न **2** अंकों का है।*

(v) ***खण्ड ग** में – प्रश्न संख्या **22** से **28** तक लघु-उत्तरीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न **3** अंकों का है।*

(vi) ***खण्ड घ** में – प्रश्न संख्या **29** तथा **30** केस अध्ययन-आधारित प्रश्न हैं। प्रत्येक प्रश्न **4** अंकों का है।*

(vii) ***खण्ड ङ** में – प्रश्न संख्या **31** से **33** तक दीर्घ-उत्तरीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न **5** अंकों का है।*

(viii) *प्रश्न-पत्र में समग्र विकल्प नहीं दिया गया है। यद्यपि, खण्ड क के अतिरिक्त सभी खण्डों के कुछ प्रश्नों में आंतरिक विकल्प का चयन दिया गया है।*

(ix) *ध्यान दें कि दृष्टिबाधित परीक्षार्थियों के लिए एक अलग प्रश्न-पत्र है।*

(x) *कैल्कुलेटर का उपयोग **वर्जित** है।*

जहाँ आवश्यक हो, आप निम्नलिखित भौतिक नियतांकों के मानों का उपयोग कर सकते हैं :

$c = 3 \times 10^8$ m/s

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

इलेक्ट्रॉन का द्रव्यमान $(m_e) = 9{\cdot}1 \times 10^{-31}$ kg

न्यूट्रॉन का द्रव्यमान = $1{\cdot}675 \times 10^{-27}$ kg

प्रोटॉन का द्रव्यमान = $1{\cdot}673 \times 10^{-27}$ kg

आवोगाद्रो संख्या = $6{\cdot}023 \times 10^{23}$ प्रति ग्राम मोल

बोल्ट्ज़मान नियतांक = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

General Instructions :

Read the following instructions carefully and follow them :

(i) *This question paper contains **33** questions. **All** questions are **compulsory**.*

(ii) *This question paper is divided into **five** sections – **Sections A, B, C, D** and **E**.*

(iii) *In **Section A** – Questions no. **1** to **16** are Multiple Choice type questions. Each question carries **1** mark.*

(iv) *In **Section B** – Questions no. **17** to **21** are Very Short Answer type questions. Each question carries **2** marks.*

(v) *In **Section C** – Questions no. **22** to **28** are Short Answer type questions. Each question carries **3** marks.*

(vi) *In **Section D** – Questions no. **29** and **30** are Case Study-based questions. Each question carries **4** marks.*

(vii) *In **Section E** – Questions no. **31** to **33** are Long Answer type questions. Each question carries **5** marks.*

(viii) *There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section A.*

(ix) *Kindly note that there is a separate question paper for Visually Impaired candidates.*

(x) *Use of calculators is **not** allowed.*

You may use the following values of physical constants wherever necessary :

$c = 3 \times 10^8$ m/s

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

Mass of electron (m_e) = $9{\cdot}1 \times 10^{-31}$ kg

Mass of neutron = $1{\cdot}675 \times 10^{-27}$ kg

Mass of proton = $1{\cdot}673 \times 10^{-27}$ kg

Avogadro's number = $6{\cdot}023 \times 10^{23}$ per gram mole

Boltzmann constant = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

खण्ड क

1. दो छोटी सर्वसम धातु की गेंदें जिन पर q एवं – 2q आवेश हैं एक-दूसरे से r दूरी पर रखी हैं। इन्हें परस्पर संपर्क में लाया जाता है और फिर इनके बीच की दूरी $\frac{r}{2}$ कर दी जाती है। आरंभ में लगने वाले बल F की तुलना में, अब इनके बीच लगेगा :

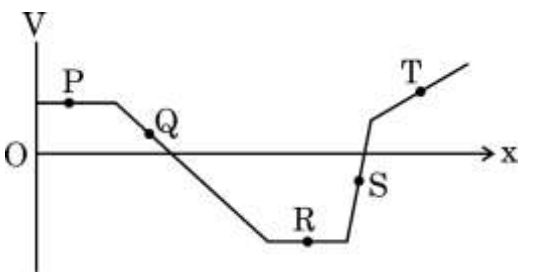
(A) आकर्षी बल $\frac{F}{2}$

(B) प्रतिकर्षी बल $\frac{F}{2}$

(C) प्रतिकर्षी बल F

(D) आकर्षी बल F

2. चित्र में किसी स्थान पर x-अक्ष के अनुदिश बदलती स्थिति के फलन के रूप में विद्युत विभव V में होने वाले परिवर्तन को निरूपित किया गया है। इस क्षेत्र में कोई आवेशित कण अधिकतम बल का अनुभव करेगा :



(A) P पर

(B) Q पर

(C) R पर

(D) S पर

SECTION A

1. Two small identical metallic balls having charges q and – 2q are kept far at a separation r. They are brought in contact and then separated at distance $\frac{r}{2}$. Compared to the initial force F, they will now :

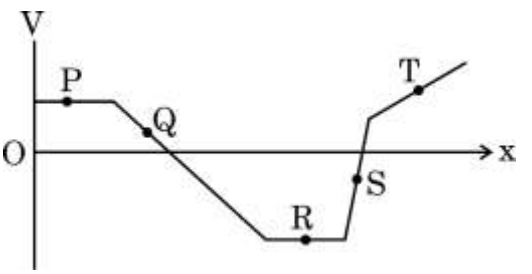
(A) attract with a force $\frac{F}{2}$

(B) repel with a force $\frac{F}{2}$

(C) repel with a force F

(D) attract with a force F

2. The figure represents the variation of the electric potential V at a point in a region of space as a function of its position along the x-axis. A charged particle will experience the maximum force at :



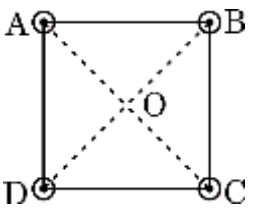
(A) P

(B) Q

(C) R

(D) S

3. किसी मेज पर रखे 'a' भुजा के एक वर्ग के चारों कोनों A, B, C एवं D पर चार लंबे, पतले ऋजुरेखीय तार ऊर्ध्वाधरत: खड़े किए गए हैं जिनमें से प्रत्येक में 'I' धारा प्रवाहित हो रही है। A पर स्थित तार में धारा की दिशा ऊपर की ओर है जबकि शेष तारों में धारा नीचे की ओर प्रवाहित होती है। वर्ग के केन्द्र पर नेट चुम्बकीय क्षेत्र का परिमाण होगा :



(A) $\frac{\mu_0 I}{\pi a}$ और यह OC के अनुदिश होगा

(B) $\frac{\mu_0 I}{\pi a \sqrt{2}}$ और यह OD के अनुदिश होगा

(C) $\frac{\mu_0 I \sqrt{2}}{\pi a}$ और यह OB के अनुदिश होगा

(D) $\frac{2 \mu_0 I}{\pi a}$ और यह OA के अनुदिश होगा

4. किसी चुम्बकीय क्षेत्र में रखे लूप से गुज़रने वाले चुम्बकीय फ्लक्स को परिवर्तित किया जा सकता है :

(A) केवल लूप का क्षेत्रफल बदल कर

(B) केवल चुम्बकीय क्षेत्र का मान बदल कर

(C) केवल चुम्बकीय क्षेत्र के सापेक्ष लूप का विन्यास बदल कर

(D) (A), (B) और (C) में दिए गए कारकों में से किसी एक या अधिक को बदल कर

5. वैद्युत ऊर्जा के dc (दिष्ट धारा) रूप की तुलना में ac (प्रत्यावर्ती धारा) रूप संबंधी निम्नलिखित में से कौन-सा कथन सत्य ***नहीं*** है ?

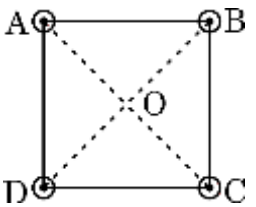
(A) ac जनन आर्थिक दृष्टि से अधिक लाभकारी है।

(B) ac वोल्टता स्तर को आसानी से और दक्षता के साथ ऊपर-नीचे किया जा सकता है।

(C) ac को मितव्ययिता के साथ सुदूर स्थानों तक संचारित किया जा सकता है।

(D) ac के उपयोग में कम जोखिम है।

3. Four long straight thin wires are held vertically at the corners A, B, C and D of a square of side 'a', kept on a table and carry equal current 'I'. The wire at A carries current in upward direction whereas the current in the remaining wires flows in downward direction. The net magnetic field at the centre of the square will have the magnitude :



(A) $\frac{\mu_0 I}{\pi a}$ and directed along OC

(B) $\frac{\mu_0 I}{\pi a \sqrt{2}}$ and directed along OD

(C) $\frac{\mu_0 I \sqrt{2}}{\pi a}$ and directed along OB

(D) $\frac{2 \mu_0 I}{\pi a}$ and directed along OA

4. The magnetic flux through a loop placed in a magnetic field can be changed by changing :

(A) area of the loop only

(B) the value of magnetic field only

(C) orientation of the loop in the magnetic field only

(D) any one or more of the factors given in (A), (B) and (C)

5. Which of the following statements is ***not*** true for electric energy in ac form compared to that in dc form ?

(A) Production of ac is economical.

(B) ac can be easily and efficiently converted from one voltage to the other.

(C) ac can be transmitted economically over long distances.

(D) ac is less dangerous.

6. काँच ($n = 1{\cdot}5$) में गमनकारी किसी समतल विद्युत-चुम्बकीय तरंग के चुम्बकीय क्षेत्र को

$$B_y = (2 \times 10^{-7}\ T) \sin (\alpha x + 1{\cdot}5 \times 10^{11}\ t)$$

द्वारा व्यक्त किया गया है

जहाँ x मीटर में है और t सेकंड में है। यहाँ α का मान है :

(A) $0{\cdot}5 \times 10^3\ m^{-1}$

(B) $6{\cdot}0 \times 10^2\ m^{-1}$

(C) $7{\cdot}5 \times 10^2\ m^{-1}$

(D) $1{\cdot}5 \times 10^3\ m^{-1}$

7. निम्नलिखित में से किस रंग के प्रकाश के फ़ोटॉन की ऊर्जा अधिकतम होगी ?

(A) लाल प्रकाश (B) पीला प्रकाश

(C) हरा प्रकाश (D) नीला प्रकाश

8. न्यूट्रॉनों की समान संख्या वाले न्यूक्लाइड कहलाते हैं :

(A) आइसोबार (B) आइसोटोन

(C) आइसोटोप (D) आइसोमर

9. द्रव्यमान संख्या 125 के एक नाभिक की त्रिज्या है :

(A) 6·0 fm

(B) 30 fm

(C) 72 fm

(D) 150 fm

10. हाइड्रोजन परमाणु की किसी कक्षा में इलेक्ट्रॉन की ऊर्जा – 3·4 eV है। इस कक्षा में इलेक्ट्रॉन का कोणीय संवेग होगा :

(A) $\frac{3h}{2\pi}$ (B) $\frac{2h}{\pi}$

(C) $\frac{h}{\pi}$ (D) $\frac{h}{2\pi}$

6. The magnetic field in a plane electromagnetic wave travelling in glass (n = 1·5) is given by

$$B_y = (2 \times 10^{-7}\ T) \sin (\alpha x + 1{\cdot}5 \times 10^{11}\ t)$$

where x is in metres and t is in seconds. The value of α is :

(A) $0{\cdot}5 \times 10^3\ m^{-1}$

(B) $6{\cdot}0 \times 10^2\ m^{-1}$

(C) $7{\cdot}5 \times 10^2\ m^{-1}$

(D) $1{\cdot}5 \times 10^3\ m^{-1}$

7. Light of which of the following colours will have the maximum energy in a photon associated with it ?

(A) Red light (B) Yellow light

(C) Green light (D) Blue light

8. Nuclides with the same number of neutrons are called :

(A) Isobars (B) Isotones

(C) Isotopes (D) Isomers

9. The radius of a nucleus of mass number 125 is

(A) 6·0 fm

(B) 30 fm

(C) 72 fm

(D) 150 fm

10. The energy of an electron in an orbit in hydrogen atom is – 3·4 eV. Its angular momentum in the orbit will be :

(A) $\frac{3h}{2\pi}$ (B) $\frac{2h}{\pi}$

(C) $\frac{h}{\pi}$ (D) $\frac{h}{2\pi}$

11. मल्टीमीटर से जाँचने पर एक अच्छी गुणवत्ता का डायोड दर्शाएगा :

(A) पश्चदिशिक बायस में उच्च प्रतिरोध और अग्रदिशिक बायस में निम्न प्रतिरोध

(B) अग्रदिशिक बायस और पश्चदिशिक बायस दोनों में ही उच्च प्रतिरोध

(C) पश्चदिशिक बायस और अग्रदिशिक बायस दोनों में ही निम्न प्रतिरोध

(D) अग्रदिशिक बायस में उच्च प्रतिरोध और पश्चदिशिक बायस में निम्न प्रतिरोध

12. $V = V_0 \sin \omega t$ वोल्ट द्वारा निरूपित ac वोल्टता के एक पूर्ण चक्र में वर्ग माध्य मूल तथा औसत मान होंगे, क्रमश: :

(A) $\frac{V_0}{2}, \frac{V_0}{\sqrt{2}}$ (B) $\frac{V_0}{\pi}, \frac{V_0}{2}$

(C) $\frac{V_0}{\sqrt{2}}, 0$ (D) $V_0, \frac{V_0}{\sqrt{2}}$

*प्रश्न संख्या **13** से **16** अभिकथन (A) और कारण (R) प्रकार के प्रश्न हैं। दो कथन दिए गए हैं – जिनमें एक को अभिकथन (A) तथा दूसरे को कारण (R) द्वारा अंकित किया गया है। सही उत्तर नीचे दिए गए कोडों (A), (B), (C) और (D) में से चुनकर दीजिए।*

(A) अभिकथन (A) और कारण (R) दोनों सही हैं और कारण (R), अभिकथन (A) की सही व्याख्या करता है।

(B) अभिकथन (A) और कारण (R) दोनों सही हैं, परन्तु कारण (R), अभिकथन (A) की सही व्याख्या ***नहीं*** करता है।

(C) अभिकथन (A) सही है, परन्तु कारण (R) ग़लत है।

(D) अभिकथन (A) और कारण (R) दोनों ग़लत हैं।

13. *अभिकथन (A)* : किसी कुंडली में उत्पन्न प्रेरित विद्युत वाहक बल (emf) अधिक होगा जब इससे संबद्ध चुम्बकीय फ्लक्स अधिक होगा।

कारण (R) : उत्पन्न प्रेरित विद्युत वाहक बल (emf) चुम्बकीय फ्लक्स के अनुक्रमानुपाती होता है।

11. A good diode checked by a multimeter should indicate :

(A) high resistance in reverse bias and a low resistance in forward bias

(B) high resistance in both forward bias and reverse bias

(C) low resistance in both reverse bias and forward bias

(D) high resistance in forward bias and low resistance in reverse bias

12. The rms and the average value of an ac voltage $V = V_0 \sin \omega t$ volt over a cycle respectively will be :

(A) $\frac{V_0}{2}, \frac{V_0}{\sqrt{2}}$ (B) $\frac{V_0}{\pi}, \frac{V_0}{2}$

(C) $\frac{V_0}{\sqrt{2}}, 0$ (D) $V_0, \frac{V_0}{\sqrt{2}}$

*Questions number **13** to **16** are Assertion (A) and Reason (R) type questions. Two statements are given — one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the codes (A), (B), (C) and (D) as given below.*

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is ***not*** the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Both Assertion (A) and Reason (R) are false.

13. *Assertion (A) :* Induced emf produced in a coil will be more when the magnetic flux linked with the coil is more.

Reason (R) : Induced emf produced is directly proportional to the magnetic flux.

14. *अभिकथन (A)* : यंग के द्विझिरी प्रयोग में, अदीप्त फ्रिंज की चौड़ाई उतनी ही होती है जितनी दीप्त फ्रिंज की होती है।

कारण (R) : फ्रिंज चौड़ाई को $\beta = \frac{\lambda D}{d}$ द्वारा व्यक्त किया जाता है, जहाँ प्रतीकों के अपने सामान्य अर्थ हैं।

15. *अभिकथन (A)* : जब भारी नाभिकों का विखंडन होता है या हल्के नाभिकों का संलयन होता है, तो ऊर्जा उत्सर्जित होती है।

कारण (R) : भारी नाभिकों में, परमाणु क्रमांक (Z) में वृद्धि के साथ बंधन ऊर्जा प्रति न्यूक्लिऑन बढ़ती है जबकि हल्के नाभिकों में, बंधन ऊर्जा प्रति न्यूक्लिऑन का मान परमाणु क्रमांक (Z) बढ़ने के साथ घटता है।

16. *अभिकथन (A)* : प्रकाश-विद्युत प्रभाव एक स्वत:प्रवर्तित परिघटना है।

कारण (R) : विकिरण के तरंग मॉडल के अनुसार, धातु के पृष्ठ से किसी इलेक्ट्रॉन को उस धातु के कार्य फलन से अधिक ऊर्जा अवशोषित करके निष्क्रमित होने में घंटों/दिनों का समय लगता है।

खण्ड ख

17. (क) किसी विद्युत इस्तरी पर इसकी मानक विशेषताएँ 2·2 kW, 220 V अंकित हैं। इसे 110 V आपूर्ति प्रदान कर उपयोग में लाया जाता है। ज्ञात कीजिए : *2*

(i) विद्युत इस्तरी का प्रतिरोध, तथा

(ii) 10 मिनट में इसके द्वारा उत्पन्न ऊष्मा।

अथवा

(ख) जब किसी 1 m लंबाई और 1·0 mm^2 अनुप्रस्थ-काट क्षेत्रफल के तार के सिरों के बीच 2 V का विभवांतर लगाया जाता है, तो इसमें 4·0 A की धारा प्रवाहित होती है।
तार के पदार्थ की प्रतिरोधकता का परिकलन कीजिए। *2*

14. *Assertion (A) :* In Young's double-slit experiment, the fringe width for dark and bright fringes is the same.

Reason (R) : Fringe width is given by $\beta = \frac{\lambda D}{d}$, where symbols have their usual meanings.

15. *Assertion (A) :* Energy is released when heavy nuclei undergo fission or light nuclei undergo fusion.

Reason (R) : For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei, it decreases with increasing Z.

16. *Assertion (A) :* Photoelectric effect is a spontaneous phenomenon.

Reason (R) : According to the wave picture of radiation, an electron would take hours/days to absorb sufficient energy to overcome the work function and come out from a metal surface.

SECTION B

17. (a) An electric iron rated 2·2 kW, 220 V is operated at 110 V supply. Find : *2*

(i) its resistance, and

(ii) heat produced by it in 10 minutes.

OR

(b) A current of 4·0 A flows through a wire of length 1 m and cross-sectional area 1·0 mm^2, when potential difference of 2 V is applied across its ends.

Calculate the resistivity of the material of the wire. *2*

18. एक समतल वृत्ताकार कुंडली को किसी एकसमान क्षैतिज चुम्बकीय क्षेत्र में इसके ऊर्ध्वाधर व्यास के परित: एक नियत कोणीय चाल ω से घुमाया जाता है। आरंभ में कुंडली का तल चुम्बकीय क्षेत्र के समांतर है। निम्नलिखित भौतिक राशियों में परिवर्तन को ωt के फलन के रूप में आलेखित कीजिए, जहाँ t व्यतीत हुए समय का द्योतक है :

(क) कुंडली से संबद्ध चुम्बकीय फ्लक्स ϕ, तथा

(ख) कुंडली में प्रेरित विद्युत वाहक बल (emf)। *2*

19. किसी कुंड में $12{\cdot}5$ m की ऊँचाई तक कोई द्रव भरा है। इसकी तली में पड़ी किसी सुई की आभासी गहराई $9{\cdot}0$ m मापी गई है। द्रव में प्रकाश की चाल का परिकलन कीजिए। *2*

20. f_1 एवं f_2 फोकस दूरी के दो पतले लेंस समाक्षीय रूप से एक-दूसरे के संपर्क में रखे गए हैं। सिद्ध कीजिए कि इस संयोजन की फोकस दूरी $f = \dfrac{f_1 f_2}{f_1 + f_2}$ होती है। *2*

21. माना कि किसी शुद्ध Si क्रिस्टल में 5×10^{28} परमाणु प्रति घन मीटर हैं। इसमें आर्सेनिक के 5×10^{22} परमाणु प्रति घन मीटर डोपित (मादित) किए गए हैं। डोपित सिलिकॉन में बहुसंख्यक एवं अल्पसंख्यक वाहक सांद्रता का परिकलन कीजिए। (दिया गया है : $n_i = 1{\cdot}5 \times 10^{16}\ m^{-3}$) *2*

खण्ड ग

22. दो समांतर प्लेट संधारित्रों X एवं Y को 6 V की एक बैटरी के साथ श्रेणीक्रम में जोड़ा गया है। इन दोनों की प्लेटों के क्षेत्रफल एवं उन प्लेटों के बीच दूरी समान हैं किंतु संधारित्र X की प्लेटों के बीच वायु है, जबकि संधारित्र Y की प्लेटों के बीच 4 परावैद्युतांक का पदार्थ है।

(क) यदि X एवं Y के संयोजन की तुल्य धारिता 4 μF हो, तो X एवं Y की धारिताओं का परिकलन कीजिए।

(ख) X तथा Y की प्लेटों के बीच विभवांतर का परिकलन कीजिए। *3*

23. सदिश रूप में किसी धारा अवयव के कारण उत्पन्न चुम्बकीय क्षेत्र का व्यंजक लिखिए। मूलबिंदु पर सममित रूप से विद्यमान किसी 1 cm लम्बाई के तार के अवयव में धनात्मक x-दिशा में 10 A की धारा प्रवाहित हो रही है। बिंदु (1 m, 1 m, 0) पर चुम्बकीय क्षेत्र $\vec{B}$ का परिकलन कीजिए। *3*

18. A plane circular coil is rotated about its vertical diameter with a constant angular speed ω in a uniform horizontal magnetic field. Initially the plane of the coil is parallel to the magnetic field. Draw plots showing the variation of the following physical quantities as the function of ωt, where t represents time elapsed :

(a) Magnetic flux ϕ linked with the coil, and

(b) emf induced in the coil. *2*

19. A tank is filled with a liquid to a height of 12·5 m. The apparent depth of a needle lying at the bottom of the tank is measured to be 9·0 m. Calculate the speed of light in the liquid. *2*

20. Two thin lenses of focal length f_1 and f_2 are placed in contact with each other coaxially. Prove that the focal length f of the combination is given by $f = \frac{f_1 f_2}{f_1 + f_2}$. *2*

21. Suppose a pure Si crystal has 5×10^{28} atoms per m^3. It is doped with 5×10^{22} atoms per m^3 of Arsenic. Calculate the majority and minority carrier concentration in the doped silicon. (Given : $n_i = 1{\cdot}5 \times 10^{16}\ m^{-3}$) *2*

SECTION C

22. Two parallel plate capacitors X and Y are connected in series to a 6 V battery. They have the same plate area and same plate separation but capacitor X has air between its plates, whereas capacitor Y contains a material of dielectric constant 4.

(a) Calculate the capacitances of X and Y, if the equivalent capacitance of the combination of X and Y is 4 μF.

(b) Calculate the potential difference across the plates of X and Y. *3*

23. Write the expression for the magnetic field due to a current element in vector form. Consider a 1 cm segment of a wire, centered at the origin, carrying a current of 10 A in positive x-direction. Calculate the magnetic field $\vec{B}$ at a point (1 m, 1 m, 0). *3*

24. L लम्बाई और r_1 त्रिज्या की किसी लम्बी परिनालिका में N_1 फेरे हैं। इसके मध्य-बिंदु के परित: सममित रूप से यह एक कुंडली से घिरी है जिसकी त्रिज्या r_2 ($> r_1$) है और जिसमें N_2 फेरे ($N_2 << N_1$) हैं। परिनालिका और कुंडली के अन्योन्य प्रेरकत्व के लिए व्यंजक व्युत्पन्न कीजिए। क्या इस प्रकरण में $M_{12} = M_{21}$ मान्य है ? *3*

25. विस्थापन धारा (i_d) क्या होती है ? किसी संधारित्र के आवेशन के संदर्भ में, दर्शाइए कि $i_d = \varepsilon_0 \frac{d\phi_E}{dt}$। यदि किसी चालक के सिरों के बीच एक नियत वोल्टता लगाई गई हो, तो इसके लिए i_d का मान क्या होगा ? *3*

26. (क) (i) नाभिकीय बलों के कोई दो लक्षण लिखिए।

(ii) यदि प्रत्येक नाभिकीय अभिक्रिया में प्रोटॉनों की संख्या तथा न्यूट्रॉनों की संख्या दोनों ही संरक्षित होती हैं, तो किसी नाभिकीय अभिक्रिया में द्रव्यमान ऊर्जा में (अथवा ऊर्जा द्रव्यमान में) किस प्रकार रूपांतरित होता है ? व्याख्या कीजिए। *3*

अथवा

(ख) (i) किसी पतली पर्णिका द्वारा ऐल्फा कणों के प्रकीर्णन के लिए प्रकीर्णित कणों की संख्या और प्रकीर्णन कोण के बीच ग्राफ बनाइए। इस ग्राफ के आधार पर निकाले गए दो महत्त्वपूर्ण निष्कर्ष लिखिए।

(ii) यदि बोर का क्वांटमीकरण अभिगृहीत (कोणीय संवेग = $\frac{nh}{2\pi}$) प्रकृति का आधारभूत नियम है, तो यह ग्रहीय गति के लिए भी समान रूप से मान्य होना चाहिए। तब हम कभी भी सूर्य के परित: ग्रहों की कक्षाओं के क्वांटमीकरण की बात क्यों नहीं करते ? व्याख्या कीजिए। *3*

27. जब किसी धातु ($\phi_0 = 1{\cdot}96$ eV) के पृष्ठ पर $6{\cdot}4 \times 10^{14}$ Hz आवृत्ति का प्रकाश आपतित किया जाता है, तो इससे इलेक्ट्रॉनों का प्रकाश-विद्युत उत्सर्जन होता है। परिकलन कीजिए : *3*

(क) आपतित प्रकाश में फ़ोटॉन की ऊर्जा,

(ख) उत्सर्जित इलेक्ट्रॉनों की अधिकतम गतिज ऊर्जा, तथा

(ग) निरोधी विभव।

28. p-n संधि डायोडों का उपयोग करके किसी पूर्ण-तरंग दिष्टकारी का परिपथ आरेख बनाइए। इसकी कार्यविधि समझाइए तथा निवेशी एवं निर्गम तरंगरूप दर्शाइए। *3*

24. A long solenoid of length L and radius r_1 having N_1 turns is surrounded symmetrically by a coil of radius r_2 ($> r_1$) having N_2 turns ($N_2 << N_1$) around its mid-point. Derive an expression for the mutual inductance of solenoid and coil. Is $M_{12} = M_{21}$ valid in this case ? *3*

25. What is displacement current (i_d) ? Considering the case of charging of a capacitor, show that $i_d = \varepsilon_0 \frac{d\phi_E}{dt}$. What is the value of i_d for a conductor across which a constant voltage is applied ? *3*

26. (a) (i) Write any two features of nuclear forces.

(ii) If both the number of protons and the neutrons are conserved in each nuclear reaction, in what way is mass converted into energy (or vice versa) in a nuclear reaction ? Explain. *3*

OR

(b) (i) Draw the number of scattered particles versus the scattering angle graph for scattering of alpha particles by a thin foil. Write two important conclusions that can be drawn from this plot.

(ii) If Bohr's quantization postulate (angular momentum = $\frac{nh}{2\pi}$) is a basic law of nature, it should be equally valid for the case of planetary motion also. Why, then, do we never speak of quantization of orbits of planets around the Sun ? Explain. *3*

27. Photoemission of electrons occurs from a metal (ϕ_0 = 1·96 eV) when light of frequency $6{\cdot}4 \times 10^{14}$ Hz is incident on it. Calculate : *3*

(a) Energy of a photon in the incident light,

(b) The maximum kinetic energy of the emitted electrons, and

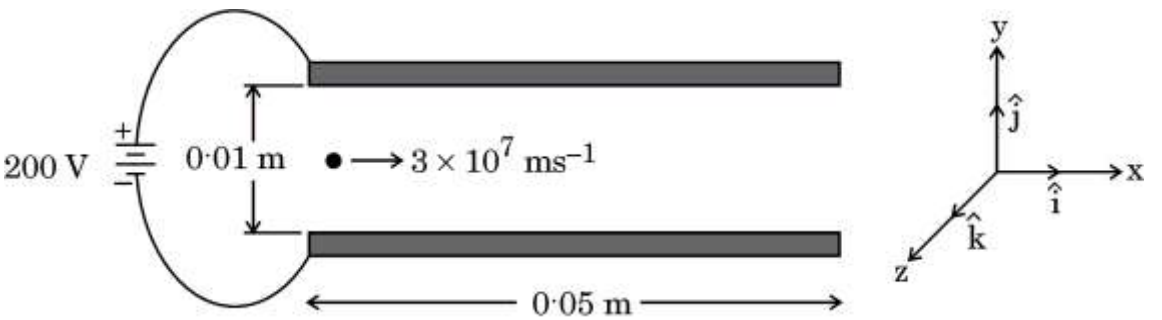
(c) The stopping potential.

28. Draw a circuit diagram of a full-wave rectifier using p-n junction diodes. Explain its working and show the input-output waveforms. *3*

खण्ड घ

*प्रश्न संख्या **29** तथा **30** केस अध्ययन-आधारित प्रश्न हैं। निम्नलिखित अनुच्छेदों को पढ़िए और उसके नीचे दिए गए प्रश्नों के उत्तर दीजिए।*

29. विद्युत विभव (V) एवं विद्युत क्षेत्र (E) स्थिर-विद्युतिकी की अत्यंत निकट रूप से संबद्ध संकल्पनाएँ हैं। विद्युत क्षेत्र एक सदिश राशि है जो आकाश में किसी दिए गए बिंदु पर रखे गए प्रति इकाई आवेश पर लगने वाले बल को निरूपित करता है, जबकि विद्युत विभव एक अदिश राशि है जो आकाश में किसी दिए गए बिंदु पर रखे गए प्रति इकाई आवेश की स्थितिज ऊर्जा को निरूपित करता है। विद्युत क्षेत्र और विद्युत विभव समीकरणों $E_r = \frac{-dV}{dr}$ एवं $\vec{E} = E_r \hat{r}$ द्वारा परस्पर संबंधित हैं, अर्थात्, विद्युत क्षेत्र विद्युत विभव की ऋणात्मक प्रवणता है। इसका तात्पर्य है कि विद्युत क्षेत्र घटते विभव की दिशा में इंगित करता है और इसका परिमाण दूरी के सापेक्ष विभव परिवर्तन की दर के बराबर होता है। विद्युत क्षेत्र वह बल है जिसके कारण एकांक आवेश उच्चतर विभव स्तर से निम्नतर विभव स्तर की ओर प्रचालित होते हैं तथा दो बिंदुओं के बीच विभवांतर इन दोनों बिंदुओं के बीच गतिशील एकांक आवेश द्वारा किए गए कार्य का निर्धारण करता है।

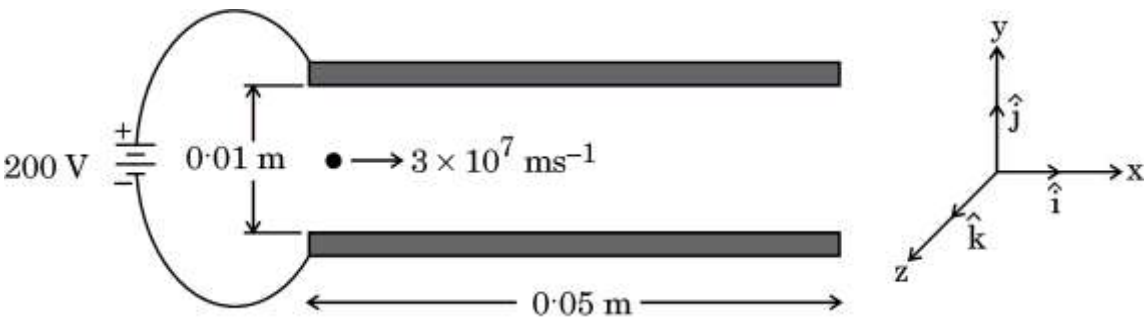


वर्गाकार चालक प्लेटों का एक युग्म जिनमें से प्रत्येक की भुजा 0·05 m लम्बाई की है, x-y तल में एक-दूसरे के समांतर रखा गया है। z-अक्ष के अनुदिश उनके बीच की दूरी 0·01 m है और उन्हें 200 V के एक विद्युत प्रदाय से जोड़ा गया है, जैसा चित्र में दर्शाया गया है। इन दोनों प्लेटों के बीच के स्थान में कोई इलेक्ट्रॉन क्षैतिजत: और सममित: 3×10^7 ms^{-1} की चाल से प्रवेश करता है। इलेक्ट्रॉन पर लगने वाले गुरुत्व प्रभाव की उपेक्षा की जा सकती है।

SECTION D

*Questions number **29** and **30** are Case Study-based questions. Read the following paragraphs and answer the questions that follow.*

29. The electric potential (V) and electric field (E) are closely related concepts in electrostatics. The electric field is a vector quantity that represents the force per unit charge at a given point in space, whereas electric potential is a scalar quantity that represents the potential energy per unit charge at a given point in space. Electric field and electric potential are related by the equations $E_r = \frac{-dV}{dr}$ and $\vec{E} = E_r \hat{r}$, i.e., electric field is the negative gradient of the electric potential. This means that electric field points in the direction of decreasing potential and its magnitude is the rate of change of potential with distance. The electric field is the force that drives a unit charge to move from higher potential region to lower potential region and electric potential difference between the two points determines the work done in moving a unit charge from one point to the other point.



A pair of square conducting plates having sides of length 0·05 m are arranged parallel to each other in x-y plane. They are 0·01 m apart along z-axis and are connected to a 200 V power supply as shown in the figure. An electron enters with a speed of 3×10^7 ms^{-1} horizontally and symmetrically in the space between the two plates. Neglect the effect of gravity on the electron.

(i) प्लेटों के बीच के क्षेत्र में विद्युत क्षेत्र $\vec{E}$ है : *1*

(A) $\left(2\times10^2\,\frac{V}{m}\right)\hat{k}$

(B) $-\left(2\times10^2\,\frac{V}{m}\right)\hat{k}$

(C) $\left(2\times10^4\,\frac{V}{m}\right)\hat{k}$

(D) $-\left(2\times10^4\,\frac{V}{m}\right)\hat{k}$

(ii) प्लेटों के बीच के क्षेत्र में, इलेक्ट्रॉन जिस त्वरण $\vec{a}$ से गति करता है, उसका मान है : *1*

(A) $-(3{\cdot}5\times10^{15}\ ms^{-2})\ \hat{k}$

(B) $(3{\cdot}5\times10^{15}\ ms^{-2})\ \hat{k}$

(C) $(3{\cdot}5\times10^{13}\ ms^{-2})\ \hat{i}$

(D) $-(3{\cdot}5\times10^{13}\ ms^{-2})\ \hat{i}$

(iii) (क) प्लेटों के बीच के क्षेत्र में चलने में इलेक्ट्रॉन द्वारा लिया गया समय अंतराल है : *1*

(A) $9{\cdot}0\times10^{-9}$ s (B) $1{\cdot}67\times10^{-8}$ s

(C) $1{\cdot}67\times10^{-9}$ s (D) $2{\cdot}17\times10^{-9}$ s

अथवा

(ख) प्लेटों के बीच के क्षेत्र में चलने में इलेक्ट्रॉन का ऊर्ध्वाधर विस्थापन है : *1*

(A) 10 mm (B) 4·9 mm

(C) 5·9 mm (D) 3·0 mm

(i) The electric field $\vec{E}$ in the region between the plates is : *1*

(A) $\left(2\times10^2\,\frac{V}{m}\right)\hat{k}$

(B) $-\left(2\times10^2\,\frac{V}{m}\right)\hat{k}$

(C) $\left(2\times10^4\,\frac{V}{m}\right)\hat{k}$

(D) $-\left(2\times10^4\,\frac{V}{m}\right)\hat{k}$

(ii) In the region between the plates, the electron moves with an acceleration $\vec{a}$ given by : *1*

(A) $-(3{\cdot}5\times10^{15}\ ms^{-2})\ \hat{k}$

(B) $(3{\cdot}5\times10^{15}\ ms^{-2})\ \hat{k}$

(C) $(3{\cdot}5\times10^{13}\ ms^{-2})\ \hat{i}$

(D) $-(3{\cdot}5\times10^{13}\ ms^{-2})\ \hat{i}$

(iii) (a) Time interval during which an electron moves through the region between the plates is : *1*

(A) $9{\cdot}0\times10^{-9}$ s (B) $1{\cdot}67\times10^{-8}$ s

(C) $1{\cdot}67\times10^{-9}$ s (D) $2{\cdot}17\times10^{-9}$ s

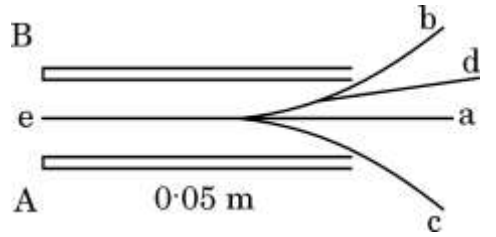
OR

(b) The vertical displacement of the electron which travels through the region between the plates is : *1*

(A) 10 mm (B) 4·9 mm

(C) 5·9 mm (D) 3·0 mm

(iv) दोनों प्लेटों के बीच इलेक्ट्रॉन द्वारा अनुरेखित पथ निम्नलिखित में से कौन-सा है ? *1*

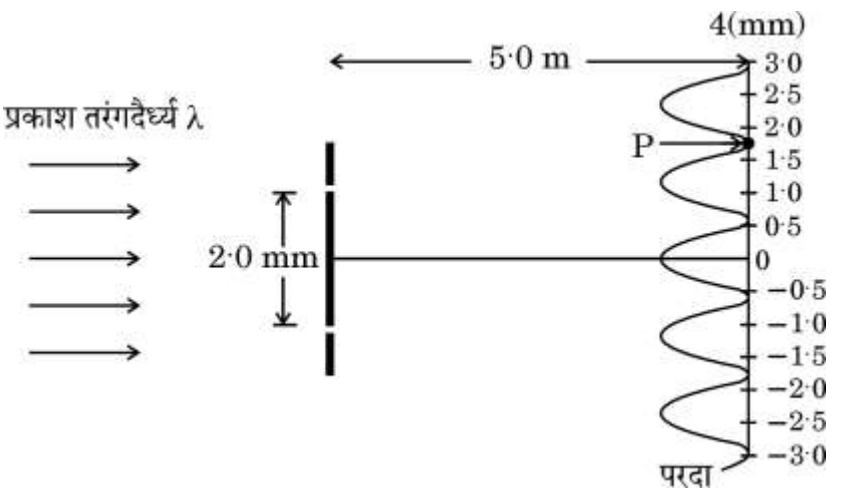


(A) a (B) b

(C) c (D) d

30. यंग के द्विझिरी प्रयोग में, प्रयुक्त दो झिरियाँ कला-संबद्ध स्रोतों की भाँति व्यवहार करती हैं । जब कला-संबद्ध प्रकाश तरंगें परस्पर अध्यारोपित होती हैं, तो वे संपोषी एवं विनाशी व्यतिकरण के कारण क्रमिक दीप्त एवं अदीप्त क्षेत्रों का व्यतिकरण पैटर्न निर्मित करती हैं।

एक-दूसरे से 2 mm की दूरी पर रखी गई दो झिरियों को किसी एकवर्णी प्रकाश स्रोत द्वारा प्रदीप्त किया गया है और व्यतिकरण पैटर्न झिरियों से 5·0 m दूर रखे परदे पर प्रेक्षित किया गया है, जैसा चित्र में दर्शाया गया है।



(i) यह व्यतिकरण प्रयोग प्रकाश के किस गुण को प्रदर्शित करता है ? *1*

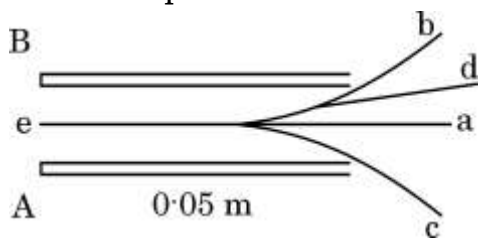
(A) प्रकाश की तरंग प्रकृति को

(B) प्रकाश की कण प्रकृति को

(C) प्रकाश की अनुप्रस्थ प्रकृति को

(D) प्रकाश की तरंग प्रकृति एवं अनुप्रस्थ प्रकृति दोनों को

(iv) Which one of the following is the path traced by the electron in between the two plates ? *1*

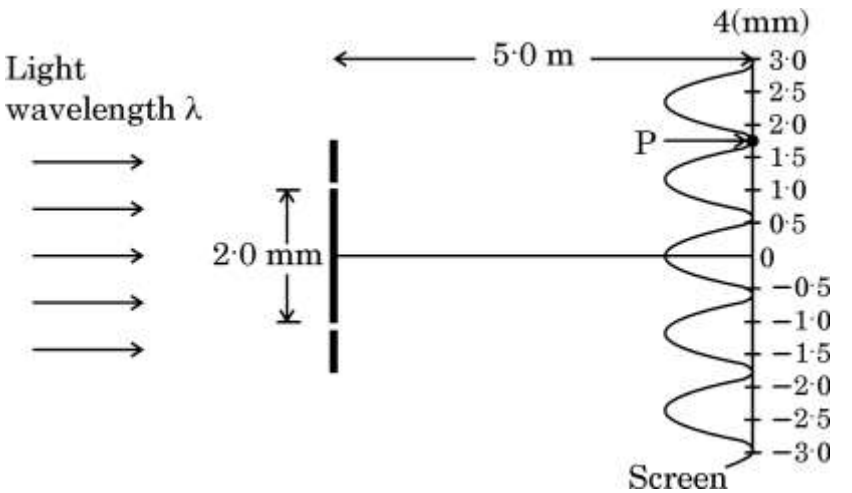


(A) a (B) b

(C) c (D) d

30. In a Young's double-slit experiment, the two slits behave as coherent sources. When coherent light waves superpose over each other they create an interference pattern of successive bright and dark regions due to constructive and destructive interference.

Two slits 2 mm apart are illuminated by a source of monochromatic light and the interference pattern is observed on a screen 5·0 m away from the slits as shown in the figure.



(i) What property of light does this interference experiment demonstrate ? *1*

(A) Wave nature of light

(B) Particle nature of light

(C) Transverse nature of light

(D) Both wave nature and transverse nature of light

(ii) (क) इस प्रयोग में प्रयुक्त प्रकाश का तरंगदैर्ध्य है : *1*

(A) 720 nm

(B) 590 nm

(C) 480 nm

(D) 364 nm

अथवा

(ख) परदे पर बने व्यतिकरण पैटर्न में फ्रिंज चौड़ाई है : *1*

(A) 1·2 mm

(B) 0·2 mm

(C) 4·2 mm

(D) 6·8 mm

(iii) बिन्दु P पर, जहाँ व्यतिकरण पैटर्न में एक निम्निष्ठ निर्मित होता है, दोनों व्यतिकरणकारी तरंगों के बीच पथांतर है : *1*

(A) $8{\cdot}1 \times 10^{-7}$ m

(B) $7{\cdot}2 \times 10^{-7}$ m

(C) $6{\cdot}5 \times 10^{-7}$ m

(D) $6{\cdot}0 \times 10^{-7}$ m

(iv) जब प्रयोग को एक ऐसे द्रव के भीतर निष्पादित किया जाता है जिसका अपवर्तनांक 1 से अधिक है, तो फ्रिंज पैटर्न : *1*

(A) लुप्त हो जाएगा

(B) धुँधला पड़ जाएगा

(C) की चौड़ाई बढ़ जाएगी

(D) सिकुड़ जाएगा

(ii) (a) The wavelength of light used in this experiment is : *1*

(A) 720 nm

(B) 590 nm

(C) 480 nm

(D) 364 nm

OR

(b) The fringe width in the interference pattern formed on the screen is : *1*

(A) 1·2 mm

(B) 0·2 mm

(C) 4·2 mm

(D) 6·8 mm

(iii) The path difference between the two waves meeting at point P, where there is a minimum in the interference pattern is : *1*

(A) $8{\cdot}1 \times 10^{-7}$ m

(B) $7{\cdot}2 \times 10^{-7}$ m

(C) $6{\cdot}5 \times 10^{-7}$ m

(D) $6{\cdot}0 \times 10^{-7}$ m

(iv) When the experiment is performed in a liquid of refractive index greater than 1, then fringe pattern will : *1*

(A) disappear

(B) become blurred

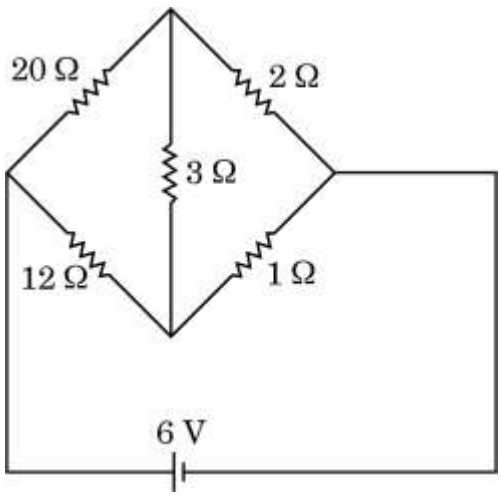
(C) be widened

(D) be compressed

खण्ड ङ

31. (क) (i) व्हीटस्टोन सेतु के संतुलन का अनुबंध व्युत्पन्न कीजिए।

(ii) चित्र में दर्शाए गए परिपथ में व्हीटस्टोन सेतु की 3 Ω शाखा में धारा ज्ञात कीजिए। *5*



अथवा

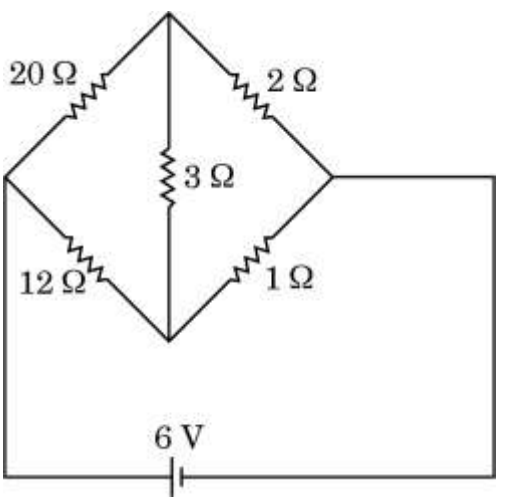
(ख) (i) l लम्बाई और A अनुप्रस्थ-काट क्षेत्रफल का एक बेलनाकार चालक है। चालक में I धारा स्तर बनाकर रखा जाता है और इलेक्ट्रॉन वेग v_d ($|\vec{v}_d| = \frac{e|\vec{E}|}{m}\tau$) से अपवाहित होते हैं, (जहाँ प्रतीकों के अपने सामान्य अर्थ हैं)। दर्शाइए कि चालक के पदार्थ की चालकता $\sigma = \frac{ne^2}{m}\tau$ है।

(ii) किसी धातु के तार का प्रतिरोध 20°C पर 1·05 Ω है और 100°C पर 1·38 Ω है। इस धातु का ताप प्रतिरोधकता गुणांक ज्ञात कीजिए। *5*

SECTION E

31. (a) (i) Derive the condition for which a Wheatstone Bridge is balanced.

(ii) Determine the current in 3 Ω branch of a Wheatstone Bridge in the circuit shown in the figure. *5*



OR

(b) (i) Consider a cylindrical conductor of length l and area of cross-section A. Current I is maintained in the conductor and electrons drift with velocity v_d ($|\vec{v}_d| = \frac{e|\vec{E}|}{m}\tau$), (where symbols have their usual meanings). Show that the conductivity σ of the material of the conductor is given by $\sigma = \frac{ne^2}{m}\tau$.

(ii) The resistance of a metal wire at 20°C is 1·05 Ω and at 100°C is 1·38 Ω. Determine the temperature coefficient of resistivity of this metal. *5*

32. (क) (i) कोई आयताकार लूप जिसकी भुजाओं की लम्बाई a एवं चौड़ाई b है और जिसमें धारा I प्रवाहित हो रही है किसी चुम्बकीय क्षेत्र $\vec{B}$ में इस प्रकार रखा है कि इसका क्षेत्र सदिश $\vec{A}$ क्षेत्र $\vec{B}$ की दिशा से θ कोण बनाता है। एक उपयुक्त आरेख की सहायता से, दर्शाइए कि लूप पर लगने वाला बल-आघूर्ण, $\vec{\tau} = \vec{m} \times \vec{B}$ होता है, जहाँ $\vec{m}$ $(= I \vec{A})$ लूप का चुम्बकीय द्विध्रुव आघूर्ण है।

(ii) 100 फेरों एवं $\left(\frac{10}{\sqrt{\pi}}\right)$ cm त्रिज्या की एक वृत्ताकार कुंडली जिसमें 5·0 A की धारा प्रवाहित हो रही है, 2·0 T के किसी एकसमान क्षैतिज चुम्बकीय क्षेत्र में ऊर्ध्वाधरत: लटकी हुई है। क्षेत्र की दिशा कुंडली के समतल पृष्ठ पर खींचे गए अभिलंब से 30° का कोण बनाती है। परिकलन कीजिए :

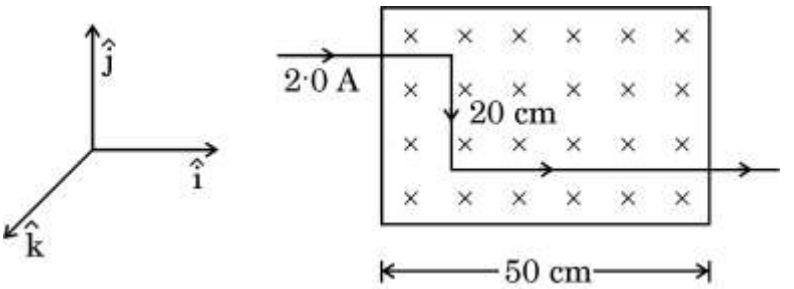
(I) कुंडली का चुम्बकीय द्विध्रुव आघूर्ण, एवं

(II) उस प्रतिकारक बल-आघूर्ण का परिमाण जो कुंडली को घूमने से रोकने के लिए इस पर लगाने की आवश्यकता हो। *5*

अथवा

(ख) (i) लम्बाई L तथा अनुप्रस्थ-काट क्षेत्रफल A वाले एक चालक पर लगने वाले बल $\vec{F}$ के लिए व्यंजक व्युत्पन्न कीजिए, जिसमें धारा I प्रवाहित हो रही है और जिसे चुम्बकीय क्षेत्र $\vec{B}$ में रखा गया है।

(ii) कोई तार है जिसमें 2·0 A धारा प्रवाहित हो रही है, इसके एक भाग को दो बार 90° पर मोड़कर $\vec{B} = -(0{\cdot}50\ T)\ \hat{k}$ के एकसमान चुम्बकीय क्षेत्र में रखा गया है, जैसा चित्र में दर्शाया गया है। तार पर लगने वाले नेट बल के परिमाण का परिकलन कीजिए। *5*



32. (a) (i) A rectangular loop of sides a and b carrying current I is placed in a magnetic field $\vec{B}$ such that its area vector $\vec{A}$ makes an angle θ with $\vec{B}$. With the help of a suitable diagram, show that the torque $\vec{\tau}$ acting on the loop is given by $\vec{\tau} = \vec{m} \times \vec{B}$, where $\vec{m}$ $(= I \vec{A})$ is the magnetic dipole moment of the loop.

(ii) A circular coil of 100 turns and radius $\left(\frac{10}{\sqrt{\pi}}\right)$ cm carrying current of 5·0 A is suspended vertically in a uniform horizontal magnetic field of 2·0 T. The field makes an angle 30° with the normal to the coil. Calculate :

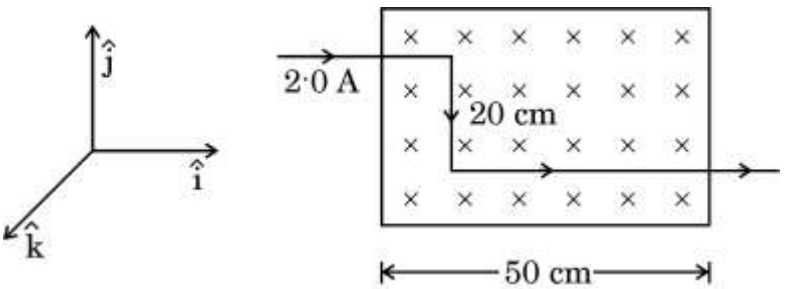
(I) the magnetic dipole moment of the coil, and

(II) the magnitude of the counter torque that must be applied to prevent the coil from turning. *5*

OR

(b) (i) Derive an expression for the force $\vec{F}$ acting on a conductor of length L and area of cross-section A carrying current I and placed in a magnetic field $\vec{B}$.

(ii) A part of a wire carrying 2·0 A current and bent at 90° at two points is placed in a region of uniform magnetic field $\vec{B} = -(0{\cdot}50\ T)\ \hat{k}$, as shown in the figure. Calculate the magnitude of the net force acting on the wire. *5*



33. (क) (i) एकवर्णी प्रकाश का एक समांतर किरण-पुंज 'a' चौड़ाई की एकल झिरी पर अभिलंबवत् आपतित है और विवर्तन पैटर्न को झिरियों से D दूरी पर रखे परदे पर प्रेक्षित किया जाता है। व्याख्या कीजिए :

(I) विवर्तन पैटर्न में उच्चिष्ठों एवं निम्निष्ठों का बनना, तथा

(II) उच्चिष्ठों की संख्या (n) में वृद्धि के साथ यह अधिकाधिक दुर्बल क्यों होता जाता है।

(ii) द्विझिरी से बने व्यतिकरण पैटर्न एवं एकल-झिरी से बने विवर्तन पैटर्न के बीच अंतर के कोई दो बिन्दु लिखिए। *5*

अथवा

(ख) (i) एक किरण आरेख की सहायता से, संयुक्त सूक्ष्मदर्शी की संरचना एवं कार्यविधि का वर्णन कीजिए।

(ii) (I) किसी उत्तल लेंस के सामने f एवं 2f के बीच रखे किसी बिंब का वास्तविक प्रतिबिंब, प्रतिबिंब की अवस्थिति पर रखे गए एक परदे पर देखा जा सकता है। यदि परदा हटा दें, तो क्या उस अवस्थिति में अभी भी प्रतिबिंब विद्यमान है ? व्याख्या कीजिए।

(II) समतल एवं उत्तल दर्पण बिंब के आभासी प्रतिबिंब बनाते हैं। क्या कुछ परिस्थितियों में इनसे वास्तविक प्रतिबिंब भी बनाए जा सकते हैं ? व्याख्या कीजिए। *5*

33. (a) (i) A parallel beam of monochromatic light falls normally on a single slit of width 'a' and a diffraction pattern is observed on a screen placed at distance D from the slits. Explain :

(I) the formation of maxima and minima in the diffraction pattern, and

(II) why the maxima go on becoming weaker and weaker with its increasing number (n).

(ii) Write any two points of difference between interference pattern due to double-slit and diffraction pattern due to single-slit. *5*

OR

(b) (i) With the help of a ray diagram, describe the construction and working of a compound microscope.

(ii) (I) The real image of an object placed between f and 2f from a convex lens can be seen on a screen placed at the image location. If the screen is removed, is the image still there ? Explain.

(II) Plane and convex mirrors produce virtual images of objects. Can they produce real images under some circumstances ? Explain. *5*

PHYSICS (042)
CODE: 55/5/1

SECTION-A 4
1 4
2 4
3 4
4 4
5 4
6 4
7 4
8 4
9 4
10 4
11 4
12 4
13 4
14 4
15 4
16 4
SECTION-B 5
17 5
18 6
19 7
20 7
21 8
SECTION-C 8
22 8
23 9
24 10
25 12
26 12
27 13
28 14
SECTION-D 15
29 15
30 15
SECTION-E 16
31 16
32 19
33 22

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior Secondary School Examination, 2026 (XIIth)
SUBJECT NAME : PHYSICS (Q.P. CODE : 042-55/5/1)

HOME

General Instructions: -

1	The CBSE has decided to introduce On Screen Marking (OSM) for the evaluation of Class XII answer Book with the 2026 Examination.
2	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
3	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, evaluation done and several other aspects. Its leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in Newspaper/Website, etc. may invite action under various rules of the Board and IPC."**
4	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In Class-XII, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
5	The Marking scheme carries only suggested value points for the answers. These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
6	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after deliberation and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
7	Evaluators will mark (√) wherever answer is correct. For wrong answer CROSS 'X' be marked. Evaluators will not put right (✓) while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
8	If a question has parts, please award marks on the right-hand side for each part in the OSM Portal. Marks awarded for different parts of the question will be totaled up by the OSM System.
9	If a question does not have any parts, marks must be awarded in the left-hand margin in the OSM Portal. This may also be followed strictly.

HOME

HOME

10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0 to 70 (example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past :- • Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) • Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0) Marks.
15	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for Spot Evaluation**" before starting the actual evaluation.
16	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.
17	**If a candidate attempts both alternatives/options in a question where only one option/ alternative is required to be attempted, the Evaluator shall award marks in both the options. The system will take the higher of two scores and disregard the other response.**
18	**In a question having two options/alternatives, if a candidate has attempted only one, then the evaluator shall mark "NA" (Not attempted) against the option that has not been attempted by the candidate.**

HOME

HOME

HOME

MARKING SCHEME: PHYSICS (042)

Session: 2025–26

HOME

Code: 55/5/1

Q. No.	VALUE POINTS/EXPECTED ANSWERS	Marks	Total Marks
	SECTION A		
1	(B) repel with a force F/2	1	1
2	(D) S	1	1
3	(C) $\frac{\mu_0 I}{\pi a}\sqrt{2}$ and directed along OB	1	1
4	(D) any one or more of the factors given in option (A), (B) and (C)	1	1
5	(D) ac is less dangerous	1	1
6	(C) 7.5×10^2 m^{-1}	1	1
7	(D) Blue light	1	1
8	(B) Isotone	1	1
9	(A) 6.0 fm(**Note. Award full marks for Attempt)**	1	1
10	(C) $\frac{h}{\pi}$	1	1
11	(A) high resistance in reverse bias and low resistance in forward bias	1	1
12	(C) $\frac{V_0}{\sqrt{2}}, 0$	1	1
13	(D) Both Assertion(A) and reason (R) are false.	1	1
14	(A) Both Assertion(A) and reason (R) are true, reason (R) is the correct explanation of the assertion(A).	1	1
15	(C) Assertion(A) is true, but reason(R) is false.	1	1
16	(B) Both Assertion(A) and reason (R) are true, but reason (R) is not the correct explanation of the assertion(A).	1	1

HOME

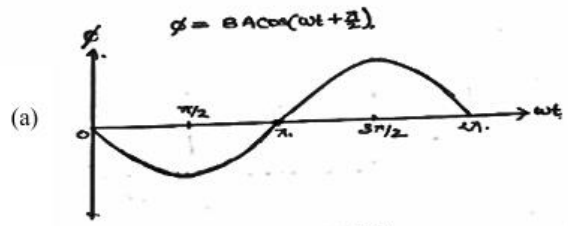
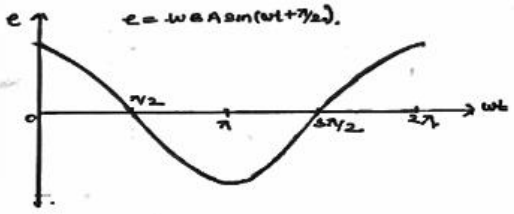
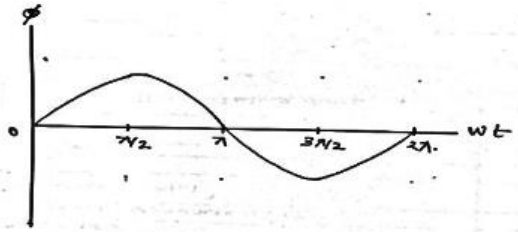
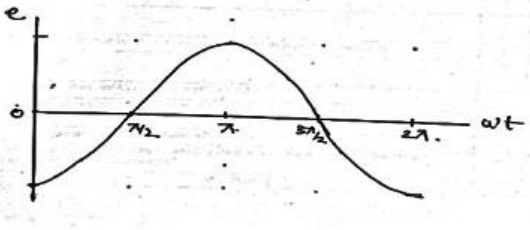
HOME

HOME

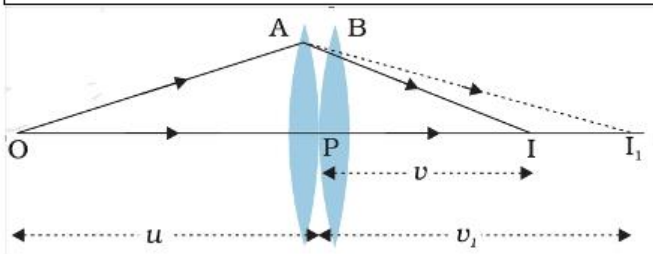
	SECTION B		
17.	(a) Calculating (i) Resistance ½ (ii) heat produced in 10 min. 1 ½		
	(i) $R=\frac{V^2}{P}$		
	$=\frac{(220)^2}{2.2 \times 10^3}=22\Omega$	½	
	(ii) $H = I^2 R t$	½	
	$I=\frac{V_{applied}}{R}=\frac{110}{22}=5A$	½	
	$=5 \times 5 \times 22 \times 600$		
	$=3.3\times10^5 J$	½	
	OR		
	(b) Calculating the resistivity of the wire. 2		
	$\rho=\frac{RA}{l}$	½	
	$R=\frac{V}{I}=\frac{2}{4}=\frac{1}{2}\Omega$	½	
	$\rho=\frac{1\times10^{-6}}{2\times1}$	½	
	$=5 \times 10^{-7}\Omega$ m	½	
			2

HOME

HOME

18.	Drawing plot showing variation of a. magnetic flux linked with a coil. 1 b. emf induced in the coil as a function of ωt. 1 (a)  (b)  Alternatively, (a)  (b)  **Note: Award full marks even if formula is not written by student.**	1 1 2	

HOME HOME HOME

19.	Calculating the speed of light in liquid. 2 $n = \frac{\text{speed of light in vacuum(c)}}{\text{speed of light in medium(v)}}$ ..... (i) $n = \frac{\text{real depth}}{\text{apparent depth}}$ $n = \frac{12.5}{9}$ .....(ii) From (i) and (ii) $v = \frac{3 \times 10^8 \times 9}{12.5}$ $= 2.16 \times 10^8$ m/s	½ ½ ½ ½	2
20.	Proving the focal length of combination is $f = \frac{f_1 f_2}{f_1 + f_2}$ 2  For the image formed by lens A $\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f_1}$ .....(i) For the image formed by second lens B $\frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_2}$ .....(ii) Adding (i)and(ii) $\frac{1}{v} - \frac{1}{u} = \frac{1}{f_2} + \frac{1}{f_1}$ $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ $f = \frac{f_1 f_2}{f_1 + f_2}$	½ ½ ½ ½	2

21.

Calculating:
Majority carrier concentration ½
Minority carrier concentration 1 ½

Majority carrier concentration = Doping concentration

∴ Majority carrier concentration (n_e)=5 x10^{22} atoms per m^3 ½

$$n_i^2 = n_e n_h$$ ½

$$n_h = \frac{n_i^2}{n_e}$$

$$n_h = \frac{(1.5 \times 10^{16})^2}{5 \times 10^{22}}$$ ½

$=4.5 \times 10^9$ atoms per m^3

Minority carrier concentration = 4.5×10^9 atoms per m^3 ½

2

SECTION C

22.

(a) Calculating the capacitance of X &Y. 1½

(b) Calculating the potential difference across plates of X & Y 1½

(a) $C_X = C$, $C_Y = KC = 4C$

$$\frac{1}{C_{eq}} = \frac{1}{C_X} + \frac{1}{C_Y}$$ ½

$$C_{eq} = \frac{C_X C_Y}{C_X + C_Y}$$

$$4 = \frac{C.4C}{C + 4C}$$

C=5μF ½

C_X =5μF ½

C_Y =20μF

(b) Total charge Q=C_{eq} V

$=4 \times 10^{-6} \times 6$ ½

$=24 \times 10^{-6}$ C

HOME

.	$V_X = \frac{Q}{C_X} = \frac{24 \times 10^{-6}}{5 \times 10^{-6}}$ $= 4.8$ V $V_Y = \frac{Q}{C_Y} = \frac{24 \times 10^{-6}}{20 \times 10^{-6}}$ $= 1.2$ V Alternatively, $V_Y = V - V_X$ $= 6 - 4.8V$ $= 1.2V$	½ ½	3
23.	Writing the expression for magnetic field in vector form. 1 Calculating magnetic field $\vec{B}$ at a given point. 2 **Magnetic field due to a current element (d*l*) at a distance r,** $d\vec{B} = \frac{\mu_0}{4\pi} \frac{I(\vec{dl} \times \vec{r})}{r^3}$ $dB = \frac{\mu_0 i\, dl\, sin\theta}{4\pi r^2}$ $r = \sqrt{2}$ m $dB = 10^{-7} \times \frac{10\ X\ 10^{-2}\ sin45^\circ}{2}$ $dB = 3.53 \times 10^{-9}\ T$ **Direction** : along +ve Z-axis	1 ½ ½ ½ ½	3

Alternatively

$\vec{r} = (\hat{i} + j)m$, r = $\sqrt{2}$ m

$\vec{dl} = 10^{-2} m$

$|\vec{Idl}| = 10 \times 10^{-2}$ i Am

$\vec{dB} = \frac{\mu_0 I(\vec{dl} \times \vec{r})}{4\pi r^3}$

$= \frac{4\pi \times 10^{-7}}{4\pi} \times \frac{10[(10^{-2})\hat{i} \times (\hat{i} + j)]}{(\sqrt{2})^3}$

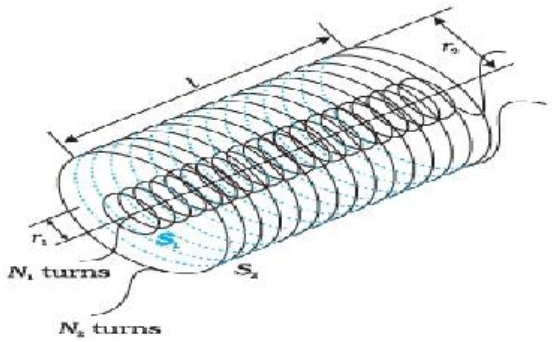
$= \frac{10^{-7}}{2\sqrt{2}}(0.1)(0 + k)$

$= \frac{5}{\sqrt{2}} \times 10^{-9} k$

$\vec{dB} = 3.53 \times 10^{-9} k$ T

24.

Deriving the expression for mutual inductance of solenoid and coil.	2
Validating $M_{12}=M_{21}$	1



HOME

Let n_1 and n_2 be the total no. of turns per unit length of solenoid S_1 and coil S_2 respectively

$N_1 = n_1 L, \quad N_2 = n_2 L$

When current I_2 is set up in S_2, flux linkage with S_1 is:

$N_1\phi_1 = N_1 A_1 B_2$ .....(i) ½

$N_1\phi_1 = (n_1 L)(\pi r_1^2)(\mu_o n_2 I_2)$

$N_1\phi_1 = (\mu_o n_1 n_2 \pi r_1^2 L I_2)$ .....(ii) ½

$N_1\phi_1 = M_{12} I_2$ .....(iii) ½

From (ii) and (iii)

$M_{12} = (\mu_o n_1 n_2 \pi r_1^2 L)$ ½

Considering the reverse case, when I_1 current is set up in S_1, flux linkage with S_2, is

$N_2\emptyset_2 = N_2 A_1 B_1$ ..... (iv)

$N_2\phi_2 = (n_2 L)(\pi r_1^2)(\mu_o n_1 I_1)$ .....(v)

$N_2\phi_2 = M_{21} I_1$.....(vi)

From (v) and (vi)

$M_{21} = (\mu_o n_1 n_2 \pi r_1^2 L)$ ½

Therefore, $M_{12} = M_{21}$ ½

Alternatively,

$$M_{12} = M_{21} = \frac{(\mu_o N_1 N_2 \pi r_1^2)}{L}$$

3

HOME

25.

Defining displacement current.	1
Showing $i_d = \varepsilon_0 \frac{d\phi_e}{dt}$	1½
Writing value of i_d when constant voltage is applied.	½

Displacement current arises due to time varying electric field and hence the time varying electric flux in a region. — 1

The plates of the capacitor have an area A & a total charge Q, the magnitude of electric field between the plates: — ½

$$E=\frac{Q/A}{\varepsilon_0}. \quad .....(i)$$

$$\phi_e = EA \quad .....(ii)$$

Substituting (i) in (ii) — ½

$$\phi_e = \frac{Q}{\varepsilon_0}$$

$$\frac{d\phi_e}{dt} = \frac{d}{dt}\left(\frac{Q}{\varepsilon_0}\right) = \frac{1}{\varepsilon_0}\frac{dQ}{dt}$$

$$\varepsilon_0 \frac{d\phi_e}{dt} = \frac{dQ}{dt}. \quad .....(iii)$$

If charge Q changes with time, the current i_d

$$i_d = \frac{dQ}{dt}$$

From eq. (iii) and (iv) — ½

$$i_d = \varepsilon_0 \frac{d\phi_e}{dt}$$

For constant voltage E = constant, so $\phi_e = 0$ — ½

$\therefore i_d = 0$ — 3

HOME

26. (a)

(i)Writing two features of nuclear force.	2
(ii)Explaining how mass converted into energy. (or vice versa) in a nuclear reaction	1

(i) Features of Nuclear force: — 1+1

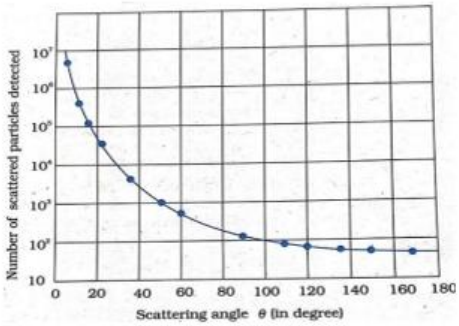
1) charge independent
2) strongest force.
3) short-range force /saturated force
4) does not follow inverse square law.

Note: Award full marks for any two valid points.

(ii) The total mass of the nuclei on the left-hand side need not be same as that on right hand side of nuclear reaction. Since Binding energy contributes to mass, the difference in these binding energies appear as energy released or absorbed in a nuclear reaction. — 1

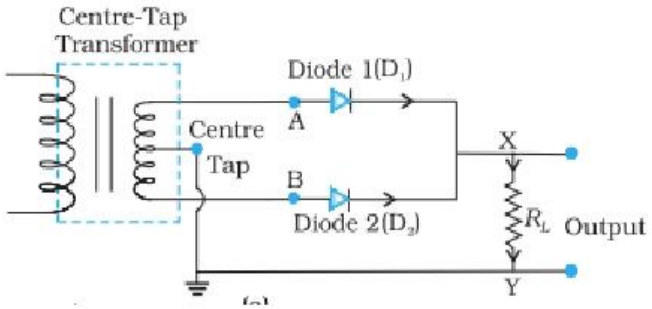
3

HOME

	OR (b) (i) Drawing the graph between scattered particles & scattering angle. 1 Writing two important conclusions. 1 (ii) Explaining invalidity for Bohr Quantisation postulate for planetary motion. 1 (i)  **Important conclusions:** 1.Most of the space in the atom is empty. 2. Most part of mass of atom and its positive charge were tightly concentrated at its centre. **Note: No marks to be deducted for scale on the axis** (ii) According to Bohr Quantisation postulate $L=mvr = nh/2\pi$ Since mass of planets is very large as compared to mass of atomic particles, angular momentum (L) will be very large. Therefore, Principal quantum number (n) will be very large. For large quantum number. the difference in successive energy levels will be negligible. Hence quantization fails.	1 1 1	3
27	Calculating a) Energy of a photon in the incident light. 1 b) Maximum kinetic energy emitted. 1 c) Stopping potential. 1 (a) $E= h\nu$ $=\frac{6.626 \times 10^{-34} \times 6.4 \times 10^{14}}{1.6 \times 10^{-19}}$ $=2.64eV$ or $42.24 \times 10^{-20} J$ (b) $K_{max}=E- \phi_0$ $=2.64-1.96=0.68eV$ or $(10.88 \times 10^{-20} J)$ (c) $eV_0= K_{max}$ $V_0= K_{max}/e$ $=0.68V$	½ ½ ½ ½ ½ ½	3

28.

Drawing a circuit diagram.	1
Explaining its working	1
Showing the input and output waveforms	1



1

Working:

Suppose the input voltage to A w.r.t centre top at any instant is positive.

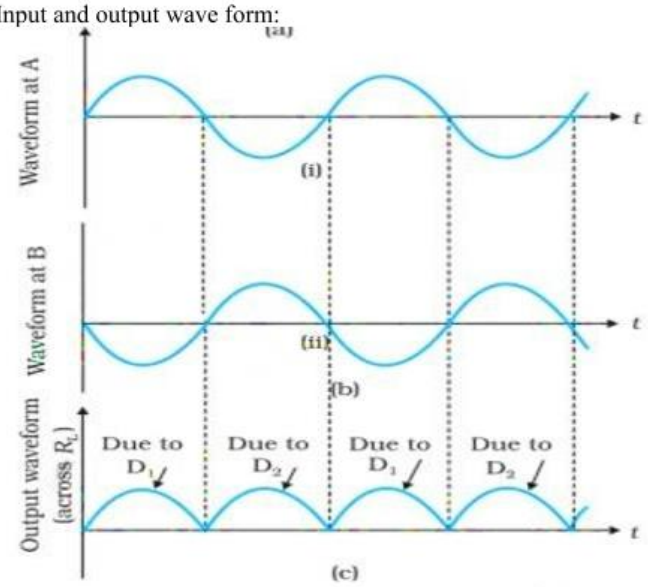
At that instant voltage at B being out of phase will be negative.

So, diode D_1 gets forward biased and conducts while D_2 being reverse biased is not conducting. Hence, during this positive half cycle we get an output current and output voltage across the load.

1

When the voltage at A becomes negative w.r.t centre top, the voltage at B would be positive, the diode D_1, would not conduct but D_2 conduct and giving an output current and voltage across the load.

Input and output wave form:



½

½

3

	Section D		
29.	(i) (D) (-2 x10^4 V/m) $\hat{k}$	1	HOME
	(ii) (B) (3.5 x10^{15} m/s^2) $\hat{k}$	1	
	(iii) (a) (C) 1.67x 10^{-9}s	1	
	OR		
	(b). (B) 4.9mm		
	(iv) (B) b	1	
			4
30.	(i) (A) wave nature of light.	1	
	(ii) (a). (C) 480 nm	1	
	OR		
	(b) (A) 1.2mm		HOME
	(iii) (B) 7.2 x10^{-7} m	1	
	(iv) (D) be compressed	1	
			4

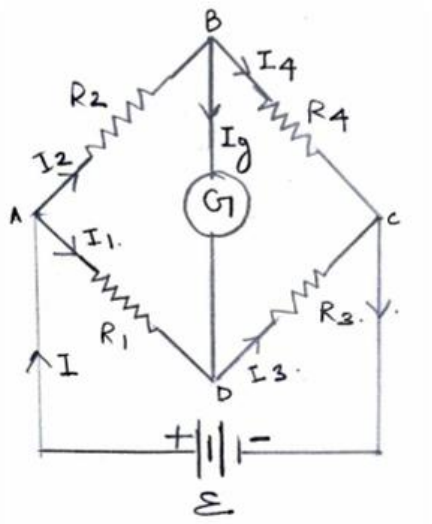
HOME

Section E

31 **a.**

(i) Deriving the condition for balanced wheat stone bridge.	2 ½
(ii) Determining the current in 3Ω branch.	2 ½

(i)



½

Applying Kirchoff's rule to closed loop ADBA.
For balanced condition Ig=0.

$-I_1R_1 + 0 + I_2R_2 = 0$ .....(i) ½

Applying Kirchoff's rule to closed loop CBDC using $I_3 = I_1$, $I_4 = I_2$

$I_2R_4 + 0 - I_1R_3 = 0$ .....(ii) ½

From eq.(i).

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$

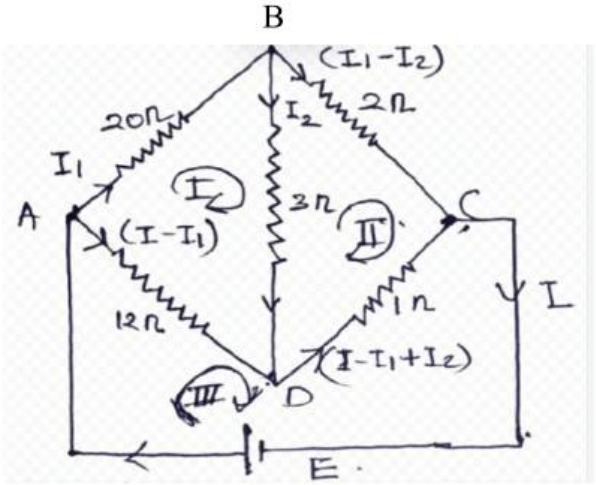
and from eq.(ii)

$$\frac{I_1}{I_2} = \frac{R_4}{R_3}$$ ½

hence $\frac{R_2}{R_1} = \frac{R_4}{R_3}$ ½

HOME HOME HOME

(ii)



½

Applying Kirchoff's rule to loop I (ABDA)

$-20\ I_1 - 3\ I_2 + 12\ (I-I_1)=0$ .....(i) ½

Applying Kirchoff's rule to loop II (BCDB)

$-2\ (I_1-I_2)+ 1(I-I_1+I_2) +3I_2=0$ .....(ii) ½

Applying Kirchoff's rule loop III (EADCE)

$-12\ (I-I_1)-1\ (I-I_1+I_2)= -6$ .....(iii) ½

After solving eq. (i), (ii),(iii)…

$I_2= 12/821 \approx 0.014A$ ½

Note: Award full marks if student takes another appropriate current distribution in the circuit.

5

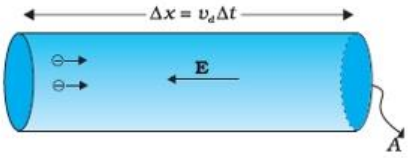
HOME

OR

(b)

(i). Showing the conductivity of material. $\sigma = ne^2\tau / m$	3
(ii). Determining the temperature coefficient of resistivity.	2

(i)



The amount of charge crossing the area in time Δt is

$Q = Ne$

$Q = (nAl)e$

$I = \frac{Q}{\Delta t}$

$I = \frac{nAle}{\Delta t}$

$I = nAe|\vec{v}_d|$ .....(i) 1

Substituting the value of $|\vec{v}_d|$ in eq.(i)

$$\frac{I}{A} = ne\left(\frac{e|\vec{E}|\tau}{m}\right) \quad \text{½}$$

$$|\vec{J}| = \frac{ne^2\tau|\vec{E}|}{m} \quad \text{.....(ii)} \quad \text{½}$$

where $\vec{J}$ is current density and parallel to $\vec{E}$, and

$\vec{J} = \sigma\vec{E}$ .....(iii) ½

From eq.(ii) and (iii) ½

$\sigma = ne^2\tau/m$

(ii)

$$\alpha = \frac{(R_2 - R_1)}{[R_1(T_2 - T_1)]} \quad \text{½}$$

$$\alpha = \frac{(1.38 - 1.05)}{[1.05 \times (100 - 20)]} \quad \text{½}$$

$$\alpha = \frac{0.33}{(1.05 \times 80)} \quad \text{½}$$

$= 0.0039\ ^\circ C^{-1}$ ½ 5

Alternatively

$R_1 = R_0(1+\alpha\,\Delta T_1)$ .....(i)

$R_2 = R_0(1+\alpha\,\Delta T_2)$.....(ii)

$$\frac{R_1}{R_2} = \frac{(1+\alpha\,\Delta T_1)}{(1+\alpha\,\Delta T_2)}$$

$$\frac{1.05}{1.38} = \frac{1+20\alpha}{1+100\alpha}$$

On solving

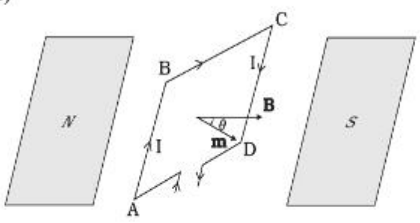
$$\alpha = \frac{11}{2580}\,^{\circ}C^{-1}$$

$= 0.0042\,^{\circ}C^{-1}$

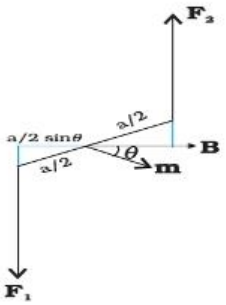
32 (a)

(i). Showing the torque acting on the loop. $\vec{\tau} = \vec{m} \times \vec{B}$	3
(ii)(I) Calculating magnetic dipole moment of the coil.	1
(II) Calculating the magnitude of counter torque.	1

(i)



(a)



(b)

½

According to Right Hand Screw Rule,
Forces on BC & DA are equal and opposite in direction with same line of action, hence they cancel out each other.

½

Force on arm AB & CD, are also equal and opposite in direction but there is a difference in line of action, so a torque will act on it.

½

$F_1 = F_2 = I\,b\,B$

τ = Force x perpendicular distance

$\tau = F_1 (a/2) \sin\theta + F_2 (a/2) \sin\theta$

$= (IbB)\, a \sin\theta$

½

$\tau = I\,A\,B \sin\theta$

$\vec{m} = I\vec{A}$

$\tau = m\,B \sin\theta$

½

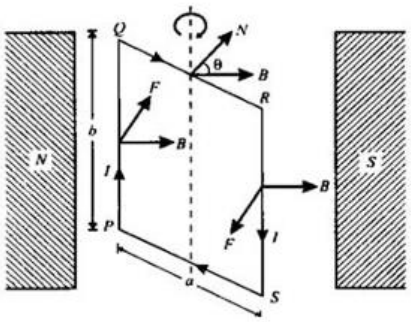
$\vec{\tau} = \vec{m} \times \vec{B}$

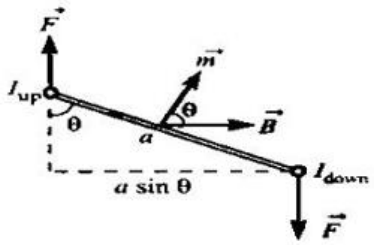
½

HOME

32.

Alternatively,





According to Flemming's left-hand rule, the magnitude of force on sides PS and QR are equal and opposite to each other, so they cancel each other.
The side PQ experiences a normal inward force equal to IbB while the side RS experiences an equal normal outward force. These two forces form a couple which exerts a torque given by:

τ = Force x perpendicular distance

= IbB× a sinθ

= IA B sinθ

But IA = m, the magnetic moment of the loop

τ = mB sinθ

$\vec{\tau} = \vec{m} \times \vec{B}$

(ii) (I)

m= NIA ½

$=100 \times 5 \times \pi\left(\frac{10X10^{-2}}{\sqrt{\pi}}\right)^2 = 5\ Am^2$ ½

(II)

τ =mB sinθ ½

=5 x 2 x sin30

=5 Nm ½

5

OR

(b)

(i). Deriving expression for the force acting on a conductor placed in magnetic field. 2½

(ii) Calculating the magnitude of net force acting on the wire. 2½

(i) Let the number density of the free electron in the conductor be *n*. So, the total charge of conductor,

$q = nALe$ ½

Total force acting on q placed in field B, moving with velocity v_d

$\vec{F} = q(\vec{v} \times \vec{B})$ ½

$\vec{F} = n(AL)e(\vec{v_d} \times \vec{B})$ 1

Here, $ne\ \vec{v_d}$ is current density $(\vec{J})$ and $|ne\ \vec{v_d}|A$ is current in the conductor,

Therefore

$\vec{F} = [\vec{J}(AL)] \times \vec{B}$

$\vec{F} = I(\vec{L} \times \vec{B})$ ½

(ii) The force acting on the wire l_1 (50cm) placed along x-axis

$\vec{F_1} = I(\vec{l_1} \times \vec{B})$ ½

$= 2(50 \times 10^{-2})\ \hat{\imath} \times (-0.5)\hat{k}$ ½

$= 0.5\hat{\jmath}$ N

The force acting on the wire l_2 (20cm) placed along y-axis

$\vec{F_2} = I(\vec{l_2} \times \vec{B})$

$= 2(20 \times 10^{-2})(\hat{\jmath}) \times (-0.5)\hat{k}$ ½

$= 0.2\ \hat{\imath}$ N

As F_1 and F_2 are perpendicular to each other, the resultant force on the wire will be

$F = \sqrt{(F_1^2 + F_2^2)}$ ½

$= \sqrt{(0.25 + 0.04)}$

$= \sqrt{0.29}N$

Alternatively, ½

$\vec{F} = \vec{F_1} + \vec{F_2}$

$\vec{F} = I(\vec{l_x} \times \vec{B}) + I(\vec{l_y} \times \vec{B})$

$= \{2(50 \times 10^{-2})\ \hat{\imath} \times (-0.5)\ \hat{k}\} + \{2(20 \times 10^{-2})(-\hat{\jmath}) \times (-0.5)\ \hat{k}\}$

$= 0.5\hat{\jmath} + 0.2\hat{\imath}$

$F = \sqrt{(F_1^2 + F_2^2)} = \sqrt{(0.25 + 0.04)} = \sqrt{0.29}$ N

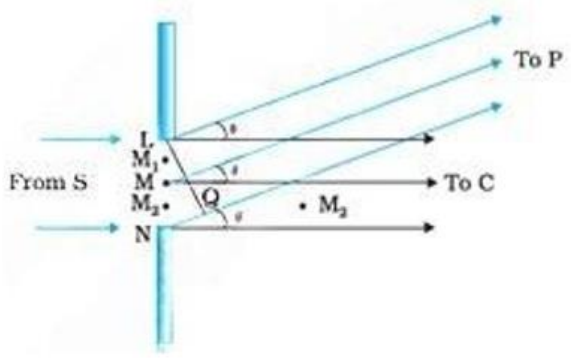
5

HOME HOME HOME

33. (a)

(i) (I)Explaining the formation of maxima and minima in the diffraction pattern.	2
(II)Explaining the reason for weakening of maxima with increasing number(n)	1
(ii) Writing two points of difference between interference and diffraction pattern	2

(i)
(I)



½

Path difference between the waves originating from points L and N superimposed at P on the screen is, NQ = a Sinθ ½

Secondary minima

$a \sin\theta = n\lambda$ n = ±1, ±2, ... ½

Secondary maxima

$a \sin\theta = (2n + 1)\,\lambda / 2$ n = ±1, ±2, ... ½

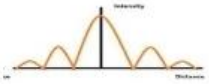
Alternatively,

The light coming from the slit superimposes at the center of screen forms central maxima with maximum intensity. For secondary maxima on screen light coming from a part (one-third, one-fifth, one-seventh….) of whole slit contribute for giving intensity on screen.

For Secondary minima, contribution from two halves of whole slit cancel each other, so the intensity falls to zero.

II.
As n increases, maxima goes on becoming weaker, since the light coming from a fraction of the slit (one-third, one-fifth, one-seventh, ..) contributes to the intensity at a point. 1

(ii)

Interference	Diffraction
The width of bright and dark bands is equal.	The width of central maxima is twice the width of secondary maxima or minima
Intensity of all bright fringes is same	Intensity of bright fringe decreases with distance from central maxima.
There is a good contrast between bright and dark fringes	There is a poor contrast between bright and dark fringes.
Intensity distribution curve: 	Intensity distribution curve: 

(½)x4

Note: Award full marks for any two correct differences.

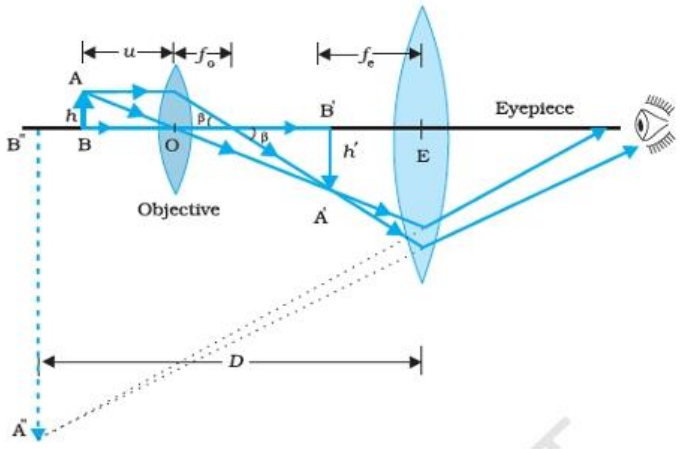
OR

(b)

(i) Construction/labelling using ray diagram.	1+1
Working of a compound microscope with help of ray diagram	1
(ii)	
(I). Explaining the formation of real image if the screen is removed.	1
(II) Explaining the circumstances for formation of real image.	1

HOME

(i)



1

Construction: It consists of two convex lenses, objective lens with small aperture placed near the object and the eye piece with large aperture placed near the eye. Both lenses have small focal length. These lenses are placed coaxially in a narrow tube with rack and pinion arrangement. 1

HOME

HOME

	Working: The lens near to the object called objective forms a real, inverted & magnified image of the object. This serves as the object for eye piece which produces the final image, enlarged & virtual. **(ii) I Yes** Real image is formed by actual intersection of rays. **II Yes** If the object is virtual. **Note: 1. If students do not write construction award full marks for well-labelled diagram representing objective lens, eye piece, along with image position at near point or normal adjustment.** **2. Deduct ½ mark if arrows are not drawn.**	1 ½ ½ ½ ½	5

HOME

HOME

Series : 6ZXWY/6

SET ~ 1

रोल नं.
Roll No.

प्रश्न-पत्र कोड
Q.P. Code **55/6/1**

परीक्षार्थी प्रश्न-पत्र कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें।
Candidates must write the Q.P. Code on the title page of the answer-book.

भौतिक विज्ञान (सैद्धान्तिक)
PHYSICS (Theory)

*निर्धारित समय : **3** घण्टे* | *अधिकतम अंक : **70***

*Time allowed : **3** hours* | *Maximum Marks : **70***

नोट / NOTE	#
(I)	कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **31** हैं। Please check that this question paper contains **31** printed pages.
(II)	प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें। Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
(III)	कृपया जाँच कर लें कि इस प्रश्न-पत्र में **33** प्रश्न हैं। Please check that this question paper contains **33** questions.
(IV)	**कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में यथा स्थान पर प्रश्न का क्रमांक अवश्य लिखें।** **Please write down the Serial Number of the question in the answer-book at the given place before attempting it.**
(V)	इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है। प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जाएगा। 10.15 बजे से 10.30 बजे तक परीक्षार्थी केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे। 15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the candidates will read the question paper only and will not write any answer on the answer-book during this period.

#

सामान्य निर्देश :

निम्नलिखित निर्देशों को ध्यानपूर्वक पढ़िए और उनका पालन कीजिए :

(i) *इस प्रश्न-पत्र में **33** प्रश्न हैं। **सभी** प्रश्न **अनिवार्य** हैं।*

(ii) *यह प्रश्न-पत्र **पाँच** खण्डों में विभाजित है – **खण्ड क, ख, ग, घ** एवं **ङ**।*

(iii) ***खण्ड क** में प्रश्न संख्या **1** से **16** तक बहुविकल्पीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न **1** अंक का है।*

(iv) ***खण्ड ख** में प्रश्न संख्या **17** से **21** तक अति लघु-उत्तरीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न **2** अंकों का है।*

(v) ***खण्ड ग** में प्रश्न संख्या **22** से **28** तक लघु-उत्तरीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न **3** अंकों का है।*

(vi) ***खण्ड घ** में प्रश्न संख्या **29** तथा **30** केस अध्ययन-आधारित प्रश्न हैं। प्रत्येक प्रश्न **4** अंकों का है।*

(vii) ***खण्ड ङ** में प्रश्न संख्या **31** से **33** तक दीर्घ-उत्तरीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न **5** अंकों का है।*

(viii) *प्रश्न-पत्र में समग्र विकल्प नहीं दिया गया है। यद्यपि, खण्ड क के अतिरिक्त अन्य खण्डों के कुछ प्रश्नों में आंतरिक विकल्प का चयन दिया गया है।*

(ix) *ध्यान दें कि दृष्टिबाधित परीक्षार्थियों के लिए एक अलग प्रश्न-पत्र है।*

(x) *कैल्कुलेटर का उपयोग **वर्जित** है।*

जहाँ आवश्यक हो, आप निम्नलिखित भौतिक नियतांकों के मानों का उपयोग कर सकते हैं :

$c = 3 \times 10^8$ m/s

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

इलेक्ट्रॉन का द्रव्यमान $(m_e) = 9{\cdot}1 \times 10^{-31}$ kg

न्यूट्रॉन का द्रव्यमान = $1{\cdot}675 \times 10^{-27}$ kg

प्रोटॉन का द्रव्यमान = $1{\cdot}673 \times 10^{-27}$ kg

आवोगाद्रो संख्या = $6{\cdot}023 \times 10^{23}$ प्रति ग्राम मोल

बोल्ट्ज़मान नियतांक = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

#

General Instructions :

Read the following instructions carefully and follow them :

(i) *This question paper contains **33** questions. **All** questions are **compulsory**.*

(ii) *This question paper is divided into **five** sections – **Sections A, B, C, D** and **E**.*

(iii) *In **Section A** – Questions no. **1** to **16** are Multiple Choice type questions. Each question carries **1** mark.*

(iv) *In **Section B** – Questions no. **17** to **21** are Very Short Answer type questions. Each question carries **2** marks.*

(v) *In **Section C** – Questions no. **22** to **28** are Short Answer type questions. Each question carries **3** marks.*

(vi) *In **Section D** – Questions no. **29** and **30** are case study-based questions. Each question carries **4** marks.*

(vii) *In **Section E** – Questions no. **31** to **33** are Long Answer type questions. Each question carries **5** marks.*

(viii) *There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section A.*

(ix) *Kindly note that there is a separate question paper for Visually Impaired candidates.*

(x) *Use of calculators is **not** allowed.*

You may use the following values of physical constants wherever necessary :

$c = 3 \times 10^8$ m/s

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

Mass of electron (m_e) = $9{\cdot}1 \times 10^{-31}$ kg

Mass of neutron = $1{\cdot}675 \times 10^{-27}$ kg

Mass of proton = $1{\cdot}673 \times 10^{-27}$ kg

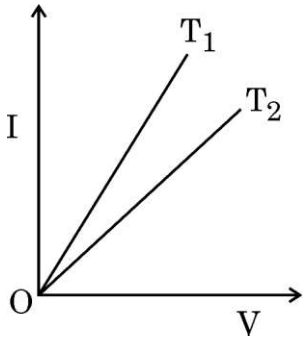
Avogadro's number = $6{\cdot}023 \times 10^{23}$ per gram mole

Boltzmann constant = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

#

खण्ड क

1. आरेख में किसी तार का दो विभिन्न तापों T_1 और T_2 पर वोल्टता (V) और धारा (I) के बीच ग्राफ दर्शाया गया है। इससे यह निष्कर्ष निकाला जा सकता है कि :



(A) $T_2 = 2T_1$ (B) $T_1 > T_2$

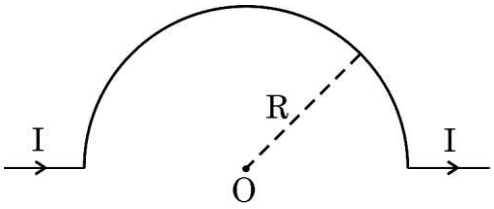
(C) $T_1 = T_2 / 3$ (D) $T_1 < T_2$

2. यदि n प्रतिरोधकों, जिनमें प्रत्येक का मान R है, के श्रेणी संयोजन और पार्श्व संयोजन के तुल्य प्रतिरोध का मान क्रमश: R_s और R_p है, तो $(R_s - R_p)$ का मान है :

(A) $\left(\frac{n^2-1}{n^2}\right)R$ (B) $\left(\frac{n^2+1}{n^2-1}\right)R$

(C) $\left(\frac{n^2-1}{n}\right)R$ (D) $\frac{(n^2+1)R}{n^2}$

3. दिए गए आरेख में बिन्दु O पर चुम्बकीय क्षेत्र का मान है :



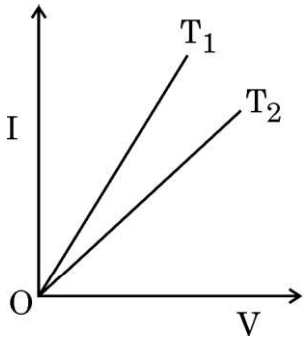
(A) $\frac{\mu_0 I}{2\pi R}$ (B) $\frac{\mu_0 I}{\pi R}$

(C) $\frac{\mu_0 I}{4R}$ (D) $\frac{\mu_0 I}{R}$

#

SECTION A

1. The figure shows the voltage (V) versus the current (I) graphs for a wire at two temperatures T_1 and T_2. One can conclude that :



(A) $T_2 = 2T_1$ (B) $T_1 > T_2$

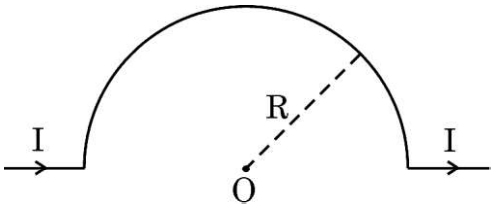
(C) $T_1 = T_2 / 3$ (D) $T_1 < T_2$

2. If R_s and R_p are the equivalent resistances of n resistors, each of value R, in series and parallel combinations respectively, then the value of $(R_s - R_p)$ is :

(A) $\left(\frac{n^2-1}{n^2}\right)R$ (B) $\left(\frac{n^2+1}{n^2-1}\right)R$

(C) $\left(\frac{n^2-1}{n}\right)R$ (D) $\frac{(n^2+1)R}{n^2}$

3. The value of magnetic field at point O in the given figure is :



(A) $\frac{\mu_0 I}{2\pi R}$ (B) $\frac{\mu_0 I}{\pi R}$

(C) $\frac{\mu_0 I}{4R}$ (D) $\frac{\mu_0 I}{R}$

4. किसी एकसमान चुम्बकीय क्षेत्र में गति करने के लिए स्वतंत्र कोई प्रतिचुम्बकीय पदार्थ का टुकड़ा :

(A) क्षेत्र के अनुदिश गति करता है

(B) क्षेत्र के विपरीत गति करता है

(C) क्षेत्र के लम्बवत गति करता है

(D) किसी भी प्रकार की गति नहीं करता है

5. किसी गैल्वेनोमीटर को वांछनीय परिसर के अमीटर में परिवर्तित किया जा सकता है उसके साथ निम्नलिखित को संयोजित करके :

(A) श्रेणी में लघु प्रतिरोध

(B) श्रेणी में उच्च प्रतिरोध

(C) पार्श्व में लघु प्रतिरोध

(D) पार्श्व में उच्च प्रतिरोध

6. कोई प्रोटॉन और कोई α-कण समान वेग $\vec{v}$ से किसी एकसमान चुम्बकीय क्षेत्र $\vec{B}$ में इस प्रकार प्रवेश करते हैं कि $\vec{v} \perp \vec{B}$ हो। तब इनके पथों की त्रिज्याओं का अनुपात होगा :

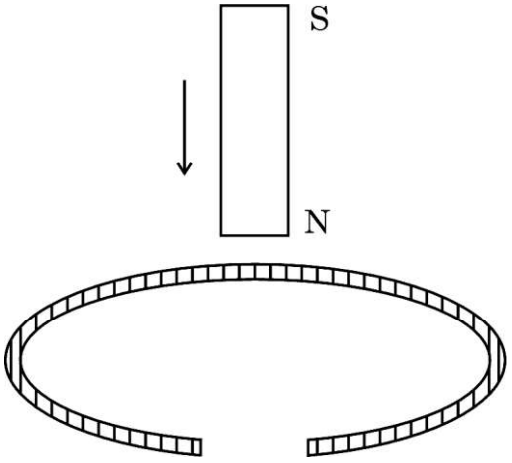
(A) 2

(B) $\frac{1}{2}$

(C) $\frac{1}{4}$

(D) 4

7. किसी छड़ चुम्बक को ऊर्ध्वाधर रखते हुए किसी ताँबे के वलय, जो आरेख में दर्शाए अनुसार कटा है, के अक्ष के अनुदिश गिराया गया है। इस गिरते हुए चुम्बक का त्वरण है :



(A) शून्य

(B) g से कम

(C) g

(D) g से अधिक

#

4. A piece of a diamagnetic material, free to move when placed in a uniform magnetic field :

(A) moves along the field

(B) moves opposite to the field

(C) moves perpendicular to the field

(D) does not move at all

5. A galvanometer can be converted into an ammeter of desired range by connecting a :

(A) small resistance in series (B) large resistance in series

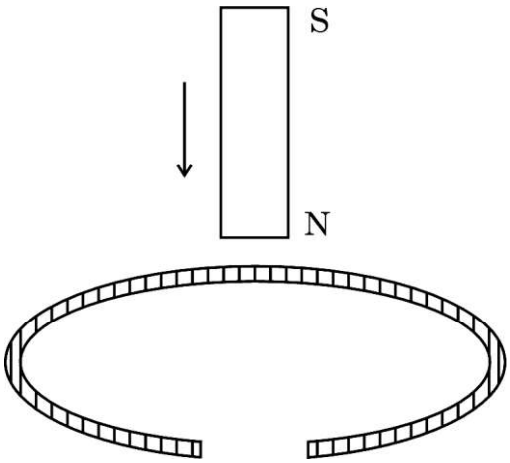
(C) small resistance in parallel (D) large resistance in parallel

6. A proton and an α-particle enter with the same velocity $\vec{v}$ in a uniform magnetic field $\vec{B}$ such that $\vec{v} \perp \vec{B}$. The ratio of the radii of their paths is :

(A) 2 (B) $\frac{1}{2}$

(C) $\frac{1}{4}$ (D) 4

7. A vertically held bar magnet is dropped along the axis of a copper ring having a cut as shown in the diagram. The acceleration of the falling magnet is :



(A) zero (B) less than g

(C) g (D) greater than g

#

8. कोई ac स्रोत किसी प्रतिरोधक और किसी प्रेरक के श्रेणी संयोजन से संयोजित है। प्रतिरोधक और प्रेरक के सिरों पर वोल्टता क्रमश: 8 V और 6 V है। स्रोत की वोल्टता है :

(A) 10 V (B) 12 V

(C) 14 V (D) 16 V

9. दो कलासंबद्ध तरंगें जिनमें प्रत्येक की तीव्रता I_0 है, किसी परदे पर व्यतिकरण पैटर्न उत्पन्न करती हैं। परदे पर प्रकाश की औसत तीव्रता है :

(A) शून्य (B) I_0

(C) $2I_0$ (D) $4I_0$

10. किसी पदार्थ का कार्यफलन 2·21 eV है। निम्नलिखित में से कौन-सा इस पदार्थ से फोटोइलेक्ट्रॉन उत्पन्न ***नहीं*** कर सकता है ?

(A) लाल प्रकाश (B) नीला प्रकाश

(C) बैंगनी प्रकाश (D) हरा प्रकाश

11. आवृत्ति $6{\cdot}0 \times 10^{14}$ Hz के किसी फ़ोटॉन का संवेग (kg m/s में) होता है :

(A) $6{\cdot}63 \times 10^{-25}$

(B) $1{\cdot}326 \times 10^{-27}$

(C) $2{\cdot}652 \times 10^{-26}$

(D) $3{\cdot}978 \times 10^{-24}$

12. किसी नाभिक में प्रोटॉन और प्रोटॉन, प्रोटॉन और न्यूट्रॉन तथा न्यूट्रॉन और न्यूट्रॉन के बीच नाभिकीय बल क्रमश: F_{pp}, F_{pn} और F_{nn} हैं। तब :

(A) $F_{pp} > F_{pn} > F_{nn}$

(B) $F_{pn} > F_{nn} > F_{pp}$

(C) $F_{nn} > F_{pp} > F_{pn}$

(D) $F_{pp} = F_{pn} = F_{nn}$

8. An ac source is connected to a resistor and an inductor in series. The voltage across the resistor and inductor are 8 V and 6 V respectively. The voltage of the source is :

(A) 10 V (B) 12 V

(C) 14 V (D) 16 V

9. Two coherent waves, each of intensity I_0, produce interference pattern on a screen. The average intensity of light on the screen is :

(A) zero (B) I_0

(C) $2I_0$ (D) $4I_0$

10. The work function of a material is 2·21 eV. Which of the following ***cannot*** produce photoelectrons from it ?

(A) Red light (B) Blue light

(C) Violet light (D) Green light

11. The momentum (in kg m/s) of a photon of frequency $6{\cdot}0 \times 10^{14}$ Hz is :

(A) $6{\cdot}63 \times 10^{-25}$

(B) $1{\cdot}326 \times 10^{-27}$

(C) $2{\cdot}652 \times 10^{-26}$

(D) $3{\cdot}978 \times 10^{-24}$

12. Inside a nucleus, the nuclear forces between proton and proton, proton and neutron, neutron and neutron are F_{pp}, F_{pn} and F_{nn} respectively. Then :

(A) $F_{pp} > F_{pn} > F_{nn}$

(B) $F_{pn} > F_{nn} > F_{pp}$

(C) $F_{nn} > F_{pp} > F_{pn}$

(D) $F_{pp} = F_{pn} = F_{nn}$

#

*प्रश्न संख्या **13** से **16** अभिकथन (A) और कारण (R) प्रकार के प्रश्न हैं। दो कथन दिए गए हैं — जिनमें एक को अभिकथन (A) तथा दूसरे को कारण (R) द्वारा अंकित किया गया है। सही उत्तर नीचे दिए गए कोडों (A), (B), (C) और (D) में से चुनकर दीजिए।*

(A) अभिकथन (A) और कारण (R) दोनों सही हैं और कारण (R), अभिकथन (A) की सही व्याख्या करता है।

(B) अभिकथन (A) और कारण (R) दोनों सही हैं, परन्तु कारण (R), अभिकथन (A) की सही व्याख्या ***नहीं*** करता है।

(C) अभिकथन (A) सही है, परन्तु कारण (R) ग़लत है।

(D) अभिकथन (A) और कारण (R) दोनों ग़लत हैं।

13. *अभिकथन (A)* : किसी परावर्ती दूरदर्शक में प्रतिबिम्ब में वर्ण विपथन नहीं होता है।

कारण (R) : वर्ण विपथन केवल किसी प्रकाशिक माध्यम से प्रकाश के अपवर्तन के कारण ही होता है।

14. *अभिकथन (A)* : विवर (होल) कोई ऐसा आभासी मुक्त कण है जिस पर प्रभावी धनात्मक इलेक्ट्रॉनिक आवेश होता है।

कारण (R) : विवर आवश्यक रूप से ऐसा रिक्त स्थान नहीं है जिसे संयोजकता बैण्ड में किसी इलेक्ट्रॉन द्वारा पीछे छोड़ दिया गया है।

15. *अभिकथन (A)* : जब उच्च परमाणु क्रमांक का कोई धातु का लक्ष्य धीमी गति से गतिमान इलेक्ट्रॉनों को रोकता है तो X-किरणें उत्पन्न होती हैं।

कारण (R) : X-किरणें निम्न-ऊर्जा के फ़ोटॉनों से बनती हैं।

16. *अभिकथन (A)* : $(30 < A < 170)$ परिसर की द्रव्यमान संख्या के लिए प्रति न्यूक्लिऑन बंधन ऊर्जा वास्तव में नियत होती है।

कारण (R) : $(30 < A < 170)$ परिसर की द्रव्यमान संख्या के लिए न्यूक्लिऑनों के बीच नाभिकीय बल लघु-परासी नहीं होते हैं।

#

*Questions number **13** to **16** are Assertion (A) and Reason (R) type questions. Two statements are given — one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the codes (A), (B), (C) and (D) as given below.*

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is ***not*** the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Both Assertion (A) and Reason (R) are false.

13. *Assertion (A) :* In a reflecting telescope, the image does not have chromatic aberration.

Reason (R) : Chromatic aberration occurs only due to refraction of light through an optical medium.

14. *Assertion (A) :* A hole is an apparent free particle with effective positive electronic charge.

Reason (R) : A hole is not necessarily a vacancy left behind by an electron in the valence band.

15. *Assertion (A) :* X-rays are produced when slow moving electrons are stopped by a metal target of high atomic number.

Reason (R) : X-rays consist of low-energy photons.

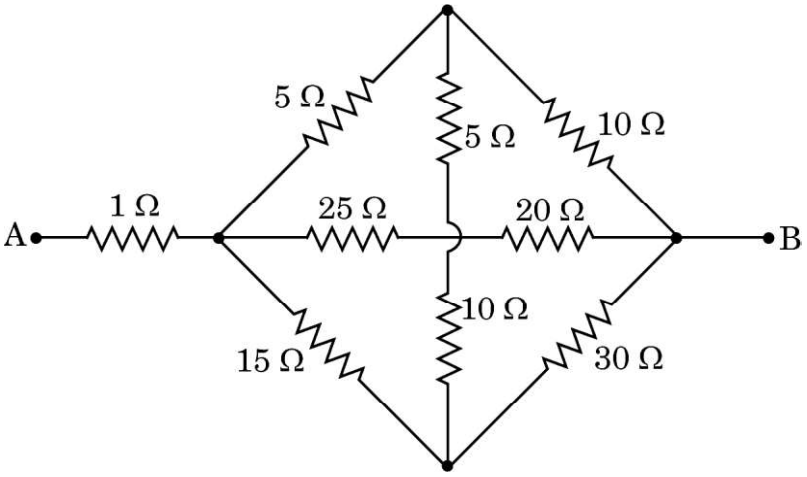
16. *Assertion (A) :* The binding energy per nucleon is practically constant for mass number in the range ($30 < A < 170$).

Reason (R) : Nuclear forces between the nucleons for mass numbers in the range ($30 < A < 170$) are not short-range.

#

खण्ड ख

17. आरेख में दर्शाए गए नेटवर्क के बिन्दु A और B के बीच तुल्य प्रतिरोध ज्ञात कीजिए। *2*



18. (क) यंग के द्विझिरी प्रयोग में पर्दे के किसी बिन्दु पर तीव्रता ज्ञात कीजिए, जिस पर व्यतिकरण करती तरंगों, जिनमें प्रत्येक की तीव्रता I_0 है, के बीच पथान्तर (i) $\frac{\lambda}{3}$, तथा (ii) $\frac{\lambda}{2}$ है। *2*

अथवा

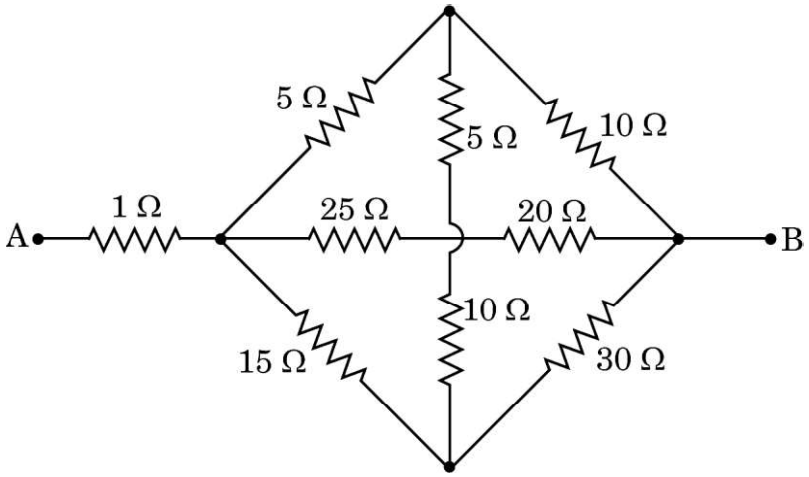
(ख) वक्रता त्रिज्या 30 cm और अपवर्तनांक 1·5 के काँच से बने किसी उत्तल गोलीय पृष्ठ के सामने 12 cm दूरी पर कोई बिन्दु प्रकाश स्रोत स्थित है। बनने वाले प्रतिबिम्ब की प्रकृति और स्थिति ज्ञात कीजिए। *2*

19. $3{\cdot}0 \times 10^{14}$ Hz आवृत्ति का कोई लेज़र पुन्ज 9 mW की औसत शक्ति उत्पन्न करता है। (i) पुन्ज के फ़ोटॉन की ऊर्जा, तथा (ii) स्रोत द्वारा प्रति सेकण्ड उत्सर्जित फ़ोटॉनों की औसत संख्या ज्ञात कीजिए। *2*

#

SECTION B

17. Find the equivalent resistance between points A and B for the network shown in the figure. *2*



18. (a) Find the intensity at a point on the screen in Young's double slit experiment, at which the interfering waves of intensity I_0 each, have a path difference of (i) $\frac{\lambda}{3}$, and (ii) $\frac{\lambda}{2}$. *2*

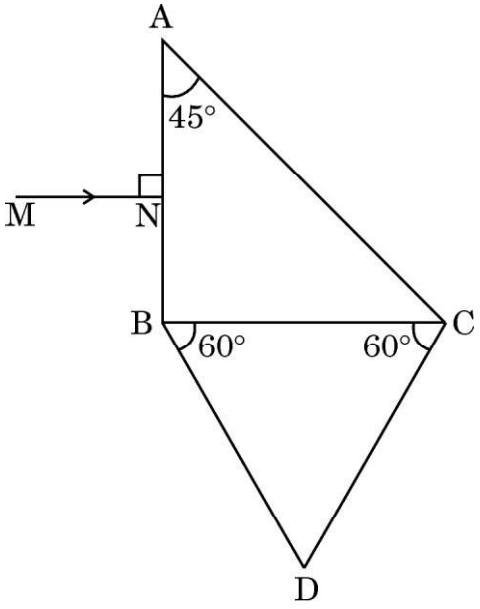
OR

(b) A point source of light in air is kept at a distance of 12 cm in front of a convex spherical surface of glass of refractive index 1·5 and radius of curvature 30 cm. Find the nature and position of the image formed. *2*

19. A laser beam of frequency $3{\cdot}0 \times 10^{14}$ Hz produces average power of 9 mW. Find (i) the energy of photon of the beam, and (ii) the number of photons emitted per second on an average by the source. *2*

#

20. कोई समकोणिक समद्विबाहु काँच का प्रिज़्म ABC किसी समबाहु त्रिभुजाकार प्रिज़्म DBC के सम्पर्क में आरेख में दर्शाए अनुसार रखा है। दोनों प्रिज़्म अपवर्तनांक 1·6 के समान काँच के बने हैं। फलक AB पर अभिलम्बवत आपतित किरण MN का वह पथ आरेखित कीजिए जिससे यह किरण इस संयोजन से गुज़रती है। *2*



21. किसी n-प्रकार के अर्धचालक में कक्ष ताप पर इलेक्ट्रॉन-विवर संयोजन एक सतत प्रक्रिया है। फिर भी इसमें इलेक्ट्रॉन सांद्रता सदैव ही विवर सांद्रता से अधिक होती है। व्याख्या कीजिए। *2*

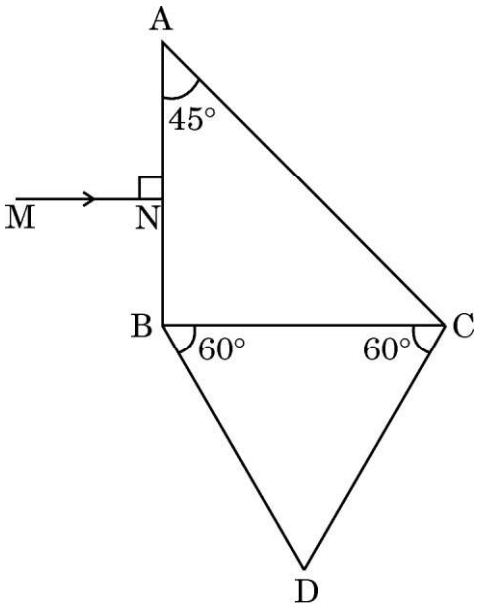
खण्ड ग

22. किसी सेल के 'वि.वा. बल' (emf) और 'टर्मिनल वोल्टता' के बीच क्या अंतर है ?

दो सेल जिनके वि.वा. बल (emf) E_1 और E_2 हैं तथा आन्तरिक प्रतिरोध क्रमश: r_1 और r_2 हैं पार्श्व में संयोजित हैं। तुल्य सेल के वि.वा. बल (emf) और आन्तरिक प्रतिरोध के लिए व्यंजक व्युत्पन्न कीजिए। *3*

#

20. A right angled isosceles glass prism ABC is kept in contact with an equilateral triangular prism DBC as shown in the figure. Both prisms are made of the same glass of refractive index 1·6. Trace the path of the ray MN incident normally on face AB as it passes through the combination. *2*



21. In an n-type semiconductor electron-hole combination is a continuous process at room temperature. Yet the electron concentration is always greater than the hole concentration in it. Explain. *2*

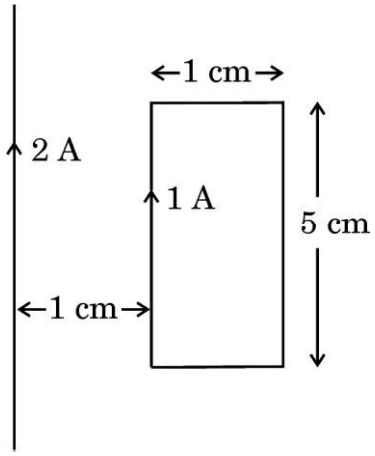
SECTION C

22. What is the difference between 'emf' and 'terminal voltage' of a cell ?

Two cells of emfs E_1 and E_2 and internal resistances r_1 and r_2 are connected in parallel. Derive an expression for the emf and internal resistance of the equivalent cell. *3*

#

23. किसी आयताकार पाश से 1 A धारा प्रवाहित हो रही है। आरेख में दर्शाए अनुसार कोई सीधा लम्बा तार जिससे 2 A धारा प्रवाहित हो रही है पाश के ही तल में उसके समीप रखा है।



ज्ञात कीजिए : *3*

(i) पाश पर कार्यरत बल-आघूर्ण, तथा

(ii) पाश पर लगे नेट बल का परिमाण और उसकी दिशा।

24. (क) लेन्ज़ का नियम लिखिए। लम्बाई L की कोई छड़ MN अपनी लम्बाई के लम्बवत तथा सिरे M से गुजरने वाले अक्ष के परित: किसी एकसमान चुम्बकीय क्षेत्र $\vec{B}$ में, जो छड़ के अक्ष के समान्तर है, किसी नियत कोणीय वेग ω से घूर्णन कराई गई है। छड़ के सिरों के बीच प्रेरित वि.वा. बल (emf) के लिए व्यंजक प्राप्त कीजिए। *3*

अथवा

(ख) किसी कुण्डली के 'स्व-प्रेरकत्व' की परिभाषा लिखिए। लम्बाई l, अनुप्रस्थ-काट क्षेत्रफल A तथा प्रति एकांक लम्बाई फेरों की संख्या n की किसी लम्बी परिनालिका के स्व-प्रेरकत्व के लिए व्यंजक व्युत्पन्न कीजिए। *3*

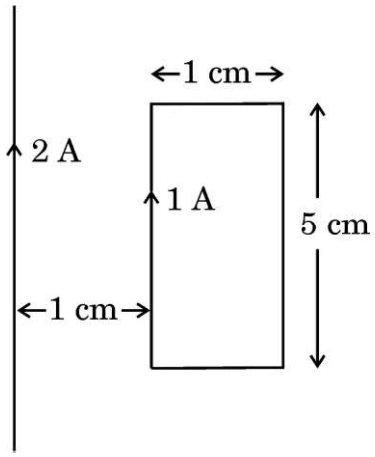
25. निम्नलिखित के लिए उपयोग की जाने वाली विद्युत-चुम्बकीय तरंगों के नाम लिखिए :

(i) रेडार, (ii) नेत्र शल्यता, तथा (iii) चिकित्सा में नैदानिक साधन के रूप में। इनके तरंगदैर्ध्य परिसर भी लिखिए। *3*

26. किसी अवतल दर्पण द्वारा उत्पन्न किसी बिम्ब का वास्तविक, उल्टा तथा विवर्धित प्रतिबिम्ब बनना दर्शाने के लिए किरण आरेख खींचिए और इस प्रकार दर्पण सूत्र प्राप्त कीजिए। *3*

#

23. A rectangular loop carries a current of 1 A. A straight long wire carrying 2 A current is kept near the loop in the same plane as shown in the figure.



Find : *3*

(i) the torque acting on the loop, and

(ii) the magnitude and direction of the net force on the loop.

24. (a) State Lenz's law. A rod MN of length L is rotated about an axis passing through its end M perpendicular to its length, with a constant angular velocity ω in a uniform magnetic field $\vec{B}$ parallel to the axis. Obtain an expression for emf induced between its ends. *3*

OR

(b) Define 'self-inductance' of a coil. Derive an expression for self-inductance of a long solenoid of cross-sectional area A and length l, having n turns per unit length. *3*

25. Name the electromagnetic wave used (i) in radar, (ii) in eye surgery and (iii) as diagnostic tool in medicine. Write their wavelength range also. *3*

26. Draw a ray diagram showing the image formation when a concave mirror produces a real, inverted and magnified image of an object and hence obtain the mirror formula. *3*

#

27. हाइड्रोजन परमाणु के बोर मॉडल के अनुसार किसी इलेक्ट्रॉन की वर्तुल कक्षा में गति बनाए रखने के लिए उसे आवश्यक बल किस प्रकार प्राप्त होता है ? हाइड्रोजन परमाणु में त्रिज्या r की वर्तुल कक्षा में गतिमान किसी इलेक्ट्रॉन की कुल ऊर्जा के लिए व्यंजक व्युत्पन्न कीजिए। इस व्यंजक में ऋणात्मक चिह्न का महत्त्व दीजिए। *3*

28. (क) 'D-T अभिक्रिया' (ड्यूटेरियम-ट्रीटियम अभिक्रिया) पर विचार कीजिए । किसी तापनाभिकीय संलयन रिएक्टर में निम्नलिखित नाभिकीय अभिक्रिया होती है :

$$^{2}_{1}H + ^{3}_{1}H \longrightarrow ^{4}_{2}He + ^{1}_{0}n + Q$$

इस अभिक्रिया में मुक्त ऊर्जा की मात्रा ज्ञात कीजिए।

दिया गया है :

$m\left(^{2}_{1}H\right) = 2{\cdot}014102 \text{ u}$

$m\left(^{3}_{1}H\right) = 3{\cdot}016049 \text{ u}$

$m\left(^{4}_{2}He\right) = 4{\cdot}002603 \text{ u}$

$m\left(^{1}_{0}n\right) = 1{\cdot}008665 \text{ u}$

$1 \text{ u} = 931 \text{ MeV/c}^2$

(ख) यह दर्शाइए कि नाभिकीय घनत्व द्रव्यमान संख्या पर निर्भर नहीं करता है। *3*

#

27. How is the necessary force provided to an electron to keep it moving in a circular orbit according to Bohr model of hydrogen atom ? Derive an expression for the total energy of an electron moving in an orbit of radius r in hydrogen atom. Give the significance of negative sign in this expression. *3*

28. (a) Consider the so-called 'D-T reaction' (Deuterium-Tritium reaction). In a thermonuclear fusion reactor, the following nuclear reaction occurs :

$$^{2}_{1}H + ^{3}_{1}H \longrightarrow ^{4}_{2}He + ^{1}_{0}n + Q$$

Find the amount of energy released in the reaction.

Given :

$m\left(^{2}_{1}H\right) = 2{\cdot}014102$ u

$m\left(^{3}_{1}H\right) = 3{\cdot}016049$ u

$m\left(^{4}_{2}He\right) = 4{\cdot}002603$ u

$m\left(^{1}_{0}n\right) = 1{\cdot}008665$ u

1 u = 931 MeV/c^2

(b) Show that the nuclear density is independent of mass number. *3*

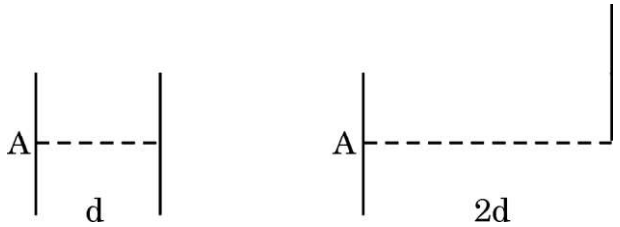
खण्ड घ

*प्रश्न संख्या **29** तथा **30** केस अध्ययन-आधारित प्रश्न हैं। निम्नलिखित अनुच्छेदों को पढ़ कर नीचे दिए गए प्रश्नों के उत्तर दीजिए।*

29. कोई संधारित्र विद्युत रोधी द्वारा पृथक दो चालकों का एक निकाय होता है। व्यवहार में, दो चालकों पर आवेश Q और $-Q$ होते हैं तथा उनमें विभवान्तर $V = V_1 - V_2$ होता है। अनुपात $\frac{Q}{V}$ एक नियतांक है जिसे C द्वारा व्यक्त किया जाता है और इसे संधारित्र की धारिता कहते हैं। धारिता Q और V पर निर्भर नहीं करती है। धारिता C केवल दो चालकों के निकाय के ज्यामितीय विन्यास (आकार, आकृति, पृथकन) तथा दोनों चालकों को पृथक करने वाले माध्यम पर निर्भर करती है। जब किसी समान्तर पट्टिका संधारित्र को आवेशित किया जाता है, तो विद्युत-क्षेत्र E_0 दो पट्टिकाओं के बीच स्थानीकृत हो जाता है तथा समस्त क्षेत्र में एकसमान होता है। जब किसी परावैद्युत की किसी पट्टिका को आवेशित पट्टिकाओं (आवेश घनत्व σ) के बीच रख दिया जाता है तो क्षेत्र द्वारा समस्त परावैद्युत ध्रुवित हो जाता है जिसके फलस्वरूप पट्टिका के फलकों पर विजातीय आवेश प्रकट हो जाते हैं जिसके पृष्ठीय आवेश घनत्व का परिमाण σ_p होता है। रैखिक परावैद्युत के लिए σ_p, E_0 के आनुपातिक होता है। परावैद्युत रखने से विद्युत-क्षेत्र परिवर्तित होता है जिससे संधारित्र की धारिता परिवर्तित होती है और इस प्रकार संधारित्र में संचित ऊर्जा परिवर्तित हो जाती है।

प्रतिरोधकों की भाँति संधारित्रों को भी श्रेणी में अथवा पार्श्व में अथवा श्रेणी और पार्श्व के संयुक्त संयोजन में संयोजित किया जा सकता है।

(i) आरेख (a) में दर्शाए गए वायु से भरे पट्टिका क्षेत्रफल A तथा पट्टिका पृथकन d के धारिता C के किसी संधारित्र पर विचार कीजिए। यदि पट्टिकाओं के बीच की दूरी को बढ़ाकर 2d कर दिया जाए तथा आरेख (b) में दर्शाए अनुसार एक पट्टिका को स्थानान्तरित कर दिया जाए, तो अब नए निकाय की धारिता होगी : *1*



(a) (b)

(A) $\frac{C}{4}$ (B) $\frac{C}{2}$

(C) 2C (D) 4C

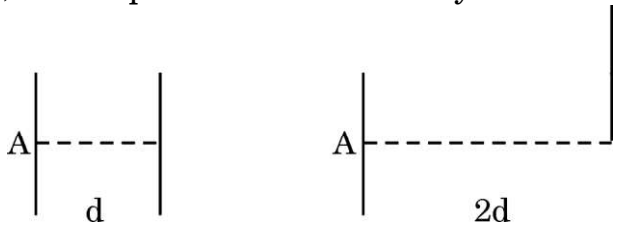
SECTION D

*Questions number **29** and **30** are case study-based questions. Read the following paragraphs and answer the questions that follow.*

29. A capacitor is a system of two conductors separated by an insulator. In practice, the two conductors have charges Q and $-$ Q with potential difference $V = V_1 - V_2$ between them. The ratio $\frac{Q}{V}$ is a constant, denoted by C and is called the capacitance of the capacitor. It is independent of Q or V. It depends only on the geometrical configuration (shape, size, separation) of the two conductors and the medium separating the conductors. When a parallel plate capacitor is charged, the electric field E_0 is localised between the plates and is uniform throughout. When a slab of a dielectric is inserted between the charged plates (charge density σ), the dielectric is polarised by the field. Consequently opposite charges appear on the faces of the slab, near the plates, with surface charge density of magnitude σ_p. For a linear dielectric σ_p is proportional to E_0. Introduction of a dielectric changes the electric field, and hence, the capacitance of a capacitor, and hence, the energy stored in the capacitor.

Like resistors, capacitors can also be arranged in series or in parallel or in a combination of series and parallel.

(i) Consider a capacitor of capacitance C, with plate area A and plate separation d, filled with air [Fig. (a)]. The distance between the plates is increased to 2d and one of the plates is shifted as shown in Fig. (b). The capacitance of the new system now is : *1*



(a) (b)

(A) $\frac{C}{4}$ (B) $\frac{C}{2}$

(C) 2C (D) 4C

#

(ii) किसी समान्तर पट्टिका संधारित्र [पट्टिका क्षेत्रफल A और पट्टिका पृथकन d ($> d_1$)] की आवेशित पट्टिकाओं (आवेश घनत्व σ) के बीच परावैद्युतांक K की कोई रैखिक परावैद्युत की पट्टिका (क्षेत्रफल A और मोटाई d_1) रख दी गई है और इस पट्टिका के फलकों पर परिमाण में σ_p आवेश घनत्व के विजातीय आवेश प्रकट हो गए हैं। परावैद्युतांक K का मान होगा : *1*

(A) $\frac{\sigma + \sigma_p}{\sigma}$ (B) $\frac{\sigma}{\sigma - \sigma_p}$

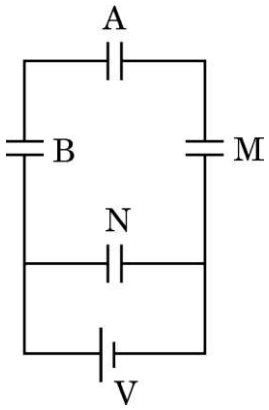
(C) $\frac{\sigma + \sigma_p}{\sigma_p}$ (D) $\frac{\sigma}{\sigma_p}$

(iii) आवेशों Q और – Q के वायु से भरे किसी समान्तर पट्टिका संधारित्र की पट्टिकाओं के बीच कोई विद्युत-क्षेत्र E स्थापित किया गया है। पट्टिकाओं के बीच परिबद्ध स्थान का आयतन V है। इस संधारित्र में संचित ऊर्जा है : *1*

(A) $\frac{1}{2}\varepsilon_0 E^2$ (B) $\varepsilon_0 Q^2 E$

(C) $\frac{1}{2}\varepsilon_0 E^2 V$ (D) $\varepsilon_0 E Q V$

(iv) (क) आरेख में दर्शाए अनुसार तीन संधारित्रों A, B और M जिनमें प्रत्येक की धारिता C है, को धारिता 2C के किसी संधारित्र N और किसी बैटरी से संयोजित किया गया है। यदि A और N पर क्रमश: Q और Q′ आवेश हैं, तो $\frac{Q'}{Q}$ है : *1*



(A) $\frac{1}{6}$ (B) $\frac{1}{3}$

(C) 3 (D) 6

अथवा

(ii) A slab (area A and thickness d_1) of a linear dielectric of dielectric constant K is inserted between charged plates (charge density σ) of a parallel plate capacitor [plate area A and plate separation d ($> d_1$)] and opposite charges with charge density of magnitude σ_p appear on the faces of the slab. The dielectric constant K is given by : *1*

(A) $\frac{\sigma + \sigma_p}{\sigma}$ (B) $\frac{\sigma}{\sigma - \sigma_p}$

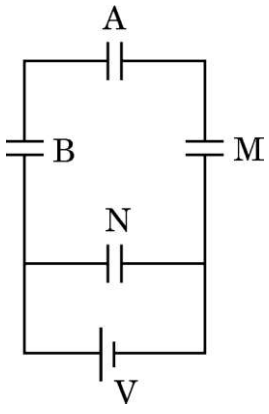
(C) $\frac{\sigma + \sigma_p}{\sigma_p}$ (D) $\frac{\sigma}{\sigma_p}$

(iii) An electric field E is established between the plates of an air filled parallel plate capacitor, with charges Q and – Q. V is the volume of the space enclosed between the plates. The energy stored in the capacitor is : *1*

(A) $\frac{1}{2}\varepsilon_0 E^2$ (B) $\varepsilon_0 Q^2 E$

(C) $\frac{1}{2}\varepsilon_0 E^2 V$ (D) $\varepsilon_0 E Q V$

(iv) (a) Three capacitors A, B and M, each of capacitance C are connected to a capacitor N of capacitance 2C and a battery as shown in the figure. If the charges on A and N are Q and Q′ respectively, then $\frac{Q'}{Q}$ is : *1*



(A) $\frac{1}{6}$ (B) $\frac{1}{3}$

(C) 3 (D) 6

OR

(ख) पट्टिका क्षेत्रफल A तथा पट्टिका पृथकन d के किसी समान्तर पट्टिका संधारित्र में परावैद्युतांक K की कोई पट्टिका (क्षेत्रफल A और मोटाई $\frac{d}{2}$) रख दी गई है। यदि संधारित्र की परावैद्युत के साथ और परावैद्युत के बिना धारिता क्रमश: C और C_0 है, तो $\frac{C}{C_0}$ है : *1*

(A) $\frac{K+1}{2K}$ (B) $\frac{2K}{K+1}$

(C) $\frac{K}{K-1}$ (D) $\frac{K-1}{K}$

30. अपद्रव्यी अर्धचालकों को शुद्ध अथवा नैज अर्धचालकों को उपयुक्त अशुद्धि से मादित करके बनाया जाता है। Si और Ge को मादित करने के लिए दो प्रकार के मादकों का उपयोग किया जाता है और इनका उपयोग करके p-प्रकार और n-प्रकार के अर्धचालक प्राप्त किए जा सकते हैं। p-n संधि बहुत सी अर्धचालक युक्तियों की मूल इकाई है। किसी p-n संधि के निर्माण के समय दो महत्त्वपूर्ण प्रक्रियाएँ होती हैं – विसरण तथा अपवाह। जब कोई इस प्रकार की संधि निर्मित होती है, तो कोई 'ह्रासी स्तर' उत्पन्न हो जाता है जो निश्चल आयन-क्रोडों से बना होता है। यह किसी संधि रोधिका विभव के लिए उत्तरदायी होता है। ह्रासी स्तर की चौड़ाई तथा रोधिका विभव की ऊँचाई संधि के अग्रबायसित अथवा पश्चबायसित होने पर परिवर्तित हो जाती है। कोई अर्धचालक डायोड आधार रूप से कोई p-n संधि होती है जिसके सिरों पर बाह्य वोल्टता अनुप्रयुक्त करने के लिए धातु के संपर्क प्रदान किए जाते हैं। डायोडों का उपयोग करके प्रत्यावर्ती वोल्टताओं (ac voltages) को दिष्टकृत किया जा सकता है।

(i) निम्नलिखित में से कौन-सा Ge के लिए दाता अशुद्धि परमाणु है ? *1*

(A) बोरॉन (B) ऐन्टिमनी

(C) ऐलुमिनियम (D) इंडियम

(ii) जब कोई पंचसंयोजी परमाणु Si के क्रिस्टलीय जालक में किसी परमाणु की स्थिति घेर लेता है तो इसके चार इलेक्ट्रॉन सिलिकॉन के चार पड़ोसियों के साथ सहसंयोजी आबन्ध बना लेते हैं जबकि पाँचवाँ इलेक्ट्रॉन पैतृक परमाणु से बँधा रहता है। इस इलेक्ट्रॉन को मुक्त करने के लिए आवश्यक ऊर्जा है लगभग : *1*

(A) 0·5 eV (B) 0·1 eV

(C) 0·05 eV (D) 0·01 eV

#

(b) A slab (area A and thickness $\frac{d}{2}$) of dielectric constant K is inserted in a parallel plate capacitor of plate area A and plate separation d. If C and C_0 are the capacitances of the capacitors with and without the dielectric, then $\frac{C}{C_0}$ is : *1*

(A) $\frac{K+1}{2K}$ (B) $\frac{2K}{K+1}$

(C) $\frac{K}{K-1}$ (D) $\frac{K-1}{K}$

30. Extrinsic semiconductors are made by doping pure or intrinsic semiconductors with suitable impurity. There are two type of dopants used in doping, Si or Ge, and using them p-type and n-type semiconductors can be obtained. A p-n junction is the basic building block of many semiconductor devices. Two important processes occur during the formation of a p-n junction : diffusion and drift. When such a junction is formed, a 'depletion layer' is created consisting of immobile ion-cores. This is responsible for a junction potential barrier. The width of a depletion layer and the height of potential barrier changes when a junction is forward-biased or reverse-biased. A semiconductor diode is basically a p-n junction with metallic contacts provided at the ends for application of an external voltage. Using diodes, alternating voltages can be rectified.

(i) Which of the following is a donor impurity atom for Ge ? *1*

(A) Boron (B) Antimony

(C) Aluminium (D) Indium

(ii) When a pentavalent atom occupies the position of an atom in the crystal lattice of Si, four of its electrons form covalent bonds with four silicon neighbours, while the fifth remains bound to the parent atom. The energy required to set this electron free is about : *1*

(A) 0·5 eV (B) 0·1 eV

(C) 0·05 eV (D) 0·01 eV

(iii) किसी p-n संधि के निर्मित होते समय : *1*

(A) n-फलक पर ऋणावेश की परत तथा p-फलक पर धनावेश की परत प्रकट होती है।

(B) n-फलक पर धनावेश की परत तथा p-फलक पर ऋणावेश की परत प्रकट होती है।

(C) संधि के p-फलक के इलेक्ट्रॉन आरम्भ में n-फलक की ओर गति करते हैं।

(D) आरम्भ में विसरण धारा निम्न तथा अपवाह धारा उच्च होती है।

(iv) (क) p-n संधि के पश्चदिशिक बायसन में : *1*

(A) अपवाह धारा कुछ mA कोटि की होती है।

(B) अधिकांश अनुप्रयुक्त वोल्टता का पात ह्रासी क्षेत्र के सिरों पर होता है।

(C) ह्रासी क्षेत्र की चौड़ाई घटती है।

(D) अनुप्रयुक्त वोल्टता में वृद्धि के साथ धारा में वृद्धि होती है।

अथवा

(ख) निवेशी आवृत्ति के रूप में 50 Hz के साथ पूर्ण-तरंग दिष्टकारी की निर्गत आवृत्ति होती है : *1*

(A) 25 Hz (B) 50 Hz

(C) 100 Hz (D) 200 Hz

खण्ड ङ

31. (क) (i) किसी ac जनित्र की कार्यविधि का सिद्धांत लिखिए। इसका नामांकित आरेख खींचकर इसकी कार्यविधि लिखिए।

(ii) किसी ac स्रोत $v = 140 \sin (100\pi)t$ V से श्रेणी में 400 Ω का प्रतिरोधक, $\left(\frac{5}{\pi}\right)$H का प्रेरक तथा $\left(\frac{50}{\pi}\right)\mu$F का संधारित्र संयोजित है। इन तीनों परिपथ अवयवों के सिरों पर rms वोल्टताएँ ज्ञात कीजिए। इन वोल्टताओं का बीजीय योगफल स्रोत की rms वोल्टता से अधिक होता है। व्याख्या कीजिए। *5*

अथवा

(ख) (i) किसी ट्रान्सफॉर्मर की कार्यविधि का सिद्धांत लिखिए। नामांकित आरेख की सहायता से किसी उच्चायी ट्रान्सफॉर्मर की कार्यविधि की व्याख्या कीजिए।

(iii) During formation of a p-n junction : *1*

(A) a layer of negative charge on n-side and a layer of positive charge on p-side appear.

(B) a layer of positive charge on n-side and a layer of negative charge on p-side appear.

(C) the electrons on p-side of the junction move to n-side initially.

(D) initially diffusion current is small and drift current is large.

(iv) (a) In reverse-biased p-n junction : *1*

(A) the drift current is of the order of few mA.

(B) the applied voltage mostly drops across the depletion region.

(C) the depletion region width decreases.

(D) the current increases with increase in applied voltage.

OR

(b) The output frequency of a full-wave rectifier with 50 Hz as input frequency is : *1*

(A) 25 Hz (B) 50 Hz

(C) 100 Hz (D) 200 Hz

SECTION E

31. (a) (i) Write the principle of working of an ac generator. Draw its labelled diagram and explain its working.

(ii) A resistor of 400 Ω, an inductor of $\left(\frac{5}{\pi}\right)$H and a capacitor of $\left(\frac{50}{\pi}\right)\mu$F are joined in series across an ac source v = 140 sin (100π)t V. Find the rms voltages across these three circuit elements. The algebraic sum of these voltages is more than the rms voltage of source. Explain. *5*

OR

(b) (i) Write the principle of working of a transformer. With the help of a labelled diagram, explain the working of a step-up transformer.

#

(ii) किसी ऐसे आदर्श ट्रान्सफॉर्मर की अभिकल्पना 50 V को 250 V में परिवर्तित करने के लिए की गई है। यह ट्रान्सफॉर्मर उस ac स्रोत से 200 W शक्ति लेता है जिसकी तात्कालिक वोल्टता $v_i = 20 \sin (100\pi)t$ V है।

ज्ञात कीजिए :

(I) निवेशी धारा का rms मान।

(II) तात्कालिक निर्गत वोल्टता के लिए व्यंजक।

(III) तात्कालिक निर्गत धारा के लिए व्यंजक। *5*

32. (क) (i) किसी संयुक्त सूक्ष्मदर्शी द्वारा प्रतिबिम्ब निर्माण दर्शाने के लिए किरण आरेख खींचिए। इस सूक्ष्मदर्शी के कुल आवर्धन के लिए व्यंजक प्राप्त कीजिए जिसमें अंतिम प्रतिबिम्ब अनन्त पर बनता है।

(ii) किसी संयुक्त सूक्ष्मदर्शी के 1·25 cm फोकस दूरी के अभिदृश्यक से 1·5 cm दूरी पर कोई बिम्ब स्थित है। नेत्रिका की फोकस दूरी 5 cm है। अंतिम प्रतिबिम्ब अनन्त पर बनता है। अभिदृश्यक और नेत्रिका के बीच की दूरी परिकलित कीजिए। *5*

अथवा

(ख) (i) हाइगेन्स सिद्धांत का उपयोग करके वायु और काँच के बीच के समतल अन्तराफलक पर वायु में संचरण करते किसी समतल तरंगाग्र के अपवर्तन की व्याख्या कीजिए। इस प्रकार स्नेल के नियम का सत्यापन कीजिए।

(ii) दर्पण सूत्र का उपयोग करके यह निगमित कीजिए कि किसी उत्तल दर्पण के सामने रखे किसी बिम्ब का दर्पण द्वारा सदैव ही आभासी प्रतिबिम्ब बनता है। *5*

33. (क) (i) किसी प्रदेश में विद्युत-क्षेत्र को $\vec{E} = 40x\,\hat{i}$ N/C द्वारा व्यक्त किया गया है। किसी एकांक धनावेश को बिन्दु (0, 3m) से बिन्दु (5m, 0) तक ले जाने में किया गया कार्य ज्ञात कीजिए।

(ii) कोई आवेश Q, त्रिज्या r और R (> r) के दो संकेन्द्री खोखले गोलों पर इस प्रकार वितरित है कि उनके पृष्ठीय आवेश घनत्व समान हैं। इन गोलों के उभयनिष्ठ केन्द्र पर :

(I) विद्युत-क्षेत्र, तथा

(II) विभव ज्ञात कीजिए। *5*

अथवा

(ii) An ideal transformer is designed to convert 50 V into 250 V. It draws 200 W power from an ac source whose instantaneous voltage is given by $v_i = 20 \sin (100\pi)t$ V.

Find :

(I) rms value of input current.

(II) expression for instantaneous output voltage.

(III) expression for instantaneous output current. *5*

32. (a) (i) Draw a ray diagram to show the image formation by a compound microscope. Obtain the expression for the total magnification of the microscope when the final image is formed at infinity.

(ii) In a compound microscope, an object is placed at a distance of 1·5 cm from the objective of focal length 1·25 cm. The eyepiece has a focal length of 5 cm. The final image is formed at infinity. Calculate the distance between the objective and the eyepiece. *5*

OR

(b) (i) Using Huygens' principle, explain the refraction of a plane wavefront, propagating in air, at a plane interface between air and glass. Hence verify Snell's law.

(ii) Use mirror formula to deduce that a convex mirror always produces a virtual image of an object kept in front of it. *5*

33. (a) (i) The electric field in a region is given by $\vec{E} = 40x\ \hat{i}$ N/C. Find the amount of work done in taking a unit positive charge from a point (0, 3m) to the point (5m, 0).

(ii) A charge Q is distributed over two concentric hollow spheres of radii r and R (> r) such that their surface charge densities are equal. Find :

(I) the electric field, and

(II) the potential

at their common centre. *5*

OR

#

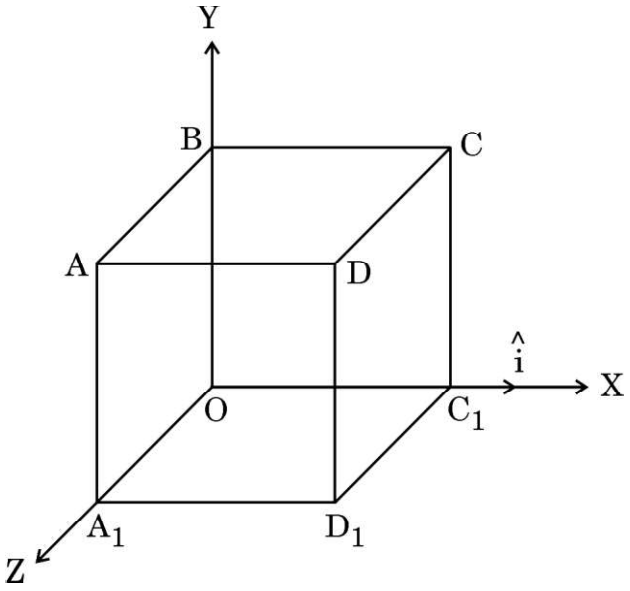
(ख) (i) द्विध्रुव आघूर्ण $\vec{p}$ के किसी द्विध्रुव के कारण इसके निरक्षीय समतल के किसी बिन्दु पर विद्युत-क्षेत्र $\vec{E}$ के लिए व्यंजक प्राप्त कीजिए और इसकी दिशा निर्दिष्ट कीजिए। इस प्रकार :

(I) इस द्विध्रुव के केन्द्र ($r = 0$) पर, तथा

(II) किसी बिन्दु $r >> a$ पर

विद्युत-क्षेत्र का मान ज्ञात कीजिए, जहाँ $2a$ द्विध्रुव की लंबाई है।

(ii) किसी प्रदेश में, जिसमें भुजा L का कोई घन आरेख में दर्शाए अनुसार स्थित है कोई विद्युत-क्षेत्र $\vec{E} = (10x + 5)\hat{i}$ N/C विद्यमान है, यहाँ x और L मीटर में हैं। इस घन से गुजरने वाला नेट फ्लक्स परिकलित कीजिए। *5*



#

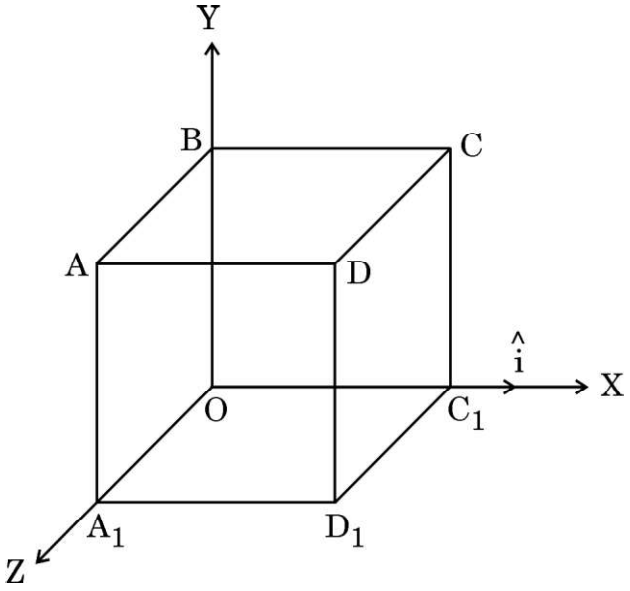
(b) (i) Obtain an expression for the electric field $\vec{E}$ due to a dipole of dipole moment $\vec{p}$ at a point on its equatorial plane and specify its direction. Hence, find the value of electric field :

(I) at the centre of the dipole (r = 0), and

(II) at a point r >> a,

where 2a is the length of the dipole.

(ii) An electric field $\vec{E} = (10x + 5)\hat{i}$ N/C exists in a region in which a cube of side L is kept as shown in the figure. Here x and L are in metres. Calculate the net flux through the cube. *5*

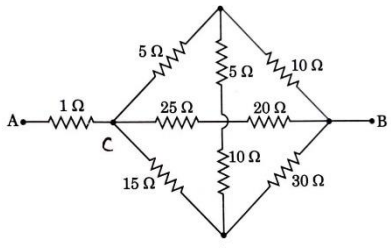


Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2025
SUBJECT NAME PHYSICS (PAPER CODE 55/6/1)

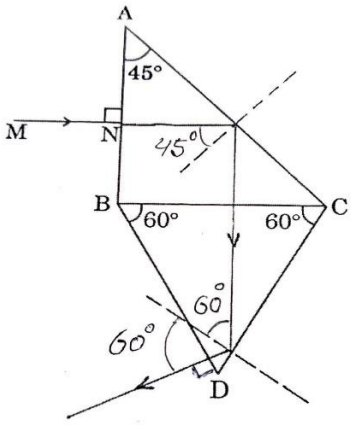
General Instructions: -

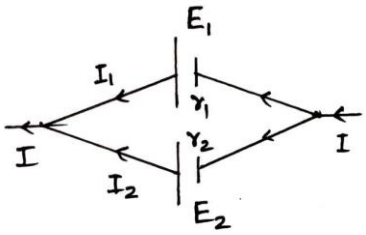
1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (✓) while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.

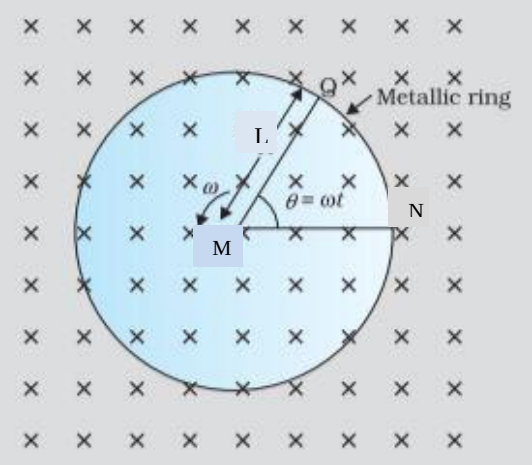
11	A full scale of marks 70 (example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any un assessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for spot Evaluation**" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

MARKING SCHEME: PHYSICS(042)			
Code: 55/6/1			
Q.No.	**VALUE POINTS/EXPECTED ANSWERS**	**Marks**	**Total Marks**
	SECTION A		
1.	(D) $T_1 < T_2$	1	1
2.	(C) $\left[\frac{n^2-1}{n}\right]R$	1	1
3.	(C) $\frac{\mu_0 I}{4R}$	1	1
4.	(D) does not move at all	1	1
5.	(C) small resistance in parallel	1	1
6.	(B) $\frac{1}{2}$	1	1
7.	(C) g	1	1
8.	(A) 10 V	1	1
9.	(C) $2I_0$	1	1
10.	(A) Red Light	1	1
11.	(B) 1.326×10^{-27}	1	1
12.	(D) $F_{pp} = F_{pn} = F_{nn}$	1	1
13.	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)	1	1
14.	(C) Assertion (A) is true, But Reason (R) is false.	1	1
15.	(D) Both Assertion (A) and Reason (R) are false.	1	1
16.	(C) Assertion (A) is true, But Reason (R) is false.	1	1
	SECTION B		
17.	Finding equivalent resistance between points A and B 2 Resistance between points C and B $\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}$ $\frac{1}{R}=\frac{1}{15}+\frac{1}{45}+\frac{1}{45}$ R = 9 Ω Equivalent resistance between points A and B 	½ ½	

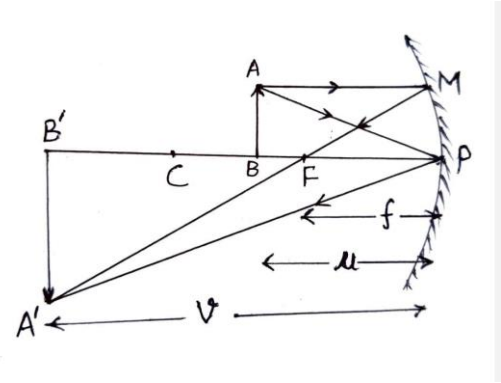
	$R_{eq} = R_1 + R_2$ $R_{eq} = 1 + 9$ $= 10\ \Omega$	½ ½	2
18.	(a) Finding the intensity for path difference of (i) $\frac{\lambda}{3}$ 1 (ii) $\frac{\lambda}{2}$ 1 (i) $\Delta\phi = \frac{2\pi}{\lambda}.\Delta x$ $\Delta\phi = \frac{2\pi}{\lambda}.\frac{\lambda}{3} = \frac{2\pi}{3}$ $I = 4I_0 \cos^2 \frac{\phi}{2}$ $I = 4I_0 \cos^2 \frac{\pi}{3}$ $I = I_0$ (ii) $\Delta\phi = \frac{2\pi}{\lambda}.\frac{\lambda}{2} = \pi$ $I = 4I_0 \cos^2 \frac{\pi}{2}$ $I = 0$ OR (b) Finding- The position of the image 1½ The nature of the image ½ $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ $\frac{1.5}{v} - \frac{1}{(-12)} = \frac{1.5-1}{30}$ v = -22.5 cm Image is virtual and erect.	½ ½ ½ ½ ½ ½ ½ ½	**2**

19.	Finding- (i) The energy of photon of the beam 1 (ii) The average number of photons emitted per second (N) 1 (i) $E = h\nu$ $= 6.63\times10^{-34}\times3.0\times10^{14}$ $= 1.99\times10^{-19}$ J (ii) $N = \frac{P}{E}$ $= \frac{9\times10^{-3}}{1.99\times10^{-19}}$ $= 4.5\times10^{16}$	½ ½ ½ ½	2
20.	Tracing the path of ray MN 2  Note: Please deduct ½ mark for not showing arrows with the rays.	1 1	2
21.	Explanation for higher electron concentration in n-type semiconductor in comparison to hole concentration 2 In a doped semiconductor the total number of conduction electrons is due to the electrons contributed by donors and those generated intrinsically, while the total number of holes is only due to the holes from the intrinsic sources.	2	2

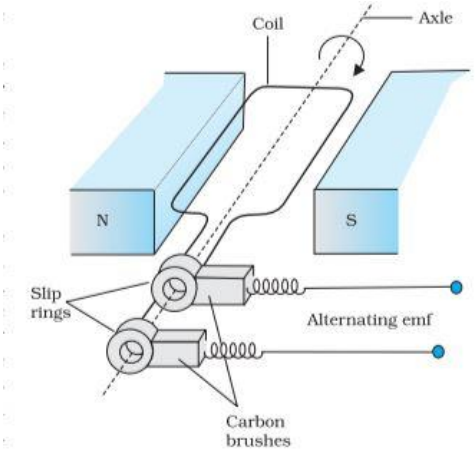
	SECTION - C		
22.	• Difference between emf and terminal voltage of a cell 1 Deriving expression for- • Equivalent emf of combination of cells 1½ • Equivalent internal resistance of combination of cells ½		
	(Any one difference) 1. Potential difference between the terminals of a cell in open circuit is emf and in closed circuit it is terminal voltage. 2. An emf does not depend on the external resistance, while terminal voltage depends on external resistance. 3. emf is the cause and terminal voltage is the effect.	1	
		½	
	$V = E_1 - I_1 r_1$ $V = E_2 - I_2 r_2$	½	
	$I = I_1 + I_2$ $I = \left(\frac{E_1 - V}{r_1}\right) + \left(\frac{E_2 - V}{r_2}\right)$ On comparing above equation with $I = \frac{E_{eq} - V}{r_{eq}}$		
	$E_{eq} = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$	½	
	$r_{eq} = \frac{r_1 r_2}{r_1 + r_2}$	½	3
23.	Finding- (i) The torque acting on the loop 1 (ii) The magnitude and direction of net force 2		
	(i) $\tau = mB\sin\theta$ As $\vec{m}$ and $\vec{B}$ are in same direction, $\theta = 0^0$	½	
	$\tau = 0$	½	
	(ii) $F = \frac{\mu_0 I_1 I_2 l}{2\pi r}$	½	

	$F_{net} = \frac{\mu_0 I_1 I_2 l}{2\pi}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ $= \frac{4\pi\times10^{-7}\times2\times1\times5\times10^{-2}}{2\pi\times10^{-2}}\left(1-\frac{1}{2}\right)$ $F_{net} = 1\times10^{-6}\ \text{N}$ Net force on the loop is towards the long straight wire.	½ ½ ½	3
24.	(a) Stating Lenz's law 1 Obtaining expression for induced emf 2 **Lenz's law** The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it. **Expression of induced emf**  The magnitude of the emf generated across the length dr of the rod as it moves at right angles to the magnetic field is given by $d\varepsilon = B\text{v}\,dr$ $\varepsilon = \int d\varepsilon$ $= \int_0^L B\text{v}\,dr$ $\varepsilon = \int_0^L B\omega r\,dr$ $\varepsilon = \frac{1}{2}BL^2\omega$ **Alternatively:** Area of the sector (QMN) = $\frac{1}{2}L^2\theta$	1 ½ ½ ½ ½ ½	

	Induced emf is $\varepsilon = B \times \frac{d}{dt}\left(\frac{1}{2}L^2\theta\right)$ $\varepsilon = \frac{1}{2}BL^2\frac{d\theta}{dt}$ $\varepsilon = \frac{1}{2}BL^2\omega$ OR (b) Definition of self inductance 1 Deriving expression for self inductance for a long solenoid 2 Self inductance of a coil is the ratio of the flux linkage to the current flowing in the coil. **Alternatively:** Self inductance of a coil is defined as the flux linked with the coil when unit current flows through it. **Alternatively**: Self inductance of a coil may be defined as the magnitude of emf induced in the coil when current changes at the rate of 1 A/s in the coil. **Expression for self inductance of a long solenoid:** The magnetic field due to current flowing in the solenoid, B = $\mu_0 nI$ Total flux linked with the given solenoid $N\phi_B = (nl)(\mu_0 nI)\,\mathrm{A}$ $N\phi_B = \mu_0 n^2\,\mathrm{A}\,lI$ Self inductance $L = \frac{N\phi_B}{I}$ $L = \mu_0 n^2\,\mathrm{A}\,l$	½ ½ ½ 1 ½ ½ ½ ½	3
25.	Naming the electromagnetic waves 1½ Writing wavelength range 1½ The electromagnetic waves used are (i) Microwaves (ii) Ultraviolet / Infrared (iii) X-Rays Wavelength range of electromagnetic waves used (i) 0.1 m to 1 mm (ii) 400 nm to 1 nm / 1mm to 700 nm (iii) 1 nm to 10^{-3} nm	½ ½ ½ ½ ½ ½	3

26.	Drawing the ray diagram 1 Obtaining the mirror formula 2  **Note:** Please deduct ½ mark of this diagram if not showing arrows with the rays. In similar triangles $\Delta A'B'F$ *and* ΔMPF $\frac{A'B'}{MP}=\frac{B'F}{FP}$ or $\frac{A'B'}{AB}=\frac{B'F}{FP}$ $(\because MP=AB)$ ---------(1) In similar triangles $\Delta A'B'P$ *and* ΔABP $\frac{A'B'}{AB}=\frac{PB'}{PB}$ -------(2) from equation (1) and (2) $\frac{B'F}{FP}=\frac{PB'}{PB}$ $\frac{PB'-PF}{FP}=\frac{PB'}{PB}$ $\frac{(-v)-(-f)}{(-f)}=\frac{(-v)}{(-u)}$ on solving we get $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$	1 ½ ½ ½ ½	3
27.	• To state the necessary force for revolving electron around the nucleus ½ • Deriving the expression for total energy of electron in hydrogen atom 2 • Significance of negative sign ½ The electrostatic force of attraction between the electrons and the nucleus provides the necessary centripetal force required to an electron to revolve in the orbit.	½	

	$\frac{mv^2}{r}=\frac{e^2}{4\pi\varepsilon_0 r^2}$ -------(1) (Z = 1 for hydrogen atom) Kinetic energy of the electron $K=\frac{1}{2}mv^2$ $K=\frac{e^2}{8\pi\varepsilon_0 r}$ (from eq(1)) Potential energy of the electron $U=\frac{-e^2}{4\pi\varepsilon_0 r}$ $\left(\because U=\frac{q_1 q_2}{4\pi\varepsilon_0 r}\right)$ Total energy of the electron E = K + U $E=\frac{-e^2}{8\pi\varepsilon_0 r}$ Note: Full credit of this part should be given if a student shows this derivation using alternative method Negative sign signifies that electron is bound to the nucleus OR force is attractive.	½ ½ ½ ½ ½	3
28.	Finding the amount of energy released 2 Showing the nuclear density is independent of mass number 1 $\Delta m=\left[m(^2_1H)+m(^3_1H)\right]-\left[m(^4_2He)+m(^1_0n)\right]$ = (2.014102 + 3.016049) – (4.002603 + 1.008665) = 0.018883u Q = $\Delta m\times 931$ = 0.018883 × 931 MeV Q = 17.58 MeV Nuclear density = $\frac{\text{Mass of nucleus}}{\text{Volume of nucleus}}$ $\rho=\frac{mA}{\frac{4}{3}\pi R^3}$ $R=R_0A^{1/3}$ $\rho=\frac{3m}{4\pi R_0^3}$ Independent of mass number (A)	½ ½ ½ ½ ½ ½	3

	SECTION - D		
29.	(i) (A) $\left(\frac{C}{4}\right)$ (ii) (B) $\frac{\sigma}{\sigma-\sigma_p}$ (iii) (C) $\frac{1}{2}\varepsilon_0 E^2 V$ (iv) (a) (D) 6 OR (b) (B) $\frac{2K}{K+1}$	1 1 1 1	4
30.	(i) (B) Antimony (ii) (C) 0.05 eV (iii) (B) A layer of positive charge on n side and a layer of negative charge on p side appear (iv) (a) (B) The applied voltage mostly drops across the depletion region OR (b) (C) 100 Hz	1 1 1 1	4
	SECTION - E		
31.	**(a)** (i) Writing principle of ac generator 1 Labelled diagram of ac generator 1 Working of ac generator 1 (ii) Finding rms voltages across three circuit elements 1½ Explanation of the algebraic sum of rms voltages across three circuit elements is more than the rms voltage source ½ **(i) Principle:** It works on the principle of electromagnetic induction.  	1 1	

Working: The coil is mechanically rotated in the uniform magnetic field. The rotation of the coil causes the magnetic flux through it to change, so an emf is induced in the coil. 1

(i) $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$

$= \sqrt{(400)^2 + \left(100\pi \times \frac{5}{\pi} - \frac{1}{100\pi \times \frac{50}{\pi} \times 10^{-6}}\right)^2}$

$= 500\,\Omega$

$I_{rms} = \frac{V_{rms}}{Z}$

$I_{rms} = \frac{140}{\sqrt{2} \times 500} = \frac{0.28}{\sqrt{2}}$ A

$(V_{rms})_R = I_{rms}\ R$

$= \frac{0.28}{\sqrt{2}} \times 400$

$= \frac{112}{\sqrt{2}} = 56\sqrt{2}$ V ½

$(V_{rms})_L = I_{rms}\ \omega \mathrm{L}$

$= \frac{0.28}{\sqrt{2}} \times 500$

$= \frac{140}{\sqrt{2}} = 70\sqrt{2}$ V ½

$(V_{rms})_C = I_{rms}\ \frac{1}{\omega C}$

$= \frac{0.28}{\sqrt{2}} \times 200$

$= \frac{56}{\sqrt{2}} = 28\sqrt{2}$ V ½

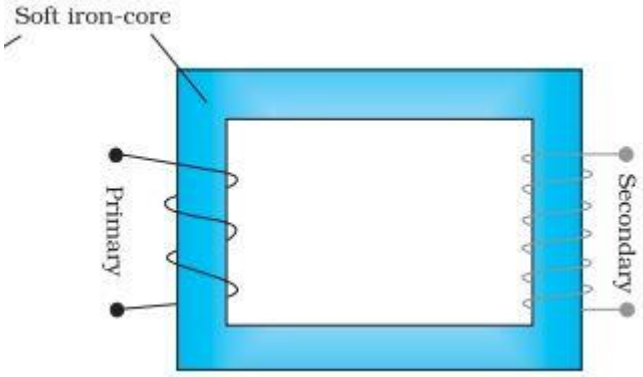
The algebraic sum of voltages is more than the rms voltage of source because voltages across R, L and C are not in phase. ½

OR

(b)

(i)	Writing principle of transformer	1
	Labelled diagram of step-up transformer	1
	Working of step-up transformer	1
(ii)	Finding-	
	• rms value of input current	1
	• expression for instantaneous output voltage	½
	• expression for instantaneous output current	½

(i) **Principle**: It works on the principle of mutual induction. 1



1

Working: When an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links the secondary and induces an emf in it. Since the no. of turns are more in secondary windings an emf induced is proportional to the no. of turns. Therefore more emf is developed across the secondary windings. 1

(ii) $P_i = V_p I_p$ ½

$200 = \frac{20}{\sqrt{2}} I_p$ ½

$I_p = 10\sqrt{2}\,\text{A}$

$\frac{V_o}{V_i} = \frac{250}{50}$

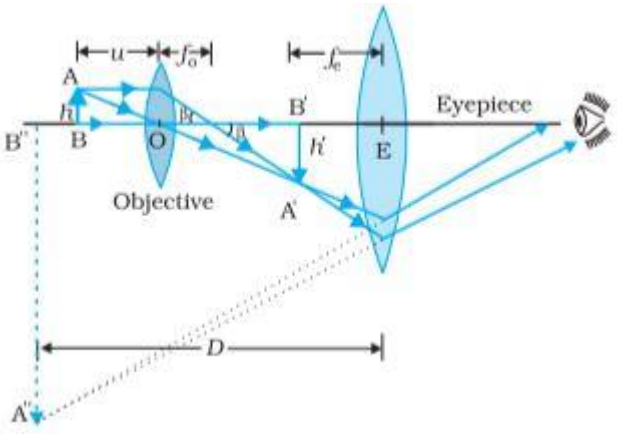
$5 = \frac{V_o}{V_i}$

$V_o = 100\sin(100\pi)\,\text{t V}$ ½

$\text{P}_o = (V_o)_{rms}(I_o)_{rms}$

$200 = \frac{100}{\sqrt{2}}(I_o)_{rms}$

$(I_o)_{rms} = 2\sqrt{2}\,\text{A}$

	$\therefore I_o = \left(2\sqrt{2}\right)\sqrt{2}\sin(100\pi)\,t$ $I_o = 4\sin(100\pi)\,t\,A$	½	**5**
32.	(a) (i) Drawing ray diagram of compound microscope 1½ Obtaining an expression for total magnification 1½ (ii) Calculating distance between the objective and the eye-piece 2 (i)  Note: Deduct ½ mark for not showing arrows with the rays. Magnification produced by objective $m_0 = \frac{h'}{h} = \frac{L}{f_o}$ Magnification produced by eye-piece $m_e = 1 + \frac{D}{f_e}$ If the final image is formed at infinity $m_e = \frac{D}{f_e}$ Total magnification $m = m_0 \times m_e$ $= \left(\frac{L}{f_o}\right)\left(\frac{D}{f_e}\right)$ (ii) $\frac{1}{v_o} - \frac{1}{u_o} = \frac{1}{f_0}$ $\frac{1}{v_o} - \frac{1}{(-1.5)} = \frac{1}{1.25}$ $v_o = 7.5\,cm$	1½ ½ ½ ½ ½ ½	

$L = |v_o| + |f_e|$ as final image is formed at infinity ($v_e = \infty, u_e = f_e$) ½

L = 7.5 + 5 ½

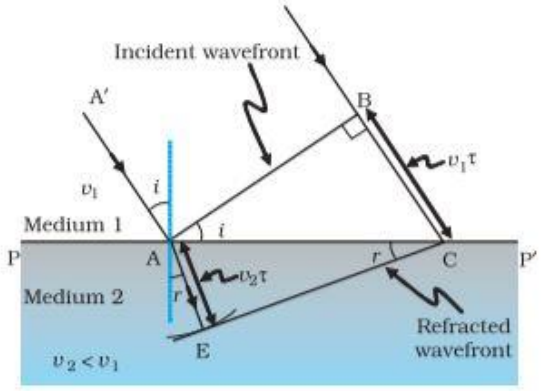
L= 12.5 cm

OR

(b)

(i) Explaining the refraction of a plane wavefront	1
Verification of Snell's law	2
(ii) Deducing that a convex mirror always produces a virtual image of an object	2

(i)



1

$\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$ ½

$\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$ ½

$\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$

$\frac{\sin i}{\sin r} = \frac{c/n_1}{c/n_2}$ ½

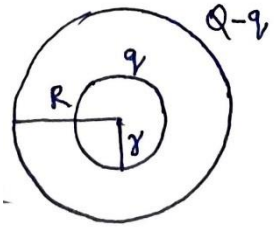
$\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$ or $n_1 \sin i = n_2 \sin r$ ½

(ii) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ ½

$u < 0$, $f > 0$

$\frac{1}{v} + \frac{1}{(-u)} = \frac{1}{f}$ ½

$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$ ½

	$\frac{1}{v}$ is positive $\therefore$ v is positive $\Rightarrow$ virtual image	½	5
33.	(i) Finding the amount of work done 2 (ii) Finding (I) The electric field at their common centre 1 (II) The potential at their common centre 2 (a) (i) $V = -\int \vec{E} \cdot \overrightarrow{dr}$ $= -\int 40\,x\,dx$ $= -20\,x^2$ Potential at A (0, 3m), $V_A = 0$ Potential at B (5m, 0), V_B = -500 V Work done in taking a unit positive charge from a point (0, 3m) to the point (5m, 0) $W = q(V_B - V_A)$ $= 1(-500 - 0)$ $W = -500\,J$ (ii) (I) Electric field at the common centre will be zero as the charge enclosed by the inner sphere is zero.  **Alternatively:** $q_{en} = 0$ $\phi_E = 0$ $\oint \vec{E}.\overrightarrow{ds} = 0$ $E = 0$ (II) $\because$ Surface charge densities are equal $\frac{q}{4\pi r^2} = \frac{Q-q}{4\pi R^2}$	½ ½ ½ 1 ½ ½ ½	

$$q = \frac{Qr^2}{R^2 + r^2}$$ ½

Potential at common centre

$$V = \frac{kq}{r} + \frac{k(Q-q)}{R}$$ ½

$$V = \frac{k}{r}\frac{Qr^2}{(R^2+r^2)} + \frac{k}{R}\left[Q - \frac{Qr^2}{(R^2+r^2)}\right]$$

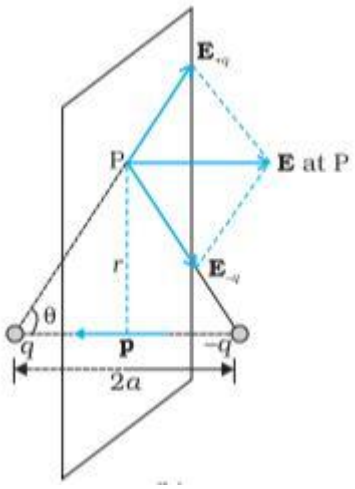
$$V = \frac{kQ(R+r)}{R^2+r^2}$$ ½

OR

(b)

(i)	Obtaining expression for electric field due to a dipole on its equatorial plane	2
	Finding electric field:	
	(I) At centre of the dipole	½
	(II) At a point r >> a	½
(ii)	Calculating net electric flux through cube	2

(i)



½

The magnitudes of the electric field due to two charges +q and -q are

$$E_{+q} = \frac{q}{4\pi\varepsilon_0}\frac{1}{\left(r^2+a^2\right)}$$

$$E_{-q} = \frac{q}{4\pi\varepsilon_0}\frac{1}{\left(r^2+a^2\right)}$$ ½

The total electric field

$$\vec{E} = -\left(E_{+q} + E_{-q}\right)\cos\theta\,\hat{p}$$

	$\vec{E} = -\frac{\vec{p}}{4\pi\varepsilon_0\left(r^2+a^2\right)^{3/2}}$	½	
	Direction of electric field is opposite to dipole moment ($\vec{p}$)	½	
	(I) At centre of dipole, r = 0		
	$\vec{E} = -\frac{-\vec{p}}{4\pi\varepsilon_0 a^3}$	½	
	(II) At a point r>>a		
	$\vec{E} = -\frac{-\vec{p}}{4\pi\varepsilon_0 r^3}$	½	
	(ii) $\vec{E} = (10x+5)\hat{i}$ N/C		
	$\phi_L = \int \vec{E}.\vec{ds}$		
	$= -E_L(L^2)$	½	
	$= -5L^2$		
	$\phi_R = E_R(L^2)$	½	
	$= (10L+5)L^2$		
	$\phi_{net} = \phi_L + \phi_R$		
	$= -5L^2 + (10L+5)L^2$	½	
	$= 10L^3$ Nm^2/C	½	5

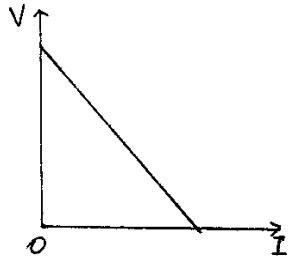
Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2025
SUBJECT NAME PHYSICS (PAPER CODE 55/6/2)

General Instructions: -

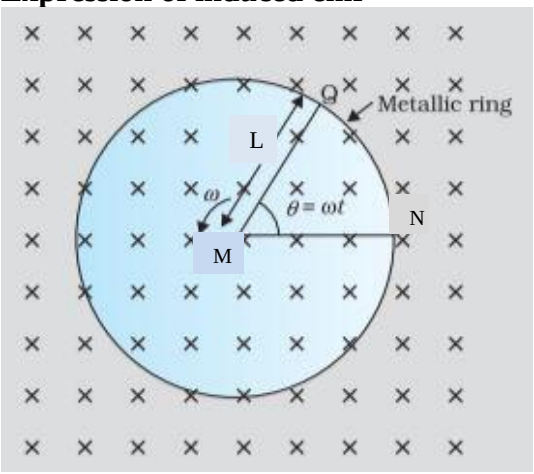
1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (✓) while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.

11	A full scale of marks 70 (example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any un assessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for spot Evaluation**" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

MARKING SCHEME: PHYSICS(042)			
Code: 55/6/2			
Q.No.	**VALUE POINTS/EXPECTED ANSWERS**	**Marks**	**Total Marks**
	SECTION A		
1.	(A) $\frac{P}{4}$	1	1
2.	(C) g	1	1
3.	(B) $(-0.16\hat{j}+0.12\hat{k})$N	1	1
4.	(A) 10 V	1	1
5.	(B) $\frac{1}{2}$	1	1
6.	(C) $2I_0$	1	1
7.	(C) $\left[\frac{n^2-1}{n}\right]R$	1	1
8.	(C) small resistance in parallel	1	1
9.	(D) $F_{pp}=F_{pn}=F_{nn}$	1	1
10.	(D) 0.55 nm	1	1
11.	(D) does not move at all	1	1
12.	(B) 1.326×10^{-27}	1	1
13.	(C) Assertion (A) is true, But Reason (R) is false.	1	1
14.	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)	1	1
15.	(C) Assertion (A) is true, But Reason (R) is false.	1	1
16.	(D) Both Assertion (A) and Reason (R) are false.	1	1
	SECTION B		
17.	Plotting the graph 1 Explaining how to find emf and internal resistance of cell ½ + ½ Graph showing the variation of terminal voltage V of the cell as a function of current I.		

	 $V = E - Ir$ E = intercept on y-axis (i.e. V-axis) r = $\lvert$slope of graph$\rvert$	1 ½ ½	2
18.	Explanation for higher electron concentration in n-type semiconductor in comparison to hole concentration 2 In a doped semiconductor the total number of conduction electrons is due to the electrons contributed by donors and those generated intrinsically, while the total number of holes is only due to the holes from the intrinsic sources.	2	2
19.	Finding force exerted by laser beam 2 No. of photons ejected per second = $\frac{P}{E}$ $= \frac{P}{\left(\frac{hc}{\lambda}\right)}$ Momentum of photon, $p = \frac{h}{\lambda}$ Force exerted by laser beam $F = 2 \times \frac{P}{\left(\frac{hc}{\lambda}\right)} \times \frac{h}{\lambda}$ $= \frac{2P}{c}$ $= \frac{2 \times 5 \times 10^{-3}}{3 \times 10^{8}}$ $F = 3.33 \times 10^{-11}$ N	 ½ ½ ½ ½	2
20.	Finding angle of incidence 1 Finding angle of refraction on face AB 1		

	In a prism we know $A+\delta=i+e \quad and \; A=r_1+r_2$ At minimum deviation $i=e \;\; and \;\; r_1=r_2=r$ $A+D_m=2i$ $i=\frac{A+D_m}{2}$ $A=2r$ $r=A/2$	½ ½ ½ ½	2
21.	(a) Finding the intensity for path difference of (i) $\frac{\lambda}{3}$ 1 (ii) $\frac{\lambda}{2}$ 1 (i) $\Delta\phi=\frac{2\pi}{\lambda}.\Delta x$ $\Delta\phi=\frac{2\pi}{\lambda}.\frac{\lambda}{3}=\frac{2\pi}{3}$ $I=4I_0\cos^2\frac{\phi}{2}$ $I=4I_0\cos^2\frac{\pi}{3}$ $I=I_0$ (ii) $\Delta\phi=\frac{2\pi}{\lambda}.\frac{\lambda}{2}=\pi$ $I=4I_0\cos^2\frac{\pi}{2}$ $I=0$ OR (b) Finding- The position of the image 1½ The nature of the image ½ $\frac{n_2}{v}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$	½ ½ ½ ½	

	$\frac{1.5}{v} - \frac{1}{(-12)} = \frac{1.5-1}{30}$ v = -22.5 cm Image is virtual and erect.	½ ½ ½	2
	SECTION - C		
22.	(a) Defining drift velocity 1 (b) Derivation of formula for current density in terms of relaxation time 2 (a) Drift velocity is the average velocity with which the free electrons move under external electric field in a conductor. (b) Current density $j = \frac{I}{A}$ $\because I = neAv_d$ $\therefore j = nev_d$ $But\ v_d = \frac{eE\tau}{m}$ $\therefore j = \frac{ne^2\tau E}{m} = \frac{ne^2\tau}{m}\left(\frac{V}{l}\right)$	1 ½ ½ ½ ½	3
23.	(a) Stating Lenz's law 1 Obtaining expression for induced emf 2 **Lenz's law** The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it. **Expression of induced emf**  	1	

The magnitude of the emf generated across the length dr of the rod as it moves at right angles to the magnetic field is given by

$d\varepsilon = B\text{v}\, dr$ ½

$\varepsilon = \int d\varepsilon$

$= \int_0^L B\text{v}\, dr$ ½

$\varepsilon = \int_0^L B\omega r\, dr$ ½

$\varepsilon = \frac{1}{2} BL^2\omega$ ½

Alternatively:

Area of the sector (QMN) = $\frac{1}{2}L^2\theta$ ½

Induced emf is $\varepsilon = B \times \frac{d}{dt}\left(\frac{1}{2}L^2\theta\right)$ ½

$\varepsilon = \frac{1}{2} BL^2 \frac{d\theta}{dt}$ ½

$\varepsilon = \frac{1}{2} BL^2\omega$ ½

OR

(b)

Definition of self inductance	1
Deriving expression for self inductance for a long solenoid	2

Self inductance of a coil is the ratio of the flux linkage to the current flowing in the coil. 1

Alternatively:
Self inductance of a coil is defined as the flux linked with the coil when unit current flows through it.

Alternatively:
Self inductance of a coil may be defined as the magnitude of emf induced in the coil when current changes at the rate of 1 A/s in the coil.

Expression for self inductance of a long solenoid:

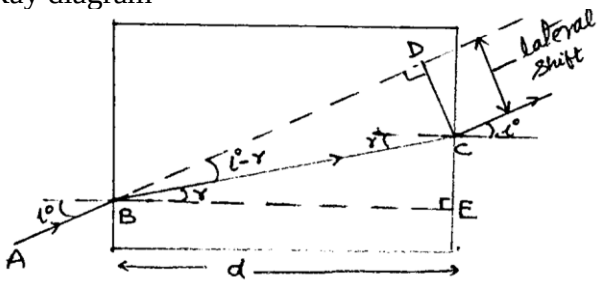
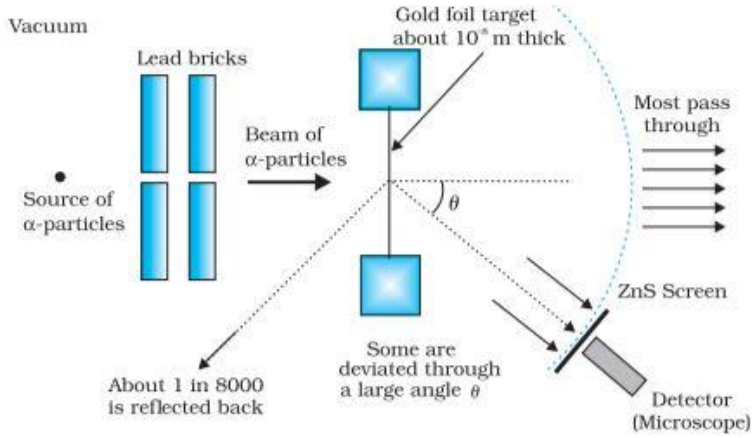
The magnetic field due to current flowing in the solenoid, B = $\mu_0 nI$ ½

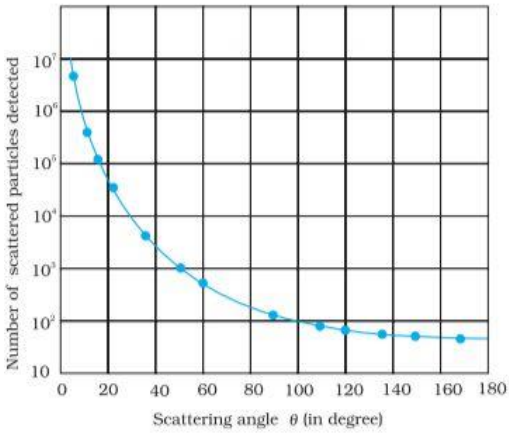
Total flux linked with the given solenoid

$N\phi_B = (nl)(\mu_0 nI)\,\text{A}$

$N\phi_B = \mu_0 n^2\,\text{A}\, lI$ ½

Self inductance

	$L = \frac{N\phi_B}{I}$ $L = \mu_0 n^2 \, A \, l$	½ ½	3
24.	Obtaining expression for lateral shift 2½ Condition for shift to be minimum ½ Ray diagram  $\sin(i-r) = \frac{CD}{BC}$ ––––––––(1) $\cos r = \frac{BE}{BC} = \frac{d}{BC}$ Putting in equation (1) $CD = \frac{d \sin(i-r)}{\cos r}$ Shift will be minimum for minimum angle of incidence.	1 ½ ½ ½ ½	3
25.	Describing briefly Geiger- Marsden scattering experiment 1 Graph showing the variation of number of scattered particles 1 Lead from the graph to discovery of nucleus 1  	1	

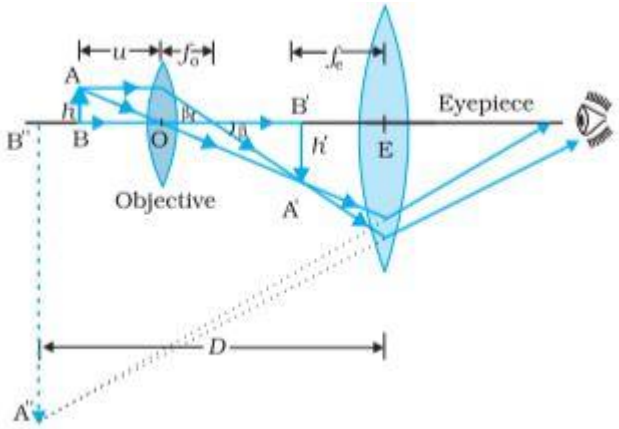
	 A small fraction of number of incident α -particles rebound back. It indicates that the number of α -particles undergoing head on collision is very small. From this we conclude that the positive charge is concentrated in a very small volume called nucleus.	1 1	 3
26.	Finding Q value of given reaction 2½ Writing nature of reaction ½ Mass defect Δm = mass of the reactants – mass of the products $\Delta m = 2\times12 - 19.992439 - 4.002603$ $\Delta m = 0.004958u$ $Q = \Delta m \times 931$ $= 0.004958 \times 931$ $= 4.62\,\text{MeV}$ The reaction is exothermic.	½ ½ ½ ½ ½ ½	 3
27.	Finding- (i) The torque acting on the loop 1 (ii) The magnitude and direction of net force 2 (i) $\tau = mB\sin\theta$ As $\vec{m}$ and $\vec{B}$ are in same direction, $\theta = 0^0$ $\tau = 0$ (ii) $F = \frac{\mu_0 I_1 I_2 l}{2\pi r}$ $F_{net} = \frac{\mu_0 I_1 I_2 l}{2\pi}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$	½ ½ ½	

	$= \frac{4\pi \times 10^{-7} \times 2 \times 1 \times 5 \times 10^{-2}}{2\pi \times 10^{-2}} \left(1 - \frac{1}{2}\right)$	½	
	$F_{net} = 1 \times 10^{-6}$ N	½	
	Net force on the loop is towards the long straight wire.	½	3
28.	Naming the electromagnetic waves 1½ Writing wavelength range 1½		
	The electromagnetic waves used are		
	(i) Microwaves	½	
	(ii) Ultraviolet / Infrared	½	
	(iii) X-Rays	½	
	Wavelength range of electromagnetic waves used		
	(i) 0.1 m to 1 mm	½	
	(ii) 400 nm to 1 nm / 1mm to 700 nm	½	
	(iii) 1 nm to 10^{-3} nm	½	3
	SECTION- D		
29.	(i) (B) Antimony	1	
	(ii) (C) 0.05 eV	1	
	(iii) (B) A layer of positive charge on n side and a layer of negative charge on p side appear	1	
	(iv) (a) (B) The applied voltage mostly drops across the depletion region	1	
	OR		
	(b) (C) 100 Hz		4
30.	(i) (A) $\left(\frac{C}{4}\right)$	1	
	(ii) (B) $\frac{\sigma}{\sigma - \sigma_p}$	1	
	(iii) (C) $\frac{1}{2}\varepsilon_0 E^2 V$	1	
	(iv) (a) (D) 6	1	
	OR		
	(b) (B) $\frac{2K}{K+1}$		4

	SECTION - E		
31.	(a)		

(i) Drawing ray diagram of compound microscope 1½
Obtaining an expression for total magnification 1½
(ii) Calculating distance between the objective and the eye-piece 2

(i)



1½

Note: Deduct ½ mark for not showing arrows with the rays.

Magnification produced by objective

$$m_0 = \frac{h'}{h} = \frac{L}{f_o}$$ ½

Magnification produced by eye-piece

$$m_e = 1 + \frac{D}{f_e}$$

If the final image is formed at infinity

$$m_e = \frac{D}{f_e}$$ ½

Total magnification

$$m = m_0 \times m_e$$

$$= \left(\frac{L}{f_o}\right)\left(\frac{D}{f_e}\right)$$ ½

(ii) $\frac{1}{v_o} - \frac{1}{u_o} = \frac{1}{f_0}$ ½

$$\frac{1}{v_o} - \frac{1}{(-1.5)} = \frac{1}{1.25}$$

$v_o = 7.5\,\text{cm}$ ½

$L = |v_o| + |f_e|$ as final image is formed at infinity ($v_e = \infty, u_e = f_e$) ½

L = 7.5 + 5

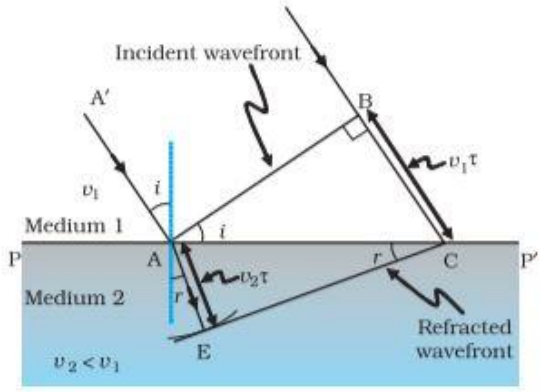
L= 12.5 cm ½

OR

(b)

(i) Explaining the refraction of a plane wavefront	1
Verification of Snell's law	2
(ii) Deducing that a convex mirror always produces a virtual image of an object	2

(i)



1

$\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$ ½

$\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$ ½

$\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$

$\frac{\sin i}{\sin r} = \frac{c/n_1}{c/n_2}$ ½

$\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$ or $n_1 \sin i = n_2 \sin r$ ½

(ii) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ ½

$u < 0 \ , \ f > 0$

$\frac{1}{v} + \frac{1}{(-u)} = \frac{1}{f}$ ½

$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$ ½

$\frac{1}{v}$ is positive

$\therefore$ v is positive $\Rightarrow$ virtual image ½

5

32.

(i) Finding the amount of work done	2
(ii) Finding	
(I) The electric field at their common centre	1
(II) The potential at their common centre	2

(a)

(i) $V = -\int \vec{E} \cdot \overrightarrow{dr}$

$= -\int 40\,x\,dx$

$= -20\,x^2$ ½

Potential at A (0, 3m), $V_A = 0$

Potential at B (5m, 0), V_B = -500 V ½

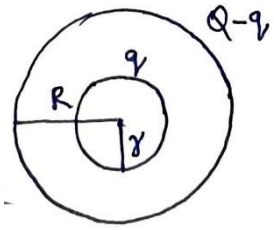
Work done in taking a unit positive charge from a point (0, 3m) to the point (5m, 0)

$W = q(V_B - V_A)$ ½

$= 1(-500 - 0)$

$W = -500\,J$ ½

(ii) (I) Electric field at the common centre will be zero as the charge enclosed by the inner sphere is zero. 1



Alternatively: $q_{en} = 0$ ½

$\phi_E = 0$

$\oint \vec{E}.\overrightarrow{ds} = 0$

$E = 0$ ½

(II) ∵ Surface charge densities are equal

$\frac{q}{4\pi r^2} = \frac{Q-q}{4\pi R^2}$ ½

$q = \frac{Qr^2}{R^2 + r^2}$ ½

Potential at common centre

$V = \frac{kq}{r} + \frac{k(Q-q)}{R}$ ½

$$V = \frac{k}{r}\frac{Qr^2}{(R^2+r^2)} + \frac{k}{R}\left[Q - \frac{Qr^2}{(R^2+r^2)}\right]$$

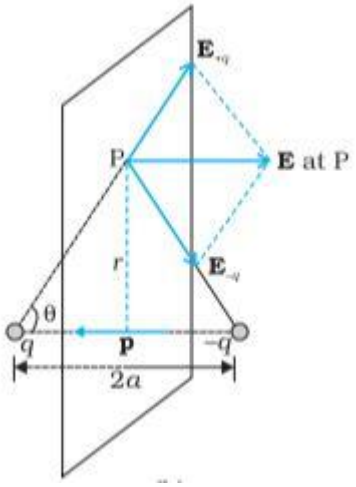
$$V = \frac{kQ(R+r)}{R^2+r^2}$$ ½

OR

(b)

(i)	Obtaining expression for electric field due to a dipole on its equatorial plane	2
	Finding electric field:	
	(I) At centre of the dipole	½
	(II) At a point r >> a	½
(ii)	Calculating net electric flux through cube	2

(i)



½

The magnitudes of the electric field due to two charges +q and -q are

$$E_{+q} = \frac{q}{4\pi\varepsilon_0}\frac{1}{\left(r^2+a^2\right)}$$

$$E_{-q} = \frac{q}{4\pi\varepsilon_0}\frac{1}{\left(r^2+a^2\right)}$$ ½

The total electric field

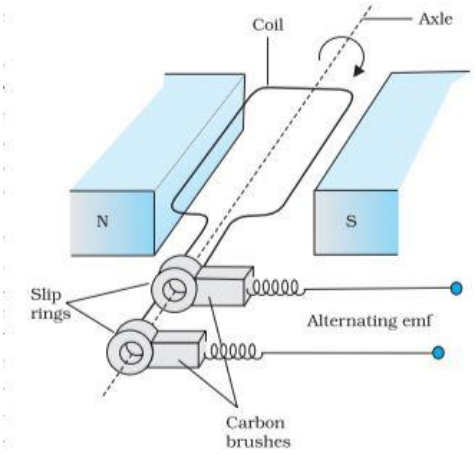
$$\vec{E} = -\left(E_{+q} + E_{-q}\right)\cos\theta\,\hat{p}$$

$$\vec{E} = -\frac{\vec{p}}{4\pi\varepsilon_0\left(r^2+a^2\right)^{3/2}}$$ ½

Direction of electric field is opposite to dipole moment ($\vec{p}$) ½

(I) At centre of dipole, r = 0

$$\vec{E} = -\frac{-\vec{p}}{4\pi\varepsilon_0 a^3}$$ ½

	(II) At a point r>>a $\vec{E} = -\frac{-\vec{p}}{4\pi\varepsilon_0 r^3}$ (ii) $\vec{E} = (10x+5)\hat{i}$ N/C $\phi_L = \int \vec{E}.\vec{ds}$ $= -E_L(L^2)$ $= -5L^2$ $\phi_R = E_R(L^2)$ $= (10L+5)L^2$ $\phi_{net} = \phi_L + \phi_R$ $= -5L^2 + (10L+5)L^2$ $= 10L^3$ Nm^2/C	½ ½ ½ ½ ½	5
33.	**(a)** (i) Writing principle of ac generator 1 Labelled diagram of ac generator 1 Working of ac generator 1 (ii) Finding rms voltages across three circuit elements 1½ Explanation of the algebraic sum of rms voltages across three circuit elements is more than the rms voltage source ½ **(i) Principle:** It works on the principle of electromagnetic induction.  **Working:** The coil is mechanically rotated in the uniform magnetic field. The rotation of the coil causes the magnetic flux through it to change, so an emf is induced in the coil. (i) $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$	1 1 1	

$$= \sqrt{(400)^2 + \left(100\pi \times \frac{5}{\pi} - \frac{1}{100\pi \times \frac{50}{\pi} \times 10^{-6}}\right)^2}$$

$= 500\,\Omega$

$I_{rms} = \frac{V_{rms}}{Z}$

$I_{rms} = \frac{140}{\sqrt{2} \times 500} = \frac{0.28}{\sqrt{2}}$ A

$(V_{rms})_R = I_{rms}\ R$

$= \frac{0.28}{\sqrt{2}} \times 400$

$= \frac{112}{\sqrt{2}} = 56\sqrt{2}$ V ½

$(V_{rms})_L = I_{rms}\ \omega L$

$= \frac{0.28}{\sqrt{2}} \times 500$

$= \frac{140}{\sqrt{2}} = 70\sqrt{2}$ V ½

$(V_{rms})_C = I_{rms} \frac{1}{\omega C}$

$= \frac{0.28}{\sqrt{2}} \times 200$

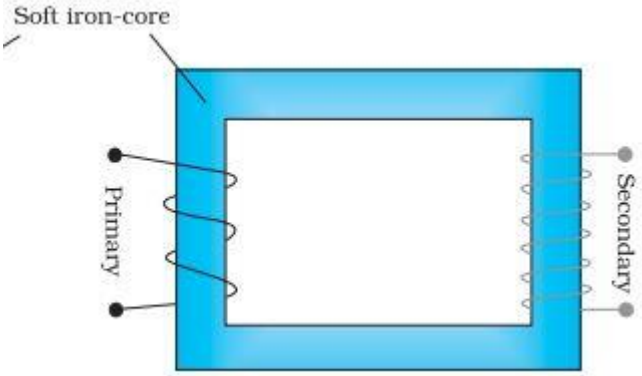
$= \frac{56}{\sqrt{2}} = 28\sqrt{2}$ V ½

The algebraic sum of voltages is more than the rms voltage of source because voltages across R, L and C are not in phase. ½

OR

(b)

(i)	Writing principle of transformer	1
	Labelled diagram of step-up transformer	1
	Working of step-up transformer	1
(ii)	Finding-	
	• rms value of input current	1
	• expression for instantaneous output voltage	½
	• expression for instantaneous output current	½

	(i) **Principle**: It works on the principle of mutual induction.  **Working:** When an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links the secondary and induces an emf in it. Since the no. of turns are more in secondary windings an emf induced is proportional to the no. of turns. Therefore more emf is developed across the secondary windings.	1 1 1	
	(ii) $P_i = V_p I_p$ $200 = \frac{20}{\sqrt{2}} I_p$ $I_p = 10\sqrt{2}\,\text{A}$ $\frac{V_o}{V_i} = \frac{250}{50}$ $5 = \frac{V_o}{V_i}$ $V_o = 100\sin(100\pi)\,\text{t V}$ $\text{P}_o = (V_o)_{rms}(I_o)_{rms}$ $200 = \frac{100}{\sqrt{2}}(I_o)_{rms}$ $(I_o)_{rms} = 2\sqrt{2}\,\text{A}$ $\therefore I_o = \left(2\sqrt{2}\right)\sqrt{2}\sin(100\pi)\,\text{t}$ $I_o = 4\sin(100\pi)\,\text{t A}$	½ ½ ½ ½	5

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2025
SUBJECT NAME PHYSICS (PAPER CODE 55/6/3)

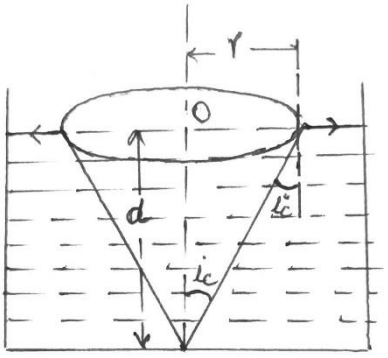
General Instructions: -

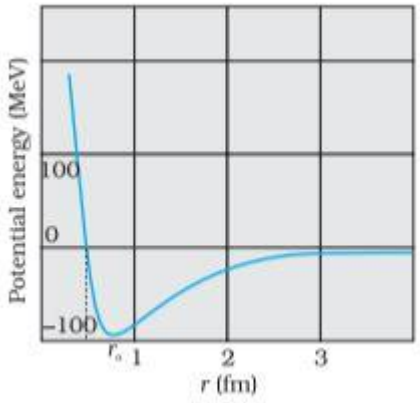
1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (✓) while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.

11	A full scale of marks 70 (example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any un assessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for spot Evaluation**" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

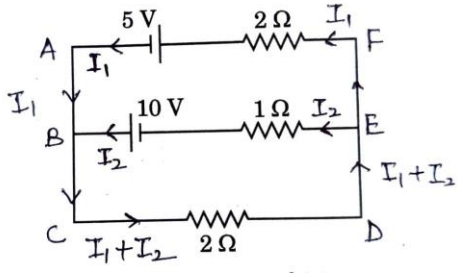
MARKING SCHEME: PHYSICS(042)			
Code: 55/6/3			
Q.No.	**VALUE POINTS/EXPECTED ANSWERS**	**Marks**	**Total Marks**
	SECTION A		
1.	(D) 2	1	1
2.	(C) $2I_0$	1	1
3.	(C) $\left[\frac{mv^2}{qE}\right]$ *in X – Y plane*	1	1
4.	(C) g	1	1
5.	(D) $F_{pp} = F_{pn} = F_{nn}$	1	1
6.	(A) 10 V	1	1
7.	(B) $\frac{1}{2}$	1	1
8.	(C) $\left[\frac{n^2-1}{n}\right]R$	1	1
9.	(D) does not move at all	1	1
10.	(D) linear momentum	1	1
11.	(C) small resistance in parallel	1	1
12.	(B) 1.326×10^{-27}	1	1
13.	(D) Both Assertion (A) and Reason (R) are false.	1	1
14.	(C) Assertion (A) is true, But Reason (R) is false.	1	1
15.	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)	1	1
16.	(C) Assertion (A) is true, But Reason (R) is false.	1	1
	SECTION - B		
17.	Explanation for higher electron concentration in n-type semiconductor in comparison to hole concentration 2 In a doped semiconductor the total number of conduction electrons is due to the electrons contributed by donors and those generated intrinsically, while the total number of holes is only due to the holes from the intrinsic sources.	2	2

18.	(a) Difference between velocity and drift velocity of electrons in a conductor 1 (b) Find the cross-sectional area of the wire 1 (a) **Velocity** is the rate of change of displacement with time. **Drift velocity** is the average velocity of free electrons under the influence of external electric field. (b) $I = neA\text{v}_d$ $A = \frac{I}{ne\text{v}_d}$ $A = \frac{3.4}{8.5\times10^{28}\times1.6\times10^{-19}\times0.2\times10^{-3}}$ $A = 1.25\times10^{-6}\ \text{m}^2$	½ ½ ½ ½	2
19.	(a) Finding the intensity for path difference of (i) $\frac{\lambda}{3}$ 1 (ii) $\frac{\lambda}{2}$ 1 (i) $\Delta\phi = \frac{2\pi}{\lambda}.\Delta x$ $\Delta\phi = \frac{2\pi}{\lambda}.\frac{\lambda}{3} = \frac{2\pi}{3}$ $I = 4I_0\cos^2\frac{\phi}{2}$ $I = 4I_0\cos^2\frac{\pi}{3}$ $I = I_0$ (ii) $\Delta\phi = \frac{2\pi}{\lambda}.\frac{\lambda}{2} = \pi$ $I = 4I_0\cos^2\frac{\pi}{2}$ $I = 0$ OR	½ ½ ½ ½	2

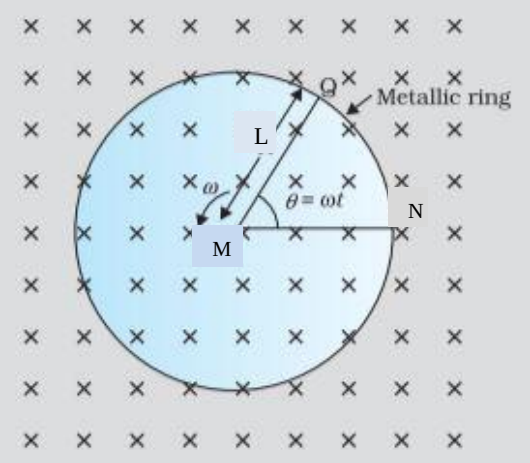
	(b) Finding- The position of the image 1½ The nature of the image ½ $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ $\frac{1.5}{v} - \frac{1}{(-12)} = \frac{1.5-1}{30}$ v = -22.5 cm Image is virtual and erect.	½ ½ ½ ½	
20.	Theoretical justification for same value of distance of closest approach 2 For a given nucleus, the distance of closest approach for a charged particle depends only on the accelerating potential difference. Since both α -particle and a deuterium ion are accelerated through same potential difference, therefore distance of closest approach will be same for both. **Note:** Award 1 mark if a student proves it mathematically.	2	2
21.	Calculating the diameter of opaque disc on the liquid surface 2 $\sin i_c = \frac{1}{\sqrt{2}}$ $i_c = 45^0$ $\tan i_c = \frac{r}{d}$ $r = d \tan 45^0$ $r = 30 \times 1$ cm $D = 2r = 60$ cm **Alternatively:** $D = 2r = \frac{2d}{\sqrt{n^2 - 1}}$ $= \frac{2 \times 30}{\sqrt{\left(\sqrt{2}\right)^2 - 1}}$ $D = 60$ cm  	½ ½ 1 1 ½ ½	2

	SECTION - C		
22.	Naming the electromagnetic waves 1½ Writing wavelength range 1½ The electromagnetic waves used are (i) Microwaves (ii) Ultraviolet / Infrared (iii) X-rays Wavelength range of electromagnetic waves used (i) 0.1 m to 1 mm (ii) 400 nm to 1 nm / 1mm to 700 nm (iii) 1 nm to 10^{-3} nm	 ½ ½ ½ ½ ½ ½	3
23.	(a) Differentiating between 'Nuclear fission' and 'Nuclear fusion' with example 1 + 1 (b) Drawing the graph 1 (a) **Nuclear fission** is the process of splitting up of a heavy nucleus into lighter ones with a release of energy. $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U \rightarrow {}^{144}_{56}Ba + {}^{89}_{36}Kr + 3\,{}^{1}_{0}n$ (or any other reaction) **Nuclear fusion** is the process of fusing of two lighter nuclei to form a heavier nucleus with the release of energy. $^{1}_{1}H + {}^{1}_{1}H \rightarrow {}^{2}_{1}H + e^{+} + \nu + 0.42\,\text{MeV}$ (or any other reaction) (b)  	 ½ ½ ½ 1	3
24.	Finding- (i) The torque acting on the loop 1 (ii) The magnitude and direction of net force 2		

	(i) $\tau = mB\sin\theta$ As $\vec{m}$ and $\vec{B}$ are in same direction, $\theta = 0^0$ $\tau = 0$ (ii) $F = \frac{\mu_0 I_1 I_2 l}{2\pi r}$ $F_{net} = \frac{\mu_0 I_1 I_2 l}{2\pi}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ $= \frac{4\pi\times10^{-7}\times2\times1\times5\times10^{-2}}{2\pi\times10^{-2}}\left(1-\frac{1}{2}\right)$ $F_{net} = 1\times10^{-6}$ N Net force on the loop is towards the long straight wire.	½ ½ ½ ½ ½ ½	3
25.	(a) Calculating • Object distance 1 • Image distance 1 (b) Justification if the silver coating around the centre of a concave mirror is removed 1 (a) $m = -\frac{v}{u}$ $-2 = -\frac{v}{u}$ $v = 2u$ $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ $\frac{1}{-10} = \frac{1}{2u} + \frac{1}{u}$ $u = -15$ cm $v = -30$ cm (b) Yes, same image is formed with reduced intensity, because reflecting area get reduced and laws of reflection still hold good for remaining part of the mirror.	½ ½ ½ ½ 1	3
26.	Stating Kirchoff's laws ½ + ½ Finding the values of current in all the three branches 2 **Junction rule:** At any junction, the sum of the currents entering the junction is equal to the sum of the currents leaving the junction. **Loop rule:** the algebraic sum of changes in potential around any closed loop involving resistors and cells in the loop is zero.	 ½ ½	

	In closed loop $BCDEB$ $2I_1+3I_2=10$ $-----(1)$ In closed loop $ABCDEFA$ $4I_1+2I_2=-5$ $-----(2)$ On solving eq. (1) and (2) $I_1=-\frac{35}{8}\text{A}$ $in\,arm\,AF$ $I_2=\frac{25}{4}\text{A}$ $in\,arm\,BE$ $I_1+I_2=-\frac{15}{8}\text{A}$ $in\,arm\,CD$  	½ ½ ½ ½	3
27.	Finding the value of- (i) Angular momentum of electron 1 (ii) Radius of the orbit 1 (iii) Kinetic energy of electron 1 (i) $L=\frac{nh}{2\pi}$ $for\ \ n=2$ $L=\frac{2\times6.63\times10^{-34}}{2\times3.14}$ $=2.11\times10^{-34}\ kg\,m^2\,s^{-1}$ (ii) $r_n=n^2r_0$ $r_2=4(0.5\overset{0}{\text{A}})$ $r_2=2\overset{0}{\text{A}}$ (iii) Total energy of electron $=-\frac{13.6}{n^2}\text{ eV}$ $E=-3.4\text{eV}$ $(n=2)$ $K=-E$ $K=3.4\text{eV}$	½ ½ ½ ½ ½ ½	3
28.	(a) Stating Lenz's law 1 Obtaining expression for induced emf 2 **Lenz's law** The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it.	1	

Expression of induced emf



The magnitude of the emf generated across the length dr of the rod as it moves at right angles to the magnetic field is given by

$d\varepsilon = B\text{v}\,dr$ ½

$\varepsilon = \int d\varepsilon$

$= \int_0^L B\text{v}\,dr$ ½

$\varepsilon = \int_0^L B\omega r\,dr$ ½

$\varepsilon = \frac{1}{2}BL^2\omega$ ½

Alternatively:

Area of the sector (QMN) = $\frac{1}{2}L^2\theta$ ½

Induced emf is $\varepsilon = B \times \frac{d}{dt}\left(\frac{1}{2}L^2\theta\right)$ ½

$\varepsilon = \frac{1}{2}BL^2\frac{d\theta}{dt}$ ½

$\varepsilon = \frac{1}{2}BL^2\omega$ ½

OR

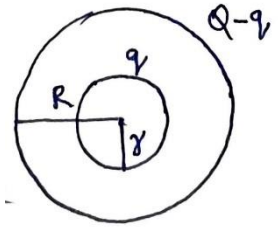
(b)

Definition of self inductance	1
Deriving expression for self inductance for a long solenoid	2

Self inductance of a coil is the ratio of the flux linkage to the current flowing in the coil. 1

Alternatively:

	Self inductance of a coil is defined as the flux linked with the coil when unit current flows through it. **Alternatively**: Self inductance of a coil may be defined as the magnitude of emf induced in the coil when current changes at the rate of 1 A/s in the coil. **Expression for self inductance of a long solenoid:** The magnetic field due to current flowing in the solenoid, B = $\mu_0 nI$ Total flux linked with the given solenoid $N\phi_B = (nl)(\mu_0 nI)\,\mathrm{A}$ $N\phi_B = \mu_0 n^2\,\mathrm{A}\,lI$ Self inductance $L = \frac{N\phi_B}{I}$ $L = \mu_0 n^2\,\mathrm{A}\,l$	½ ½ ½ ½	3
	SECTION – D		
29.	(i) (a) (D) 6 OR (b) (B) $\frac{2K}{K+1}$ (ii) (C) $\frac{1}{2}\varepsilon_0 E^2 V$ (iii) (B) $\frac{\sigma}{\sigma - \sigma_p}$ (iv) (A) $\left(\frac{C}{4}\right)$	1 1 1 1	4
30.	(i) (a) (B) The applied voltage mostly drops across the depletion region OR (b) (C) 100 Hz (ii) (B) A layer of positive charge on n side and a layer of negative charge on p side appear (iii) (C) 0.05 eV (iv) (B) Antimony	1 1 1 1	4

	SECTION – E		
31.	(i) Finding the amount of work done 2 (ii) Finding (I) The electric field at their common centre 1 (II) The potential at their common centre 2		
	(a)		
	(i) $V = -\int \vec{E} \cdot \overrightarrow{dr}$		
	$= -\int 40\,x\,dx$		
	$= -20\,x^2$	½	
	Potential at A (0, 3m), $V_A = 0$		
	Potential at B (5m, 0), V_B = -500 V	½	
	Work done in taking a unit positive charge from a point (0, 3m) to the point (5m, 0)		
	$W = q(V_B - V_A)$	½	
	$= 1(-500 - 0)$		
	$W = -500\,J$	½	
	(ii) (I) Electric field at the common centre will be zero as the charge enclosed by the inner sphere is zero.	1	
			
	Alternatively: $q_{en} = 0$	½	
	$\phi_E = 0$		
	$\oint \vec{E}.\overrightarrow{ds} = 0$		
	$E = 0$	½	
	(II) ∵ Surface charge densities are equal		
	$\frac{q}{4\pi r^2} = \frac{Q-q}{4\pi R^2}$	½	
	$q = \frac{Qr^2}{R^2 + r^2}$	½	
	Potential at common centre		
	$V = \frac{kq}{r} + \frac{k(Q-q)}{R}$	½	

$$V = \frac{k}{r}\frac{Qr^2}{(R^2+r^2)} + \frac{k}{R}\left[Q - \frac{Qr^2}{(R^2+r^2)}\right]$$

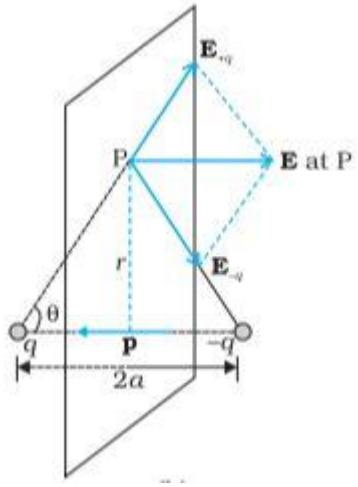
$$V = \frac{kQ(R+r)}{R^2+r^2}$$ ½

OR

(b)

(i)	Obtaining expression for electric field due to a dipole on its equatorial plane	2
	Finding electric field:	
	(I) At centre of the dipole	½
	(II) At a point r >> a	½
(ii)	Calculating net electric flux through cube	2

(i)



½

The magnitudes of the electric field due to two charges +q and -q are

$$E_{+q} = \frac{q}{4\pi\varepsilon_0}\frac{1}{\left(r^2+a^2\right)}$$

$$E_{-q} = \frac{q}{4\pi\varepsilon_0}\frac{1}{\left(r^2+a^2\right)}$$ ½

The total electric field

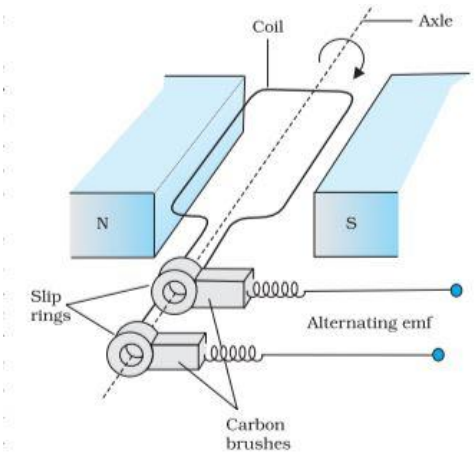
$$\vec{E} = -\left(E_{+q}+E_{-q}\right)\cos\theta\,\hat{p}$$

$$\vec{E} = -\frac{\vec{p}}{4\pi\varepsilon_0\left(r^2+a^2\right)^{3/2}}$$ ½

Direction of electric field is opposite to dipole moment ($\vec{p}$) ½

(I) At centre of dipole, r = 0

$$\vec{E} = -\frac{-\vec{p}}{4\pi\varepsilon_0 a^3}$$ ½

	(II) At a point r>>a $\vec{E} = -\frac{-\vec{p}}{4\pi\varepsilon_0 r^3}$ (ii) $\vec{E} = (10x+5)\hat{i}$ N/C $\phi_L = \int \vec{E}.\vec{ds}$ $= -E_L(L^2)$ $= -5L^2$ $\phi_R = E_R(L^2)$ $= (10L+5)L^2$ $\phi_{net} = \phi_L + \phi_R$ $= -5L^2 + (10L+5)L^2$ $= 10L^3$ Nm^2/C	½ ½ ½ ½ ½	5
32.	**(a)** (i) Writing principle of ac generator 1 Labelled diagram of ac generator 1 Working of ac generator 1 (ii) Finding rms voltages across three circuit elements 1½ Explanation of the algebraic sum of rms voltages across three circuit elements is more than the rms voltage source ½ **(i) Principle:** It works on the principle of electromagnetic induction.  **Working:** The coil is mechanically rotated in the uniform magnetic field. The rotation of the coil causes the magnetic flux through it to change, so an emf is induced in the coil. (i) $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$	1 1 1	

$$= \sqrt{(400)^2 + \left(100\pi \times \frac{5}{\pi} - \frac{1}{100\pi \times \frac{50}{\pi} \times 10^{-6}}\right)^2}$$

$= 500\,\Omega$

$I_{rms} = \frac{V_{rms}}{Z}$

$I_{rms} = \frac{140}{\sqrt{2} \times 500} = \frac{0.28}{\sqrt{2}}$ A

$(V_{rms})_R = I_{rms}\ R$

$= \frac{0.28}{\sqrt{2}} \times 400$

$= \frac{112}{\sqrt{2}} = 56\sqrt{2}$ V ½

$(V_{rms})_L = I_{rms}\ \omega L$

$= \frac{0.28}{\sqrt{2}} \times 500$

$= \frac{140}{\sqrt{2}} = 70\sqrt{2}$ V ½

$(V_{rms})_C = I_{rms} \frac{1}{\omega C}$

$= \frac{0.28}{\sqrt{2}} \times 200$

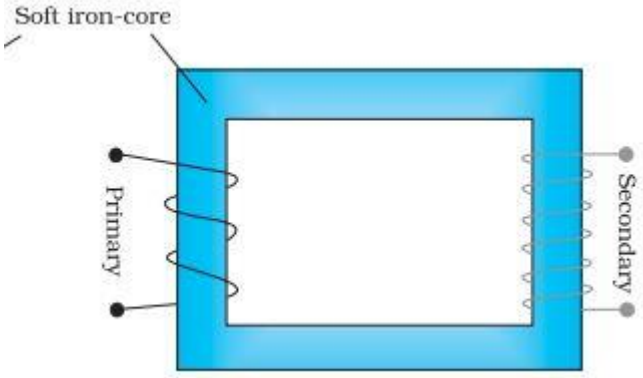
$= \frac{56}{\sqrt{2}} = 28\sqrt{2}$ V ½

The algebraic sum of voltages is more than the rms voltage of source because voltages across R, L and C are not in phase. ½

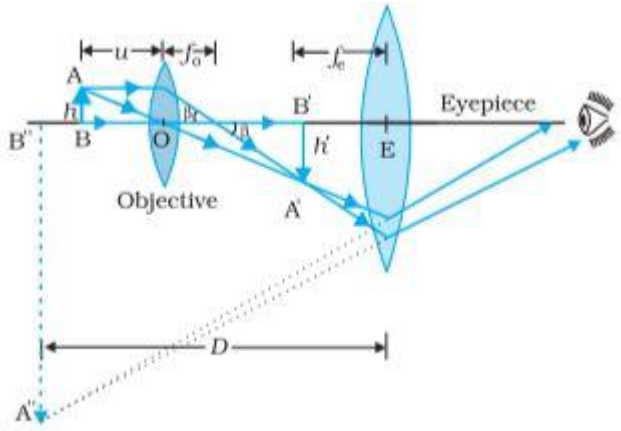
OR

(b)

(i)	Writing principle of transformer	1
	Labelled diagram of step-up transformer	1
	Working of step-up transformer	1
(ii)	Finding-	
	• rms value of input current	1
	• expression for instantaneous output voltage	½
	• expression for instantaneous output current	½

	(i) **Principle**: It works on the principle of mutual induction.  **Working:** When an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links the secondary and induces an emf in it. Since the no. of turns are more in secondary windings an emf induced is proportional to the no. of turns. Therefore more emf is developed across the secondary windings. (ii) $P_i = V_p I_p$ $200 = \frac{20}{\sqrt{2}} I_p$ $I_p = 10\sqrt{2}\,\text{A}$ $\frac{V_o}{V_i} = \frac{250}{50}$ $5 = \frac{V_o}{V_i}$ $V_o = 100\sin(100\pi)\,\text{t V}$ $\text{P}_o = (V_o)_{rms}(I_o)_{rms}$ $200 = \frac{100}{\sqrt{2}}(I_o)_{rms}$ $(I_o)_{rms} = 2\sqrt{2}\,\text{A}$ $\therefore I_o = \left(2\sqrt{2}\right)\sqrt{2}\sin(100\pi)\,\text{t}$ $I_o = 4\sin(100\pi)\,\text{t A}$	1 1 1 ½ ½ ½ ½	5
33.	(a) (i) Drawing ray diagram of compound microscope 1½ Obtaining an expression for total magnification 1½ (ii) Calculating distance between the objective and the eye-piece 2		

(i)



1½

Note: Deduct ½ mark for not showing arrows with the rays.

Magnification produced by objective

$$m_0 = \frac{h'}{h} = \frac{L}{f_o}$$ ½

Magnification produced by eye-piece

$$m_e = 1 + \frac{D}{f_e}$$

If the final image is formed at infinity

$$m_e = \frac{D}{f_e}$$ ½

Total magnification

$$m = m_0 \times m_e$$

$$= \left(\frac{L}{f_o}\right)\left(\frac{D}{f_e}\right)$$ ½

(i) $\frac{1}{v_o} - \frac{1}{u_o} = \frac{1}{f_0}$ ½

$$\frac{1}{v_o} - \frac{1}{(-1.5)} = \frac{1}{1.25}$$

$v_o = 7.5\,\text{cm}$ ½

$L = |v_o| + |f_e|$ as final image is formed at infinity ($v_e = \infty, u_e = f_e$) ½

L = 7.5 + 5

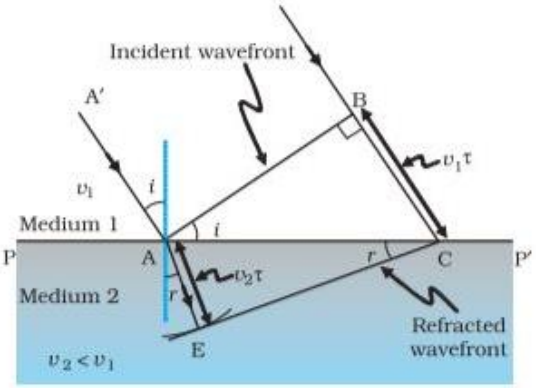
L= 12.5 cm ½

OR

(ii)

(i) Explaining the refraction of a plane wavefront	1
Verification of Snell's law	2
(ii) Deducing that a convex mirror always produces a virtual image of an object	2

(i)



1

$\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$ ½

$\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$ ½

$\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$

$\frac{\sin i}{\sin r} = \frac{c/n_1}{c/n_2}$ ½

$\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$ or $n_1 \sin i = n_2 \sin r$ ½

(ii) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ ½

$u < 0 \ , \ f > 0$

$\frac{1}{v} + \frac{1}{(-u)} = \frac{1}{f}$ ½

$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$ ½

$\frac{1}{v}$ is positive

$\therefore$ v is positive $\Rightarrow$ virtual image ½

5

Series P2QRS/2

Set-1

प्रश्न-पत्र कोड
Q.P. Code **55/2/1**

रोल नं.
Roll No.

परीक्षार्थी प्रश्न-पत्र कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें ।
Candidates must write the Q.P. Code on the title page of the answer-book.

भौतिक विज्ञान (सैद्धान्तिक)

PHYSICS (Theory)

निर्धारित समय : 3 घण्टे *अधिकतम अंक : 70*

Time allowed : 3 hours *Maximum Marks : 70*

	नोट		**NOTE**
(I)	कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **27** हैं ।	(I)	Please check that this question paper contains **27** printed pages.
(II)	कृपया जाँच कर लें कि इस प्रश्न-पत्र में **33** प्रश्न हैं ।	(II)	Please check that this question paper contains **33** questions.
(III)	प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।	(III)	Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
(IV)	**कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में प्रश्न का क्रमांक अवश्य लिखें ।**	(IV)	**Please write down the serial number of the question in the answer-book before attempting it.**
(V)	इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जाएगा । 10.15 बजे से 10.30 बजे तक छात्र केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।	(V)	15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer-book during this period.

सामान्य निर्देश :

निम्नलिखित निर्देशों को ध्यानपूर्वक पढ़िए और उनका पालन कीजिए :

(i) *इस प्रश्न-पत्र में* ***33*** *प्रश्न हैं ।* ***सभी*** *प्रश्न* ***अनिवार्य*** *हैं ।*

(ii) *यह प्रश्न-पत्र* ***पाँच*** *खण्डों में विभाजित है –* ***खण्ड क, ख, ग, घ*** *एवं* ***ङ*** *।*

(iii) ***खण्ड क*** *में प्रश्न संख्या* ***1*** *से* ***16*** *तक बहुविकल्पीय प्रकार के प्रश्न हैं । प्रत्येक प्रश्न* ***1*** *अंक का है ।*

(iv) ***खण्ड ख*** *में प्रश्न संख्या* ***17*** *से* ***21*** *तक अति लघु-उत्तरीय प्रकार के प्रश्न हैं । प्रत्येक प्रश्न* ***2*** *अंकों का है ।*

(v) ***खण्ड ग*** *में प्रश्न संख्या* ***22*** *से* ***28*** *तक लघु-उत्तरीय प्रकार के प्रश्न हैं । प्रत्येक प्रश्न* ***3*** *अंकों का है ।*

(vi) ***खण्ड घ*** *में प्रश्न संख्या* ***29*** *तथा* ***30*** *प्रकरण अध्ययन आधारित प्रश्न हैं । प्रत्येक प्रश्न* ***4*** *अंकों का है ।*

(vii) ***खण्ड ङ*** *में प्रश्न संख्या* ***31*** *से* ***33*** *तक दीर्घ-उत्तरीय प्रकार के प्रश्न हैं । प्रत्येक प्रश्न* ***5*** *अंकों का है ।*

(viii) *प्रश्न-पत्र में समग्र विकल्प नहीं दिया गया है । यद्यपि, खण्ड क के अतिरिक्त अन्य खण्डों के कुछ प्रश्नों में आंतरिक विकल्प का चयन दिया गया है ।*

(ix) *ध्यान दें कि दृष्टिबाधित परीक्षार्थियों के लिए एक अलग प्रश्न-पत्र है ।*

(x) *कैल्कुलेटर का उपयोग* ***वर्जित*** *है ।*

जहाँ आवश्यक हो, आप निम्नलिखित भौतिक नियतांकों के मानों का उपयोग कर सकते हैं :

$c = 3 \times 10^8$ m/s

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

इलेक्ट्रॉन का द्रव्यमान $(m_e) = 9{\cdot}1 \times 10^{-31}$ kg

न्यूट्रॉन का द्रव्यमान = $1{\cdot}675 \times 10^{-27}$ kg

प्रोटॉन का द्रव्यमान = $1{\cdot}673 \times 10^{-27}$ kg

आवोगाद्रो संख्या = $6{\cdot}023 \times 10^{23}$ प्रति ग्राम मोल

बोल्ट्ज़मान नियतांक = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

General Instructions :

Read the following instructions carefully and follow them :

(i) *This question paper contains **33** questions. **All** questions are **compulsory**.*

(ii) *This question paper is divided into **five** sections – **Sections A, B, C, D** and **E**.*

(iii) *In **Section A** – Questions no. **1** to **16** are Multiple Choice type questions. Each question carries **1** mark.*

(iv) *In **Section B** – Questions no. **17** to **21** are Very Short Answer type questions. Each question carries **2** marks.*

(v) *In **Section C** – Questions no. **22** to **28** are Short Answer type questions. Each question carries **3** marks.*

(vi) *In **Section D** – Questions no. **29** and **30** are case study based questions. Each question carries **4** marks.*

(vii) *In **Section E** – Questions no. **31** to **33** are Long Answer type questions. Each question carries **5** marks.*

(viii) *There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section A.*

(ix) *Kindly note that there is a separate question paper for Visually Impaired candidates.*

(x) *Use of calculators is **not** allowed.*

You may use the following values of physical constants wherever necessary :

$c = 3 \times 10^8$ m/s

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

Mass of electron (m_e) = $9{\cdot}1 \times 10^{-31}$ kg

Mass of neutron = $1{\cdot}675 \times 10^{-27}$ kg

Mass of proton = $1{\cdot}673 \times 10^{-27}$ kg

Avogadro's number = $6{\cdot}023 \times 10^{23}$ per gram mole

Boltzmann constant = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

खण्ड क

1. दो आवेशित कण P और Q जिनके समान आवेश परन्तु विभिन्न द्रव्यमान m_P और m_Q हैं, विराम से आरम्भ करके किसी एकसमान विद्युत क्षेत्र $\vec{E}$ में समान दूरी क्रमश: t_P और t_Q समय में तय करते हैं । गुरुत्व के प्रभाव की उपेक्षा करते हुए, अनुपात $\left(\frac{t_P}{t_Q}\right)$ होगा :

(A) $\frac{m_P}{m_Q}$

(B) $\frac{m_Q}{m_P}$

(C) $\sqrt{\frac{m_P}{m_Q}}$

(D) $\sqrt{\frac{m_Q}{m_P}}$

2. किसी चालक में जिसके सिरों पर विभवान्तर V है इलेक्ट्रॉनों के अपवाह की चाल v_d है । यदि V घटकर $\left(\frac{V}{2}\right)$ हो जाए, तो अपवाह चाल हो जाएगी :

(A) $\frac{v_d}{2}$

(B) v_d

(C) $2\, v_d$

(D) $4\, v_d$

3. 4·4 m लम्बे तार, जिसे वृत्ताकार पाश की आकृति में मोड़ा गया है, से 1·0 A धारा प्रवाहित हो रही है । इस पाश का चुम्बकीय आघूर्ण होगा :

(A) $0{\cdot}7\ Am^2$

(B) $1{\cdot}54\ Am^2$

(C) $2{\cdot}10\ Am^2$

(D) $3{\cdot}5\ Am^2$

SECTION A

1. Two charged particles P and Q, having the same charge but different masses m_P and m_Q, start from rest and travel equal distances in a uniform electric field $\vec{E}$ in time t_P and t_Q respectively. Neglecting the effect of gravity, the ratio $\left(\frac{t_P}{t_Q}\right)$ is :

(A) $\frac{m_P}{m_Q}$ (B) $\frac{m_Q}{m_P}$

(C) $\sqrt{\frac{m_P}{m_Q}}$ (D) $\sqrt{\frac{m_Q}{m_P}}$

2. Electrons drift with speed v_d in a conductor with potential difference V across its ends. If V is reduced to $\left(\frac{V}{2}\right)$, their drift speed will become :

(A) $\frac{v_d}{2}$

(B) v_d

(C) $2\ v_d$

(D) $4\ v_d$

3. A wire of length 4·4 m is bent round in the shape of a circular loop and carries a current of 1·0 A. The magnetic moment of the loop will be :

(A) $0{\cdot}7\ Am^2$

(B) $1{\cdot}54\ Am^2$

(C) $2{\cdot}10\ Am^2$

(D) $3{\cdot}5\ Am^2$

4. 10 cm त्रिज्या की कोई वृत्ताकार कुण्डली किसी चुम्बकीय क्षेत्र $\vec{B} = (1{\cdot}0\ \hat{i} + 0{\cdot}5\ \hat{j})$ mT में इस प्रकार रखी है कि कुण्डली के पृष्ठ के अभिलम्बवत बाहर की ओर एकांक सदिश का मान $(0{\cdot}6\ \hat{i} + 0{\cdot}8\ \hat{j})$ है । कुण्डली से संबद्ध चुम्बकीय फ्लक्स है :

(A) $0{\cdot}314\ \mu$Wb (B) $3{\cdot}14\ \mu$Wb

(C) $31{\cdot}4\ \mu$Wb (D) $1{\cdot}256\ \mu$Wb

5. निम्नलिखित में से कौन-सी राशि/राशियाँ किसी आदर्श ट्रान्सफॉर्मर की प्राथमिक और द्वितीयक कुण्डलियों में समान रहती है/हैं ?

विद्युत धारा, वोल्टता, शक्ति, चुम्बकीय फ्लक्स

(A) केवल विद्युत धारा

(B) केवल वोल्टता

(C) केवल शक्ति

(D) चुम्बकीय फ्लक्स और शक्ति दोनों

6. किसी $100\sqrt{2}$ V, 50 Hz के ac स्रोत से कोई प्रतिरोधक और कोई आदर्श प्रेरक श्रेणी में संयोजित हैं । जब किसी वोल्टमीटर को प्रतिरोधक अथवा प्रेरक के सिरों से संयोजित किया जाता है, तो उसका पाठ्यांक समान होता है । वोल्टमीटर का पाठ्यांक है :

(A) $100\sqrt{2}$ V (B) 100 V

(C) $50\sqrt{2}$ V (D) 50 V

7. तरंगदैर्घ्य 10 nm की विद्युत-चुम्बकीय तरंगों को कहते हैं :

(A) अवरक्त तरंगें (B) पराबैंगनी किरणें

(C) गामा किरणें (D) X-किरणें

8. किसी प्रकाश-सुग्राही पृष्ठ का कार्य-फलन 3·315 eV है । इस पृष्ठ से इलेक्ट्रॉनों के प्रकाशिक-उत्सर्जन के लिए अंतक तरंगदैर्घ्य है :

(A) 150 nm (B) 200 nm

(C) 375 nm (D) 500 nm

4. A circular coil of radius 10 cm is placed in a magnetic field $\vec{B} = (1{\cdot}0\ \hat{i} + 0{\cdot}5\ \hat{j})$ mT such that the outward unit vector normal to the surface of the coil is $(0{\cdot}6\ \hat{i} + 0{\cdot}8\ \hat{j})$. The magnetic flux linked with the coil is :

(A) 0·314 μWb (B) 3·14 μWb

(C) 31·4 μWb (D) 1·256 μWb

5. Which of the following quantity/quantities remains same in primary and secondary coils of an ideal transformer ?
Current, Voltage, Power, Magnetic flux

(A) Current only

(B) Voltage only

(C) Power only

(D) Magnetic flux and Power both

6. A resistor and an ideal inductor are connected in series to a $100\sqrt{2}$ V, 50 Hz ac source. When a voltmeter is connected across the resistor or the inductor, it shows the same reading. The reading of the voltmeter is :

(A) $100\sqrt{2}$ V (B) 100 V

(C) $50\sqrt{2}$ V (D) 50 V

7. Electromagnetic waves with wavelength 10 nm are called :

(A) Infrared waves (B) Ultraviolet rays

(C) Gamma rays (D) X-rays

8. The work function for a photosensitive surface is 3·315 eV. The cut-off wavelength for photoemission of electrons from this surface is :

(A) 150 nm (B) 200 nm

(C) 375 nm (D) 500 nm

9. किसी परमाणु के ऊर्जा स्तर A, B और C ऊर्जा के बढ़ते हुए मानों अर्थात् $E_A < E_B < E_C$ के तद्नुरूप हैं । मान लीजिए संक्रमण C से B, B से A तथा C से A के तद्नुरूप विकिरणों के तरंगदैर्घ्य क्रमश: λ_1, λ_2 और λ_3 हैं । तब λ_1, λ_2 और λ_3 के बीच सही संबंध है :

(A) $\lambda_1^2 + \lambda_2^2 = \lambda_3^2$ (B) $\frac{1}{\lambda_1} + \frac{1}{\lambda_2} = \frac{1}{\lambda_3}$

(C) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ (D) $\lambda_1 + \lambda_2 = \lambda_3$

10. गाइगर-मार्सडन के किसी प्रयोग में कोई ऐल्फा कण किसी गोल्ड नाभिक पर गतिज ऊर्जा K से उपगमन करता है । यह नाभिक से किसी दूरी d पर क्षणिक रुकता है और अपनी दिशा उत्क्रमित कर लेता है । तब d किसके अनुक्रमानुपाती है ?

(A) $\frac{1}{\sqrt{K}}$ (B) $\sqrt{K}$

(C) $\frac{1}{K}$ (D) K

11. किसी नैज Si को किसके साथ मादित करने पर n-प्रकार का अर्धचालक Si प्राप्त होता है ?

(A) Al (B) B

(C) P (D) In

12. जब किसी p-n संधि डायोड को पश्चदिशिक बायसित किया जाता है, तब :

(A) रोधिका की ऊँचाई घटती है तथा ह्रासी क्षेत्र की चौड़ाई बढ़ जाती है ।

(B) रोधिका की ऊँचाई बढ़ती है तथा ह्रासी क्षेत्र की चौड़ाई बढ़ जाती है ।

(C) रोधिका की ऊँचाई घटती है तथा ह्रासी क्षेत्र की चौड़ाई सिकुड़ जाती है ।

(D) रोधिका की ऊँचाई बढ़ती है तथा ह्रासी क्षेत्र की चौड़ाई सिकुड़ जाती है ।

*प्रश्न संख्या **13** से **16** अभिकथन (A) और कारण (R) प्रकार के प्रश्न हैं । दो कथन दिए गए हैं — जिनमें एक को अभिकथन (A) तथा दूसरे को कारण (R) द्वारा अंकित किया गया है । सही उत्तर नीचे दिए गए कोडों (A), (B), (C) और (D) में से चुनकर दीजिए ।*

(A) अभिकथन (A) और कारण (R) दोनों सही हैं और कारण (R), अभिकथन (A) की सही व्याख्या करता है ।

(B) अभिकथन (A) और कारण (R) दोनों सही हैं, परन्तु कारण (R), अभिकथन (A) की सही व्याख्या ***नहीं*** करता है ।

(C) अभिकथन (A) सही है, परन्तु कारण (R) ग़लत है ।

(D) अभिकथन (A) ग़लत है तथा कारण (R) भी ग़लत है ।

9. Energy levels A, B and C of an atom correspond to increasing values of energy i.e. $E_A < E_B < E_C$. Let λ_1, λ_2 and λ_3 be the wavelengths of radiation corresponding to the transitions C to B, B to A and C to A, respectively. The correct relation between λ_1, λ_2 and λ_3 is :

(A) $\lambda_1^2 + \lambda_2^2 = \lambda_3^2$

(B) $\frac{1}{\lambda_1} + \frac{1}{\lambda_2} = \frac{1}{\lambda_3}$

(C) $\lambda_1 + \lambda_2 + \lambda_3 = 0$

(D) $\lambda_1 + \lambda_2 = \lambda_3$

10. An alpha particle approaches a gold nucleus in Geiger-Marsden experiment with kinetic energy K. It momentarily stops at a distance d from the nucleus and reverses its direction. Then d is proportional to :

(A) $\frac{1}{\sqrt{K}}$

(B) $\sqrt{K}$

(C) $\frac{1}{K}$

(D) K

11. An n-type semiconducting Si is obtained by doping intrinsic Si with :

(A) Al

(B) B

(C) P

(D) In

12. When a p-n junction diode is subjected to reverse biasing :

(A) the barrier height decreases and the depletion region widens.

(B) the barrier height increases and the depletion region widens.

(C) the barrier height decreases and the depletion region shrinks.

(D) the barrier height increases and the depletion region shrinks.

*Questions number **13** to **16** are Assertion (A) and Reason (R) type questions. Two statements are given — one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the codes (A), (B), (C) and (D) as given below.*

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is ***not*** the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

13. *अभिकथन (A) :* आपतित विकिरणों की दी गयी आवृत्ति और त्वरक विभव के लिए प्रकाश-विद्युत धारा के मान में आपतित विकिरणों की तीव्रता में वृद्धि के साथ वृद्धि होती है ।

कारण (R) : आपतित विकिरणों की तीव्रता में वृद्धि के फलस्वरूप प्रति सेकण्ड उत्सर्जित होने वाले प्रकाशिक-इलेक्ट्रॉनों की संख्या में वृद्धि होती है और इस प्रकार प्रकाश-विद्युत धारा में वृद्धि हो जाती है ।

14. *अभिकथन (A) :* लेंज़ का नियम ऊर्जा संरक्षण नियम का ही एक निष्कर्ष है ।

कारण (R) : किसी आदर्श प्रेरक में शक्ति क्षय नहीं होता है ।

15. *अभिकथन (A) :* कोई इलेक्ट्रॉन और कोई प्रोटॉन समान संवेग $\vec{p}$ से किसी चुम्बकीय क्षेत्र $\vec{B}$ में इस प्रकार प्रवेश करते हैं कि $\vec{p} \perp \vec{B}$ है । तब ये दोनों समान त्रिज्या के वृत्ताकार पथ पर गमन करते हैं ।

कारण (R) : चुम्बकीय क्षेत्र $\vec{B}$ में गमन करने वाले द्रव्यमान m और आवेश q के आवेशित कण के वृत्ताकार पथ की त्रिज्या, $r = \frac{mv}{qB}$ द्वारा दर्शायी जाती है ।

16. *अभिकथन (A) :* किसी संयुक्त सूक्ष्मदर्शी की आवर्धन क्षमता ऋणात्मक होती है ।

कारण (R) : बिम्ब के सापेक्ष अंतिम प्रतिबिम्ब सीधा बनता है ।

खण्ड ख

17. किसी चालक की प्रतिरोधकता की परिभाषा लिखिए । किसी चालक की प्रतिरोधकता निम्नलिखित पर किस प्रकार निर्भर करती है : *2*

(क) चालक में मुक्त इलेक्ट्रॉनों का संख्या घनत्व (n)

(ख) उनका विश्रांति काल (τ)

13. *Assertion (A) :* Photoelectric current increases with an increase in intensity of incident radiation, for a given frequency of incident radiation and the accelerating potential.

Reason (R) : Increase in the intensity of incident radiation results in an increase in the number of photoelectrons emitted per second and hence an increase in the photocurrent.

14. *Assertion (A) :* Lenz's law is a consequence of the law of conservation of energy.

Reason (R) : There is no power loss in an ideal inductor.

15. *Assertion (A) :* An electron and a proton enter with the same momentum $\vec{p}$ in a magnetic field $\vec{B}$ such that $\vec{p} \perp \vec{B}$. Then both describe a circular path of the same radius.

Reason (R) : The radius of the circular path described by the charged particle (charge q, mass m) moving in the magnetic field $\vec{B}$ is given by $r = \frac{mv}{qB}$.

16. *Assertion (A) :* The magnifying power of a compound microscope is negative.

Reason (R) : The final image formed is erect with respect to the object.

SECTION B

17. Define resistivity of a conductor. How does the resistivity of a conductor depend upon the following : *2*

(a) Number density of free electrons in the conductor (n)

(b) Their relaxation time (τ)

18. (क) दो कलासंबद्ध प्रकाश स्रोतों से निकलने वाली तरंगें, जिनमें प्रत्येक का आयाम 'a' तथा आवृत्ति 'ω' है, किसी बिन्दु पर अध्यारोपण करती हैं । यदि इन दोनों तरंगों के बीच कलान्तर ϕ है, तो इस बिन्दु पर परिणामी तीव्रता के लिए व्यंजक व्युत्पन्न कीजिए । *2*

अथवा

(ख) यंग के द्विझिरी प्रयोग में व्यतिकरण पैटर्न पर क्या प्रभाव होगा जब (i) स्रोत झिरी को झिरियों के तल के निकट लाया जाए, और (ii) झिरियों के बीच पृथक्कन में वृद्धि की जाए ? अपने उत्तरों की पुष्टि कीजिए । *2*

19. किसी उत्तल लेंस ($n = 1{\cdot}52$) की वायु में फोकस दूरी $15{\cdot}0$ cm है । अपवर्तनांक $1{\cdot}65$ के द्रव में डुबोने पर इस लेंस की फोकस दूरी ज्ञात कीजिए । लेंस की प्रकृति क्या होगी ? *2*

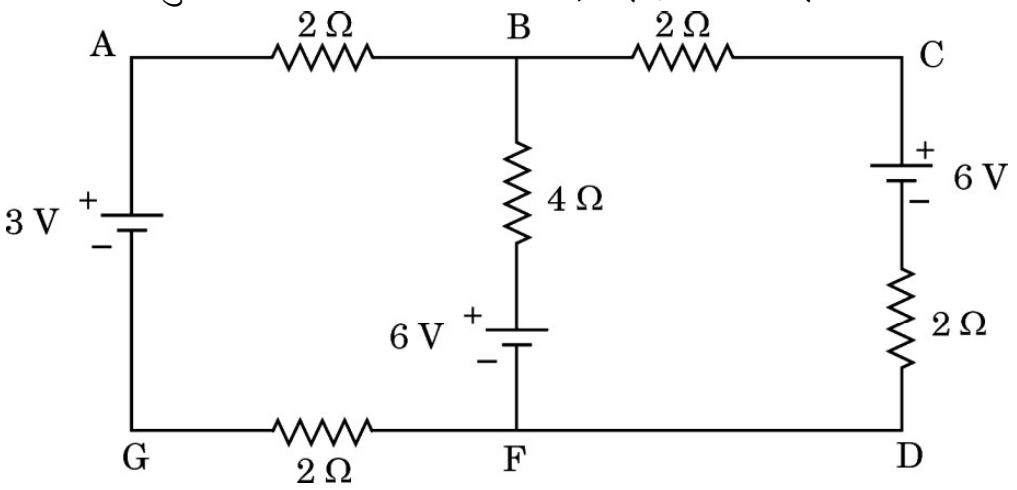
20. कार्बन के समस्थानिक ${}^{12}_{6}C$ का नाभिकीय द्रव्यमान $12{\cdot}000000$ u है । इसके नाभिक की बंधन ऊर्जा परिकलित कीजिए ।

दिया गया है : $m_p = 1{\cdot}007825$ u; $m_n = 1{\cdot}008665$ u. *2*

21. किसी नैज अर्धचालक के ऊर्जा अन्तराल में क्या प्रभावी अन्तर होता है जब उसे अपमिश्रित किया जाता है : (क) त्रिसंयोजी अपद्रव्य के साथ, और (ख) पंचसंयोजी अपद्रव्य के साथ ? प्रत्येक स्थिति में अपने उत्तर की पुष्टि कीजिए । *2*

खण्ड ग

22. आरेख में तीन आदर्श बैटरियों के साथ विद्युत परिपथ दर्शाया गया है । इसकी शाखाओं AG, BF और CD में विद्युत धाराओं के परिमाण और दिशाएँ ज्ञात कीजिए । *3*



18. (a) Two waves, each of amplitude 'a' and frequency 'ω' emanating from two coherent sources of light superpose at a point. If the phase difference between the two waves is ϕ, obtain an expression for the resultant intensity at that point. *2*

OR

(b) What is the effect on the interference pattern in Young's double-slit experiment when (i) the source slit is moved closer to the plane of the slits, and (ii) the separation between the two slits is increased ? Justify your answers. *2*

19. A convex lens (n = 1·52) has a focal length of 15·0 cm in air. Find its focal length when it is immersed in liquid of refractive index 1·65. What will be the nature of the lens ? *2*

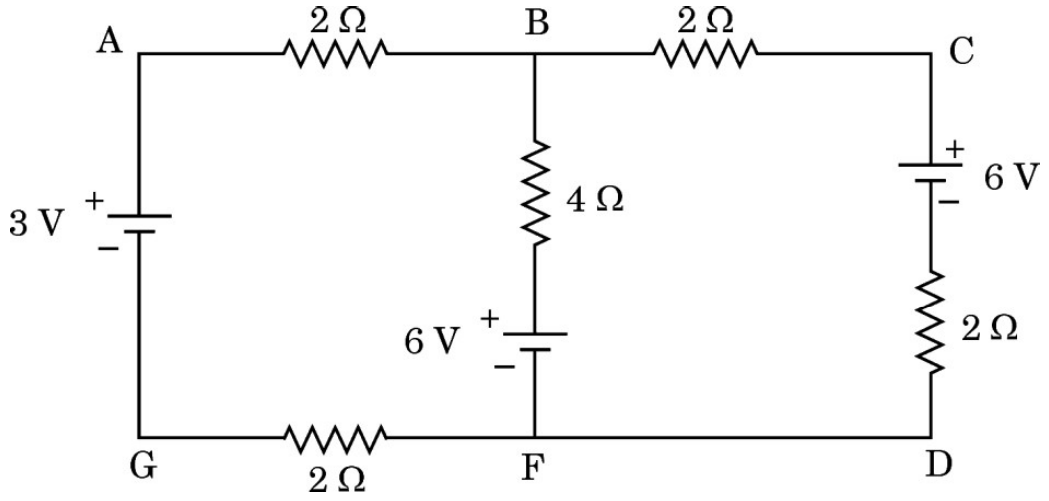
20. The carbon isotope $^{12}_{6}C$ has a nuclear mass of 12·000000 u. Calculate the binding energy of its nucleus.

Given m_p = 1·007825 u; m_n = 1·008665 u. *2*

21. How does the energy gap of an intrinsic semiconductor effectively change when doped with a (a) trivalent impurity, and (b) pentavalent impurity ? Justify your answer in each case. *2*

SECTION C

22. The figure shows a circuit with three ideal batteries. Find the magnitude and direction of currents in the branches AG, BF and CD. *3*



23. (क) किसी माध्यम में विद्युत-चुम्बकीय तरंग की चाल किन कारकों पर निर्भर करती है ?

(ख) कोई विद्युत-चुम्बकीय तरंग किस प्रकार उत्पन्न की जाती है ?

(ग) z-अक्ष के अनुदिश संचरण करती किसी विद्युत-चुम्बकीय तरंग का व्यवस्था आरेख विद्युत और चुम्बकीय क्षेत्रों को चित्रित करते हुए खींचिए । *3*

24. त्रिज्या 1·6 cm तथा प्रतिरोध 5·0 Ω की 100 फेरों वाली कोई कुण्डली त्रिज्या 1·8 cm और 250 फेरे प्रति सेन्टीमीटर वाली परिनालिका के समाक्ष है । परिनालिका में विद्युत धारा 25 ms में 1·5 A से घटकर शून्य हो जाती है । इस अवधि में कुण्डली में प्रेरित धारा परिकलित कीजिए । ($\pi^2 = 10$ लीजिए) *3*

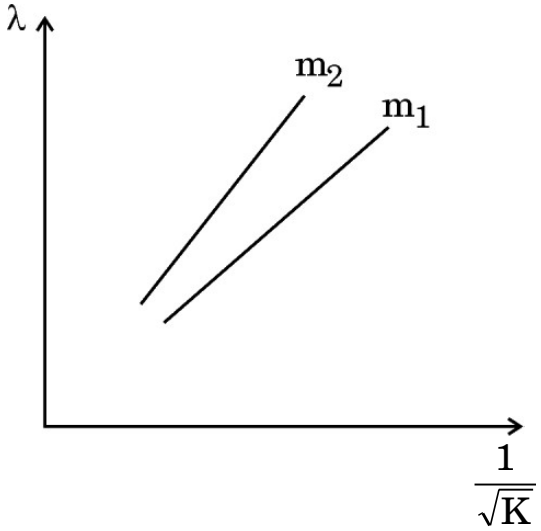
25. (क) दो लम्बे सीधे समान्तर चालकों से विपरीत दिशाओं में स्थायी धाराएँ प्रवाहित हो रही हैं । इन दोनों चालकों के बीच अन्योन्य बल की प्रकृति की व्याख्या कीजिए । दोनों चालकों के बीच बल के परिमाण के लिए व्यंजक प्राप्त कीजिए और इस प्रकार एक ऐम्पियर की परिभाषा दीजिए । *3*

अथवा

(ख) किसी एकसमान चुम्बकीय क्षेत्र $\vec{B}$ में स्थित किसी धारावाही पाश पर कार्यरत बल-आघूर्ण $\vec{\tau}$ के लिए व्यंजक प्राप्त कीजिए । आवश्यक आरेख भी खींचिए । *3*

26. बोर के अभिगृहीतों का उपयोग करके हाइड्रोजन परमाणु में nवीं कक्षा के किसी इलेक्ट्रॉन की त्रिज्या के लिए व्यंजक व्युत्पन्न कीजिए । बोर त्रिज्या a_0 का संख्यात्मक मान भी ज्ञात कीजिए । *3*

27. दो कणों, जिनके द्रव्यमान m_1 और m_2 हैं, के लिए दे ब्रॉग्ली तरंगदैर्घ्य λ को $\frac{1}{\sqrt{K}}$ के फलन के रूप में आरेख में दर्शाया गया है । यहाँ K गतिमान कणों की ऊर्जा है ।



(क) यहाँ किसी रेखा की प्रवणता (ढाल) क्या निरूपित करती है ?

(ख) इनमें से कौन-सा कण अधिक भारी है ?

(ग) क्या यह ग्राफ किसी फ़ोटॉन के लिए भी वैध है ?

प्रत्येक प्रकरण में अपने उत्तर की पुष्टि कीजिए । *3*

23. (a) On what factors does the speed of an electromagnetic wave in a medium depend ?

(b) How is an electromagnetic wave produced ?

(c) Sketch a schematic diagram depicting the electric and magnetic fields for an electromagnetic wave propagating along z-axis. *3*

24. A 100-turn coil of radius 1·6 cm and resistance 5·0 Ω is co-axial with a solenoid of 250 turns/cm and radius 1·8 cm. The solenoid current drops from 1·5 A to zero in 25 ms. Calculate the current induced in the coil in this duration. (Take $\pi^2 = 10$) *3*

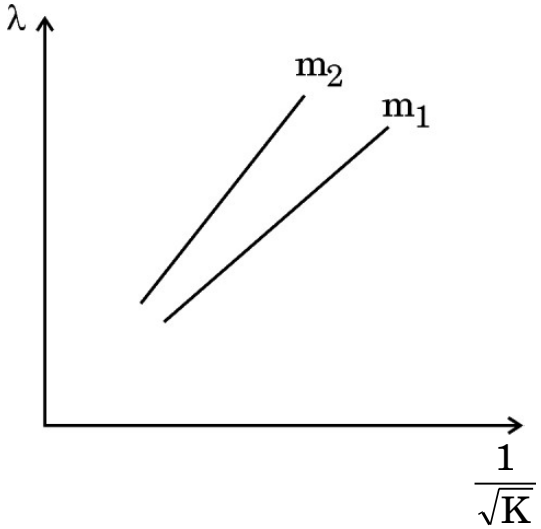
25. (a) Two long, straight, parallel conductors carry steady currents in opposite directions. Explain the nature of the force of interaction between them. Obtain an expression for the magnitude of the force between the two conductors. Hence define one ampere. *3*

OR

(b) Obtain an expression for the torque $\vec{\tau}$ acting on a current carrying loop in a uniform magnetic field $\vec{B}$. Draw the necessary diagram. *3*

26. Using Bohr's postulates, derive the expression for the radius of the nth orbit of an electron in a hydrogen atom. Also find the numerical value of Bohr's radius a_0. *3*

27. de Broglie wavelength λ as a function of $\frac{1}{\sqrt{K}}$, for two particles of masses m_1 and m_2 are shown in the figure. Here, K is the energy of the moving particles.



(a) What does the slope of a line represent ?

(b) Which of the two particles is heavier ?

(c) Is this graph also valid for a photon ?

Justify your answer in each case. *3*

28. परिपथ आरेख की सहायता से किसी p-n संधि डायोड की पूर्ण तरंग दिष्टकारी के रूप में कार्यविधि की व्याख्या कीजिए । इसके निवेशी और निर्गत तरंगरूप भी खींचिए । *3*

खण्ड घ

प्रकरण अध्ययन आधारित प्रश्न

*प्रश्न संख्या **29** तथा **30** प्रकरण अध्ययन आधारित प्रश्न हैं । निम्नलिखित अनुच्छेदों को पढ़ कर दिए गए प्रश्नों के उत्तर दीजिए ।*

29. जब किसी सेल के टर्मिनलों को किसी R प्रतिरोध के चालक से संयोजित किया जाता है, तो परिपथ से विद्युत धारा प्रवाहित होती है । सेल का विद्युत-अपघट्य भी धारा के पथ में चालक की भाँति कुछ प्रतिरोध लगाता है । विद्युत-अपघट्य द्वारा लगाए गए इस प्रतिरोध को सेल का आन्तरिक प्रतिरोध (r) कहते हैं । यह प्रतिरोध विद्युत-अपघट्य की प्रकृति, विद्युत-अपघट्य में इलेक्ट्रोडों के डूबे हुए क्षेत्रफल तथा ताप पर निर्भर करता है । आन्तरिक प्रतिरोध के कारण सेल द्वारा आपूर्त ऊर्जा का कुछ भाग ऊष्मा के रूप में नष्ट हो जाता है ।

जब सेल से कोई धारा नहीं ली जा रही होती है, तो उसके दो इलेक्ट्रोडों के बीच विभवान्तर को सेल का वि.वा. बल (emf) (ε) कहते हैं । सेल से धारा लेते समय दो इलेक्ट्रोडों के बीच विभवान्तर को टर्मिनल विभवान्तर (V) कहते हैं ।

(i) ***असत्य*** कथन चुनिए : *1*

(A) सेल को अनावेशित करते समय बन्द परिपथ में किसी सेल के दो टर्मिनलों के बीच विभवान्तर (V), सेल के वि.वा. बल (emf) (ε) से सदैव कम होता है ।

(B) विद्युत-अपघट्य का ताप घटने पर सेल का आन्तरिक प्रतिरोध घट जाता है ।

(C) सेल से धारा लेते समय $V = \varepsilon - Ir$ होता है ।

(D) सेल के दो टर्मिनलों के बीच विभवान्तर (V) और इससे प्रवाहित धारा (I) के बीच ग्राफ सरल रेखा होता है जिसकी प्रवणता ऋणात्मक होती है ।

(ii) 2·0 V और 6·0 V वि.वा. बल (emf) वाले दो सेल, जिनके आन्तरिक प्रतिरोध क्रमश: 0·1 Ω और 0·4 Ω हैं, पार्श्व में संयोजित हैं । इस संयोजन का तुल्य वि.वा. बल (emf) होगा : *1*

(A) 2·0 V (B) 2·8 V

(C) 6·0 V (D) 8·0 V

28. With the help of a circuit diagram, explain the working of a p-n junction diode as a full wave rectifier. Draw its input and output waveforms. *3*

SECTION D
Case Study Based Questions

*Questions number **29** and **30** are case study based questions. Read the following paragraphs and answer the questions that follow.*

29. When the terminals of a cell are connected to a conductor of resistance R, an electric current flows through the circuit. The electrolyte of the cell also offers some resistance in the path of the current, like the conductor. This resistance offered by the electrolyte is called internal resistance of the cell (r). It depends upon the nature of the electrolyte, the area of the electrodes immersed in the electrolyte and the temperature. Due to internal resistance, a part of the energy supplied by the cell is wasted in the form of heat.

When no current is drawn from the cell, the potential difference between the two electrodes in known as emf of the cell (ε). With a current drawn from the cell, the potential difference between the two electrodes is termed as terminal potential difference (V).

(i) Choose the ***incorrect*** statement : *1*

(A) The potential difference (V) between the two terminals of a cell in a closed circuit is always less than its emf (ε), during discharge of the cell.

(B) The internal resistance of a cell decreases with the decrease in temperature of the electrolyte.

(C) When current is drawn from the cell then $V = \varepsilon - Ir$.

(D) The graph between potential difference between the two terminals of the cell (V) and the current (I) through it is a straight line with a negative slope.

(ii) Two cells of emfs 2·0 V and 6·0 V and internal resistances 0·1 Ω and 0·4 Ω respectively, are connected in parallel. The equivalent emf of the combination will be : *1*

(A) 2·0 V (B) 2·8 V

(C) 6·0 V (D) 8·0 V

(iii) विलयन में डूबे हुए इलेक्ट्रोड विद्युत-अपघट्य से आवेशों का आदान-प्रदान करते हैं । अपने से संलग्न विद्युत-अपघट्य के सापेक्ष धनात्मक इलेक्ट्रोड का विभव V_+ ($V_+ > 0$) तथा ऋणात्मक इलेक्ट्रोड का विभव $-(V_-)$ ($V_- \geq 0$) हो जाता है । जब सेल से कोई धारा नहीं ली जा रही होती है, तब *1*

(A) $\varepsilon = V_+ + V_- > 0$ (B) $\varepsilon = V_+ - V_- > 0$

(C) $\varepsilon = V_+ + V_- < 0$ (D) $\varepsilon = V_+ + V_- = 0$

(iv) (क) 2 V वि.वा. बल (emf) और 0·1 Ω आन्तरिक प्रतिरोध के पाँच सर्वसम सेलों को पार्श्व में संयोजित किया गया है । इस संयोजन को फिर 9·98 Ω के बाह्य प्रतिरोधक से संयोजित किया गया है । प्रतिरोधक से प्रवाहित धारा है : *1*

(A) 0·05 A (B) 0·1 A

(C) 0·15 A (D) 0·2 A

अथवा

(ख) खुले परिपथ में किसी सेल के सिरों पर विभवान्तर 6 V है । 2 A विद्युत धारा लेने पर यह विभवान्तर 4 V हो जाता है । सेल का आन्तरिक प्रतिरोध है : *1*

(A) 1·0 Ω (B) 1·5 Ω

(C) 2·0 Ω (D) 2·5 Ω

30. जब कोई प्रकाश की किरण सघन माध्यम से विरल माध्यम में संचरण करती है, तो वह अभिलम्ब से दूर मुड़ जाती है । जब आपतन कोण में वृद्धि करते हैं, तो अपवर्तित किरण अभिलम्ब से और अधिक मुड़ती जाती है । सघन माध्यम में किसी विशेष आपतन कोण के लिए अपवर्तित किरण दोनों माध्यमों के अन्तरापृष्ठ को ठीक-ठीक स्पर्श करती है । इस आपतन कोण को सम्मिलित माध्यमों के युगल (जोड़े) के लिए क्रांतिक कोण कहते हैं ।

(i) क्रांतिक कोण पर आपतन करने वाली किरण के लिए परावर्तन कोण का मान होता है : *1*

(A) 0° (B) $< 90°$

(C) $> 90°$ (D) 90°

(ii) जल $\left(n = \frac{4}{3}\right)$ में गमन करती कोई 600 nm तरंगदैर्घ्य की प्रकाश किरण जल-वायु अन्तरापृष्ठ पर क्रांतिक कोण से कम कोण पर आपतन करती है । अपवर्तित किरण से संबद्ध तरंगदैर्घ्य है : *1*

(A) 400 nm (B) 450 nm

(C) 600 nm (D) 800 nm

(iii) Dipped in the solution, the electrode exchanges charges with the electrolyte. The positive electrode develops a potential V_+ ($V_+ > 0$), and the negative electrode develops a potential $-(V_-)$ ($V_- \geq 0$), relative to the electrolyte adjacent to it. When no current is drawn from the cell then : *1*

(A) $\varepsilon = V_+ + V_- > 0$ (B) $\varepsilon = V_+ - V_- > 0$

(C) $\varepsilon = V_+ + V_- < 0$ (D) $\varepsilon = V_+ + V_- = 0$

(iv) (a) Five identical cells, each of emf 2 V and internal resistance 0·1 Ω are connected in parallel. This combination in turn is connected to an external resistor of 9·98 Ω. The current flowing through the resistor is : *1*

(A) 0·05 A (B) 0·1 A

(C) 0·15 A (D) 0·2 A

OR

(b) Potential difference across a cell in the open circuit is 6 V. It becomes 4 V when a current of 2 A is drawn from it. The internal resistance of the cell is : *1*

(A) 1·0 Ω (B) 1·5 Ω

(C) 2·0 Ω (D) 2·5 Ω

30. When a ray of light propagates from a denser medium to a rarer medium, it bends away from the normal. When the incident angle is increased, the refracted ray deviates more from the normal. For a particular angle of incidence in the denser medium, the refracted ray just grazes the interface of the two surfaces. This angle of incidence is called the critical angle for the pair of media involved.

(i) For a ray incident at the critical angle, the angle of reflection is : *1*

(A) 0° (B) < 90°

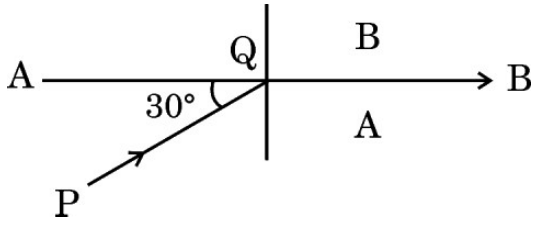
(C) > 90° (D) 90°

(ii) A ray of light of wavelength 600 nm is incident in water $\left(n = \frac{4}{3}\right)$ on the water-air interface at an angle less than the critical angle. The wavelength associated with the refracted ray is : *1*

(A) 400 nm (B) 450 nm

(C) 600 nm (D) 800 nm

(iii) (क) आरेख में दो माध्यमों A और B के बीच अन्तरापृष्ठ AB को दर्शाया गया है । सघन माध्यम A में, आपतित किरण PQ क्षैतिज से 30° का कोण बनाती है । अपवर्तित किरण अन्तरापृष्ठ के समान्तर है । माध्यम A के सापेक्ष माध्यम B का अपवर्तनांक है : *1*



(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{\sqrt{5}}{2}$

(C) $\frac{4}{\sqrt{3}}$ (D) $\frac{2}{\sqrt{3}}$

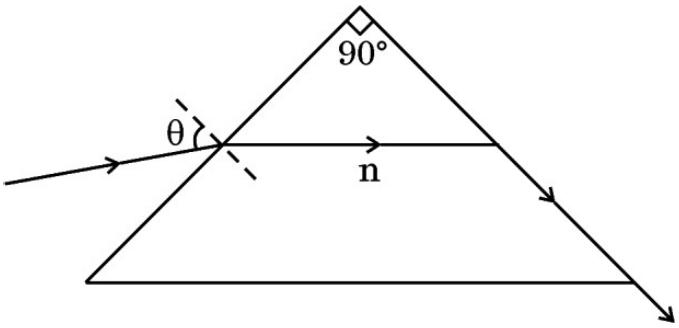
अथवा

(ख) दो माध्यम A और B किसी समतल सीमा द्वारा पृथक्कित हैं । A और B माध्यम में प्रकाश की चाल क्रमश: $2 \times 10^8\ ms^{-1}$ और $2{\cdot}5 \times 10^8\ ms^{-1}$ है । माध्यम A से माध्यम B में गमन करने वाली प्रकाश की किरण के लिए क्रांतिक कोण है : *1*

(A) $\sin^{-1}\frac{1}{2}$ (B) $\sin^{-1}\frac{4}{5}$

(C) $\sin^{-1}\frac{3}{5}$ (D) $\sin^{-1}\frac{2}{5}$

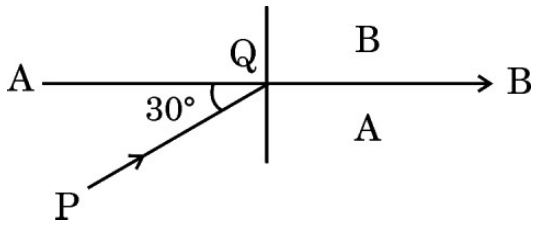
(iv) आरेख में किसी त्रिभुजाकार प्रिज़्म से गमन करती किसी प्रकाश की किरण का पथ दर्शाया गया है । इस परिघटना में कोण θ का मान है : *1*



(A) $\sin^{-1}\sqrt{n^2-1}$ (B) $\sin^{-1}(n^2-1)$

(C) $\sin^{-1}\left[\frac{1}{\sqrt{n^2-1}}\right]$ (D) $\sin^{-1}\left[\frac{1}{(n^2-1)}\right]$

(iii) (a) The interface AB between the two media A and B is shown in the figure. In the denser medium A, the incident ray PQ makes an angle of 30° with the horizontal. The refracted ray is parallel to the interface. The refractive index of medium B w.r.t. medium A is : *1*



(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{\sqrt{5}}{2}$

(C) $\frac{4}{\sqrt{3}}$ (D) $\frac{2}{\sqrt{3}}$

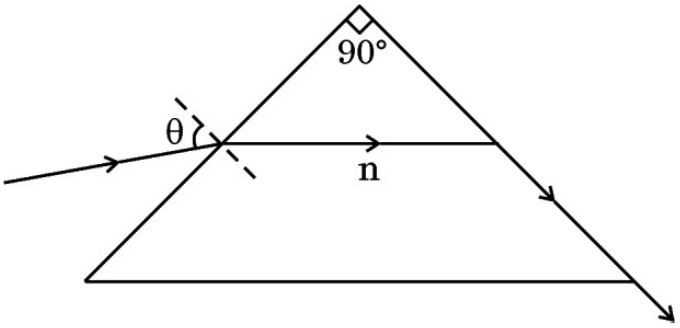
OR

(b) Two media A and B are separated by a plane boundary. The speed of light in medium A and B is 2×10^8 ms^{-1} and $2{\cdot}5 \times 10^8$ ms^{-1} respectively. The critical angle for a ray of light going from medium A to medium B is : *1*

(A) $\sin^{-1}\frac{1}{2}$ (B) $\sin^{-1}\frac{4}{5}$

(C) $\sin^{-1}\frac{3}{5}$ (D) $\sin^{-1}\frac{2}{5}$

(iv) The figure shows the path of a light ray through a triangular prism. In this phenomenon, the angle θ is given by : *1*



(A) $\sin^{-1}\sqrt{n^2-1}$ (B) $\sin^{-1}(n^2-1)$

(C) $\sin^{-1}\left[\frac{1}{\sqrt{n^2-1}}\right]$ (D) $\sin^{-1}\left[\frac{1}{(n^2-1)}\right]$

खण्ड ङ

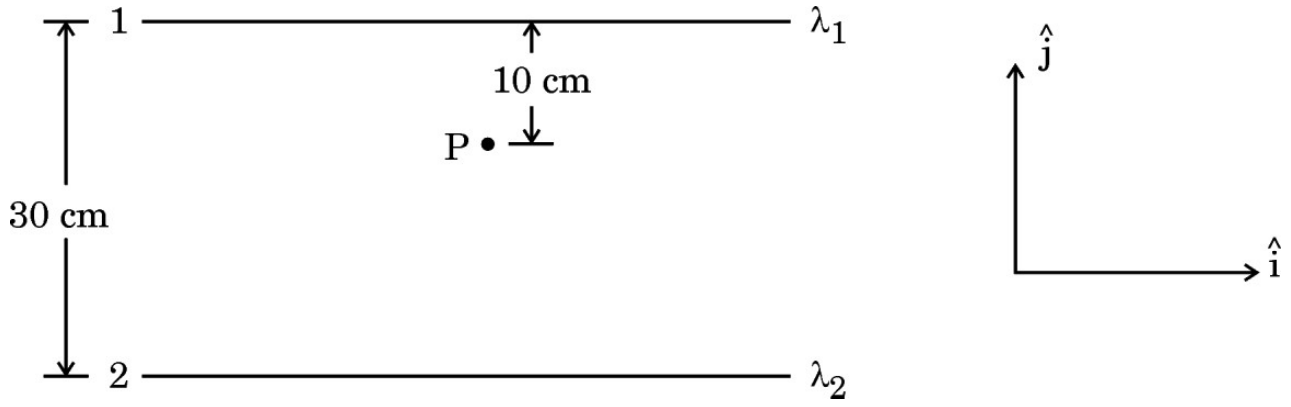
31. (क) (i) द्विध्रुव आघूर्ण $\vec{p}$ के किसी लघु द्विध्रुव के कारण, द्विध्रुव के साइज की तुलना में उसके केन्द्र से बहुत अधिक दूरी पर स्थित किसी बिन्दु $\vec{r}$ पर, विद्युत विभव के लिए व्यंजक प्राप्त कीजिए ।

(ii) किसी समबाहु त्रिभुज के शीर्षों पर तीन बिन्दु आवेश q, 2q और nq स्थित हैं । यदि इस निकाय की स्थितिज ऊर्जा शून्य है, तो n का मान ज्ञात कीजिए । *5*

अथवा

(ख) (i) स्थिरवैद्युतिकी का गाउस नियम लिखिए । इस नियम का अनुप्रयोग करके किसी एकसमान आवेशित अनन्त समतल चादर के निकट किसी बिन्दु पर विद्युत क्षेत्र $\vec{E}$ प्राप्त कीजिए ।

(ii) दो लम्बे सीधे तार 1 और 2 आरेख में दर्शाए अनुसार रखे गए हैं । इन दोनों तारों के रैखिक आवेश घनत्व क्रमश: $\lambda_1 = 10\ \mu C/m$ और $\lambda_2 = -20\ \mu C/m$ हैं । बिन्दु P पर स्थित किसी इलेक्ट्रॉन द्वारा अनुभव किया जाने वाला नेट बल $\vec{F}$ ज्ञात कीजिए । *5*



SECTION E

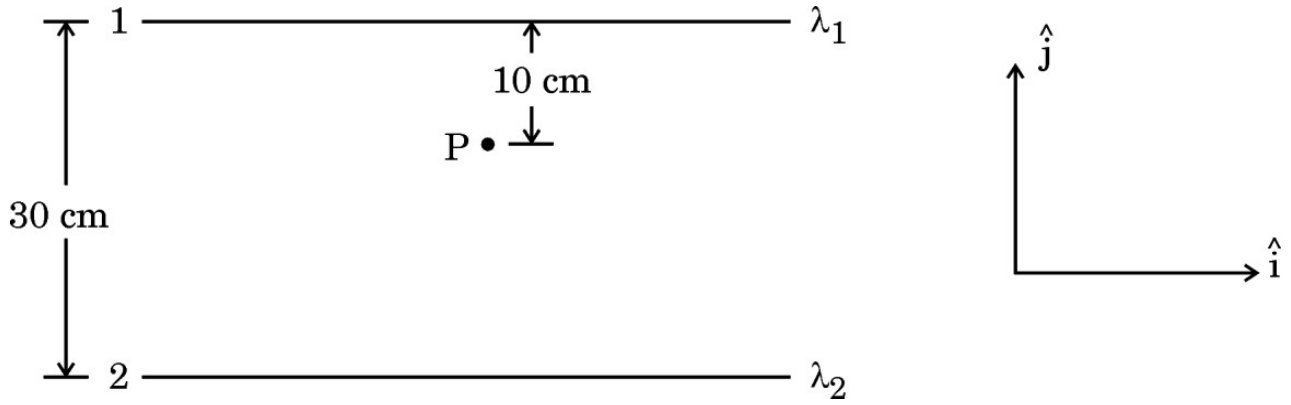
31. (a) (i) Obtain an expression for the electric potential due to a small dipole of dipole moment $\vec{p}$, at a point $\vec{r}$ from its centre, for much larger distances compared to the size of the dipole.

(ii) Three point charges q, 2q and nq are placed at the vertices of an equilateral triangle. If the potential energy of the system is zero, find the value of n. *5*

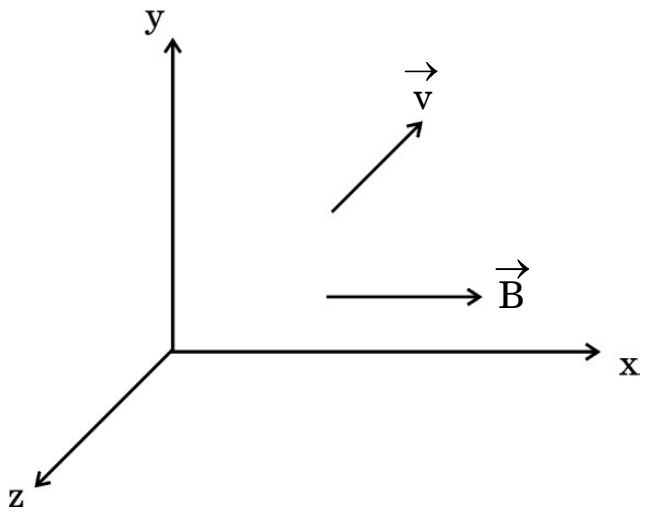
OR

(b) (i) State Gauss's Law in electrostatics. Apply this to obtain the electric field $\vec{E}$ at a point near a uniformly charged infinite plane sheet.

(ii) Two long straight wires 1 and 2 are kept as shown in the figure. The linear charge density of the two wires are $\lambda_1 = 10\ \mu C/m$ and $\lambda_2 = -20\ \mu C/m$. Find the net force $\vec{F}$ experienced by an electron held at point P. *5*



32. (क) (i) आरेख में दर्शाए अनुसार द्रव्यमान m और आवेश q का कोई कण किसी चुम्बकीय क्षेत्र $\vec{B}$ में वेग $\vec{v}$ से गतिमान है । यह दर्शाइए कि यह कण कुण्डलिनी पथ पर गमन करता है । इस प्रकार इसके परिक्रमण की आवृत्ति प्राप्त कीजिए ।



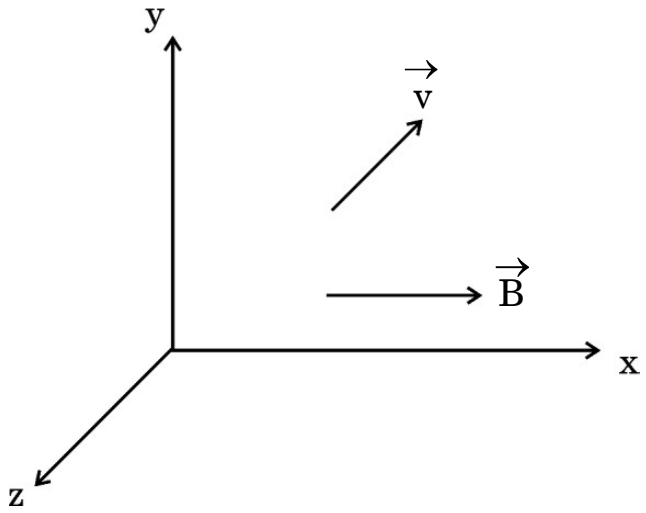
(ii) किसी हाइड्रोजन परमाणु में कोई इलेक्ट्रॉन 2 Å त्रिज्या की किसी कक्षा में 8×10^{14} परिक्रमण प्रति सेकण्ड से गति कर रहा है । इस इलेक्ट्रॉन की कक्षीय गति से संबद्ध चुम्बकीय आघूर्ण ज्ञात कीजिए । *5*

अथवा

(ख) (i) किसी गैल्वेनोमीटर की धारा सुग्राहिता किसे कहते हैं ? दर्शाइए कि किसी गैल्वेनोमीटर की धारा सुग्राहिता में वृद्धि किस प्रकार की जा सकती है । "किसी गैल्वेनोमीटर की धारा सुग्राहिता में वृद्धि होने पर यह आवश्यक नहीं है कि उसकी वोल्टता सुग्राहिता में भी वृद्धि हो ।" व्याख्या कीजिए ।

(ii) किसी चल कुण्डली गैल्वेनोमीटर का प्रतिरोध 15 Ω है तथा वह पूर्ण पैमाना विक्षेपण के लिए 20 mA धारा लेता है । इस गैल्वेनोमीटर को (0 – 100 V) परिसर के वोल्टमीटर में किस प्रकार परिवर्तित किया जा सकता है ? *5*

32. (a) (i) A particle of mass m and charge q is moving with a velocity $\vec{v}$ in a magnetic field $\vec{B}$ as shown in the figure. Show that it follows a helical path. Hence, obtain its frequency of revolution.



(ii) In a hydrogen atom, the electron moves in an orbit of radius 2 Å making 8×10^{14} revolutions per second. Find the magnetic moment associated with the orbital motion of the electron. *5*

OR

(b) (i) What is current sensitivity of a galvanometer ? Show how the current sensitivity of a galvanometer may be increased. "Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity." Explain.

(ii) A moving coil galvanometer has a resistance 15 Ω and takes 20 mA to produce full scale deflection. How can this galvanometer be converted into a voltmeter of range 0 to 100 V ? *5*

33. (क) (i) यंग के द्विझिरी प्रयोग के व्यतिकरण पैटर्न और एकल झिरी के कारण विवर्तन पैटर्न के बीच कोई दो अन्तर दीजिए ।

(ii) द्विझिरी व्यतिकरण पैटर्न के प्रकरण में तीव्रता वितरण ग्राफ खींचिए ।

(iii) तरंगदैर्घ्य λ के एकवर्णीय प्रकाश का उपयोग करने पर यंग के द्विझिरी प्रयोग में पर्दे के जिस बिन्दु पर पथान्तर λ है, वहाँ प्रकाश की तीव्रता K मात्रक है । पर्दे के जिस बिन्दु पर पथान्तर $\frac{\lambda}{6}$ है, वहाँ प्रकाश की तीव्रता ज्ञात कीजिए । *5*

अथवा

(ख) (i) किसी संयुक्त सूक्ष्मदर्शी द्वारा स्पष्ट दर्शन की न्यूनतम दूरी पर प्रतिबिम्ब बनना दर्शाने के लिए नामांकित किरण आरेख खींचिए । इसकी आवर्धन क्षमता के लिए व्यंजक व्युत्पन्न कीजिए ।

(ii) कोई दूरदर्शी (दूरबीन) 100 cm और 5 cm फोकस दूरी के दो लेंसों से मिलकर बना है । उस स्थिति में इसकी आवर्धन क्षमता ज्ञात कीजिए जिसमें अंतिम प्रतिबिम्ब अनन्त पर बनता है । *5*

33. (a) (i) Give any two differences between the interference pattern obtained in Young's double-slit experiment and a diffraction pattern due to a single slit.

(ii) Draw an intensity distribution graph in case of a double-slit interference pattern.

(iii) In Young's double-slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen, where path difference is λ, is K units. Find the intensity of light at a point on the screen where the path difference is $\frac{\lambda}{6}$. *5*

OR

(b) (i) Draw a labelled ray diagram of a compound microscope showing image formation at least distance of distinct vision. Derive an expression for its magnifying power.

(ii) A telescope consists of two lenses of focal length 100 cm and 5 cm. Find the magnifying power when the final image is formed at infinity. *5*

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT- PHYSICS (CODE 55/2/1)

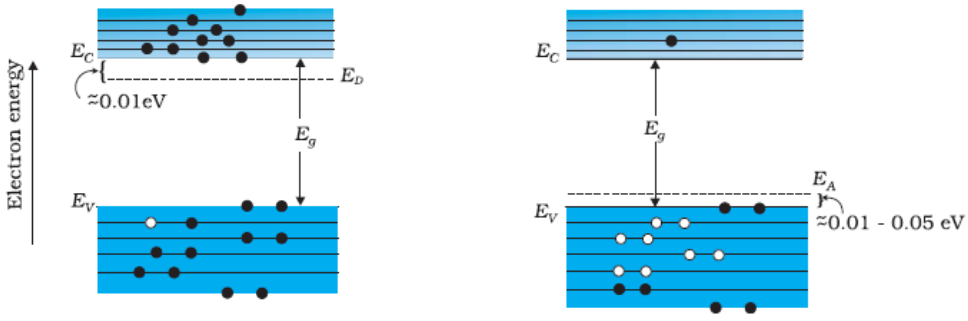
General Instructions: -

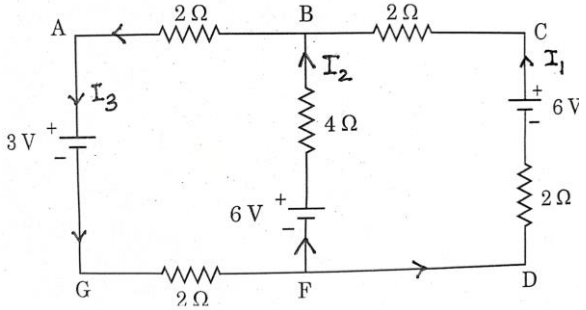
1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc. may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark (√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right **(✓)** while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should be

	retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0 – 70 has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for Spot Evaluation**" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

MARKING SCHEME : PHYSICS (042)			
CODE :55/2/1			
Q.No	**VALUE POINTS/EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
SECTION –A			
1.	(C) $\sqrt{\frac{m_p}{m_Q}}$	1	1
2.	(A) $\frac{v_d}{2}$	1	1
3.	(B) $1.54 Am^2$	1	1
4.	(C) 31.4μWb	1	1
5.	(D) Magnetic Flux and Power both	1	1
6.	(B) 100V	1	1
7.	(B) Ultraviolet rays	1	1
8.	(C) 375 nm	1	1
9.	(B) $\frac{1}{\lambda_1}+\frac{1}{\lambda_2}=\frac{1}{\lambda_3}$	1	1
10.	(C) $\frac{1}{K}$	1	1
11.	(C) P	1	1
12.	(B) The barrier height increases and the depletion region widens.	1	1
13.	(A) Both Assertion(A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	1	1
14.	(B) Both Assertion(A) and Reason (R) are true but Reason(R) is not the correct explanation of the Assertion (A)	1	1
15.	(A) Both Assertion(A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	1	1
16.	(C) Assertion(A) is true, but Reason (R) is false	1	1
SECTION -B			
17.	Defining resistivity 1 Dependence of resistivity on (a) Number density of free electron ½ (b) Relaxation time ½ Resistance offered by a material of unit length and having unit cross-sectional area is called resistivity. **1** $\rho=\frac{m}{ne^2\tau}$ (a) $\rho\alpha\frac{1}{n}$ **½** (b) $\rho\alpha\frac{1}{\tau}$ **½**		**2**

18.	**(a)** Obtaining expression for resultant intensity 2		
	$x_1 = a\cos\omega t$ $x_2 = a\cos(\omega t + \phi)$ $x = x_1 + x_2$ $= a(\cos\omega t + \cos(\omega t + \phi))$ $= a(2\cos(\omega t + \frac{\phi}{2})\cos\frac{\phi}{2})$	½	
	$= 2a\cos\frac{\phi}{2}\cos(\omega t + \frac{\phi}{2})$ Intensity I = K (amplitude) ^{2} where K is a constant. $= K(2a\cos\frac{\phi}{2})^2$	½ ½	
	$= 4I_0\cos^2\frac{\phi}{2}$ $I_o = Ka^2$ = intensity of each incident wave. **(Note : Award full credit of this part for all other alternative correct methods)**	½	
	OR		
	(b) Effect and justification (i) Source slit moved closer to plane of slits 1 (ii) Separation between two slits 1		
	(i)Sharpness of interference pattern decreases $\frac{s}{S} < \frac{\lambda}{d}$ As S decreases, interference patterns produced by different parts of the source overlap and finally fringes disappear. **Alternatively** As the source slit is brought closer to the plane of the slits, the screen gets illuminated uniformly and fringes disappear. **Alternatively** Interference pattern is not formed. **(Note : Award full credit of this part if a student merely attempts this part.)**	**1**	
	(ii) $\beta = \frac{\lambda D}{d}$ As d increases, β decreases and fringes disappear.	½ ½	**2**
19.	Finding focal length 1 ½ Nature of the lens ½ For convex lens in air $\frac{1}{f_a} = \left(\frac{n_g}{n_a} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$		

	For convex lens in liquid. $\frac{1}{f_l}=\left(\frac{n_g}{n_l}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ $\frac{f_l}{f_a}=\frac{\frac{1.52-1}{1}}{\frac{1.52-1.65}{1.65}}$ $= -6.6$ $f_l = -6.6\ f_a$ $= -99$cm Nature of the lens: Diverging/ behaves like a concave lens.	½ ½ ½ ½	**2**
20.	Calculation of binding energy 2 Binding Energy $= (Zm_p + (A-Z)m_n - M_N) \times 931.5$ MeV B. E.$= (6\times1.007825 + 6\times1.008665 - 12.000000)$ x 931.5 MeV $= (0.09894)$ x 931.5 MeV B. E. = 92.16 MeV	½ ½ ½ ½	**2**
21.	Effect on energy gap and justification (i) Trivalent impurity ½ + ½ (ii) Pentavalent impurity ½ + ½ (i) Decreases Justification: An acceptor energy level is formed just above the top of the valence band. (ii) Decreases Justification: A donor level is formed just below the bottom of conduction band. **Alternatively**  **(Note : Award the credit of justification if a student draws band diagram)**	½ ½ ½ ½	**2**
	SECTION C		
22.	Finding magnitude and direction of current in AG, BF and CD 1+1+1		



½

By Kirchoff's Laws (at point B)

$I_1 + I_2 = I_3$ …….(1)

In the closed loop AGFBA ½

$3 + 2I_3 - 6 + 4I_2 + 2I_3 = 0$

$I_2 + I_3 = \frac{3}{4}$ …….(2)

From (i) ½

$2I_1 + I_2 = \frac{3}{4}$ …….(3)

In closed loop BFDCB ½

$-4I_2 + 6 + 2I_1 - 6 + 2I_1 = 0$

$I_2 - I_1 = 0$

$I_2 = I_1$ ……..(4)

Putting in (3) ½

$I_1 = \frac{1}{4} A$

From (4)

$I_2 = \frac{1}{4} A$

From (2) $I_3 = \frac{1}{2} A$ ½ **3**

23.

(a) Factors affecting speed of Electromagnetic wave	1
(b) Production of Electromagnetic wave	1
(c) Sketch of Electromagnetic wave	1

(a) Speed of EM waves $v = \frac{1}{\sqrt{\mu\varepsilon}}$

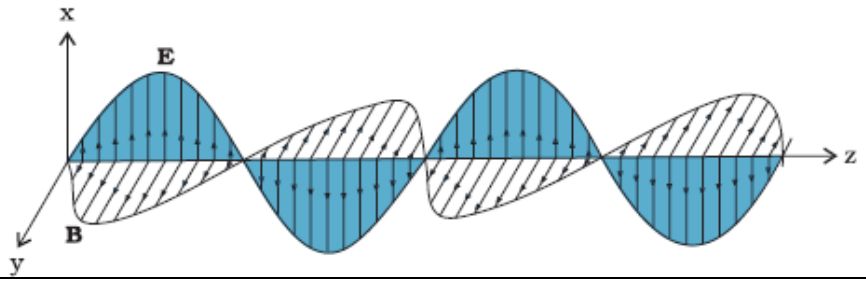
Speed depends upon

(i) Permittivity (ε) of medium ½ + ½

(ii) Magnetic permeability (μ) of medium

(b) Accelerated charges or oscillating charges produce electromagnetic waves **1**

(c)



1 **3**

24.

Calculation of current induced in the coil	3

Induced emf $(\varepsilon) = \dfrac{-Nd\phi}{dt}$ ½

$= \dfrac{-NAdB}{dt}$

$= -NA\dfrac{d}{dt}(\mu_0 nI)$

$= -N\mu_0 n(\pi r^2)\dfrac{dI}{dt}$

$\varepsilon = \dfrac{100\times 4\pi\times 10^{-7}\times 250\times 10^{2}\times \pi\times (1.6\times 10^{-2})^2\times 1.5}{25\times 10^{-3}}$ **1**

$=0.1536\text{V}$ ½

$I = \dfrac{\varepsilon}{R}$ ½

$= 0.03\text{A}$ ½

Alternatively

$\varepsilon = -M\dfrac{dI}{dt}$ ½

$M = \mu_0 n_1 n_2 \pi r_1^2 l$ ½

$= \mu_0 (n_1 l) n_2 \pi r_1^2$

$= 4\pi\times 10^{-7}\times 100\times 250\times 10^{2}\times \pi\times (1.6\times 10^{-2})^2$

$= 2.56\times 10^{-3} H$ ½

$= -2.56\times 10^{-3}\times \dfrac{(0-1.5)}{25\times 10^{-3}}$

$=0.1536\text{V}$ ½

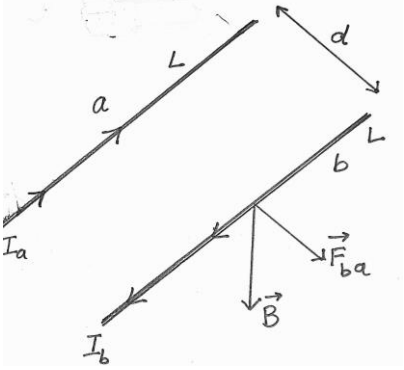
$I = \dfrac{\varepsilon}{R} = \dfrac{0.1536}{5}$ ½

$= 0.03\text{A}$ ½ **3**

25. **(a)**

Explaining nature of force	½
Obtaining expression of force	1½
Defining one ampere	1

Nature of force is repulsive. ½



½

Magnetic field due to current I_a at all points of conductor b

$B_{ab} = \frac{\mu_0 I_a}{2\pi d}$ directed downwards

½

Force experienced by conductor b on its segment of length *l*

$F_{ab} = I_b l B_{ab}$

$= \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards left

½

Similarly

Force experienced by conductor a on its segment of length *l*

$F_{ba} = \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards right

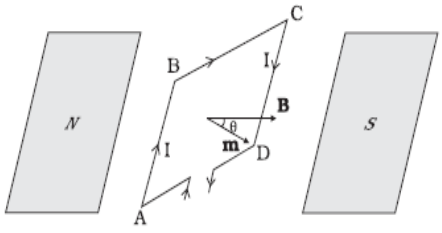
One ampere is that steady current which when maintained in each of two very long straight parallel conductors of negligible cross- section, placed one metre apart in vacuum produces a force of 2×10^{-7} N/m on each conductor.

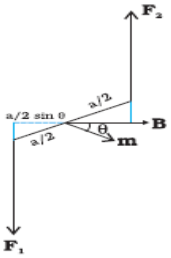
1

OR

(b)

Obtaining expression of torque	2
Drawing diagram	1





1

Forces on arm BC and DA are equal and opposite and act along the axis of the coil. Being collinear they cancel each other.

½

Forces on arms AB and CD are equal and opposite but not collinear. They form a couple.

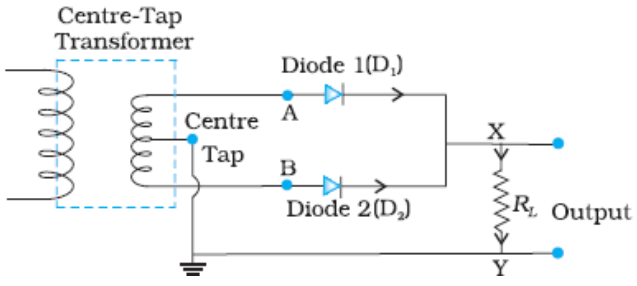
$F_1 = F_2 = IbB$

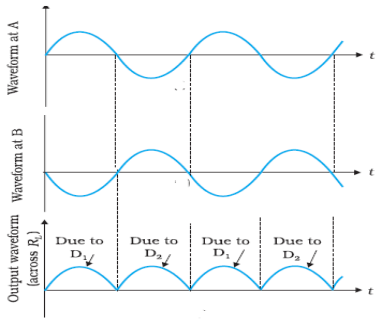
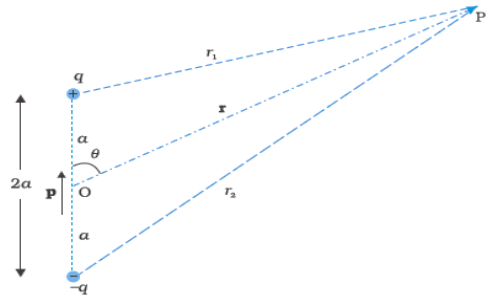
½

$\tau = F_1 \frac{a}{2} \sin\theta + F_2 \frac{a}{2} \sin\theta$

$\tau = IabB \sin\theta$

½

	$\tau = IAB\sin\theta$ (where A = ab & m = IA) $\vec{\tau} = \vec{m} \times \vec{B}$	½	**3**
26.	Deriving expression for radius 2 Finding numerical value of a_o 1 From Bohr's second postulate $mvr = \frac{nh}{2\pi}$ ……(1) Also $\frac{mv^2}{r} = \frac{e^2}{4\pi\varepsilon_0 r^2}$ (z=1) $v = \frac{e}{\sqrt{4\pi\varepsilon_0 mr}}$ Substituting in (1) and simplifying $r = \frac{n^2h^2\varepsilon_0}{\pi me^2}$ For n = 1 r = a_o (Bohr's radius) $a_o = \frac{(6.63\times10^{-34})^2 \times 8.854\times10^{-12}}{3.14\times9.1\times10^{-31}\times(1.6\times10^{-19})^2}$ = $5.29\text{x}10^{-11}$m = 0.53Å	½ ½ ½ ½ ½ ½	**3**
27.	(a) Interpretation of slope of line and justification ½ + ½ (b) Identification and justification ½ + ½ (c) Validation of graph and justification ½ + ½ (a) $\lambda = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2m}} \times \frac{1}{\sqrt{K}}$ $slope = \frac{h}{\sqrt{2m}}$ (b) $slope\,\alpha\,\frac{1}{\sqrt{m}}$ Slope of m_2 is more than that of m_1.Therefore, m_1 is heavier. (c) No Momentum (p) = $\sqrt{2mK}$ is not valid for a photon	½ ½ ½ ½ ½ ½	**3**
28.	Explaining working of full wave rectifier 2 Drawing input and output wave forms 1  When input voltage at A with respect to the centre tap at any instant is positive, at that instant voltage at B, being out of phase will be negative,	**1** ½	

	during the positive half cycle diode D_1 gets forward biased and conducts while diode D_2 gets reverse biased and does not conduct. Hence during positive half cycle an output current and output voltage across R_L is obtained. During second half of the cycle when voltage at A becomes negative with respect to centre tap, the voltage at B would be positive hence D_1 would not conduct but D_2 would be giving an output current and output voltage. We get output voltage in both positive and negative half cycles.  	½ 1	3
29.	(i) (B) The internal resistance of a cell decreases with the decrease in temperature of the electrolyte. (ii) (B) 2.8 V (iii) (A) $\varepsilon = V_+ + V_- > 0$ (iv) (a) (D) 0.2A **OR** (b) (A) 1.0Ω	1 1 1 1	4
30.	(i) Since no option is correct, award 1 mark to all students. (ii) (D) 800 nm (iii) (a) (A) $\frac{\sqrt{3}}{2}$ **OR** (b) (B) $\sin^{-1}\left(\frac{4}{5}\right)$ (iv) (A) $\sin^{-1}\sqrt{n^2-1}$	1 1 1 1	4
31.	**(a)** (i) Obtaining expression for electric potential 3 (ii) Finding the value of n 2 (i)  Potential due to the dipole is the sum of potentials due to charges q and -q	 ½ ½	

$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r_1} - \frac{q}{r_2}\right)$ ----------(1)

By geometry

½

$r_1^2 = r^2 + a^2 - 2ar\cos\theta$

$r_2^2 = r^2 + a^2 + 2ar\cos\theta$

For r >> a, retaining terms only up to first order in a/r

$r_1^2 = r^2\left(1 - \frac{2a\cos\theta}{r} + \frac{a^2}{r^2}\right)$

$\cong r^2\left(1 - \frac{2a\cos\theta}{r}\right)$

Similarly ½

$r_2^2 \cong r^2\left(1 + \frac{2a\cos\theta}{r}\right)$

Using the binomial theorem and retaining terms up to the first order in a/r

$\frac{1}{r_1} \cong \frac{1}{r}\left(1 - \frac{2a\cos\theta}{r}\right)^{-1/2}$

$\cong \frac{1}{r}\left(1 + \frac{a\cos\theta}{r}\right)$ ----------(2)

$\frac{1}{r_2} \cong \frac{1}{r}\left(\frac{1 + 2a\cos\theta}{r}\right)^{-1/2}$ ----------(3) ½

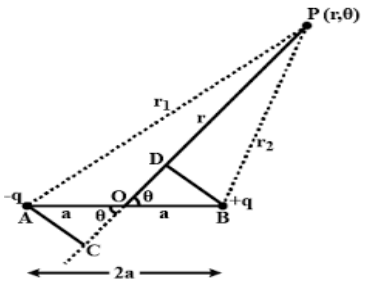
$\cong \frac{1}{r}\left(1 - \frac{a\cos\theta}{r}\right)$

Using eqn. (1) (2), (3) and p = 2qa

$V = \frac{q}{4\pi\varepsilon_0}\frac{2a\cos\theta}{r^2}$ ½

$= \frac{\mathrm{p}\cos\theta}{4\pi\varepsilon_0 r^2}$

Alternatively –



½

$r_2 = r + a\cos\theta$ ½

$r_1 = r - a\cos\theta$

$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ ½

$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r - a\cos\theta} - \frac{1}{r + a\cos\theta}\right)$

$= \frac{q}{4\pi\varepsilon_0}\left(\frac{2a\cos\theta}{r^2 - a^2\cos^2\theta}\right)$ ½

½

$$= \frac{p}{4\pi\varepsilon_0 r^2}\left(\frac{\cos\theta}{1-\frac{a^2}{r^2}\cos^2\theta}\right)$$ ½

For r>>a, neglecting $\frac{a^2}{r^2}$

V= $\frac{P\cos\theta}{4\pi\varepsilon_0 r^2}$ ½

(ii) Consider the side of equilateral triangle as 'a'

Potential energy = U= $\frac{kq_1q_2}{a}+\frac{kq_2q_3}{a}+\frac{kq_1q_3}{a}$ ½

According to question

$U = \frac{k(q)(2q)}{a}+\frac{k(2q)(nq)}{a}+\frac{k(q)(\mathrm{n}\,q)}{a}=0$ ½

$= \frac{2q^2}{a}+\frac{2nq^2}{a}+\frac{\mathrm{n}\,q^2}{a}=0$

$2+2n+n=0$ ½

$3n=-2$

$n=-\frac{2}{3}$

OR

(b)

(i) Statement of Gauss's Law	1
Obtaining expression for electric field	2
(ii) Finding net force on electron	2

1

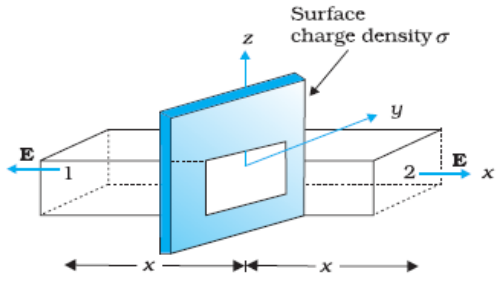
(i) Electric Flux through a closed surface is equal to $\frac{q}{\varepsilon_0}$, where q is the total charge enclosed by the surface. $\phi = \frac{q}{\varepsilon_0}$

Alternatively

The surface integral of electric field over a closed surface is $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface.

$\oint \vec{E}.d\vec{S} = \frac{q}{\varepsilon_0}$

(Award ½ mark for writing the formula only.)

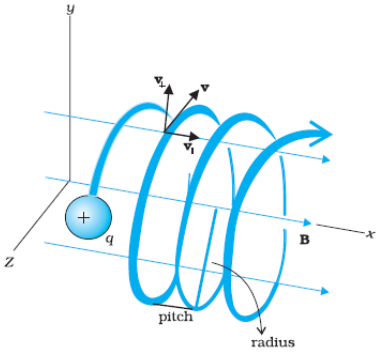


½

(Gaussian surface can be cylindrical also)

As seen from figure, only two faces 1 and 2 will contribute to the flux.

Flux $\vec{E}.d\vec{s}$ through both the surfaces is equal and add up. ½

	The charge enclosed by surface is σA, where σ is surface charge density According to Gauss's theorem $2EA = \sigma A / \varepsilon_0$ $E = \sigma / 2\varepsilon_0$ $\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$ where n̂ is unit vector directed normally out of the plane (ii) $\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 r}\hat{r}$ According to question E_1 (at point P) $= \frac{\lambda_1}{2\pi\varepsilon_0 r_1}$ $\vec{E} = \frac{10\times10^{-6}}{2\pi\varepsilon_0(10\times10^{-2})}(-\hat{j})\ N/C$ E_2 (at point P) $= \frac{\lambda_2}{2\pi\varepsilon_0 r_2}$ $\vec{E} = \frac{20\times10^{-6}}{2\pi\varepsilon_0(20\times10^{-2})}(-\hat{j})\ N/C$ $E_{net} = \frac{10\times10^{-6}}{2\pi\varepsilon_0}\left(\frac{1}{0.1}+\frac{2}{0.2}\right)(-\hat{j})\ N/C$ $= 3.6\times10^{6}\ (-\hat{j})\ N/C$ $\vec{F}_{net} = q\times\vec{E}_{net}$ $\vec{F} = -1.6\times10^{-19}\times3.6\times10^{6}(-\hat{j})\ N$ $= 5.76\times10^{-13}N\ (\hat{j})$	½ ½ ½ ½ ½ ½	5
32.	**(a)** (i) Showing helical path 1 ½ Obtaining frequency of revolution 1 ½ (ii) Finding magnetic moment of electron 2  $v_\perp = v\sin\theta$ is perpendicular to $\vec{B}$ and $v_\parallel = v\cos\theta$ is parallel to $\vec{B}$ Due to $v_\perp$ the charge describes circular path and $v_\parallel$ pushes it in the direction of $\vec{B}$. Therefore under the combined effect of two components the charged particle describes helical path, as shown in the figure. The centripetal force	½ **1**	

$\frac{mv_\perp^2}{r} = B\,qv_\perp$ ½

$v_\perp = \frac{Bqr}{m}$ $(v_\perp = v\sin\theta)$ ½

Time period = $T = \frac{2\pi r}{v_\perp}$

$= \frac{2\pi m}{Bq}$

$frequency\, v = \frac{1}{T} = \frac{Bq}{2\pi m}$ ½

(ii) Magnetic moment $m = I\,A$

$I = \frac{e}{T} = ev$ ½

$= 1.6\times10^{-19}\times8\times10^{14}$

$= 1.28\times10^{-4}\,A$ ½

$M = 1.28\times10^{-4}\times3.14\times(2\times10^{-10})^2$ ½

$= 5.12\pi\times10^{-24}\,Am^2 = 1.6\times10^{-23}\,Am^2$ ½

OR

(b)

(i) Definition of current sensitivity	1
Showing dependence of current sensitivity & explanation	1+1
(ii) Calculation of resistance	2

(i) Deflection produced per unit current is called its current sensitivity. **1**

$I_S = \frac{\theta}{I} = \frac{NBA}{K}$

Current sensitivity can be increased by
(a) increasing number of turns in coil
(b) increasing area of coil in magnetic field **1**
(c) decreasing K (Torsional Constant)
(any one)

$V_s = \frac{\theta}{V} = \frac{NBA}{KR}$

If current sensitivity is increased by increasing number of turns of the coil, the resistance of the galvanometer will also increase. Thus voltage sensitivity may not increase. **1**

(ii) $V = I_G(R+G)$

$R = \frac{V}{I_G} - G$ ½

$= \frac{100}{20\times10^{-3}} - 15$

$= 5000 - 15$ ½

$= 4985\Omega$ ½

By connecting 4985Ω in series with galvanometer it is converted to voltmeter of range (0-100V) ½ **5**

33. **(a)**

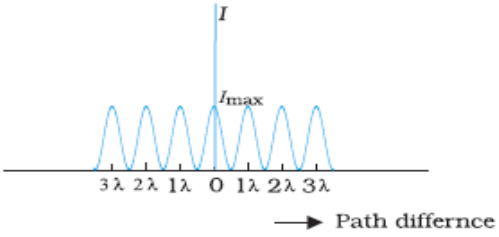
(i) Two differences between interference pattern and diffraction pattern	2
(ii) Intensity distribution graph	1
(iii) Finding intensity of light	2

(i)

	Interference	Diffraction
1	Bands are equally spaced	Bands are not equally spaced.
2	Intensity of bright bands is same.	Intensity of maxima decreases on either side of central maxima.
3	First maxima is at an angle λ / a	First minima is at an angle λ / a

1 + 1

(ii)



1

(iii) Path difference $(\Delta) = \lambda$

$$\phi = \frac{2\pi\Delta}{\lambda}$$

$$\phi = 2\pi$$ **½**

$$I = 4I_0 \cos^2 \frac{\phi}{2}$$

$$K = 4I_0 \cos^2 \pi \ = 4I_0$$ **½**

$$\text{Path difference} = \frac{\lambda}{6}$$

$$\phi = \pi / 3$$ **½**

$$I = 4I_0 \cos^2 \frac{\pi}{6}$$

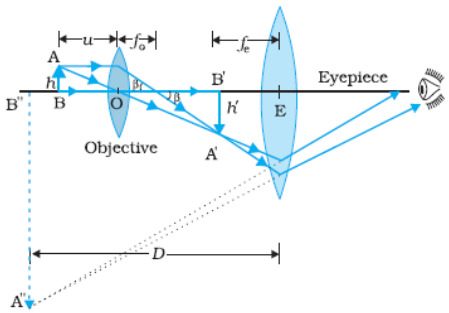
$$= 4I_0 \times \frac{3}{4}$$

$$= \frac{3}{4}\text{K}$$ **½**

OR

(b)

(i) Drawing labeled ray diagram	1
Derivation of magnifying power	2
(iii) Finding magnifying power	2

	(i)  The magnification obtained by eye-piece lens $m_e = \left(1+\frac{D}{f_e}\right)$ The magnification obtained by objective lens $m_0 = \frac{v_0}{-u_0}$ Hence the total magnifying power is $m = m_0 \times m_e$ $= \frac{v_0}{-u_0}\left(1+\frac{D}{f_e}\right)$ $(ii)\,\mathrm{m} = \left\|\frac{f_0}{f_e}\right\|$ Identification of focal length of objective and eyepiece $f_0 = 100cm$ $f_e = 5cm$ $m = \left\|\frac{100}{5}\right\| = 20$	**1** ½ ½ ½ ½ **1** ½ ½	**5**

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT- PHYSICS (CODE 55/2/2)

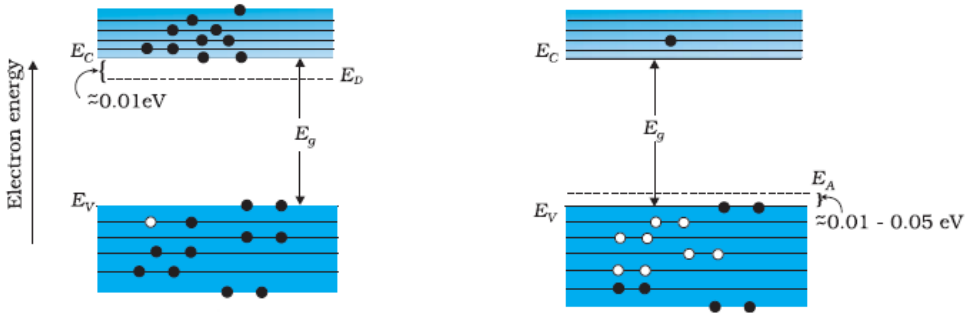
General Instructions: -

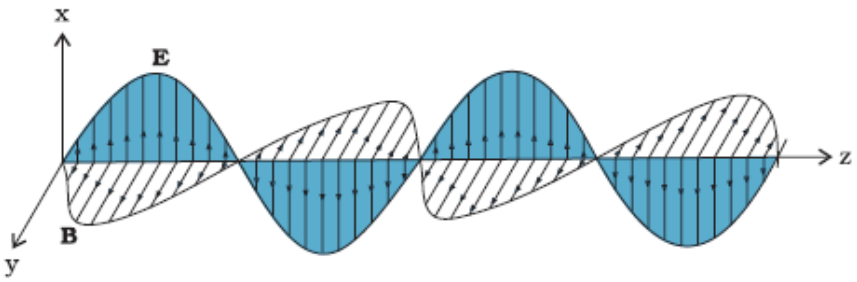
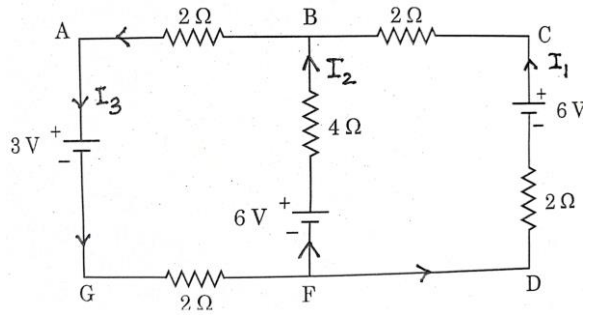
1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc. may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark (√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right **(✓)** while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should be

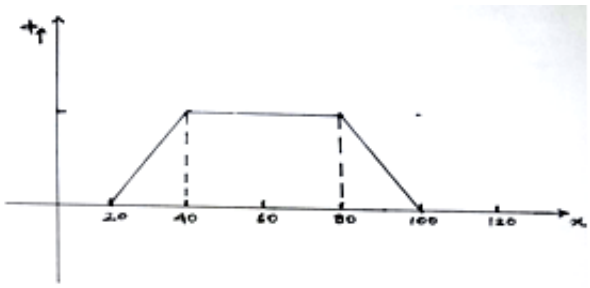
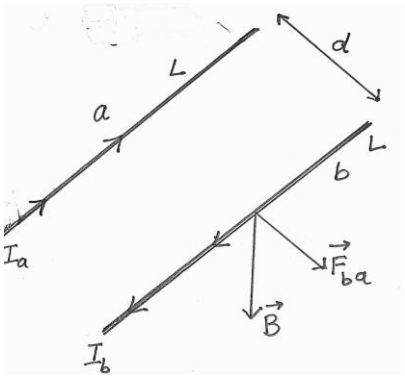
	retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0 – 70 has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for Spot Evaluation**" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

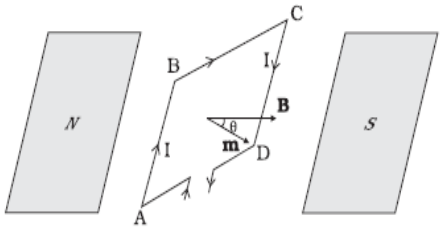
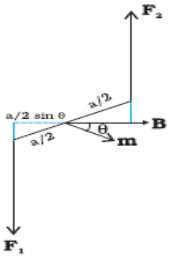
MARKING SCHEME : PHYSICS (042)			
CODE : 55/2/2			
Q.No	**VALUE POINTS/EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	SECTION -A		
1.	(C) $\frac{C}{4}$	**1**	**1**
2.	(A) $\frac{v_d}{2}$	**1**	**1**
3.	(D) $\varepsilon_1 > \varepsilon_3 > \varepsilon_2$	**1**	**1**
4.	(C) 31.4μWb	**1**	**1**
5.	(D) Magnetic Flux and Power both	**1**	**1**
6.	(A) $\frac{10^5}{4\pi}$ Hz	**1**	**1**
7.	(B) Ultraviolet rays	**1**	**1**
8.	(D) 2.14 e V	**1**	**1**
9.	(B) $\frac{1}{\lambda_1}+\frac{1}{\lambda_2}=\frac{1}{\lambda_3}$	**1**	**1**
10.	(C) $\frac{1}{K}$	**1**	**1**
11.	(C) P	**1**	**1**
12.	(B) The barrier height increases and the depletion region widens.	**1**	**1**
13.	(C) Assertion (A) is true, but Reason (R) is false	**1**	**1**
14.	(A) Both Assertion (A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	**1**	**1**
15.	(B) Both Assertion (A) and Reason (R) are true but Reason(R) is not the correct explanation of the Assertion (A)	**1**	**1**
16.	(A) Both Assertion (A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	**1**	**1**
	SECTION – B		
17	(a) Explanation 1 (b) Explanation 1 (a) Electric field is established throughout the circuit, almost instantly. It causes a local electron drift at every point, thus establishment of current does not have to wait for electrons from one end of the conductor to travel to other end. (b) Ohm's law asserts that the plot of I versus V is linear i.e. R is independent of V, while equation V=IR defines resistance and it may be applied to all conducting devices whether they obey Ohm's law or not.	**1** **1**	**2**
18	Finding focal length 1 ½ Nature of the lens ½		

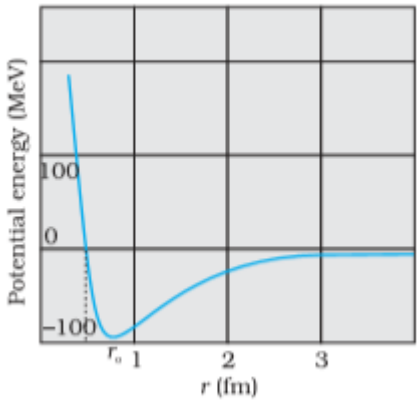
	For convex lens in air $\frac{1}{f_a} = \left(\frac{n_g}{n_a} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ For convex lens in liquid. $\frac{1}{f_l} = \left(\frac{n_g}{n_l} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\frac{f_l}{f_a} = \frac{\frac{1.52-1}{1}}{\frac{1.52-1.65}{1.65}}$ $= -6.6$ $f_l = -6.6\ f_a$ $= -99$cm Nature of the lens: Diverging/ behaves like a concave lens.	½ ½ ½ ½	**2**
19.	**(a)** Obtaining expression for resultant intensity 2 $x_1 = a\cos\omega t$ $x_2 = a\cos(\omega t + \phi)$ $x = x_1 + x_2$ $= a(\cos\omega t + \cos(\omega t + \phi))$ $= a(2\cos(\omega t + \frac{\phi}{2})\cos\frac{\phi}{2})$ $= 2a\cos\frac{\phi}{2}\cos(\omega t + \frac{\phi}{2})$ Intensity I = K (amplitude)^2 where K is a constant. $= K(2a\cos\frac{\phi}{2})^2$ $= 4I_0\cos^2\frac{\phi}{2}$ $I_o = Ka^2$ = intensity of each incident wave. **(Award full credit of this part for all other alternative correct methods)** **OR** **(b)** Effect and justification (i) Source slit moved closer to plane of slits 1 (ii) Separation between two slits 1 (i)Sharpness of interference pattern decreases $\frac{s}{S} < \frac{\lambda}{d}$ As S decreases, interference patterns produced by different parts of the source overlap and finally fringes disappear. **Alternatively** As the source slit is brought closer to the plane of the slits, the screen gets illuminated uniformly and fringes disappear.	½ ½ ½ ½ **1**	

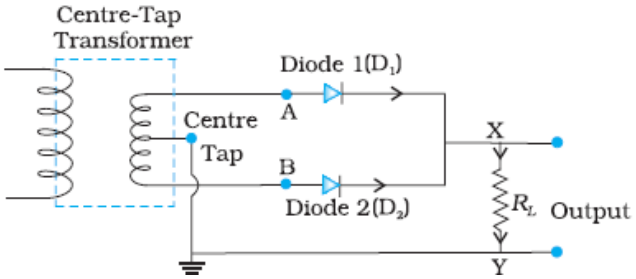
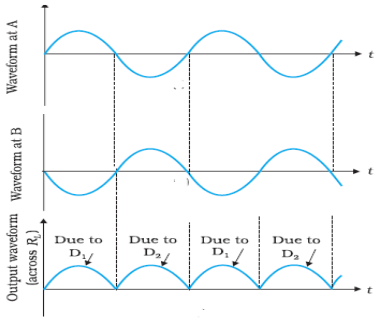
	Alternatively Interference pattern is not formed. **(Note : Award full credit of this part if a student merely attempts this part.)** (ii) $\beta = \frac{\lambda D}{d}$ As d increases, β decreases and fringes disappear.	½ ½	**2**
20.	Calculating energy released/ absorbed 2 Energy = mass defect x 931 Mev Mass defect $= \Delta m = (2 \times 12.000000 - 19.992439 - 4.002603)$ $= 0.004958$u Energy released = 0.004958 x 931 MeV = 4.62 MeV	½ ½ ½ ½	**2**
21.	Effect on energy gap and justification (i) Trivalent impurity ½ + ½ (ii) Pentavalent impurity ½ + ½ (i) Decreases Justification: An acceptor energy level is formed just above the top of the valence band. (ii) Decreases Justification: A donor level is formed just below the bottom of conduction band. **Alternatively**  **(Note : Award the credit of justification if a student draws band diagram)**	½ ½ ½ ½	**2**
	SECTION-C		
22.	(a) Factors affecting speed of Electromagnetic wave 1 (b) Production of Electromagnetic wave 1 (c) Sketch of Electromagnetic wave 1 (a) Speed of EM waves $v = \frac{1}{\sqrt{\mu\varepsilon}}$ Speed depends upon		

	(i) Permittivity (ε) of medium (ii) Magnetic permeability (μ) of medium (b) Accelerated charges or oscillating charges produce electromagnetic waves (c) 	½ + ½ **1** **1**	**3**
23.	Finding magnitude and direction of current in AG, BF and CD 1+1+1  By Kirchoff's Laws (at point B) $I_1 + I_2 = I_3$ …….(1) In the closed loop AGFBA $3+ 2I_3 – 6 + 4I_2 + 2I_3 = 0$ $I_2 + I_3 = \frac{3}{4}$ …….(2) From (i) $2I_1 + I_2 = \frac{3}{4}$ …….(3) In closed loop BFDCB $- 4I_2 + 6 + 2I_1 - 6 + 2I_1=0$ $I_2 - I_1 = 0$ $I_2 = I_1$ ……..(4) Putting in (3) $I_1 = \frac{1}{4} A$ From (4) $I_2 = \frac{1}{4} A$ From (2) $I_3 = \frac{1}{2} A$	½ ½ ½ ½ ½	**3**

24.	(a) Plotting graph 1½ (b) Finding magnetic flux 1 (c) Requirement of external work ½ (a)  (b) $\phi = \text{B.A}$ $= 5\times10^{-3}\times20\times10^{-2}\times10\times10^{-2}$ $= 10^{-4} Wb$ (c) Yes, external work is required.	**1** ½ ½ ½ ½	**3**
25.	**(a)** Explaining nature of force ½ Obtaining expression of force 1½ Defining one ampere 1 Nature of force is repulsive.  Magnetic field due to current I_a at all points of conductor b $B_{ab} = \frac{\mu_0 I_a}{2\pi d}$ directed downwards Force experienced by conductor b on its segment of length l $F_{ab} = I_b l B_{ab}$ $= \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards left Similarly Force experienced by conductor a on its segment of length l	½ ½ ½ ½	

	$F_{ba} = \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards right One ampere is that steady current which when maintained in each of two very long straight parallel conductors of negligible cross- section, placed one metre apart in vacuum produces a force of 2×10^{-7} N/m on each conductor.	**1**	
	OR		
	(b) Obtaining expression of torque 2 Drawing diagram 1   	**1**	
	Forces on arm BC and DA are equal and opposite and act along the axis of the coil. Being collinear they cancel each other.	½	
	Forces on arms AB and CD are equal and opposite but not collinear. They form a couple. $F_1 = F_2 = IbB$ $\tau = F_1 \frac{a}{2} \sin\theta + F_2 \frac{a}{2} \sin\theta$ $\tau = IabB \sin\theta$ $\tau = IAB \sin\theta$ (where A = ab & m = IA) $\vec{\tau} = \vec{m} \times \vec{B}$	½ ½	**3**
26.	(a) Explaining de Broglie hypothesis 1 (b) Finding ratio of de Broglie wavelength i) Accelerated through same potential difference 1 ii) Moving with same kinetic energy 1 (a) Moving particles of matter display wave like properties under suitable conditions. The wave length λ associated with a particle of momentum p is given as $\lambda = \frac{h}{p} = \frac{h}{mv}$ λ is the attribute of a wave while momentum is a typical attribute of particle.	**1**	
	(b) (i) $\lambda = \frac{h}{\sqrt{2meV}}$ $\frac{\lambda_p}{\lambda_\alpha} = \frac{\sqrt{2 \times 4m_p \times 2e \times V}}{\sqrt{2 \times m_p \times e \times V}}$	½	

	$= 2\sqrt{2}$ (ii) $\lambda = \frac{h}{\sqrt{2mK}}$ $\frac{\lambda_p}{\lambda_\alpha} = \frac{\sqrt{2 \times 4m_p \times K}}{\sqrt{2 \times m_p \times K}}$ $= 2$	½ ½ ½	**3**
27.	(a) Plotting graph 1 (b) Identifying and justifying regions i) Attracting nuclear force ½ + ½ ii) Repulsive nuclear force ½ + ½ (a)  (**Give full credit for graph without values)** (b) $F = -\frac{dU}{dx}$ i) For distance larger than r_o, force is attractive Since slope of the curve is positive ii) For distance less than r_o, force is repulsive Since slope of the curve is negative	**1** ½ ½ ½ ½	**3**
28.	Explaining working of full wave rectifier 2 Drawing input and output wave forms 1		

	 When input voltage at A with respect to the centre tap at any instant is positive, at that instant voltage at B, being out of phase will be negative, during the positive half cycle diode D_1 gets forward biased and conducts while diode D_2 gets reverse biased and does not conduct. Hence during positive half cycle an output current and output voltage across R_L is obtained. During second half of the cycle when voltage at A becomes negative with respect to centre tap, the voltage at B would be positive hence D_1 would not conduct but D_2 would be giving an output current and output voltage. We get output voltage in both positive and negative half cycles. 	1 ½ ½ 1	3
29	(i) Since no option is correct, award 1 mark to all students. (ii) (D) 800 nm (iii) (a) (A) $\frac{\sqrt{3}}{2}$ **OR** (b) (B) $\sin^{-1}\left(\frac{4}{5}\right)$ (iv) (A) $\sin^{-1}\sqrt{n^2-1}$	1 1 1 1	4
30	(i) (B) The internal resistance of a cell decreases with the decrease in temperature of the electrolyte. (ii) (B) 2.8 V (iii) (A) $\varepsilon = V_+ + V_- > 0$ (iv) (a) (D) 0.2A **OR** (b) (A) 1.0Ω	1 1 1 1	4

31.

(a)

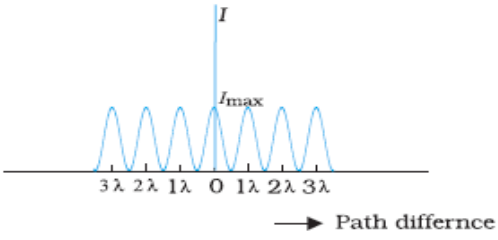
(i) Two differences between interference pattern and diffraction pattern	2
(ii) Intensity distribution graph	1
(iii) Finding intensity of light	2

(i)

	Interference	Diffraction
1	Bands are equally spaced	Bands are not equally spaced.
2	Intensity of bright bands are same.	Intensity of maxima decreases on either side of central maxima.
3	First maxima is at an angle λ / a	First minima is at an angle λ / a

1 + 1

(ii)



1

(iii) Path difference $(\Delta) = \lambda$

$$\phi = \frac{2\pi\Delta}{\lambda}$$

½

$$\phi = 2\pi$$

$$I = 4I_0 \cos^2 \frac{\phi}{2}$$

$$K = 4I_0 \cos^2 \pi \ = 4I_0$$

½

$$\text{Path difference} = \frac{\lambda}{6}$$

$$\phi = \pi / 3$$

$$I = 4I_0 \cos^2 \frac{\pi}{6}$$

½

$$= 4I_0 \times \frac{3}{4}$$

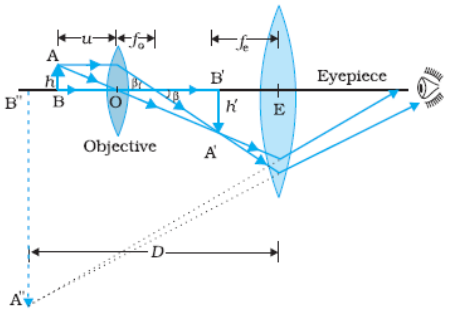
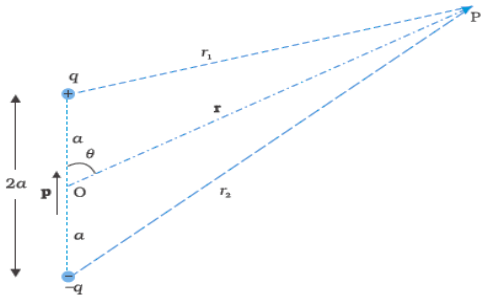
$$= \frac{3}{4}\text{K}$$

½

OR

(b)

(i) Drawing labeled ray diagram	1
Derivation of magnifying power	2
(iii) Finding magnifying power	2

	(i)  The magnification obtained by eye-piece lens $m_e = \left(1+\frac{D}{f_e}\right)$ The magnification obtained by objective lens $m_0 = \frac{v_0}{-u_0}$ Hence the total magnifying power is $m = m_0 \times m_e$ $= \frac{v_0}{-u_0}\left(1+\frac{D}{f_e}\right)$ $(ii)\ \mathrm{m} = \left\|\frac{f_0}{f_e}\right\|$ Identification of focal length of objective and eyepiece $f_0 = 100cm$ $f_e = 5cm$ $m = \left\|\frac{100}{5}\right\| = 20$	1 ½ ½ ½ 1 ½ ½	5
32.	**(a)** (i) Obtaining expression for electric potential 3 (ii) Finding the value of n 2 (i)  Potential due to the dipole is the sum of potentials due to charges q and -q $V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r_1}-\frac{q}{r_2}\right)$ ----------(1) By geometry $r_1^2 = r^2 + a^2 - 2ar\cos\theta$ $r_2^2 = r^2 + a^2 + 2ar\cos\theta$ For r >> a, retaining terms only up to first order in a/r	½ ½ ½	

$r_1^2 = r^2\left(1-\frac{2a\cos\theta}{r}+\frac{a^2}{r^2}\right)$

$\cong r^2\left(1-\frac{2a\cos\theta}{r}\right)$

Similarly ½

$r_2^2 \cong r^2\left(1+\frac{2a\cos\theta}{r}\right)$

Using the binomial theorem and retaining terms up to the first order in a/r

$\frac{1}{r_1} \cong \frac{1}{r}\left(1-\frac{2a\cos\theta}{r}\right)^{-1/2}$

$\cong \frac{1}{r}\left(1+\frac{a\cos\theta}{r}\right)$ ----------(2)

$\frac{1}{r_2} \cong \frac{1}{r}\left(\frac{1+2a\cos\theta}{r}\right)^{-1/2}$ ----------(3)

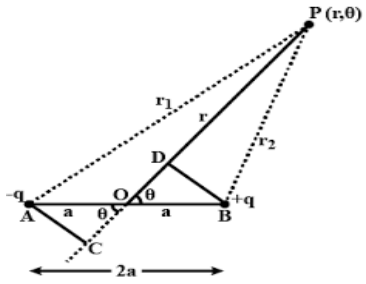
$\cong \frac{1}{r}\left(1-\frac{a\cos\theta}{r}\right)$ ½

Using eqn. (1) (2), (3) and p = 2qa

$V = \frac{q}{4\pi\varepsilon_0}\frac{2a\cos\theta}{r^2}$

$= \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$ ½

Alternatively –



½

$r_2 = r + a\cos\theta$

$r_1 = r - a\cos\theta$ ½

$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r_1}-\frac{1}{r_2}\right)$

$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r-a\cos\theta}-\frac{1}{r+a\cos\theta}\right)$ ½

$= \frac{q}{4\pi\varepsilon_0}\left(\frac{2a\cos\theta}{r^2-a^2\cos^2\theta}\right)$ ½

$= \frac{p}{4\pi\varepsilon_0 r^2}\left(\frac{\cos\theta}{1-\frac{a^2}{r^2}\cos^2\theta}\right)$ ½

For r>>a, neglecting $\frac{a^2}{r^2}$

V= $\frac{P\cos\theta}{4\pi\varepsilon_0 r^2}$ ½

(ii) Consider the side of equilateral triangle as ‘a’

Potential energy = U= $\frac{kq_1q_2}{a}+\frac{kq_2q_3}{a}+\frac{kq_1q_3}{a}$ ½

According to question

$U=\frac{k(q)(2q)}{a}+\frac{k(2q)(nq)}{a}+\frac{k(q)(\text{n}\,q)}{a}=0$ ½

$=\frac{2q^2}{a}+\frac{2nq^2}{a}+\frac{\text{n}\,q^2}{a}=0$ ½

$2+2n+n=0$

$3n=-2$

$n=-\frac{2}{3}$ ½

OR

(b)

(i) Statement of Gauss's Law	1
Obtaining expression for electric field	2
(ii) Finding net force on electron	2

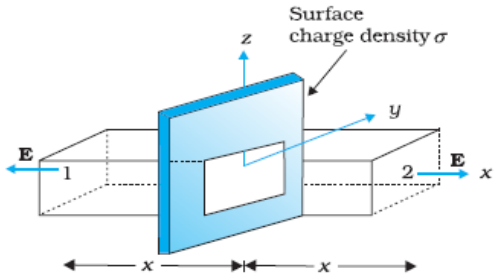
(i) Electric Flux through a closed surface is equal to $\frac{q}{\varepsilon_0}$, where q is the total charge enclosed by the surface. $\phi=\frac{q}{\varepsilon_0}$ **1**

Alternatively

The surface integral of electric field over a closed surface is $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface.

$\oint \vec{E}.\text{d}\vec{\text{S}}=\frac{q}{\varepsilon_0}$

(Award ½ marks for writing the formula only.)



½

(Gaussian surface can be cylindrical also)

As seen from figure, only two faces 1 and 2 will contribute to the flux. ½

Flux $\vec{E}.\text{d}\vec{s}$ through both the surfaces is equal and add up.

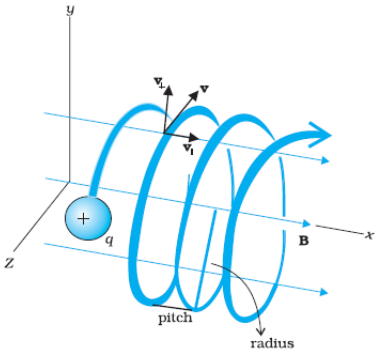
The charge enclosed by surface is σA, where σ is surface charge density

According to Gauss's theorem

$2EA=\sigma A/\varepsilon_0$ ½

$E=\sigma/2\varepsilon_0$

$\vec{E}=\frac{\sigma}{2\varepsilon_0}\hat{n}$ where n̂ is unit vector directed normally out of the plane ½

	(ii) $\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 r}\hat{r}$ According to question E_1 (at point P) $= \frac{\lambda_1}{2\pi\varepsilon_0 r_1}$ $\vec{E} = \frac{10\times10^{-6}}{2\pi\varepsilon_0(10\times10^{-2})}\ (-\hat{j})\ N/C$ E_2 (at point P) $= \frac{\lambda_2}{2\pi\varepsilon_0 r_2}$ $\vec{E} = \frac{20\times10^{-6}}{2\pi\varepsilon_0(20\times10^{-2})}\ (-\hat{j})\ N/C$ $E_{net} = \frac{10\times10^{-6}}{2\pi\varepsilon_0}\left(\frac{1}{0.1}+\frac{2}{0.2}\right)\ (-\hat{j})\ N/C$ $= 3.6\times10^{6}\ (-\hat{j})\ N/C$ $\vec{F}_{net} = q\times\vec{E}_{net}$ $\vec{F} = -1.6\times10^{-19}\times3.6\times10^{6}\ (-\hat{j})\ N$ $= 5.76\times10^{-13}N\ (\hat{j})$	½ ½ ½ ½	5
33.	**(a)** (i) Showing helical path 1 ½ Obtaining frequency of revolution 1 ½ (ii) Finding magnetic moment of electron 2  $v_\perp = v\sin\theta$ is perpendicular to $\vec{B}$ and $v_\parallel = v\cos\theta$ is parallel to $\vec{B}$ Due to $v_\perp$ the charge describes circular path and $v_\parallel$ pushes it in the direction of $\vec{B}$. Therefore under the combined effect of two components the charged particle describes helical path, as shown in the figure. The centripetal force $\frac{mv_\perp^2}{r} = B\,qv_\perp$ $v_\perp = \frac{Bqr}{m}$ $(v_\perp = v\sin\theta)$ Time period = T $= \frac{2\pi r}{v_\perp}$	½ **1** ½ ½	

$= \frac{2\pi m}{Bq}$

$frequency\, v = \frac{1}{T} = \frac{Bq}{2\pi m}$ ½

(ii) Magnetic moment $m = I\,A$

$I = \frac{e}{T} = ev$

$= 1.6\times10^{-19}\times8\times10^{14}$ ½

$= 1.28\times10^{-4}\,A$

$M = 1.28\times10^{-4}\times3.14\times(2\times10^{-10})^2$ ½

$= 5.12\pi\times10^{-24}\,Am^2 = 1.6\times10^{-23}\,Am^2$ ½

OR

(b)

(i) Definition of current sensitivity	1
Showing dependence of current sensitivity & explanation	1+1
(ii) Calculation of resistance	2

(i) Deflection produced per unit current is called its current sensitivity. **1**

$I_S = \frac{\theta}{I} = \frac{NBA}{K}$

Current sensitivity can be increased by
(a) increasing number of turns in coil
(b) increasing area of coil in magnetic field
(c) decreasing K (Torsional Constant) **1**
(any one)

$V_s = \frac{\theta}{V} = \frac{NBA}{KR}$

If current sensitivity is increased by increasing number of turns of the coil, the resistance of the galvanometer will also increase. Thus voltage sensitivity may not increase. **1**

(ii) $V = I_G(R+G)$

$R = \frac{V}{I_G} - G$ ½

$= \frac{100}{20\times10^{-3}} - 15$ ½

$= 5000 - 15$

$= 4985\Omega$ ½

By connecting 4985Ω in series with galvanometer it is converted to voltmeter of range (0-100V) ½ 5

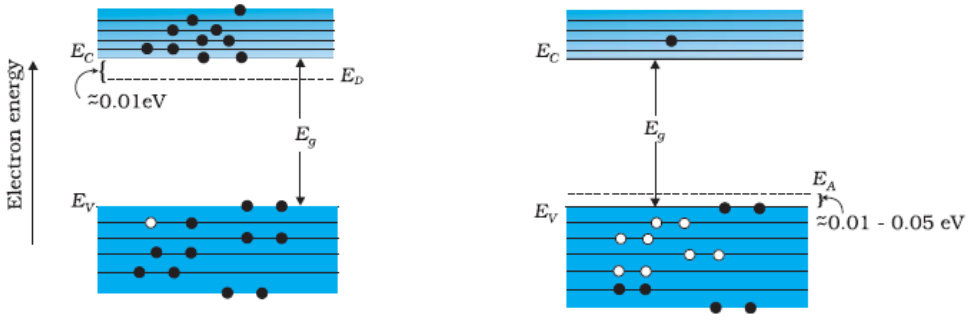
Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT- PHYSICS (CODE 55/2/3)

General Instructions: -

1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc. may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark (√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right **(✓)** while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should be

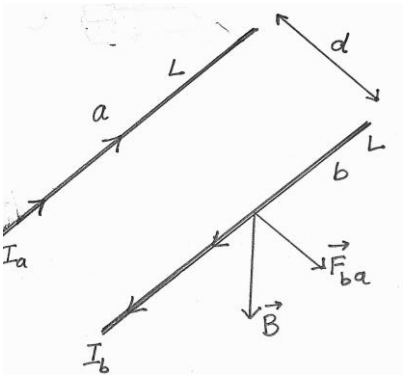
	retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0 – 70 has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for Spot Evaluation**" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

MARKING SCHEME : PHYSICS (042)			
CODE :55/2/3			
Q.No	**VALUE POINTS/EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	SECTION-A		
1.	(D) $\frac{1}{3}$	**1**	**1**
2.	(A) $\frac{v_d}{2}$	**1**	**1**
3.	(B) Resistance of the coil	**1**	**1**
4.	(C) 31.4μWb	**1**	**1**
5.	(D) Magnetic Flux and Power both	**1**	**1**
6.	(A) $\frac{5\pi}{6}$	**1**	**1**
7.	(C) III	**1**	**1**
8.	(B) $8x10^{-28}$	**1**	**1**
9.	(C) P	**1**	**1**
10.	(B) $\frac{1}{\lambda_1}+\frac{1}{\lambda_2}=\frac{1}{\lambda_3}$	**1**	**1**
11.	(B) The barrier height increases and the depletion region widens.	**1**	**1**
12.	(C) $\frac{1}{K}$	**1**	**1**
13.	(A) Both Assertion(A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	**1**	**1**
14.	(C) Assertion(A) is true, but Reason (R) is false	**1**	**1**
15.	(B) Both Assertion(A) and Reason (R) are true but Reason(R) is not the correct explanation of the Assertion (A)	**1**	**1**
16.	(A) Both Assertion(A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	**1**	**1**
	SECTION- B		
17.	Deriving relation 2 $V = IR$ $El = \frac{I\rho l}{A}$ (V= El, $R = \frac{\rho l}{A}$) $E = \frac{I}{A}\rho$ $E = \sigma\rho$	½ ½ ½ ½	**2**
18.	Effect on energy gap and justification (i) Trivalent impurity ½ + ½ (ii) Pentavalent impurity ½ + ½ (i) Decreases Justification: An acceptor energy level is formed just above the top of the valence band.	½ ½	

	(ii) Decreases Justification: A donor level is formed just below the bottom of conduction band. **Alternatively**  **(Note : Award the credit of justification if a student draws band diagram)**	½ ½	**2**
19.	**(a)** Obtaining expression for resultant intensity 2 $x_1 = a\cos\omega t$ $x_2 = a\cos(\omega t + \phi)$ $x = x_1 + x_2$ $= a(\cos\omega t + \cos(\omega t + \phi))$ $= a(2\cos(\omega t + \frac{\phi}{2})\cos\frac{\phi}{2})$ $= 2a\cos\frac{\phi}{2}\cos(\omega t + \frac{\phi}{2})$ Intensity I = K (amplitude) ^{2} where K is a constant. $= K(2a\cos\frac{\phi}{2})^2$ $= 4I_0\cos^2\frac{\phi}{2}$ $I_o = Ka^2$ = intensity of each incident wave. **(Award full credit of this part for all other alternative correct methods)** **OR** **(b)** Effect and justification (i) Source slit moved closer to plane of slits 1 (ii) Separation between two slits 1 (i)Sharpness of interference pattern decreases $\frac{s}{S} < \frac{\lambda}{d}$ As S decreases, interference patterns produced by different parts of the source overlap and finally fringes disappear. **Alternatively** As the source slit is brought closer to the plane of the slits, the screen gets illuminated uniformly and fringes disappear.	½ ½ ½ ½ **1**	

	Alternatively Interference pattern is not formed. **(Note : Award full credit of this part if a student merely attempts this part.)** (ii) $\beta = \frac{\lambda D}{d}$ As d increases, β decreases and fringes disappear.	½ ½	**2**
20.	Finding ratio of period of revolution 2 $T = \frac{2\pi r_n}{v_n}$ $r_n \alpha n^2$ $v_n \alpha \frac{1}{n}$ $T \alpha n^3$ $\frac{T_2}{T_1} = \frac{(n_2)^3}{(n_1)^3}$ $= \frac{(2)^3}{(1)^3}$ $= \frac{8}{1}$	½ ½ ½ ½	**2**
21.	Finding focal length 1 ½ Nature of the lens ½ For convex lens in air $\frac{1}{f_a} = \left(\frac{n_g}{n_a} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ For convex lens in liquid. $\frac{1}{f_l} = \left(\frac{n_g}{n_l} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\frac{f_l}{f_a} = \frac{\frac{1.52-1}{1}}{\frac{1.52-1.65}{1.65}}$ $= -6.6$ $f_l = -6.6\ f_a$ $= -99$cm Nature of the lens: Diverging/ behaves like a concave lens.	½ ½ ½ ½	**2**
	SECTION- C		
22.	**(a)** Explaining nature of force ½ Obtaining expression of force 1½ Defining one ampere 1		

Nature of force is repulsive. ½



½

Magnetic field due to current I_a at all points of conductor b

$B_{ab} = \frac{\mu_0 I_a}{2\pi d}$ directed downwards ½

Force experienced by conductor b on its segment of length *l*

$F_{ab} = I_b l B_{ab}$

$= \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards left ½

Similarly

Force experienced by conductor a on its segment of length *l*

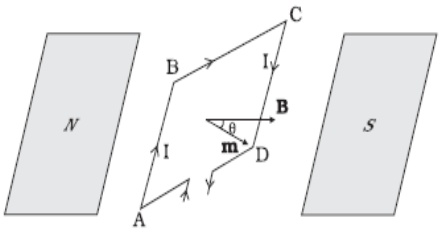
$F_{ba} = \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards right

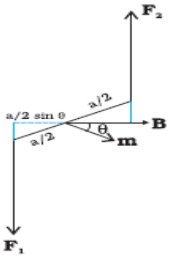
One ampere is that steady current which when maintained in each of two very long straight parallel conductors of negligible cross- section, placed one metre apart in vacuum produces a force of 2×10^{-7} N/m on each conductor. **1**

OR

(b)

Obtaining expression of torque	2
Drawing diagram	1





1

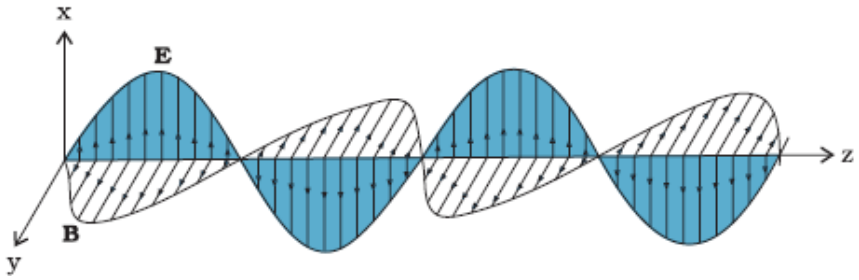
½

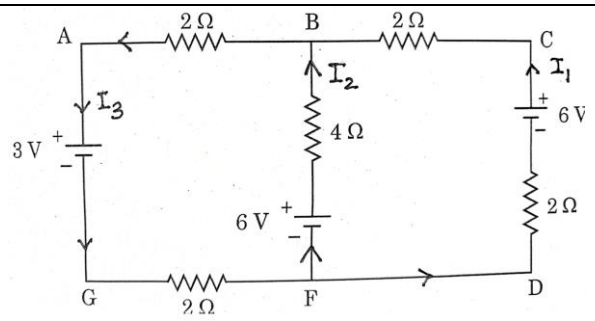
Forces on arm BC and DA are equal and opposite and act along the axis of the coil. Being collinear they cancel each other.

Forces on arms AB and CD are equal and opposite but not collinear. They form a couple. ½

$F_1 = F_2 = IbB$

$\tau = F_1 \frac{a}{2} \sin\theta + F_2 \frac{a}{2} \sin\theta$ ½

	$\tau = IabB\sin\theta$ $\tau = IAB\sin\theta$ (where A = ab & m = IA) $\vec{\tau} = \vec{m} \times \vec{B}$	½	**3**
23.	(a) Factors affecting speed of Electromagnetic wave 1 (b) Production of Electromagnetic wave 1 (c) Sketch of Electromagnetic wave 1 (a) Speed of EM waves $v = \frac{1}{\sqrt{\mu\varepsilon}}$ Speed depends upon (i) Permittivity (ε) of medium (ii) Magnetic permeability (μ) of medium (b) Accelerated charges or oscillating charges produce electromagnetic waves (c)  	½ + ½ **1** **1**	**3**
24.	(a) Finding output voltage 1 (b) Finding instantaneous voltage 1 (c) Finding current 1 (a) $V_P(\text{rms}) = \frac{140}{\sqrt{2}} = \frac{140}{1.4} = 100V$ $\therefore V_s = \frac{N_s}{N_p} V_p = \frac{1000}{200} 100 = 500V$ (b) $v_s = 500\sqrt{2}\sin 100\,pt = 700\sin 100\,pt$ (c) Power Output = Power Input $I_s = \frac{5000}{500} = 10A$	½ ½ **1** **1**	**3**
25.	Finding magnitude and direction of current in AG, BF and CD 1+1+1		



½

By Kirchoff's Laws (at point B)

$I_1 + I_2 = I_3$ …….(1)

In the closed loop AGFBA ½

$3 + 2I_3 - 6 + 4I_2 + 2I_3 = 0$

$I_2 + I_3 = \frac{3}{4}$ …….(2)

From (i) ½

$2I_1 + I_2 = \frac{3}{4}$ …….(3)

In closed loop BFDCB ½

$-4I_2 + 6 + 2I_1 - 6 + 2I_1 = 0$

$I_2 - I_1 = 0$

$I_2 = I_1$ ……..(4)

Putting in (3) ½

$I_1 = \frac{1}{4} A$

From (4)

$I_2 = \frac{1}{4} A$

From (2) $I_3 = \frac{1}{2} A$ ½ **3**

26.

(a) Three characteristics	1 ½
(b) Identifying more stable nucleus and reason	1 ½

(a) Characteristics of nuclear forces :-

1. Saturated in nature
2. Attractive for distances larger than r_0 and repulsive for distance less than r_o
3. Do not depend on nature of electric charge i.e. same for n-n, n-p and p-p pairs.
4. Much stronger than gravitational forces.

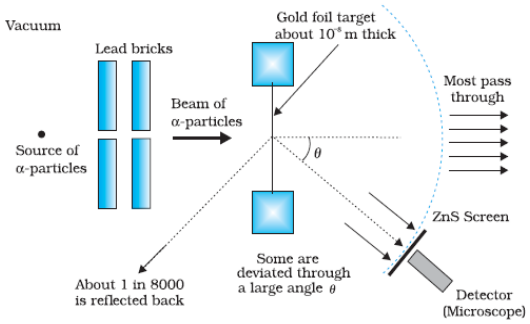
(Any three) **1½**

(b) $^{8}_{4}X$ is more stable ½

The ratio of number of neutrons to the number of protons is more in $^{8}_{4}X$ than $^{5}_{3}Y$ **1** **3**

27.

(a) Drawing schematic arrangement	1
(b) Explaining conclusions	1
(c) Defining distance of closest approach	1



1

(b) -Entire positive charge and most of the mass of atom are concentrated in the nucleus.
- Electrons move in orbits about the nucleus just as planets around the sun.
- Size of nucleus is about 10^{-15}m to 10^{-14}m.
- Most of the space in an atom is empty.

1

(c) The distance of the α particle from the centre of nucleus at which the whole of the initial kinetic energy of the particle gets converted into the electric potential energy.

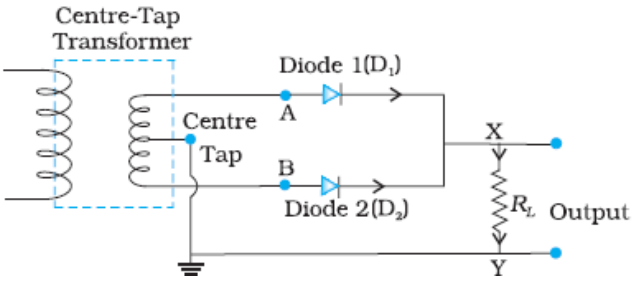
1 **3**

Alternatively

The distance of the α particle from the centre of nucleus at which it stops momentarily and reverses its direction.

28.

Explaining working of full wave rectifier	2
Drawing input and output wave forms	1



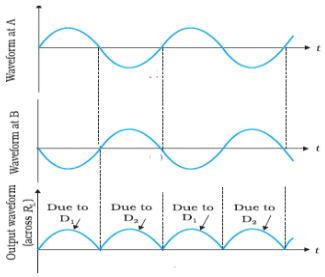
1

When input voltage at A with respect to the centre tap at any instant is positive, at that instant voltage at B, being out of phase will be negative, during the positive half cycle diode D_1 gets forward biased and conducts while diode D_2 gets reverse biased and does not conduct.
Hence during positive half cycle an output current and output voltage across R_L is obtained.

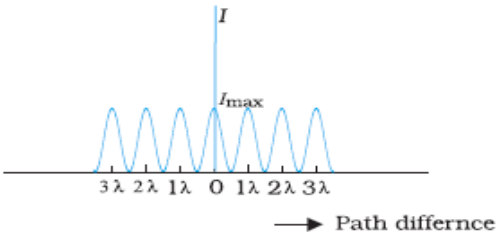
½

During second half of the cycle when voltage at A becomes negative with respect to centre tap, the voltage at B would be positive hence D_1 would not conduct but D_2 would be giving an output current and output voltage.
We get output voltage in both positive and negative half cycles.

½

		**1**	**3**
29.	(i) Since no option is correct, award 1 mark to all students. (ii) (D) 800 nm (iii) (a) (A) $\frac{\sqrt{3}}{2}$ **OR** (b) (B) $\sin^{-1}\left(\frac{4}{5}\right)$ (iv) (A) $\sin^{-1}\sqrt{n^2-1}$	**1** **1** **1** **1**	**4**
30.	(i) (B) The internal resistance of a cell decreases with the decrease in temperature of the electrolyte. (ii) (B) 2.8 V (iii) (A) $\varepsilon = V_+ + V_- > 0$ (iv) (a) (D) 0.2A **OR** (b) (A) 1.0Ω	**1** **1** **1** **1**	**4**
31.	**(a)** (i) Two differences between interference pattern and diffraction pattern 2 (ii) Intensity distribution graph 1 (iii) Finding intensity of light 2 (i) (ii) (iii) Path difference $(\Delta) = \lambda$	**1 + 1** **1**	

	Interference	Diffraction
1	Bands are equally spaced	Bands are not equally spaced.
2	Intensity of bright bands is same.	Intensity of maxima decreases on either side of central maxima.
3	First maxima is at an angle λ / a	First minima is at an angle λ / a



$$\phi = \frac{2\pi\Delta}{\lambda}$$

$$\phi = 2\pi$$

$$I = 4I_0 \cos^2 \frac{\phi}{2}$$

$$K = 4I_0 \cos^2 \pi \ = 4I_0$$ ½

$$\text{Path difference} = \frac{\lambda}{6}$$

$$\phi = \pi / 3$$

$$I = 4I_0 \cos^2 \frac{\pi}{6}$$ ½

$$= 4I_0 \times \frac{3}{4}$$

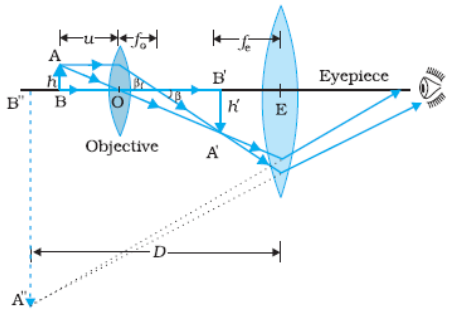
$$= \frac{3}{4}\text{K}$$ ½

OR

(b)

(i)	Drawing labeled ray diagram	1
	Derivation of magnifying power	2
(iii)	Finding magnifying power	2

(i)



1

The magnification obtained by eye-piece lens $m_e = \left(1 + \frac{D}{f_e}\right)$ ½

The magnification obtained by objective lens $m_0 = \frac{v_0}{-u_0}$ ½

Hence the total magnifying power is

$m = m_0 \times m_e$ ½

$= \frac{v_0}{-u_0}\left(1 + \frac{D}{f_e}\right)$ ½

$(ii)\ \text{m} = \left|\frac{f_0}{f_e}\right|$ **1**

Identification of focal length of objective and eyepiece

$f_0 = 100cm$

$f_e = 5cm$ ½

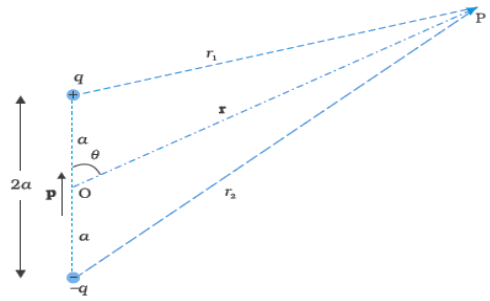
$m = \left|\frac{100}{5}\right| = 20$ ½ **5**

32.

(a)

(i) Obtaining expression for electric potential	3
(ii) Finding the value of n	2

(i)



½

Potential due to the dipole is the sum of potentials due to charges q and -q

$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r_1} - \frac{q}{r_2}\right) \quad \text{----------(1)}$$ ½

By geometry

$$r_1^2 = r^2 + a^2 - 2ar\cos\theta$$

$$r_2^2 = r^2 + a^2 + 2ar\cos\theta$$ ½

For r >> a, retaining terms only up to first order in a/r

$$r_1^2 = r^2\left(1 - \frac{2a\cos\theta}{r} + \frac{a^2}{r^2}\right)$$

$$\cong r^2\left(1 - \frac{2a\cos\theta}{r}\right)$$

Similarly

$$r_2^2 \cong r^2\left(1 + \frac{2a\cos\theta}{r}\right)$$ ½

Using the binomial theorem and retaining terms up to the first order in a/r

$$\frac{1}{r_1} \cong \frac{1}{r}\left(1 - \frac{2a\cos\theta}{r}\right)^{-1/2}$$

$$\cong \frac{1}{r}\left(1 + \frac{a\cos\theta}{r}\right) \quad \text{----------(2)}$$

$$\frac{1}{r_2} \cong \frac{1}{r}\left(\frac{1 + 2a\cos\theta}{r}\right)^{-1/2} \quad \text{----------(3)}$$

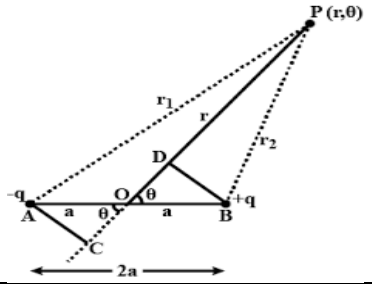
$$\cong \frac{1}{r}\left(1 - \frac{a\cos\theta}{r}\right)$$ ½

Using eqn. (1) (2), (3) and p = 2qa

$$V = \frac{q}{4\pi\varepsilon_0}\frac{2a\cos\theta}{r^2}$$

$$= \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$$ ½

Alternatively –



½

$r_2 = r + a\cos\theta$

$r_1 = r - a\cos\theta$

$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ ½

$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r - a\cos\theta} - \frac{1}{r + a\cos\theta}\right)$ ½

$= \frac{q}{4\pi\varepsilon_0}\left(\frac{2a\cos\theta}{r^2 - a^2\cos^2\theta}\right)$ ½

$= \frac{p}{4\pi\varepsilon_0 r^2}\left(\frac{\cos\theta}{1 - \frac{a^2}{r^2}\cos^2\theta}\right)$ ½

For r>>a, neglecting $\frac{a^2}{r^2}$

V= $\frac{P\cos\theta}{4\pi\varepsilon_0 r^2}$ ½

(ii) Consider the side of equilateral triangle as 'a'

Potential energy = U= $\frac{kq_1q_2}{a} + \frac{kq_2q_3}{a} + \frac{kq_1q_3}{a}$ ½

According to question

$U = \frac{k(q)(2q)}{a} + \frac{k(2q)(nq)}{a} + \frac{k(q)(\mathrm{n}\,q)}{a} = 0$ ½

$= \frac{2q^2}{a} + \frac{2nq^2}{a} + \frac{\mathrm{n}\,q^2}{a} = 0$

$2 + 2n + n = 0$ ½

$3n = -2$

$n = -\frac{2}{3}$ ½

OR

(b)

(i) Statement of Gauss's Law	1
Obtaining expression for electric field	2
(ii) Finding net force on electron	2

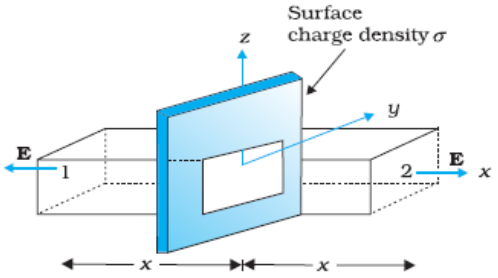
(i) Electric Flux through a closed surface is equal to $\frac{q}{\varepsilon_0}$, where q is the total charge enclosed by the surface. $\phi = \frac{q}{\varepsilon_0}$ **1**

Alternatively

The surface integral of electric field over a closed surface is $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface.

$\oint \vec{E}.\mathrm{d}\vec{S} = \frac{q}{\varepsilon_0}$

(Award ½ mark for writing the formula only.)



(Gaussian surface can be cylindrical also) ½

As seen from figure, only two faces 1 and 2 will contribute to the flux.

Flux $\vec{E}.d\vec{s}$ through both the surfaces is equal and add up. ½

The charge enclosed by surface is σA, where σ is surface charge density

According to Gauss's theorem

$2EA = \sigma A / \varepsilon_0$ ½

$E = \sigma / 2\varepsilon_0$ ½

$\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$ where n̂ is unit vector directed normally out of the plane

(ii) $\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 r}\hat{r}$

According to question

E_1 (at point P) $= \frac{\lambda_1}{2\pi\varepsilon_0 r_1}$

$= \frac{10\times10^{-6}}{2\pi\varepsilon_0(10\times10^{-2})}\ (-\hat{j})\ N/C$ ½

E_2 (at point P) $= \frac{\lambda_2}{2\pi\varepsilon_0 r_2}$

$= \frac{20\times10^{-6}}{2\pi\varepsilon_0(20\times10^{-2})}\ (-\hat{j})\ N/C$ ½

$E_{net} = \frac{10\times10^{-6}}{2\pi\varepsilon_0}\left(\frac{1}{0.1}+\frac{2}{0.2}\right)(-\hat{j})\ N/C$

$= 3.6\times10^{6}\ (-\hat{j})\ N/C$ ½

$F_{net} = q\times E_{net}$

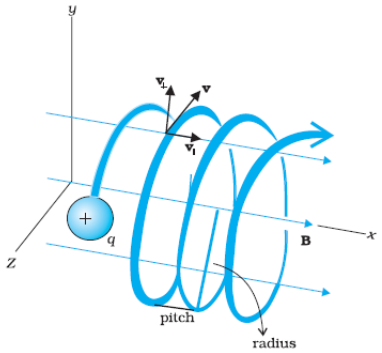
$= -1.6\times10^{-19}\times3.6\times10^{6}\ (-\hat{j})\ N$

$= 5.76\times10^{-13}N\ (\hat{j})$ ½ 5

33.

(a)

(i) Showing helical path	1 ½
Obtaining frequency of revolution	1 ½
(ii) Finding magnetic moment of electron	2



½

$v_\perp = v\sin\theta$ is perpendicular to $\vec{B}$ and

$v_\parallel = v\cos\theta$ is parallel to $\vec{B}$

Due to $v_\perp$ the charge describes circular path and $v_\parallel$ pushes it in the direction of $\vec{B}$. Therefore under the combined effect of two components the charged particle describes helical path, as shown in the figure. **1**

The centripetal force

$$\frac{mv_\perp^2}{r} = B\,qv_\perp$$ ½

$$v_\perp = \frac{Bqr}{m} \qquad (v_\perp = v\sin\theta)$$ ½

Time period = $T = \frac{2\pi r}{v_\perp}$

$$= \frac{2\pi m}{Bq}$$

$$frequency\ v = \frac{1}{T} = \frac{Bq}{2\pi m}$$ ½

(ii) Magnetic moment $m = I\,A$

$$I = \frac{e}{T} = ev$$ ½

$$= 1.6\times10^{-19}\times8\times10^{14}$$

$$= 1.28\times10^{-4}\,A$$ ½

$$M = 1.28\times10^{-4}\times3.14\times(2\times10^{-10})^2$$ ½

$$= 5.12\pi\times10^{-24}\,Am^2 = 1.6\times10^{-23}\,Am^2$$ ½

OR

(b)

(i) Definition of current sensitivity	1
Showing dependence of current sensitivity & explanation	1+1
(ii) Calculation of resistance	2

(i) Deflection produced per unit current is called its current sensitivity. **1**

$$I_S = \frac{\theta}{I} = \frac{NBA}{K}$$

Current sensitivity can be increased by

(a) increasing number of turns in coil

	(b) increasing area of coil in magnetic field (c) decreasing K (Torsional Constant) **(any one)**	**1**	
	$V_s = \frac{\theta}{V} = \frac{NBA}{KR}$ If current sensitivity is increased by increasing number of turns of the coil, the resistance of the galvanometer will also increase. Thus voltage sensitivity may not increase.	**1**	
	(ii) $V = I_G(R+G)$		
	$R = \frac{V}{I_G} - G$	½	
	$= \frac{100}{20\times10^{-3}} - 15$	½	
	$= 5000 - 15$	½	
	$= 4985\Omega$		
	By connecting 4985Ω in series with galvanometer it is converted to voltmeter of range (0-100V)	½	**5**