Subject: PHYSICS (042)
Sample Question Paper
Class – XII
Academic Session 2026–27

Maximum Marks: 70 **Time Allowed: 3 hours**

General Instructions

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQ and four Assertion-Reasoning based of 1mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study-based questions of four marks each and Section E contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in two questions in Section B, one question in Section C, and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary.

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

ii. $m_e = 9.1 \times 10^{-31}$ kg

iii. $m_p = 1.7 \times 10^{-27}$ kg

iv. $e = 1.6 \times 10^{-19}$ C

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

vi. $h = 6.63 \times 10^{-34}$ J s

vii. $\varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}$

viii. Avogadro's number = 6.023×10^{23} per gram mole

ix. radius of nucleus $\approx 10^{-15}$ m

SECTION A (16 x 1 = 16)		
Q.No.	**Question**	**Marks**
1.	A point charge **+Q** is placed at the centre of a spherical Gaussian surface of radius **R**. If the radius of the sphere is doubled, the electric flux through the surface will A. become half B. become double C. remain the same D. become four times	1

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2.	If two identical heaters each rated as (1000 W, 220 V) are connected in parallel to 220 V, then the total power consumed is- A. 200 W B. 250 W C. 2000 W D. 2500 W	1
3.	An infinitely long cylinder is kept parallel to a uniform magnetic field B directed along negative y –axis. What will be the direction of induced current as seen from the y axis? A. clockwise of the negative y-axis B. anticlockwise of the negative y-axis C. no current will be induced D. along the direction of the magnetic field	1
4.	If electric field associated with an electromagnetic wave is given by **E**= 30 sin ($0.2\pi \times 10^{-4}$ $m^{-1}x - 0.6\ \pi \times 10^{4}$ Hz t)$\hat{j}$ then the direction of propagation of the wave is along, A. $\hat{\imath}$ B. $-\hat{\imath}$ C. $\hat{k}$ D. $-\hat{k}$	1
5.	Which one of the following phenomenon is **not** explained by Huygens' construction of wave front? A. Diffraction B. Refraction C. Reflection D. Origin of spectra	1
6.	If wave front from star in nearby galaxy is detected by a telescope at the top of some mountain in India then the shape of the wavefront detected will be A. diverging spherical B. converging spherical C. plane D. cylindrical	1

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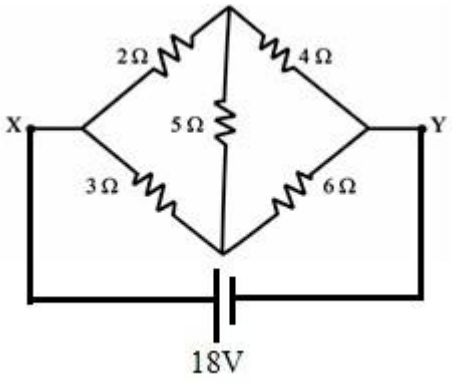
7.	The binding energy per nucleon curve shows a maximum around mass number A=56. What does this imply about nuclei near iron (Fe)? A. They are the least stable nuclei. B. They are the most tightly bound nuclei. C. They undergo spontaneous fission releasing maximum energy. D. They cannot participate in nuclear reactions.	1
8.	A ball of superconducting material is dipped in liquid nitrogen and placed near a bar magnet. The direction of the movement of the ball and the magnetic moment would be-	1

	Direction of the movement of ball	Direction of the magnetic moment
A.	Towards the bar magnet	Opposite to that of the bar magnet
B.	Towards the bar magnet	Same direction as that of the bar magnet
C.	Away from the bar magnet	Same direction as that of the bar magnet
D.	Away from the bar magnet	Opposite to that of the bar magnet

9.	A bridge circuit is shown in the following figure. The total current flowing in the circuit is-  A. 18 A B. 5 A C. 5/18 A D. 18/5A **For Visually Impaired Students only** In a Wheat-stone bridge, all the four arms have equal resistance R. If the resistance of the galvanometer arm is 2R, the equivalent resistance of the combination as seen by the battery is- A. 2R B. R C. R/2 D. R/4	1

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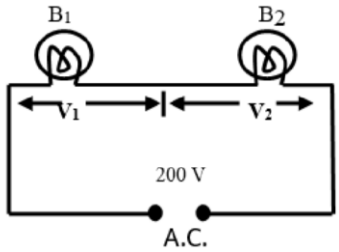
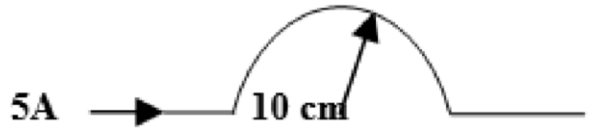
10.	Two electric bulbs, B_1 and B_2, are connected in series to an A.C. supply of 200 V. The power ratings printed on the bulbs are:  • B_1: 200 V, 60 W • B_2: 200 V, 100 W Using their rated voltage–power information, the ratio of their resistances R_1/R_2 is- A. 5:3 B. 3:5 C. 3:4 D. 4:3	1
11.	If nucleus scaled to football size is approximately 22cm, then the radius of the orbit of electron will be approximately: A. 22 cm B. 22 m C. 22 km D. 22000 km	1
12.	A current of 5A is passing through a long wire which has semicircular loop of radius 10 cm as shown in the figure-  The magnetic field produced at the center of the loop is- A. 2 π μ T B. 4 π μ T C. 5 π μ T D. 8 π μ T	1

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	For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.	
	A. both Assertion and Reason are true and Reason is the correct explanation of Assertion. B. both Assertion and Reason are true but Reason is not the correct explanation of Assertion. C. Assertion is true but Reason is false. D. both Assertion and Reason are false.	
13.	**Assertion** (A): In Rutherford's scattering experiment, most of the alpha particles passed through the gold foil undeflected. **Reason** (R): The electrons in the atom are very light and do not affect the path of the alpha particles significantly.	1
14.	A convex lens of focal length 20 cm is used to form a real image of a point object placed 30 cm from the lens. The lens is then immersed in water of refractive index 1.33 (the lens material has refractive index 1.5). **Assertion** (A): The focal length of the lens increases when it is immersed in water. **Reason** (R): The focal length of a lens depends on the relative refractive index of the lens material with respect to the surrounding medium, as given by the lens maker's formula.	1
15.	In Young's double slit experiment, the distance between the slits is 0.25mm and the screen is placed 1.0m away. A student uses monochromatic light of wavelength 500nm. **Assertion** (A): The fringe width observed on the screen will be 2.0mm. **Reason** (R): The fringe width in YDSE is directly proportional to the slit separation and inversely proportional to the wavelength of light.	1
16.	**Assertion** (A): If a conductor is placed in an external electric field, the electric field inside the conductor becomes infinity in electrostatic equilibrium. **Reason** (R): Free electrons inside the conductor rearrange themselves in such a way that the internal electric field is in the same direction as that of the external field.	1

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	SECTION B	
17.	The electric and magnetic fields associated with an electromagnetic radiation in a medium are given as follows: $E = 30 \sin (2\pi \times 10^{18} \text{rads}^{-1} t + \pi \times 10^{10} \text{m}^{-1} x)$ Vm^{-1} $B = 10^{-7} \sin (2\pi \times 10^{18} \text{rad}^{-1} t + \pi \times 10^{10} \text{m}^{-1} x)$ T I. What is the refractive index of the medium through which the wave is propagating? II. Find the frequency of the wave and identify the electromagnetic wave.	2
18.	Write the nature of path of free electrons in a conductor in the a) presence of electric field, b) absence of electric field.	2
19.	Two like charges +q and +q are placed at a distance d. What work must be done by an external agent to bring another charge +q from infinity to the midpoint of the line joining the two given charges?	2
20(A)	A certain magnetic substance is found to have a relative permeability of 800. What type of magnetic material is it? Write any two characteristics that such a material exhibits. **OR**	2
20(B)	State Gauss's law of magnetism. Also discuss its significance.	
21(A)	I. Why hydrogen spectral lines are considered to be a fingerprint of the element? II. If energy of an electron of the hydrogen atom in ground state is -13.6 eV, what should be the minimum energy of photon which can ionize the atom? **OR**	2
21(B)	State Bohr's quantization condition for defining stationary orbit. How does de Broglie hypothesis explain the stationary orbit?	
	SECTION C	
22.	Compare the energy band diagrams of metals, insulators, and semiconductors. I. Explain how the band gap determines conductivity. II. Apply this reasoning to justify why diamond (C) is an insulator while tin (Sn) is a conductor, though both are the elements of group IV.	3

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23.	Explain- I. It is easier to start a car engine on a warm day than on a chilly day. II. The resistance of our body is so large, even then one experiences a strong shock (sometimes even fatal)) when one accidentally touches the live wire of, say 240 V supply. III. Heat is generated continuously in an electric heater but its temperature becomes constant after some time.	3
24.	The atomic mass of $^{16}_{8}O$ is 15.99493 u. Calculate the binding energy per nucleon of the oxygen nucleus. *(Given: mass of proton = 1.00727 u, mass of neutron = 1.00866 u, 1 u = 931.5 MeV/c^2)*	3
25.	A diamond has a refractive index of 2.42. I. A ray of light inside the diamond strikes the surface at an angle of incidence of 30^0 .State whether it will undergo refraction or total internal reflection. II. Explain why diamonds sparkle when cut properly.	2+1
26.	Derive Snell's law of refraction using Huygens' wave theory. What prediction of the wave theory was later experimentally verified?	3
27(A)	I. An ammeter has an internal resistance of 13 Ω and is originally designed to measure currents only up to 100 A**.** To extend its range for high-current measurements, a shunt resistor is connected in parallel with it. After adding the shunt, the same meter can now read currents as high as 750 A without damage. Using the principle of current division in parallel circuits, determine the value of the shunt resistance required to increase the measuring range of the ammeter. II. The coil of a moving coil galvanometer is wound over a metal frame. Why?	3
	OR	
27(B)	I. A small current loop behaves like a tiny magnet when placed in a magnetic field. Using this idea, explain what physical quantity determines the strength and orientation of such a magnetic dipole. Also state the SI unit of this quantity. II. A steel wire of length l has a magnetic moment m. It is bent into a semicircular arc. What is its new magnetic moment?	

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28.	I. A bar magnet falls from a height through a metal ring. Its acceleration will be less than 'g'. Explain. II. A coil of copper wire is wound uniformly on a wooden equilateral triangular frame. If each side of the triangle is increased to 5 times its original length, while keeping the number of turns per unit length unchanged, how does the self-inductance of the coil change?	3
	SECTION D	
29.	In 2023, researchers developed flexible semiconductor films using organic polymers that could be printed like newspaper sheets. These films can bend, fold, and still conduct electricity efficiently. Unlike traditional silicon chips, polymer semiconductors are lightweight, biodegradable, and can be integrated into clothing or medical patches. Imagine a shirt that monitors your heartbeat or a bandage that tracks wound healing in real time. Such innovations extend the idea of semiconductors beyond rigid circuits, showing how manipulating band gaps and carrier mobility in new materials can revolutionize electronics for healthcare, sustainability, and wearable technology.	
	I. Which advantage of semiconductors makes them ideal for wearable devices like smart shirts? A. High voltage operation (~100 V) B. Bulky design and short life C. Low power consumption and reliability D. Requirement of external heating	1
	II. Carbon (diamond) has a band gap of 5.4 eV, while silicon has 1.1 eV. Why is silicon used in electronic devices but not the diamond? A. Diamond has too many free electrons. B. Diamond's band gap is too large for thermal excitation at room temperature. C. Silicon has weaker covalent bonds than diamond. D. Diamond cannot form covalent bonds.	1
	III. In an intrinsic semiconductor at room temperature A. only electrons contribute to conduction. B. only holes contribute to conduction. C. number of electrons equals number of holes. D. no conduction occurs at all.	1
	IV. How will you use the concept of majority and minority carriers to explain the efficiency of polymer semiconductors in wearable technology?	1

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30.	In 1905, Albert Einstein explained the photoelectric effect by proposing that light consists of discrete packets of energy called photons. Each photon carries an energy $E=h\nu$. When a photon strikes a metal surface, it can transfer its energy to an electron. If the photon's energy exceeds the work function of the metal, the electron can be emitted with maximum kinetic energy $K_{max}=h\nu-\phi_0$. This discovery challenged the classical wave theory, which predicted that electron emission should depend only on the intensity of light. Instead, experiments showed that emission of electrons depends on frequency too, proving the particle nature of light.	
	I. Define the term *work function*.	1
	II. Why the increase in the intensity of light does not increase the maximum kinetic energy of photoelectrons?	1
	III. A metal surface has a work function of 2 eV. The light of frequency 1.2×10^{15}Hz falls on it. Which statement is correct? A. No electron is emitted because the intensity is low. B. Electrons are emitted with maximum kinetic energy less than 2 eV. C. Electrons are emitted with maximum kinetic energy greater than 0 eV. D. Electron emission depends only on the intensity of light and not on the frequency.	1
	IV. Which observation/s directly contradicts the classical wave theory of light? A. Photoelectric current increases with intensity B. The maximum kinetic energy depends only on the frequency and not on the intensity. C. The electrons are emitted instantaneously. D. Both B and C.	1
	SECTION E	
31(A)	I. An isolated conductor cannot have a large capacitance. Why? II. How would you connect 6 μF, 9 μF and 18 μF capacitors to obtain- i. the minimum capacitance ii. the maximum capacitance III. The capacitance of a parallel plate capacitor is increased as the area of the plates increases. What are the other two factors on which the capacitance depends?	2+2+1
	OR	

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31(B)	I. Show that the electric field at any point is equal to the negative of the potential gradient at that point. II. A small metallic sphere is gradually charged in open air. It is observed that electrical breakdown of air occurs when the electric field at its surface reaches 2.5×10^6 V m^{-1} .If the sphere is allowed to attain a maximum potential of 5×10^5 V without causing any discharge, determine the minimum radius the insulated sphere must have.	3+2
32(A)	A compound microscope consists of an objective lens of focal length 2 cm and an eyepiece lens of focal length 5 cm. The object is placed 2.2 cm from the objective lens. I. Calculate the position of the image formed by the objective lens. II. The eyepiece is so placed that the final image is formed at infinity. Find the magnifying power of the microscope. III. Explain briefly why the compound microscope provides much higher magnification compared to a simple magnifier.	2+2+1
	OR	
32(B)	An astronomical telescope uses an objective lens of focal length 100 cm and an eyepiece of focal length 5 cm. I. Calculate the magnifying power of the telescope when the final image is formed at infinity. II. If the least distance of distinct vision of the observer is 25 cm, calculate the magnifying power when the final image is formed at this distance. III. Explain why the objective lens of an astronomical telescope is made with a large focal length and aperture, while the eyepiece has a small focal length.	
33(A)	A certain electrical device is used to convert an alternating voltage of smaller magnitude into a much larger alternating voltage without violating the law of conservation of energy. I. With the help of a neat labelled diagram, describe the principle on which this device operates and explain how it increases the voltage. II. State the basic working mechanism of the device and mention the condition required in its input signal for proper functioning. III. Give one reason why this device does not operate with 100% efficiency in practical situations.	2+2+1
	OR	
33(B)	I. What do you mean by the resonance condition of a series LCR–circuit? II. Write an expression for the resonant frequency. Describe the use of a series resonant circuit in the tuning of a radio receiver.	3+2

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Marking Scheme
Class – XII
Academic Session 2026–27

Maximum Marks: 70 **Time Allowed: 3 hours**

Q. No	SECTION A	Marks
1.	C. remain the same According to Gauss's Law, electric flux, $\Phi = \frac{Q}{\varepsilon_0}$ Flux depends only on the enclosed charge, not on the shape or size of the Gaussian surface. Therefore, doubling the radius does not change the flux**.**	1
2.	C. 2000 W For a parallel combination , $P= P_1+P_2$ =1000+1000=2000 W	1
3.	C. No current will be induced As the cylinder is kept stationary and also the magnetic field is uniform. The flux linked with the cylinder is not changing, so no current is induced in the cylinder.	1
4.	A. $\hat{\imath}$ The direction of propagation of electromagnetic waves is given by –ω/k and is along x axis as equation of wave is a function of x	1
5.	D. Origin of spectra All three can be explained by Huygens' construction of wave front but Origin of spectra cannot.	1
6.	C. Plane As star will act as distance point source hence wavefront detected will be plane.	1
7.	B. They are the most tightly bound nuclei. A maximum in binding energy per nucleon means these nuclei are the most stable and most tightly bound. • They do not undergo spontaneous fission (that's typical for very heavy nuclei like uranium). • They are certainly not the least stable — in fact, they are the most stable. • They can still participate in nuclear reactions, but they are at the "energy valley," so both fusion (lighter nuclei) and fission (heavier nuclei) tend to release energy by moving toward iron.	1

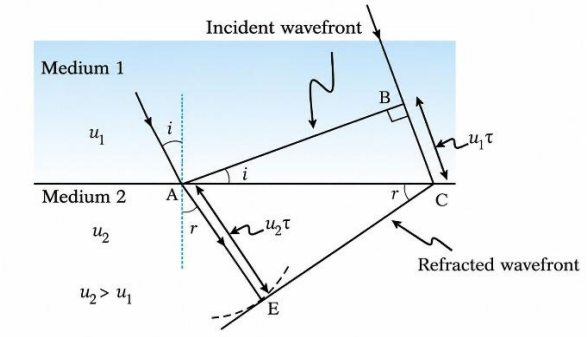
8.	D. Away from the bar magnet and opposite to that of bar magnet As the ball is dipped in liquid nitrogen, its temperature becomes less than the critical temperature and it becomes a superconductor. In this state, the ball becomes diamagnetic.	1
9.	B. 5 A The Wheatstone bridge is balanced, because $\frac{2\Omega}{4\Omega} = \frac{3\Omega}{6\Omega}$. The 5 Ω resistance is ineffective, we now have- (2 Ω + 4 Ω) and (3 Ω + 6 Ω) resistances in parallel. $R_{AB} = \frac{6\ X\ 9}{6+9} = \frac{18}{5}\ \Omega$ Now, I= V/R Or, I= $\frac{18}{18/5}$A =5A **<u>For Visually Impaired Students only</u>** B. R In the balanced condition, the resistance R of the galvanometer is ineffective. We have (R+R) and (R+R) resistances in parallel. $R_{eq} = \frac{2R\ X\ 2R}{2R+2R} = R$	1
10.	A. 5:3 Here P_1=60 W , P_2=100 W $R_1 = \frac{V^2}{P_1}$ and $R_2 = \frac{V^2}{P_2}$ $\therefore \frac{R_1}{R_2} = \frac{P_2}{P_1} = \frac{100}{60}$ = 5: 3	1
11.	C. 22 km Typical **nuclear radius** ≈ 10^{-15}m (1 femtometer). Atom radius (electron orbit, roughly Bohr radius) ~ 10^{-10} m Ratio of atom size to nucleus size ~ 10^5. Football (nucleus) radius ~ 22 cm = 0.22 m. Multiply by 10^5 0.22m×10^5=22,000m=22km.	1
12.	C. 5 π μ T **B** = $\frac{\mu_0 I}{4R} = \frac{4\pi \text{ x } 10^{-7} \text{x } 5}{4\ x\ 0.10} T$ =5π x10^{-6} T =5 π μ T	1

	For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below. A. both Assertion and Reason are true and Reason is the correct explanation of Assertion. B. both Assertion and Reason are true but Reason is not the correct explanation of Assertion. C. Assertion is true but Reason is false. D. both Assertion and Reason are false.	
13.	B. both Assertion and Reason are true but Reason is not the correct explanation of Assertion. Explanation: Both are true; most of the space is empty (nucleus tiny), so alpha particles pass undeflected; electron mass has negligible deflecting effect on energetic alpha particles, as reason for statement is "most of the space is empty (nucleus tiny)"	1
14.	A. both Assertion and Reason are true and Reason is the correct explanation of Assertion. Explanation: Both true and R explains A; lens maker's formula uses relative index ($\frac{\mu_{lens}}{\mu_{medium}}$ - 1), so in water the relative refractive index decreases and f increases.	1
15.	C. Assertion is true but Reason is false Fringe width in YDSE is inversely proportional to the slit separation and directly proportional to the wavelength of light.	1
16.	D. both Assertion and Reason are false. Electrons in a conductor move freely. When an external field is applied, charges rearrange until the internal field they create exactly cancels the external field. This is the reason the net internal field becomes zero.	1
	SECTION B	
17.	I. Refractive index of medium (μ) = $\frac{c}{v_{medium}}$ C= 3 × 10^8m/s $V_{medium}=\frac{2\pi \times 10^{18}}{\pi \times 10^{10}}$ = 2 × 10^8 m/s μ =$\frac{3 \times 10^8}{2 \times 10^8}$ = 1.5 II. Angular frequency (ω)= 2π × 10^{18} rad s^{-1}	½ ½ ½

	Or, $2\pi\nu = 2\pi \times 10^{18}$ rad s^{-1} Or, $\nu = 10^{18}\ s^{-1}$ - This frequency correspond to X Ray	½
18.	The nature of the path of free electrons in a conductor differs depending on whether an electric field is present or not: a. In the presence of an electric field • Free electrons experience a net force opposite to the direction of the electric field. • This causes them to drift slowly in the direction opposite to the field (since electrons are negatively charged). • Despite this drift, electrons still undergo frequent collisions with atoms in the conductor, resulting in a zigzag or random motion superimposed with a net drift. • This net movement of electrons constitutes an electric current. b. In the absence of an electric field • Electrons move randomly due to thermal energy. • There is no net movement of electrons in any particular direction. • The motion is random and chaotic, similar to the movement of gas molecules. • As a result, no electric current flows in the conductor.	1 1
19.	At the midpoint, distance from both charges is d/2 Potential due to one charge +q at the midpoint of the line: $V_1 = \frac{kq}{\frac{d}{2}} = \frac{2kq}{d}$ Potential due to both charges; V = 2 x $\frac{2kq}{d} = \frac{4kq}{d}$ Work done by external gent : W = qV = q ($\frac{4kq}{d}$) = $4kq^2/d$	½ ½ ½ ½
20(A)	Given: Relative magnetic permeability, μ_r=800 Since the relative permeability is much greater than 1, the material is a ferromagnetic material. Properties: 1. Ferromagnetic materials are strongly attracted by a magnetic field because they have a very high value of magnetic permeability. 2. They can retain magnetism even after the external magnetic field is removed, meaning they show hysteresis and can be made into permanent magnets.	1 ½ x2

20(B)	Gauss's law for magnetism states that the net magnetic flux through any closed surface is always zero: $\Phi_B = \oint \vec{B}.\ d\vec{S} = 0$ This means that the magnetic field lines neither begin nor end at any point. Significance: • Magnetic monopoles do not exist • Magnetic field lines always form continuous loops	1 ½ x 2
21(A)	I. Hydrogen spectral lines are considered to be a fingerprint of the element because they represent the unique set of colored lines emitted when hydrogen atoms transit between energy levels. This phenomenon, known as the line spectrum, is a result of the quantized energy levels of electrons in the hydrogen atom. Each spectral line corresponds to a specific energy transition, and the distinct pattern of these lines allows for the identification of hydrogen in various environments. II. The minimum energy of a photon that can ionize an electron in a hydrogen atom is 13.6 eV. This is the ionization energy required to remove the electron from its ground considering all the energy is transferred to electron.	1
21(B)	Postulate: Bohr postulated that electrons revolve around the nucleus in certain discrete circular orbits without radiating energy. His quantization condition is: mvr = $\frac{nh}{2\pi}$ Where: • m = mass of the electron • v = velocity of the electron • r = radius of the orbit • n = principal quantum number Explanation of stationary orbits using de Broglie hypothesis: According to de Broglie, a moving electron behaves like a matter wave with wavelength: $\lambda = h/mv$ For an orbit to be stable (stationary), the electron wave must form a standing wave around the nucleus. This is possible only when the circumference of the orbit is an integral multiple of the wavelength: $2\pi r = n\lambda$ Substituting $\lambda = h/mv$	1 1

	$2\pi r = nh/mv$ Or, $mvr = nh/2\pi$ This is exactly Bohr's quantization condition. Hence, de Broglie hypothesis explains Bohr's stationary orbits as those orbits in which the electron's matter wave forms a standing wave, leading to stable, non-radiating orbits.	
	SECTION C	
22.	Metals: Overlapping bands or partially filled conduction band; free electrons yield high conductivity. Insulators: Large band gap; negligible thermal excitation at room temperature; poor conductivity. Semiconductors: Moderate band gap; thermally/optically excited carriers; conductivity can be varied with doping. Diamond vs tin: Diamond (C): Strong network, large gap (~ 5.4 eV); insulator at room temperature. Tin (Sn): Metallic bonding with overlapping bands; conductor due to available states at Fermi level. Conclusion: Band gap magnitude controls room-temperature carrier availability and hence conductivity.	1 1 1
23.	I. The internal resistance of a car battery decreases with increase in temperature. Therefore, on a warm day a car battery gives large current which helps in starting the car engine. II. It is because our body is sensitive to minute currents even as low as a few mA. III. When the temperature of the heater becomes greater than the temperature of its surroundings, it begins to lose heat to surroundings. A stage is reached when the rate of production of heat becomes equal to the rate of loss of heat and the temperature becomes constant.	1 1 1
24.	Z= 8 protons, N= 8 neutrons. Sum of nucleon masses: $m_pZ + m_nN = 8(1.00727) + 8(1.00866)$ =8.05816 + 8.06928 = 16.12744 u Mass defect $\Delta m = 16.12744 - 15.99493 = 0.132514$ Binding energy $B = \Delta m \times 931.5 = 0.13251 \times 931.5 \approx 123.4$ MeV Binding energy per nucleon $\frac{B}{A} = \frac{123.4}{16} \approx 7.71$ MeV	1 1 1

25.	For diamond, refractive index μ=2.42 Critical angle $\Theta_c = \sin^{-1}\frac{1}{2.42}$ Or, $\Theta_c < 30^0$ I. Given incidence angle: 30^0. Since $30^0 > \Theta_c$, the ray exceeds the critical angle Hence, the ray will undergo Total Internal Reflection (TIR) inside the diamond. II. A well-cut diamond has facets (the flat faces) angled just right so that light hitting them reflects back inward (TIR) instead of leaking out the sides or bottom. So the light gets trapped inside the piece of diamond.	1 1
26.	Huygens' principle: Every point on a wavefront acts as a source of secondary wavelets, and the new wavefront at a later time is the common tangent (envelope) to these wavelets.  Consider a plane wavefront AB incident on the boundary between two media at an angle of incidence i. • Velocity of light in medium 1 = v_1 • Velocity of light in medium 2 = v_2 • Angle of refraction = r Let point A of the wavefront strike the boundary first. After time t: • Point B(still in medium 1) advances to C, where $BC = v_1 t$ • From point A, a secondary wavelet grows into medium 2 with radius $AE = v_2 t$ The refracted wavefront is the tangent CE drawn to the wavelet from A. From the geometry of the figure: Sin i = $\frac{BC}{AC}$; Sin r = $\frac{AE}{AC}$ Or, $\frac{Sin\ i}{Sin\ r} = \frac{BC}{AE} = \frac{v_1 t}{v_2 t} = \frac{v_1}{v_2}$ But the refractive index n of a medium is defined as	1 <

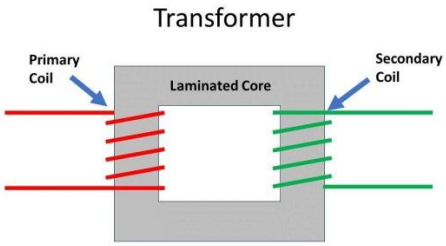
	n = $\frac{c}{v}$ hence, $\frac{v_1}{v_2} = \frac{n_1}{n_2}$ Therefore, $$n_1 \sin i = n_2 \sin r$$ This is Snell's law of refraction. Prediction of wave theory later experimentally verified The wave theory of light (from Huygens' construction) predicted that light travels more slowly in an optically denser medium than in a rarer medium: $$v \propto \frac{1}{n}$$ This prediction was experimentally verified by Foucault (and later Fizeau), who showed that the speed of light in water is less than its speed in air—contradicting the earlier corpuscular (Newtonian) theory.	1
27(A)	I. The original ammeter can be treated as the galvanometer. S = $\frac{I_g\, G}{I - I_g}$ =$\frac{100\ X\ 13}{750-100}$ = $\frac{1300}{650}$ = 2 Ω II. To provide electromagnetic damping. The induced currents set up in the metal frame help to damp the oscillation of the coil in the magnetic field.	1 ½ ½ 1
	OR	
27(B)	I. Magnetic dipole moment SI unit: ampere metre^2 (Am^2) or joule per tesla (JT^{-1}) II. Pole strength, $q_m = \frac{m}{l}$ When the wire is bent into a semicircular arc, the separation between the poles changes from l to 2r, where r is the radius of the semicircular arc. l = π r r = $\frac{l}{\pi}$ New magnetic moment = q_m x 2r = $\frac{m}{l}$ x $\frac{2l}{\pi}$ = $\frac{2m}{\pi}$	½ ½ ½ ½ ½ ½
28.	I. As the magnet falls, the magnetic flux linked with the copper ring increases. The current induced in the ring opposes the downward motion of the magnet. II. Self Inductance, L α $\frac{N^2 A}{l}$ Here N→5N Area as square of linear dimension, A→5^2A = 25 A	1 ½

		Magnetic path Length, l →5l $\frac{L'}{L} = \frac{(5N)^2.25A/5l}{N^2A/l}$ $=\frac{25\ X\ 25}{5}$ =125 L' = 125 L	½ ½ ½
		SECTION D	
29.	I.	**C. Low power consumption and reliability** Wearable devices need to operate continuously with minimal energy usage and dependable performance, which semiconductors provide.	1
	II.	**B. Diamond's band gap is too large for thermal excitation at room temperature.** Because of its large band gap, diamond does not allow sufficient charge carriers to be generated at room temperature, making it unsuitable as a semiconductor	1
	III.	**C. Number of electrons equals number of holes.** In intrinsic semiconductors, electrons and holes are generated in pairs, so their numbers are equal.	1
	IV.	In polymer semiconductors, electrical conduction mainly occurs due to **majority carriers** (electrons in n-type or holes in p-type materials). By controlling the concentration and mobility of these carriers, polymer semiconductors can conduct electricity efficiently even when bent or stretched. Minority carriers play a role in recombination processes and stability. This balance allows polymer semiconductors to function reliably at low power, making them well-suited for flexible, lightweight, and wearable technologies such as smart clothing and medical patches.	1
30.	I.	The **work function (ϕ_0)** of a metal is the **minimum energy required to remove an electron from the surface of the metal** so that it just escapes with zero kinetic energy.	1
	II.	Increasing light intensity increases the **number of photons**, not the energy of each photon. Since the energy of a photon depends only on its **frequency**($E = h\nu$), the **maximum kinetic energy** of emitted electrons depends only on frequency, not intensity. Higher intensity only increases the number of emitted electrons (photoelectric current).	1
	III.	C. Electrons are emitted with maximum kinetic energy greater than 0 eV. Photon energy: $E = h\nu \approx 4.14 \times 10^{-15} \times 1.2 \times 10^{15} \approx 5$ eV Maximum kinetic energy: $K_{\max} = E - \phi_0 = 5 - 2 = 3$ Ev	1

	IV. D. **(**Both B and C) • B: Maximum kinetic energy depends only on frequency, not intensity • C: Electrons are emitted instantaneously Both observations cannot be explained by classical wave theory and support the particle nature of light	1
	SECTION E	
31(A)	I. An isolated conductor cannot have a large capacitance because its capacitance depends directly on its size (radius). For an isolated sphere: $C=4\pi\varepsilon_0 R$ Since ε_0 is a constant, the only way to increase capacitance is by increasing R (the radius). A very large capacitance would require an extremely large-sized conductor**,** which is not practically possible. Therefore, an isolated conductor always has a small capacitance**.** II. i. For minimum capacitance, the three capacitors must be connected in series, $\frac{1}{C_{min}} = \frac{1}{6} + \frac{1}{9} + \frac{1}{18} = \frac{6}{18} = \frac{1}{3}$ C_{min} = 3 μF ii. For maximum capacitance, the three capacitors must be connected in parallel, C_{max} = 6+ 9 + 18 = 33 μF III. The other two factors on which capacitance of a parallel plate capacitor depends, are- i. Distance between the plates (C α 1/d) ii. Permittivity of the medium between the plates (C α ε)	½ ½ ½ ½ ½ ½ ½ ½ x 2
	OR	

31(B)	I. Consider a small positive charge +q placed in an electric field $\overrightarrow{E}$. Suppose it is displaced through a very small distance *dx* in the direction of the field. Force on the charge, $\overrightarrow{F}$ =q$\vec{E}$ Work done by the electric field in moving the charge through distance *dr,* $dW = \vec{F} \cdot d\vec{r} = qE.dr$ ……(1) Here,the change in electric potential , $dV = \frac{dW}{q}$ From (1)- $dV = -\frac{qE.dr}{q}$ $dV = -E.dr$ ⇨ $E = -\frac{dV}{dr}$ i.e. The electric field at any point is equal to the negative gradient of electric potential at that point. II. Potential gradient, $\frac{dV}{dr} = 2.5 \times 10^6\ Vm^{-1}$ $dV = 2.5 \times 10^6\, dr$ $V = 2.5 \times 10^6\, r$ $r = \frac{V}{2.5 \times 10^6}$ $= \frac{5\ X\ 10^5}{2.5 \times 10^6}$ $r = 2 \times 10^{-1} = 0.2$ m	½ ½ ½ ½ ½ ½ ½ ½ ½
32(A)	I. Position of the image formed by the objective lens Using the lens formula: $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$ $\frac{1}{2} = \frac{1}{v_o} - \left(\frac{1}{-2.2}\right)$ $\frac{1}{v_o} = \frac{1}{2} - \frac{1}{2.2}$ $\frac{1}{v_o} = \frac{2.2 - 2}{4.4} = \frac{0.2}{4.4}$ $v_o = 22$ cm Image formed by the objective lens is at 22 cm from it. II. Magnifying power of the microscope (final image at infinity)	2+2+1

	Magnifying power of a compound microscope: $$M = \left(\frac{v_o}{u_o}\right)\left(\frac{D}{f_e}\right)$$ where $D = 25$ cm(least distance of distinct vision) $$M = \left(\frac{22}{2.2}\right)\left(\frac{25}{5}\right)$$ $$M = 10 \times 5 = 50$$ Magnifying power of the microscope = 50 III. A compound microscope provides much higher magnification than a simple magnifier because: A compound microscope uses two lenses: • The objective lens produces a highly magnified real image of a very small object. • The eyepiece lens further magnifies this image. Thus, the total magnification is the product of the magnifications of the objective and the eyepiece, making it much greater than that of a simple magnifier, which uses only a single lens.	
	OR	
32(B)	Given: Focal length of objective lens, $f_o = 100$ cm Focal length of eyepiece lens, $f_e = 5$ cm Least distance of distinct vision, $D = 25$ cm I. Magnifying power when final image is formed at infinity For an astronomical telescope (normal adjustment): $$M = \frac{f_o}{f_e}$$ $$M = \frac{100}{5} = 20$$ Magnifying power = 20 II. Magnifying power when final image is formed at the least distance of distinct vision $$M = \frac{f_o}{f_e}\left(1+\frac{f_e}{D}\right)$$ $$M = \frac{100}{5}\left(1+\frac{5}{25}\right)$$ $$M = 20(1+0.2) = 20 \times 1.2 = 24$$ Magnifying power = 24 III. Reason for design of objective and eyepiece in an astronomical telescope	2+2+1

	• The objective lens is made with a large focal length to produce a highly magnified real image of distant celestial objects and with a large aperture to collect more light, increasing brightness and resolution. • The eyepiece lens has a small focal length so that it can further magnify the image formed by the objective. This combination results in high magnifying power and a brighter, clearer image of distant astronomical objects.	
33(A)	I. Device: Step–up transformer  Principle – Mutual induction: When an alternating current flows in the primary coil, it produces a time-varying magnetic flux in the soft iron core. This changing flux links with the secondary coil and, by Faraday's law of electromagnetic induction**,** an emf is induced in the secondary. For an ideal transformer : $\frac{V_S}{V_P} = \frac{N_S}{N_P}$ If $N_s > N_p$, then $V_s > V_p$: the transformer steps up the voltage. Because in an ideal transformer- $P_{in} = P_{out} \Rightarrow V_p I_p = V_s I_s$, The law of conservation of energy is not violated: when voltage increases, current decreases correspondingly. II. Working mechanism: • The primary coil is supplied with an alternating voltage. • This produces an alternating magnetic field in the core. • The changing magnetic flux linked with the secondary coil induces an alternating emf in it. • Thus energy is transferred from primary to secondary coil through the changing magnetic field in the core, without any electrical contact between the two windings.	1 ½ ½ 1 1

	Condition for proper functioning: The input must be alternating current (a.c.), not direct current (d.c.) With d.c. there is no change of flux, hence no induced emf in the secondary coil. III. Any one of the following : • Copper losses • Eddy current losses. • Hysteresis loss • Flux leakage Because of these losses, output power is less than input power, so efficiency is less than 100%.	1
	OR	
33(B)	I. Resonance condition in a series LCR circuit & resonant frequency A series LCR circuit has a resistor (R), inductor (L) and capacitor (C) all in series with an AC source. Resonance condition: The circuit is said to be in resonance when its inductive reactance equals its capacitive reactance: $X_L = X_C$ $\omega L = \frac{1}{\omega C}$ Where ω is the angular frequency of the a.c. supply. At resonance: • The net reactance $X=X_L-X_C = 0$ • The impedance Z=R (minimum) • The current in the circuit is maximum for the given applied voltage Hence the circuit behaves as a purely resistive circuit at resonance. The resonant frequency, $f_0 = \frac{\omega_0}{2\pi} = \frac{1}{2\pi\sqrt{LC}}$ II. Use of a series resonant circuit in tuning a radio receiver A radio station transmits electromagnetic waves of a definite frequency**.** In a radio receiver, the input stage contains a tuneable series LCR circuit (or LC tank) whose resonance frequency can be changed. • The inductor (L) is usually fixed. • The capacitor (C) is made variable (variable capacitor).	1 ½ ½ 1 1

	By adjusting the variable capacitor **C**, the resonant frequency, $f_0 = \frac{1}{2\pi\sqrt{LC}}$ is changed until it becomes equal to the frequency of the desired radio station. At this condition: • The LCR circuit is at resonance with that station's frequency. • Its impedance is minimum, so the current (and hence signal voltage**)** is maximum for that particular station. • Signals of other frequencies (other stations) are not at resonance, so their currents are much smaller and get largely rejected. Thus, by using a series resonant circuit, the radio receiver can select (tune to) one particular station and reject others.	1

PHYSICS – Code No. 042
SAMPLE QUESTION PAPER
CLASS – XII (2025 – 26)

Time Allowed: 3 hours **Maximum Marks: 70**

General Instructions

(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) **Section A** contains **sixteen questions, twelve MCQ and four assertion reasoning based of 1 mark each**, **Section B** contains **five questions of two marks each**, **Section C** contains seven questions of three marks each, **Section D** contains **two case study-based questions of four marks each** and **Section E** contains **three long answer questions of five marks each**.
(5) There is no overall choice. However, an internal choice has been provided in two question in Section B, one question in Section C and all three questions in Section E. You have to attempt only one of the choices in such questions.
(6) Use of calculators is not allowed.
(7) You may use the following values of physical constants where ever necessary

i. $c = 3 \times 10^8$ m/s
ii. $m_e = 9.1 \times 10^{-31}$ kg
iii. $m_p = 1.7 \times 10^{-27}$ kg
iv. $e = 1.6 \times 10^{-19}$ C
v. $\mu_0 = 4\pi \times 10^{-7}$ T m $\boldsymbol{A^{-1}}$
vi. $h = 6.63 \times 10^{-34}$ J s
vii. $\varepsilon_0 = 8.854 \times 10^{-12}$ $\boldsymbol{C^2 N^{-1} m^{-2}}$
viii. Avogadro's number = 6.023 X $\boldsymbol{10^{23}}$ per gram mole

SECTION A		
Q.No.	**Question**	**Marks**
1.	If a charged hollow sphere and a solid sphere of aluminum and copper of equal radii are in electrostatic equilibrium, then which of the following statements is true? (A) Both the spheres are having equal charges. (B) The hollow sphere will have more charge than solid sphere at its surface. (C) The aluminum sphere will have more charge on its surface than copper sphere. (D) If hollow sphere is also made up of aluminum then it will have more charge.	1

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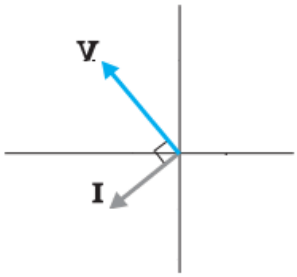
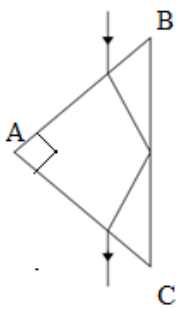
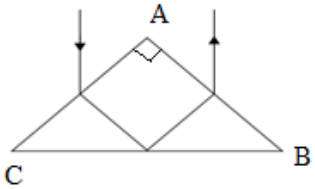
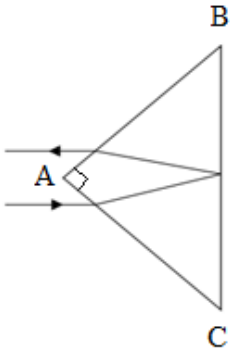
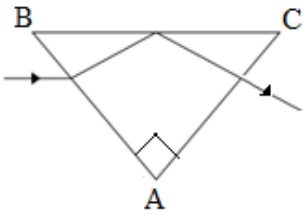
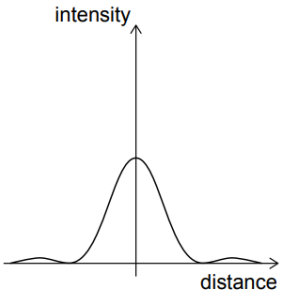
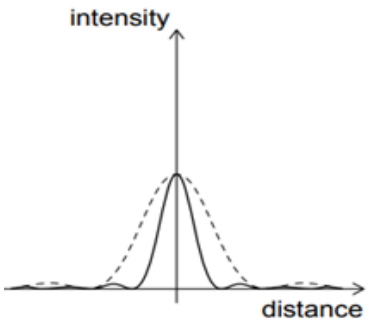
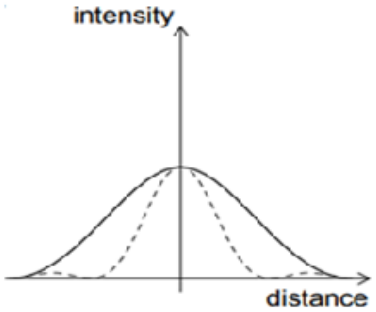
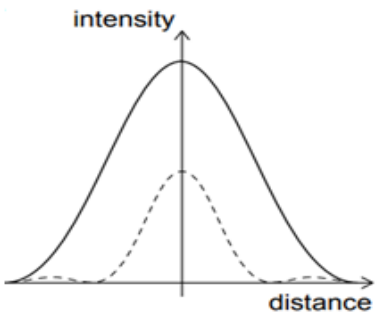
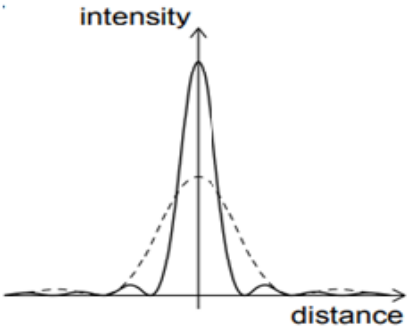
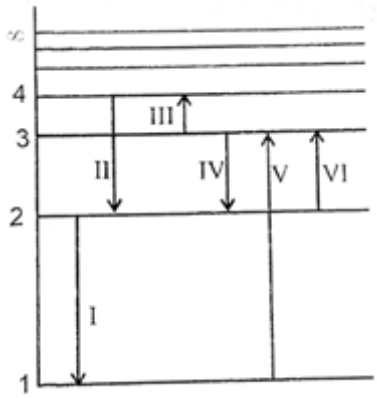
2.	A coil contains N turns of insulated copper wire of diameter d and resistivity ρ wound on a cylinder of diameter D. What is the total resistance between the two ends of the coil of copper wire?(given: D>>d) (A) $\frac{4\rho ND}{d^2}$ (B) $\frac{8\rho ND}{d^2}$ (C) $\frac{2\rho ND}{d^2}$ (D) $\frac{12\rho ND}{d^2}$	1
3.	If the phasor diagram for a device connected to AC supply is as shown in the fig, then which of the following statements is true?  (A) When the frequency of the AC source is increased than the impedance of the device decreases. (B) This device behaves as conducting wire when connected across DC source. (C) When the frequency of the AC source is decreased than the impedance of the device decreases. (D) D. This device stores energy in the form of magnetic potential energy.	1
4.	Which of the following statement is true for the radio waves and the gamma rays? (A) The energy of gamma rays is lesser than that of the radio waves. (B) The frequency of the radio waves is higher than that of gamma rays. (C) The radio waves and the gamma rays have the same energy. (D) The energy of radio waves is lesser than that of the gamma rays.	1
5.	A glass prism has internal angles of 45°, 45° and 90°. The glass has a critical angle of 45°. Which of the following ray diagrams depicts the possible path the of light through the prism? (A) (B)  	1

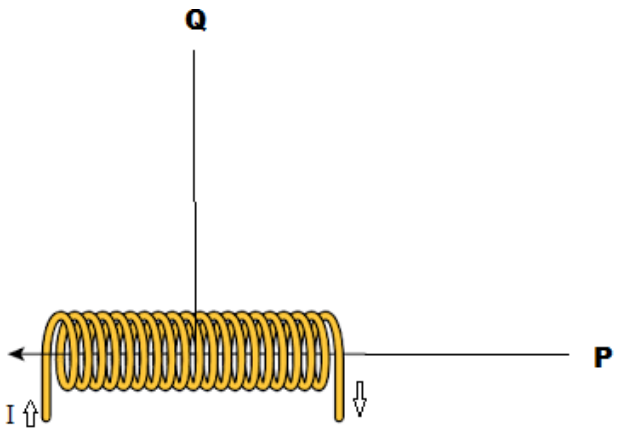
** Please note that the assessment scheme of the Academic Session 2024-25 will continue in the current session i.e. 2025-26.*

	(C)  (D)  **For VI-Candidates** Light passes from a certain medium into air. The critical angle of the given medium is Θ, which of the following expressions gives the speed of light in the given medium? Where c is the speed of light in air. (A) $\frac{1}{c\sin\theta}$ (B) $\frac{\sin\theta}{c}$ (C) $\frac{c}{\sin\theta}$ (D) $c\sin\theta$	
6.	The light from a monochromatic source is incident on a single slit and the resulting diffraction pattern is viewed on a screen. The graph shows the variation of the intensity with the distance on the screen.  The width of slit is increased keeping the intensity of the source the same. Which of the following graphs is correct? (The original curve is shown with a dashed line.) (A)  (B)  	1

** Please note that the assessment scheme of the Academic Session 2024-25 will continue in the current session i.e. 2025-26.*

	(C)  (D)  **For VI-Candidates** The phenomenon of superposition of two waves, resulting in redistribution of energy is known as…… (A) diffraction (B) interference (C) reflection (D) refraction	
7.	Which of the following transitions corresponds to the emission of the radiation of the maximum wavelength?  (A) I (B) III (C) IV (D) VI	1
	(for V.I. Candidates) Which of the following transitions corresponds to the emission of the radiation of the maximum wavelength? I — From 4th orbit to 2nd orbit. II — From 2nd orbit to 1st orbit. III — From 3rd orbit to 4th orbit. IV — From 3rd orbit to 2nd orbit. V — From 1st orbit to 3rd orbit. VI — From 2nd orbit to 3rd orbit. (A) I (B) III (C) IV (D) VI	

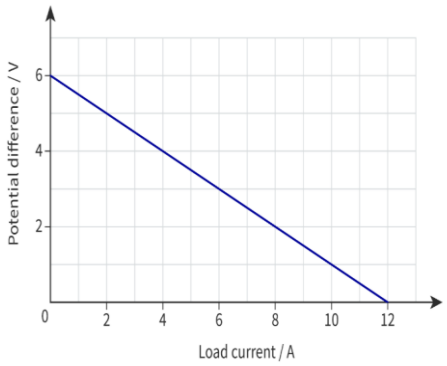
** Please note that the assessment scheme of the Academic Session 2024-25 will continue in the current session i.e. 2025-26.*

8.	A charged particle is projected along the axis of a current carrying loop. Which of the following statements is true? (A) The acceleration of the charged particle will depend on the velocity with which it is projected. (B) The acceleration of the charged particle will depend on the magnitude of the current passing through the coil. (C) The acceleration of the charged particle will depend on the radius of the coil. (D) The charged particle will move with constant velocity.	1
9.	Two small identical magnets are allowed to fall freely one through a vertical solenoid of 20 m made up of copper and another in air through the same vertical distance. The time taken by the two magnets to fall will be (A) same in both the cases. (B) more for the magnet falling in air. (C) more for the magnet falling through the solenoid. (D) infinite.	1
10.	The emf generated by an AC generator is given by $V=V_o \sin \omega t$, where ω is angular frequency of armature of generator. What will be the emf if the angular frequency is doubled (A) $V=V_o \sin 2\omega t$ (B) $V=2V_o \sin \omega t$ (C) $V=2V_o \sin 2\omega t$ (D) $V=V_o \sin \omega t$	1
11.	The ratio of the nuclear densities of two nuclei having the mass numbers 8 and 27 is (A) 8:27 (B) 3:2 (C)2:3 (D) 1:1	1
12.	When we move magnetic compass from point P to Q then which of the following statement is true  	1

** Please note that the assessment scheme of the Academic Session 2024-25 will continue in the current session i.e. 2025-26.*

	(A) The deflection of the magnetic needle at P and Q will be in the same direction. (B) The deflection of the magnetic needle at P and Q will be in the opposite directions. (C) The deflection of the magnetic needle at P and Q will be perpendicular to each other. (D) The deflection of the magnetic needle at P and Q will be inclined at 45° with respect to each other.	
	For Questions 13 to 16, two statements are given one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below. (A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion. (B) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion. (C) Assertion is true but Reason is false. (D) Both Assertion and Reason are false.	
13.	**Assertion (A):** Total energy of an electron in hydrogen atom is negative. **Reason (R):** The centripetal force is provided by electrostatic force.	1
14.	**Assertion (A):** The critical angle of light passing from glass to air is minimum for violet colour. **Reason (R):** The wavelength of blue light is greater than the light of other colours.	1
15.	**Assertion (A):** Two light sources emitting waves of similar wavelengths are coherent. **Reason (R):** Two light sources emitting waves having zero or constant phase difference are known as coherent sources.	1
16.	**Assertion (A):** For three point charges to be in equilibrium, they must be collinear. **Reason(R):** One of the three charges must have different polarity than rest of the two.	1
	SECTION B	
17.	The amplitude of the magnetic field of a plane electromagnetic wave propagating along positive X axis in vacuum is 510 nT$\hat{k}$ and its angular frequency is 60 x 10^6 rad/sec. Write the expression for the electric field $\left(\vec{E}\right)$.	2
18.	The following graph shows the potential difference across the terminals of a cell against its load current.	2

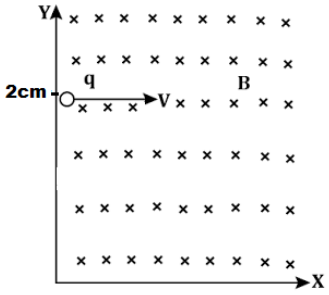
** Please note that the assessment scheme of the Academic Session 2024-25 will continue in the current session i.e. 2025-26.*

	 Find, (I) the emf of the cell and (II) the internal resistance of the cell. **For VI candidates** Find the relation between internal resistance, emf, external resistance and the total current in the circuit ?	
19.	A charge q is placed inside a sphere of radius 'a' filled with water and another charge 2q is placed inside cube of side '2a' which is vacuumed inside. Find the ratio of the flux linked with the sphere to that linked with the cube. (Take relative permittivity of water as 80)	2
20(I)	Write an expression for the magnetic force per unit length between two parallel thin current carrying wires. Hence define one ampere. **OR**	2
20(II)	Draw a diagram representing the behaviour of magnetic field lines for a (A) diamagnetic & (B) paramagnetic substance. **For VI-Candidates** Sate Gauss's law of magnetism? Hence find the magnetic flux linked with the sphere enclosing a current carrying solenoid?	2
21(I)	How does the impact parameter affect the trajectory of a α – particles scattered by a heavy nucleus? What is the value of impact parameter for head on collision of α – particles with the nucleus? **OR**	2
21(II)	Plot a graph showing variation of de-Broglie wavelength λ versus $\frac{1}{\sqrt{V}}$, where V is accelerating potential for a particle of mass m and charge q. Obtain the slope of this graph.	

** Please note that the assessment scheme of the Academic Session 2024-25 will continue in the current session i.e. 2025-26.*

SECTION C		
22.	With the help of circuit diagram explain working of the full wave rectifier.	3
23.	(I) The current I_1 in a wire is getting divided in two wires with currents I_2 and I_3 at a junction in a circuit.The currents in the three wires are related by $I_1 = I_2 + I_3$. (A) State the fundamental law from which this relation is derived. (B) Explain the validation of law of conservation of energy in Kirchhoff's voltage law? (II) How the balancing condition gets affected if you are interchanging the galvanometer and the cell in the Wheat stone bridge?	3
24.	A fast-moving neutron collides with the nucleus of Plutonium (Pu), thereby producing Xenon (Xe) and Zirconium (Zr) along with neutrons. (I) Write the nuclear fission reaction. (II) Find the energy released in the above nuclear reaction. Given atomic masses: m $(^{239}_{94}Pu) = 239.052157$u, m $(^{103}_{40}Zr) = 102.926597$u, m $(^{134}_{54}Xe) = 133.905040$u & m $(^{1}_{0}n) = 1.00866$u.	3
25.	A compound microscope consists of an objective lens of focal length 0.82 cm and an eyepiece lens of focal length 2.9 cm. An object is placed 0.91 cm from the objective lens. The image is formed at the near point (25 cm) from the eye. (I) Calculate that the angular magnification of the microscope. (II) Draw the ray diagram of compound microscope in normal adjustment.	3
26.	Draw the reflected wave front for a plane wave front incident on a plane reflecting surface. Hence verify the laws of reflection using Huygen's principle. **For VI Candidates** (I) Define wave front? (II) Define wavelet? (III) What will be the shape of the wave front intercepted by a large reflecting type telescope on earth, due to a star far-away from our solar system?	3

** Please note that the assessment scheme of the Academic Session 2024-25 will continue in the current session i.e. 2025-26.*

27(I)	If a point sized object having charge 1C and mass 1g is projected with velocity of $2\hat{\imath}$ m/s from a point (0,2cm,0) in the region of magnetic field -0.1$\hat{k}$ T which spreads in the first quadrant.  (A) What will be the shape of the path followed by the given charged particle? (B) At what point it will cross the X-axis? (C) What will be the kinetic energy of particle when it will enter in the fourth quadrant? **OR**	3
27(II)	A solenoid has a core of material with relative permeability 200. The windings of the solenoid are insulated from the core and carry a current of 1A. If the number of turns is 2000 per metre, calculate (A) magnetic intensity, (B) magnetic field & (C) magnetisation	3
28.	A conducting coil of 50 turns and area $\frac{5}{\pi}$ cm^2 is rotating along the axis of solenoid of length 50cm and 2000 turns, carrying current of 5 A. What will be the value of maximum emf generated?	3
	SECTION - D	
29	When an external voltage is applied across a semiconductor diode such that p-side is connected to the positive terminal of the battery and n-side to the negative terminal it is said to be forward biased. The applied voltage mostly drops across the depletion region and the voltage drop across the p-side and n-side of the junction is negligible. When an external voltage is applied across the diode such that n-side is positive and p-side is negative, it is said to be reverse biased. The applied voltage mostly drops across the depletion region.	1 Mark each

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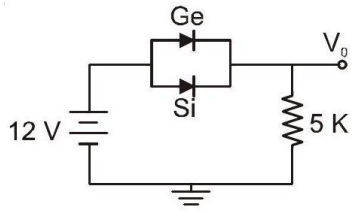
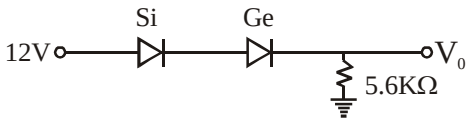
(I) Ge and Si diodes start conducting at 0.3 V and 0.7 V respectively. In the following figure if Ge diode connection are reversed, the value of V_0 changes by (assume that the Ge diode has large breakdown voltage)



(A) 0.2 V (B) 0.4 V

(C) 0.6 V (D) 0.8 V

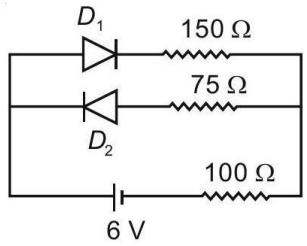
(II.) The value of V_0 and I_d for the network are :



(A) 13 V, 2.32mA (B) 11.7 V, 2.08mA

(C) 11.3V, 2.01mA (D) 11V, 1.96mA

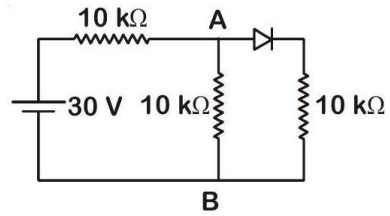
(III.) The circuit shown below contains two ideal diodes, each with a forward resistance of 50Ω. If the battery voltage is 6 V, the current through the 100Ω resistance (in amperes) is



(A) 0.036 (B) 0.020

(C) 0.030 (D) 0.027

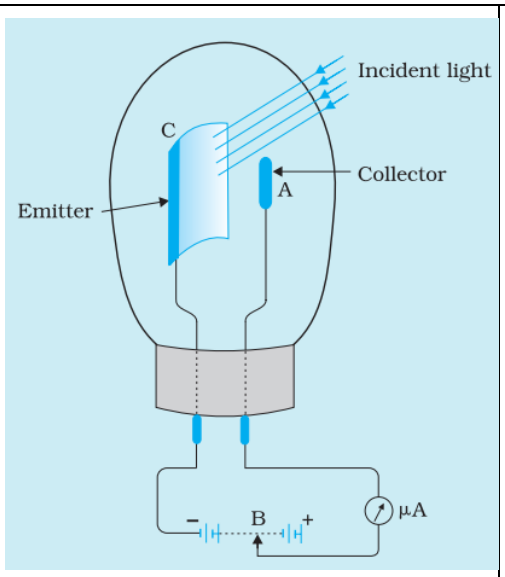
(IV) In the figure, potential difference between A and B is



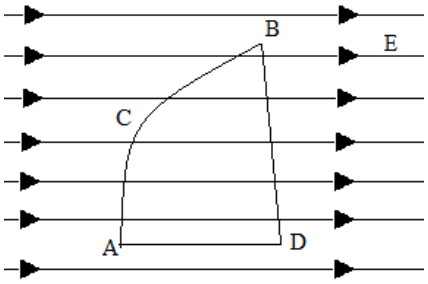
(A) Zero (B) 5 V

(C) 10 V (D) 15 V

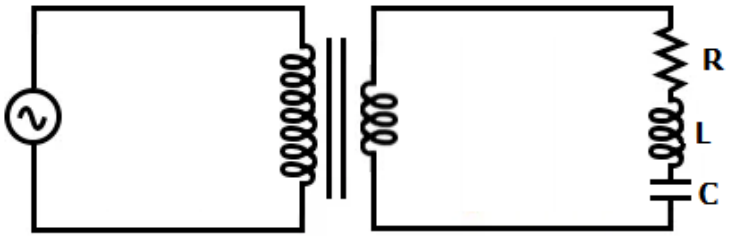
** Please note that the assessment scheme of the Academic Session 2024-25 will continue in the current session i.e. 2025-26.*

30.	Photoelectric effect is phenomenon of the ejection of electrons when the radiation of suitable frequency is made to fall on the surface of a metal. When light of suitable wavelength falls on the emitter C given in the diagram, the photoelectrons are emitted. These photoelectrons are drawn to the collector A. The photoelectric current of the order of a few microamperes can be normally obtained from the device given in figure. The device given converts a change in intensity of illumination into a change in photocurrent. This current can be used to operate control systems and in light measuring devices. The devices are made up of metals with low ionization enthalpies, for example platinum whose work function is 6.35 eV. 	
	(I) If infrared radiation of 3 x 10^{11} Hz is used as incident radiation, determine the reading of microammeter? Justify mathematically.	2
	(II) In the given diagram, if terminal B is shifted towards the left then how will it affect the reading of the microammeter? **(for V.I. candidates)** (II) If the supplied voltage is decreased, then what will be effect on the reading of the microammeter?	1
	(III) Plot a graph showing this variation in reading of micrometre on shifting the terminal B towards the right. **(for V.I. candidates)** (III) If the intensity of incident radiation is doubled, by what factor will the kinetic energy change?	1
SECTION E		
31(I)	(A) A dielectric slab of thickness t, is introduced between the plates of parallel plate capacitor of area A and separation d (where t<d). Find an expression for the capacitance with the dielectric slab. (B) A copper sphere of capacitor C is dropped in ocean. Will the capacitance of the sphere increase, decrease or remain same? Justify. (C) A capacitor is connected across a source of potential difference V and then the separation 'd' between the plates is increased using insulating stick. Plot 'V' vs 'd' graph for the given capacitor.	2+2+1

** Please note that the assessment scheme of the Academic Session 2024-25 will continue in the current session i.e. 2025-26.*

	For VI Candidates (C) A capacitor is connected across potential difference V and is then separation between plates 'd' is increase using insulating stick. Will the energy stored in capacitor increase or decrease? Justify **OR**	
31 (II)	(A) If a charge of 1μC is placed at the origin and another charge of 3 μC placed at the point (20m,0m,0m) in an external uniform electric field of 40V/m $\hat{\imath}$ with the electric potential at origin to be zero. Find the electrical potential energy of system. (B) If one charge particle is moved from A to C To B and another charge particle of equal magnitude is moved from A to D to B, In uniform external magnetic field. Than for which charge particle more work will be needed? (use fig for reference)  (C) Electrostatic potential is constant throughout the volume of conductor has the same value on its surface why? **For VI candidates** (C) If A charge particle is taken from A to B from two different path one path has resistance of 10Ω and another has capacitance of 3μF. work done by which path will be more.	3+1+1
32(I)	(A) Derive lens maker's formula. (B) Equi-convex lenses are to be manufactured from a glass of refractive index 1.55, with both faces of the same radius of curvature. What is the radius of curvature required if the focal length is to be 10cm? **OR**	3+2
32(II)	(A) Define angle of deviation in a prism? (B) Obtain the relation A+δ=i+e for a prism where A is the angle of prism, δ is the angle of deviation, i is the angle of incidence and e is the angle of emergence. Write this relation for the minimum deviation? (C) Write the condition for minimum deviation.	1+3+1

** Please note that the assessment scheme of the Academic Session 2024-25 will continue in the current session i.e. 2025-26.*

33(I)	(A) State the working principle of a moving coil galvanometer? What modification is required in the galvanometer to make its scale linear? (B) If a galvanometer of resistance 49.5Ω has range of 0.05A. What will be the value of resistance needed to convert it in ammeter of range 5A? (C) How these two resistors should be connected to galvanometer in both cases? **OR**	2+2+1
33(II)	(A) An input potential V_{in}=200 Sin $100\pi t$ V is provided to an ideal transformer having 1000 turns in primary coil and 100 turns in secondary coil as shown in figure. The load circuit has a resistance of 4Ω, a capacitive reactance of 2Ω and an inductive reactance of 6Ω.  Find: (i) the output voltage across the load circuit (ii) the current flowing through the load circuit (iii) the power supplied to the load circuit by the transformer (B) State the working principle of a transformer and explain how it is a key component in the transfer of electrical power over long distances.	3+2

** Please note that the assessment scheme of the Academic Session 2024-25 will continue in the current session i.e. 2025-26.*

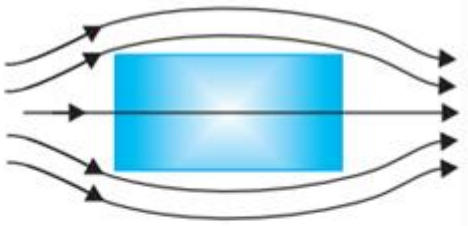
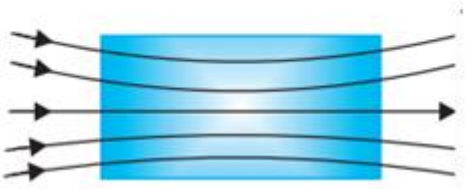
PHYSICS – Code No. 042
MARKING SCHEME
CLASS – XII (2025 – 26)

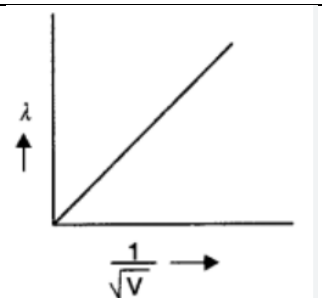
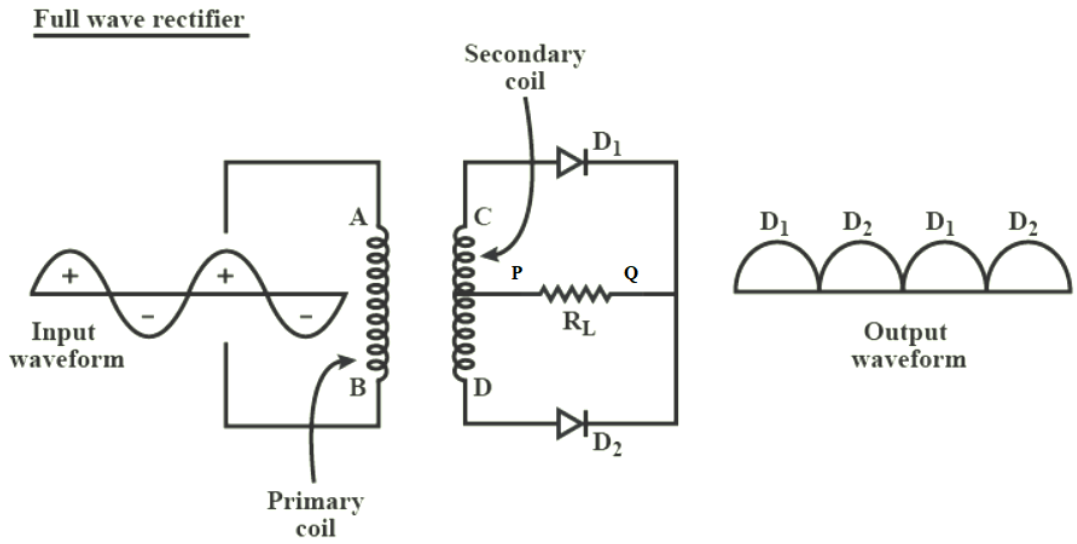
SECTION A		
Q.No	**Questions**	**Marks**
1.	**Answer: (A)** Both are having equal charges For two bodies to be in equilibrium, both should have same potential(V). As V=$\frac{C}{q}$ Where C of sphere is $4\pi\varepsilon_o r$. Which is independent of all the factors mentioned in options.	1
2.	**Answer: (A)** Diameter of copper wire d, Diameter of cylindrical iron is D No.of turns N,(D>>d) Length=N x Circumference of cylinder L= NπD R= $\frac{\rho L}{A} = \frac{\rho N \Pi D}{d^2\frac{\Pi}{4}}$ R=$\frac{4\rho ND}{d^2}$	1
3.	**Answer: (A)** When the frequency of the AC source is increased than the impedance of the device decreases. As in phasor diagram current leads the voltage, so given appliance is capacitor.	1
4.	**Answer: (D)** The energy of radio waves is lesser than that of the gamma rays. Since the frequency of radio waves is less than gamma waves. E = hν Hence, energy of radio waves is less than gamma waves	1

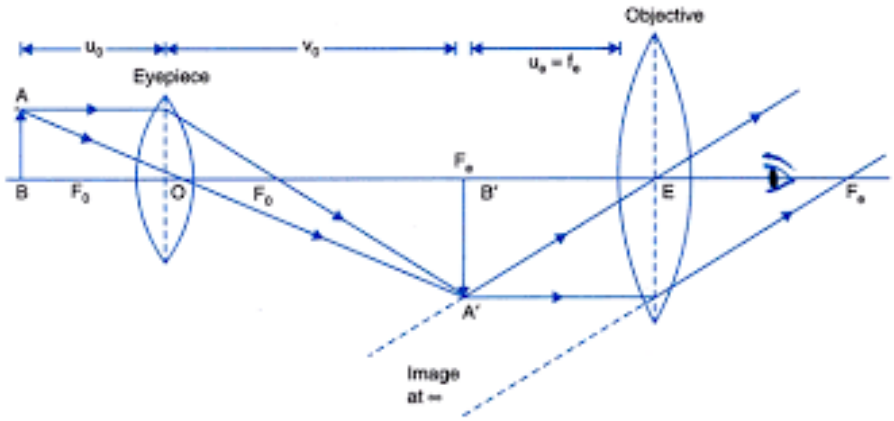
5.	**Answer: (A)** Total Internal reflection ***<u>For VI- Students</u>*** **Answer: (D)** $\frac{v_1}{c} = \frac{Sin\Theta_c}{sin\,90}$ cSinΘ	1
6.	**Answer: (D)** Slit width increases hence amplitude will increase, so intensity will also increase. ***<u>For VI- Students</u>*** **Answer: (B)** Interference	1 1
7.	**Answer: (C)** IV Transition III, V, VI corresponds to absorption of energy. Maximum emitted wavelength corresponds minimum energy difference. $\Delta E_I > \Delta E_{II} > \Delta E_{IV}$ Therefore, maximum emitted wavelength corresponds to transition IV. ***<u>For VI- Students</u>*** Transition III, V, VI corresponds to absorption of energy. Maximum emitted wavelength corresponds minimum energy difference. $\Delta E_{II} > \Delta E_I > \Delta E_{IV}$ Therefore, maximum emitted wavelength corresponds to transition IV.	1
8.	**Answer: (D)** The charged particle will move with constant velocity. As charge particle is moving parallel to magnetic field, there will be no acceleration.	1

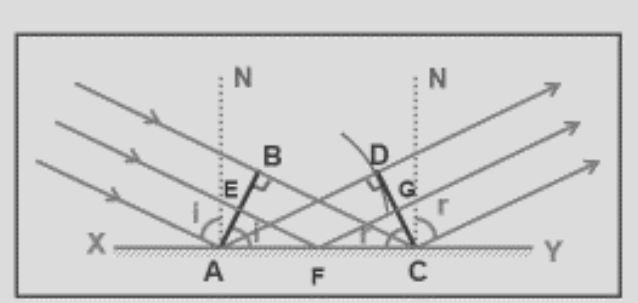
9.	**Answer: (C)** more for the magnet falling through the solenoid. Emf will be induced in solenoid due to motion of magnet through it. As per Lenz's law induced emf will oppose the motion of magnet.	1
10.	**Answer: (C)** $V=2V_o \sin 2\omega t$ As $V= NBA\omega \sin \omega t$	1
11.	**Answer: (D)** 1:1 Nuclear density does not depend on mass number.	1
12.	**Answer: (B)** The deflection of the magnetic needle at P and Q will be in the opposite directions. As magnetic field at equator is antiparallel to magnetic field at pole.	1
13.	**Answer: (B)** both Assertion and Reason are true but Reason is not the correct explanation of Assertion.	1
14.	**Answer: (C)** Assertion is true but Reason is false.	1
15.	**Answer: (D)** both Assertion and Reason are false	1
16.	**Answer: (B)** both Assertion and Reason are true but Reason is not the correct explanation of Assertion. If three point charges are in equilibrium then forces acting on each charges should be linearly opposite.	1

SECTION B		
17.	Given, $B_o = 510$ nT $= 510 \times 10^{-9}$ T $\omega = 60 \times 10^6$ rad/sec $E_o = cB_o = 153$ N/C $k = \omega/c = 20 \times 10^{-2}$ rad/m $E = E_o \sin(\omega t - kz)$ $E = 153 \sin(60 \times 10^6 t - 20 \times 10^{-2} x)$ N/C	1 1
18.	(I) E.m.f of the cell is 6V, As when load current is zero potential difference becomes equal to emf of the cell. (II) Explanation: The internal resistance of a cell can be determined as the negative slope of its voltage–current graph. First, we can determine the slope by choosing two points on the line: $\textbf{Slope} = \frac{0-6}{12-0} = -0.5$ This means that the internal resistance must be 0.50 ohm (Ω). **For VI-Candidates** E = V + v = IR + Ir (where V is potential drop in the external circuit and v is potential drop in the cell) Or, E = I (R + r) Or, I = E / (R + r) This is the relation.	1 1 1 1
19.	From Gauss's theorem $Ø = \frac{q}{\varepsilon_r \varepsilon_o}$ [Where ε_r is relative permittivity of medium inside Gaussian surface] For sphere, $Ø_{sphere} = \frac{q}{\varepsilon_{water} \varepsilon_o}$ ……..(i) For cube $Ø_{cube} = \frac{2q}{\varepsilon_o}$ ……(ii) Dividing (i) by (ii) $\frac{Ø sphere}{Ø cube} = \frac{1}{2\varepsilon_{water}} = \frac{1}{160}$	½ ½ 1

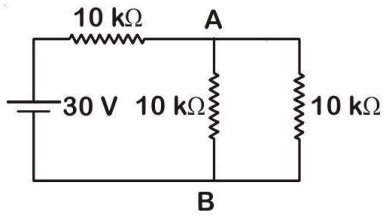
20. (I)	$\frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi r}$ (I_1 is the current in first wire and I_2 is the current in second wire) Thus we define ampere as the current flowing in each conductor separated by a unit distance so that one conductor applies a force of 2×10^{-7} N on a unit length of another parallel conductor. **Or**	1 1
20 (II)	 (a)  (b) **For VI-Candidates** Gauss's law for magnetism is: The net magnetic flux through any closed surface is zero. Hence magnetic flux linked to given sphere will also be zero.	1 1 1 1
21A.	Smaller is the impact parameter, larger is the angle at which α – particles scatters. Larger is the impact parameter, α – particles scatter less keeping its original trajectory. For head on collision, the value of impact parameter is zero. **OR**	1 1

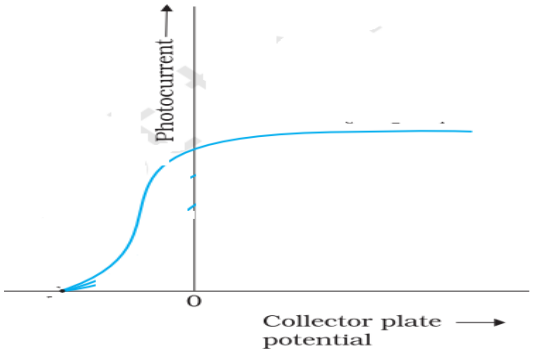
21B.	 $\lambda=\frac{h}{mv}$ $\lambda=\frac{h}{\sqrt{2mqV}}$, comparing this equation with y = mx slope= $\frac{h}{\sqrt{2mq}}$.	1 1
	SECTION C	
22.	In the full wave rectifier:D_1 and D_2 are pn junction diode which allow current to pass only in forward biasing. During odd half cycle the diode D_1 will be forward biased hence potential at the Q will be more then Potential at P and during this cycle D_2 will not permit current through it. During even half cycle the diode D_2 will be forward biased hence potential at the Q will be more then Potential at P and during this cycle D1 will not permit current through it. Hence we will get DC as output as shown in diagram. 	1 2
23.	(I) (A)Conservation of electric charge (B) KVL is obeys law of conservation of energy as it is supplied voltage is equal to the voltage across each component in the loop. (OR) algebraic sum of voltages equal to zero. (II) No change in balancing condition is observed.	1 1 1

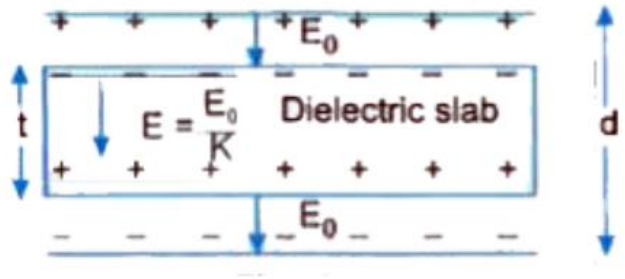
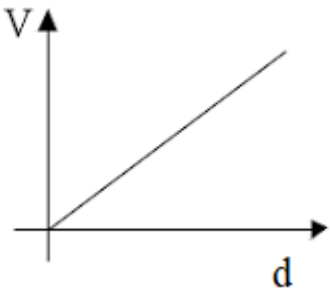
24.	A fast-moving neutron collides with the nucleus of Plutonium (Pu), thereby producing Xenon (Xe) and Zirconium (Zr) along with neutrons. (I) Nuclear fission reaction. $^{239}_{94}Pu + {}^{1}_{0}n \rightarrow {}^{134}_{54}Xe + {}^{103}_{40}Zr + 3\ {}^{1}_{0}n$ (II) Δm = [m ($^{239}_{94}Pu$) + m ($^{1}_{0}n$)] - [m ($^{134}_{54}Xe$) + m ($^{103}_{40}Zr$) + 3 m ($^{1}_{0}n$)] = [239.052157 + 1.00866] - [133.905040 + 102.926597 + 3 X 1.00866] = 240.060817 – 239.857617 = 0.2032 amu Q value = Δmc^2 = 0.2032 x 931.5 MeV = 189.2808 MeV	1 1 1
25.	(I) $\frac{1}{v_0} = \frac{1}{f_0} - \frac{1}{u_0}$ v_0= 8.3 cm Angular magnification M=m_0xm_e M= $\frac{v_0}{u_0}(\frac{D}{f_e}+1)$ M= - $\frac{8.3}{0.91}$ X ($\frac{25}{2.9}+1$) M= -87.7 (II)  	1 1 1

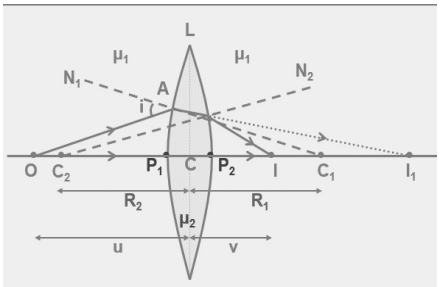
26.	 AB – Incident wavefront CD – Reflected wavefront XY – Reflecting surface	1
	If c be the speed of light, t be the time taken by light to go from B to C or A to D or E to G through F, then $t=\frac{EF}{C}+\frac{FG}{C}$ $t=\frac{AF\ Sin\ i}{C}+\frac{FC\ Sin r}{C}$ $t=\frac{AC\ Sin\ r+AF(Sin\ i-Sin\ r)}{C}$	
	For rays of light from different parts on the incident wavefront, the values of AF are different. But light from different points of the incident wavefront should take the same time to reach the corresponding points on the reflected wavefront. So, t should not depend upon AF. This is possible only if sin i – sin r = 0. i.e. sin i = sin r or i = r Hence proved.	1 1
	<u>For VI candidates</u> (i) A wavefront is the locus of points (wavelets) having the same phase of oscillations (ii) Each point on a wavefront acts as a fresh source of disturbance of light known as wavefront. (iii) Planer.	1 1 1
27. (I)	As charge particle is moving perpendicular to magnetic field it will follow circular trajectory in clock wise direction. Magnetic force will act as centripetal force. Given: Q=1C; $M=10^{-3}$kg; v=2m/s & $B=-0.1T\hat{k}$	

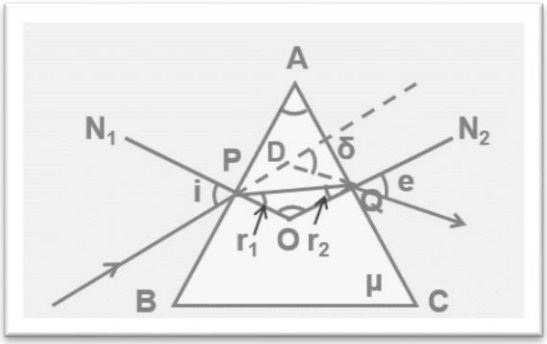
	Radius of trajectory is given by R= $\frac{mv}{qb}$ = 2cm (A) Quarter Circle (B) It will cross the X axis at 2cm. (C) As work done by B is on charge particle is zero it's kinetic energy(K) will remain same K= $\frac{1}{2}mv^2$ Or, K = $\frac{1}{2}x10^{-3}x2^2J = 2 \times 10^{-3}J$	 1 1 1
27 (II)	Given: μ_r=200 I=1A N=200turn/m (A) H=nI Or,H=2000/m X 1A=2 X 10^3A/m (B) B= $\mu_o\mu_r$H Or, B=200 x 4π x 10^{-7}x 2 X 10^3A/m Or, B= 0.50T (C) Magnetisation is given by M=(μ_r -1)H=199 x 10^3 A/m Or,M = 1.99 x 10^5 A/m	 1 1 1
28.	Given: No of turns of coil N_c=50 Area of coil= $\frac{5}{\pi}$ cm^2=$\frac{5}{\pi}$ x $10^{-4}m^2$ For solenoid: N_s=2000, L=0.5m, n = N/L=4000turns/m, I= 5A	

	Magnetic field due to solenoid 'B'=μ_onI Or,B=4000 x 4π x 10^{-7} x 5 T Or,B= 8π x 10^{-2} T	1
	Flux linked to coil $\emptyset_B$=$N_c\vec{B}.\vec{A}$ Or, $\emptyset_B$=N_cBA cosωt	1
	Emf $\varepsilon = \frac{d\emptyset_B}{dt}$ = N_cBAω sin ωt *Or,* ε_{max} = N_cBA *Or,* ε_{max} = 50 x 8π x 10^{-2} T x $\frac{5}{\pi}$ x $10^{-4}m^2$ *Or,* ε_{max} = 2Mv	1
	SECTION - D	
29.	(I) (B) Voltage drop across diode will change from 0.3 to 0.7 V. Value of V_0 changes by 0.4 V.	1
	(II) (D) 11V, 1.96Ma $V_0 = E - V_{si} - V_{Ge} = 12.07 - 0.3 = 11V$ $I_d = V_0/R = 11/5.6 \times 10^{-3} = 1.96$ Ma	1
	(III) (B) $I = \frac{6}{50+150+100} = \frac{6}{300}$ A = 0.02 A	1
	(IV) (C)  Here the diode is in forward bias. So we replace it by a connecting wire. $V_a - V_b = \frac{l}{2} \times 10$ $= \frac{30}{15 \times 2} \times 10$ V = 10 V	1

30.	(I) If infrared radiation is used as incident radiation, determine the reading $W_o = h\nu_o$ Threshold frequency, $\nu_o = \frac{Wo}{h} = \frac{6.35 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}} = 1.5 \times 10^{15}$ hz Frequency of infrared radiation < threshold frequency (ν_o) , hence no emmision of photoelectrons will take place, therefore reading of the microammeter = 0 (II) Photoelectric current decreases with decrease in potential. At some stage, for a certain potential of plate A, all the emitted electrons are stopped by the plate A and the photoelectric current becomes zero. (III)  **(for V.I. candidates)** No change in Kinetic Energy.	1 1 1 1 1
	SECTION E	
31. (I)	(A) In absence of dielectric slab, the capacitance of parallel plate capacitor is given by $C = \frac{A\varepsilon_0}{d}$ When a dielectric slab of thickness t(t < d) is introduced between the plates without touching the plates , the electric field in air $E_o = \frac{\sigma}{\varepsilon_0}$ (σ *is charge density given by* $\frac{q}{A}$) but on account of polarisation of dielectric the electric field inside the dielectric changes to $E = \frac{Eo}{K}$ If potential difference between the plates of capacitor be V. now , then clearly	½

	$V= E_o(d-t) + Et;$ Or, $V= E_o(d-t) + \frac{Eo}{K} t;$ Or, $V= E_o(d-t+\frac{t}{k})= \frac{\sigma}{\varepsilon_0} (d-t+\frac{t}{k})$ Or, $V=\frac{q}{A\varepsilon_0} (d-t+\frac{t}{k})$	1 ½
		
	(B) Capacitance of sphere will Increase. Justification: As $C=\frac{q}{V}$ & $V=\int \vec{E}.\vec{dl}$ As, electric field will decrease, due to polarization of water. Resulting in decrease in potential. Hence, capacitance of sphere will increase	1 1
	(C) 	1
	For VI Candidates (C) energy stored in capacitor will decrease. Justification Energy=$\frac{Q^2}{2C}$ When separation is increased capacitance will increase and charge will remain same.	

	Or	
31 (II)	(A) $U=\frac{Kq_1q_2}{r_{12}}+q_1V(r_1)+ q_2V(r_2)$ Or, $U=\frac{Kq_1q_2}{r_{12}}+q_1 (E\ r_{1-0})+ q_2(E\ r_{2-0})$ Or, $U=(\frac{9X10^9X10^{-6}X3X10^{-6}}{20} + 0 +3 \times 10^{-6} \times 40x20)$ J Or, $U=37.5 \times 10^{-4}$J (B) Work done will be same for both paths, as electric field is conservative in nature. (C) As electric field inside the conductor is zero so there will be no work needed in moving unit positive charge inside or on the surface.	1 1 1 1 1
32. (I)	(A) Lens Maker's Formula: For refraction at LP_1N, $\frac{\mu_1}{CO}+\frac{\mu_2}{CI1}=\frac{\mu_2-\mu_1}{CC1}$ (as if the image is formed in the denser medium) For refraction at LP_2N $\frac{\mu_2}{-CI_1}+\frac{\mu_1}{CI}=\frac{\mu_2-\mu_1}{CC_2}$ (as if the object is in the denser medium and the image is formed in the rarer medium) Combining the refractions at both the surfaces. $\frac{\mu_1}{CO}+\frac{\mu_2}{CI}= \mu_2-\mu_1(\frac{1}{CC_1}+\frac{1}{CC_2})$ Substituting the values with sign convections, $\frac{1}{-u}+\frac{1}{v}=\frac{\mu_2-\mu_1}{\mu_1}(\frac{1}{R_1}-\frac{1}{R_2})$  Since $\frac{\mu_2}{\mu_1}=\mu$ $\frac{1}{-u}+\frac{1}{v}=\frac{\mu_2-\mu_1}{\mu_1}(\frac{1}{R_1}-\frac{1}{R_2})$ (or)	1 1

	$\frac{1}{-u}+\frac{1}{v}=(\mu-1)(\frac{1}{R_1}-\frac{1}{R_2})$ When the object is kept at infinity, the image is formed at the principal focus. i.e. u = - ∞, v = + f. $\frac{1}{f}=(\mu-1)(\frac{1}{R_1}-\frac{1}{R_2})$ This equation is called 'Lens Maker's Formula'. (B) Refractive index of glass, μ = 1.55 Focal length of the convexo-concave lens, f = 10 cm Radius of curvature of one face of the first Convex surface = R_1 Radius of curvature of the other face of the second convex surface = $-R_1$ Therefore, R_1 = R and R_2 = -R The value of R can be calculated from Lens – Maker formula: (1/f) = (μ – 1) [(1/ R_1) – (1/ R_2)] (1/10) = (1.55 -1) [(1/R) + (1/R)] (1/10) = 0.55 x (2/R) Therefore R = (0.55 x 2 x10) =11cm Hence, the radius of curvature of the convexo-concave is 11cm **(OR)**	1 1 1
32 (II)	(A)The **angle of deviation** represents the angle by which a light ray is deviated after passing through a prism. (B) Refraction of light through prism :  In quadrilateral APOQ, A + O = 180° …….(1) In triangle OPQ, $r_1 + r_2$ + O = 180° …….(2)	1 1

	In triangle DPQ $\delta = (i - r_1) + (e - r_2)$ $\delta = (i + e) - (r_1 + r_2)$ …….(3) From (1) and (2), $A = r_1 + r_2$ From (3), $\delta = (i + e) - (A)$ $i + e = A + \delta$ Sum of angle of incidence and angle of emergence is equal to the sum of angle of prism and angle of deviation. (C) When angle of incidence increases, the angle of deviation decreases. At a particular value of angle of incidence the angle of deviation becomes minimum and is called 'angle of minimum deviation'. At δ_m, • $i = e$ and $r_1 = r_2 = r$ (say) • At minimum deviation, refracted ray become parallel to incident ray. (Award full marks if either of condition is mentioned)	1 1 1
33. (I)	(A) Torque due to current carrying coil. Modification in designing of galvanometer are (i) Poles of magnet are made spherical (ii) Iron ore is placed inside the coil. (B) Given: $R_g = 49.5\Omega$; Range=0.05A For ammeter let resistance needed be R_a. As per requirement Range x $R_g = R_a(5-0.05)$ $R_a = \frac{0.5\ X\ 49.5}{4.95} = 0.5\ \Omega$ (C) R_a will be connected in series & R_v is connected in parallel. **Or**	1 ½ ½ 1 1 1
33 (II)	(A)Given: In load circuit, $R=4\Omega$, $X_c=2\ \Omega$, $X_l=6\ \Omega$, $N_p=1000$,	

	N_s=100, V_{in}=200V$\sin 100\pi t$ (i) Output voltage Across Load Circuit $\frac{V_{out}}{V_{in}} = \frac{N_s}{N_p}$=0.1 Or, V_{out}=0.1 x 200V$\sin 100\pi t$, Or, V_{out}=20V$\sin 100\pi t$. (ii) Current flowing through load circuit As, I=$I_m\sin(\omega t+Ø)$ Where, $I_m = \frac{V_m}{Z}$, $Z=\sqrt{R^2 + ({X_c}^2 - {X_L}^2)}$ Or,$Z=4\sqrt{2}$ Ω,& $I_m = \frac{20}{4\sqrt{2}}A = \frac{5\sqrt{2}}{2}A$; $Ø = \tan^{-1}\frac{X_C - X_L}{R} = \tan^{-1} 1 = \frac{\pi}{4}$ $I=\frac{5\sqrt{2}}{2}A\sin(100\pi t+\frac{\pi}{4})$' (iii) Find the Power supplied to load circuit By the transformer. $P= \frac{V_m I_m}{2}\cos Ø$ Where, $\cos Ø=\cos\frac{\pi}{4} = \frac{1}{\sqrt{2}}$ P=20V x $\frac{5\sqrt{2}}{2}$ Ax$\frac{1}{\sqrt{2}}$ =50W (B) Ac transformer works on the principal of ' Mutual Induction' A.C transformer can increase output potential. As P=V/I So increase in output potential results in decrease in output current, resulting in significant decrease in power loss in transmission wires between power plants and Cities. In respective cities they are stepped down.	1 1 1 1 1

SAMPLE QUESTION PAPER

PHYSICS

Subject Code – 042

CLASS – XII

Academic Session 2024 – 25

Maximum Marks: 70 **Time Allowed: 3 hours**

General Instructions

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) **Section A** contains **sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each**, **Section B** contains **five questions of two marks each**, **Section C** contains seven questions of three marks each, **Section D** contains **two case study-based questions of four marks each** and **Section E** contains **three long answer questions of five marks each**.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary

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

ii. $m_e = 9.1 \times 10^{-31}$ kg

iii. $m_p = 1.7 \times 10^{-27}$ kg

iv. $e = 1.6 \times 10^{-19}$ C

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

vi. $h = 6.63 \times 10^{-34}$ J s

vii. $\varepsilon_0 = 8.854 \times 10^{-12}$ $\boldsymbol{C^2 N^{-1} m^{-2}}$

viii. Avogadro's number = 6.023 X $\mathbf{10^{23}}$ per gram mole

[SECTION – A] **(16x1=16 marks)**

Q1. A uniform electric field pointing in positive X-direction exists in a region. Let A be the origin, B be the point on the X-axis at x = +1 cm and C be the point on the Y-axis at y = +1 cm. Then the potential at points A, B and C satisfy.

(A) $V_A < V_B$ (B) $V_A > V_B$. (C) $V_A < V_C$ (D) $V_A > V_C$

Q2. A conducting wire connects two charged conducting spheres of radii r_1 and r_2 such that they attain equilibrium with respect to each other. The distance of separation between the two spheres is very large as compared to either of their radii.

The ratio of the magnitudes of the electric fields at the surfaces of the spheres of radii r_1 and r_2 is

(A) $\frac{r_1}{r_2}$ (B) $\frac{r_2}{r_1}$ (C) $\frac{{r_2}^2}{{r_1}^2}$ (D) $\frac{{r_1}^2}{{r_2}^2}$

Q3. A long straight wire of circular cross section of radius 'a' carries a steady current I. The current is uniformly distributed across its cross section. The ratio of magnitudes of the magnetic field at a point a/2 above the surface of wire to that of a point a/2 below its surface is

(A) 4:1 (B) 1:1 (C) 4: 3 (D) 3 :4

Q4. The diffraction effect can be observed in

(A) sound waves only
(B) light waves only
(C) ultrasonic waves only
(D) sound waves as well as light waves

Q5. A capacitor consists of two parallel plates, with an area of cross-section of 0.001 m^2, separated by a distance of 0.0001 m. If the voltage across the plates varies at the rate of 10^8 V/s, then the value of displacement current through the capacitor is

(A) $8.85 \times 10^{-3} A$ (B) $8.85 \times 10^{-4} A$ (C) $7.85 \times 10^{-3} A$ (D) $9.85 \times 10^{-3} A$

Q6. In a series LCR circuit, the voltage across the resistance, capacitance and inductance is 10 V each. If the capacitance is short circuited the voltage across the inductance will be

(A) 10 V (B) $10\sqrt{2}$ V (C) $10/\sqrt{2}$ V (D) 20 V

Q7. Correct match of column I with column II is

C-l (waves)	C-ll (Production)
(1) Infra-red	P . Rapid vibration of electrons in aerials
(2) Radio	Q . Electrons in atoms emit light when they move from higher to lower energy level.
(3) Light	R . Klystron valve
(4) Microwave	S . Vibration of atoms and molecules

(A) 1-P, 2-R, 3-S, 4-Q (B) 1-S, 2-P, 3-O, 4-R

(C) 1-Q, 2-P, 3-S, 4-R (D) 1-S. 2-R, 3-P, 4-Q

Q8. The distance of closest approach of an alpha particle is *d* when it moves with a speed V towards a nucleus.

Another alpha particle is projected with higher energy such that the new distance of the closest approach is *d*/2. What is the speed of projection of the alpha particle in this case?

(A) V /2 (B) $\sqrt{2}$ V (C) 2 V (D) 4 V

Q9. A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of virtual image from the surface of the sphere is

(A) 2 cm (B) 4 cm (C) 6 cm (D) 12 cm

Q10. Colours observed on a CD (Compact Disk) is due to

(A) Reflection (B) Diffraction (C) Dispersion (D) Absorption

Q11. The number of electrons made available for conduction by dopant atoms depends strongly upon

(A) doping level (B) increase in ambient temperature

(C) energy gap (D) options (A) and (B) both

Q12. If copper wire is stretched to make its radius decrease by 0.1%, then the percentage change in its resistance is approximately

(A)–0.4% (B) +0.8% (C) +0.4% (D) +0.2%

For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
C. If Assertion is true but Reason is false.
D. If both Assertion and Reason are false.

Q13. Assertion (A): On increasing the current sensitivity of a galvanometer by increasing the number of turns may not necessarily increase its voltage sensitivity.
Reason(R) : The resistance of the coil of the galvanometer increases on increasing the number of turns.

Q14. Assertion (A): In a hydrogen atom there is only one electron but its emission spectrum shows many lines.
Reason (R): In a given sample of hydrogen there are many atoms each containing one electron; hence many electrons in different atoms may be in different orbits so many transitions from higher to lower orbits are possible.

Q15. Assertion (A): Nuclei having mass number about 60 are least stable**..**
Reason (R): When two or more light nuclei are combined into a heavier nucleus then the binding energy per nucleon will decrease.

Q16. Assertion (A): de Broglie's wavelength of a freely falling body keeps decreasing with time.
Reason (R): The momentum of the freely falling body increases with time.

[SECTION – B] (05x2=10 marks)

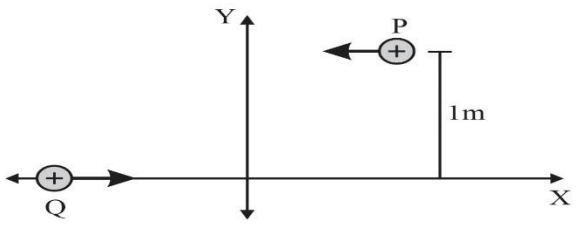
Q17. A platinum surface having work function 5.63 eV is illuminated by a monochromatic source of 1.6 x 10^{15} Hz. What will be the minimum wavelength associated with the ejected electron.

Q18. (I) A beam of light consisting of two wavelengths, 4000 Å and 6000 Å, is used to obtain interference fringes in a Young's double-slit experiment. What is the least distance from the central maximum where the dark fringe is obtained?

OR

(II) In Young's double-slit experiment using monochromatic light of wavelength λ, the intensities of two sources are I. What is the intensity of light at a point where path difference between wavefronts is λ/4?

Q19. P and Q are two identical charged particles each of mass 4×10^{-26} kg and charge 4.8×10^{-19} C, each moving with the same speed of 2.4×10^{5} m/s as shown in the figure. The two particles are equidistant (0.5 m) from the vertical Y -axis. At some instant, a magnetic field B is switched on so that the two particles undergo head-on collision.



Find –

(I) the direction of the magnetic field and

(II) the magnitude of the magnetic field applied in the region.

(for VI candidates)

A proton is moving with speed of 2×10^{5} m s^{-1} enters a uniform magnetic field B = 1.5 T. At the entry velocity vector makes an angle of 30° to the direction of the magnetic field. Calculate

(a) the pitch of helical path described by the charge

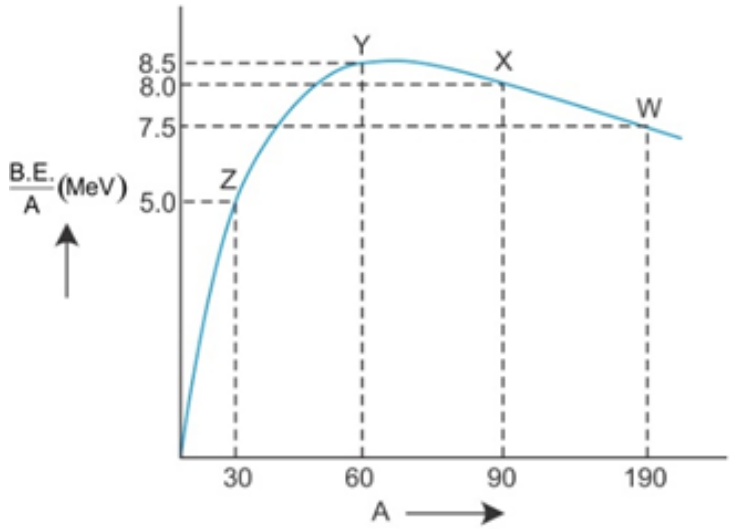
(b) Kinetic energy after completing half of the circle.

Q.20. Binding energy per nucleon vs mass number curve for nuclei is shown in the figure. W, X, Y and Z are four nuclei indicated on the curve. Identify which of the following nuclei is most likely to undergo

(i) Nuclear Fission

(ii) Nuclear Fusion.

Justify your answer.



(for V.I. Candidates)

Binding energy per nucleon and mass number of the following nuclei are given in the below table

Nuclei	Binding energy per nucleon (MeV)	Mass number
W	7.5	190
X	8.0	90
Y	8.5	60
Z	5.0	30

Identify which of the following nuclei is most likely to undergo

(i) Nuclear Fission

(ii) Nuclear Fusion.

Justify your answer.

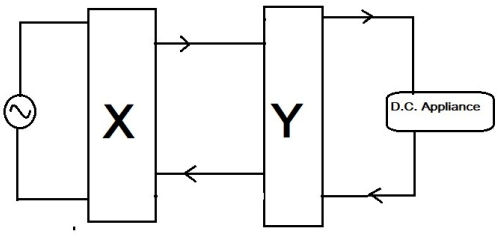
Q21. A cylindrical conductor of length l and cross-section area A is connected to a DC source. Under the influence of electric field set up due to source, the free electrons begin to drift in the opposite direction of the electric field.

(I) Draw the curve showing the dependency of drift velocity on relaxation time.

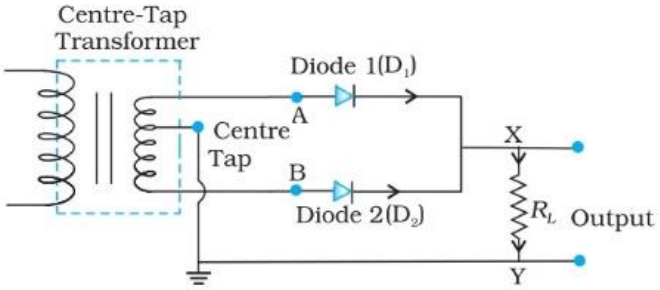
(II) If the DC source is replaced by a source whose current changes its magnitude with time such that $I = I_o \sin 2\pi\nu t$, where ν is the frequency of variation of current, then determine the average drift velocity of the free electrons over one complete cycle.

[SECTION – C] **(07x3=21 marks)**

Q22. (I) Identify the circuit elements X and Y as shown in the given block diagram and draw the output waveforms of X and Y.



(II) If the centre tapping is shifted towards Diode D1 as shown in the diagram, draw the output waveform of the given circuit.



(for V.I. candidates)

Which device is used to convert AC into DC. State it's underlying principle and explain its working. If the frequency of input AC to this device is 60 Hz, then what will be frequency of the output of this device.

Q23. Find the expression for the capacitance of a parallel plate capacitor of plate area A and plate separation d when (I) a dielectric slab of thickness t and (II) a metallic slab of thickness t, where (t < d) are introduced one by one between the plates of the capacitor. In which case would the capacitance be more and why?

Q24. (I) Draw a ray diagram for the formation of image by a Cassegrain telescope.

(II)Why these types of telescopes are preferred over refracting type telescopes. (Write 2 points)

(for V.I. Candidates)

A Cassegrain telescope is built with an arrangement of two mirrors placing them 20 mm apart. If the radius of curvature of the large mirror is 200mm and the small mirror is 150mm, where will the final image of an object at infinity be?

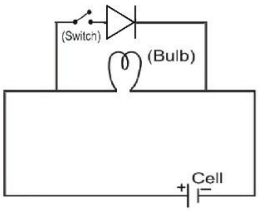
Q25. (I) Draw the energy band diagram for P-type semiconductor at (i) T=0K and (ii) room temperature.

(II)In the given diagram considering an ideal diode, in which condition will the bulb glow

(a) when the switch is open

(b) when the switch is closed

Justify your answer.



(for V.I. Candidates)

Explain briefly how

(i) barrier potential is formed in p-n junction diode.

(ii) Width of depletion region of the diode is affected when it is (a) forward biased, (b) reverse biased.

Q26. A boy is holding a smooth, hollow and non-conducting pipe vertically with charged spherical ball of mass 10 g carrying a charge of +10 mC inside it which is free to move along the axis of the pipe. The boy is moving the pipe from East to West direction in the presence of magnetic field of 2T. With what minimum velocity, should the boy move the pipe such that the ball does not move along the axis. Also determine the direction of the magnetic field.

Q27. A light ray entering a right-angled prism undergoes refraction at the face AC as shown in Fig. 1.

(I) What is the refractive index of the material of the prism in Fig. 1?

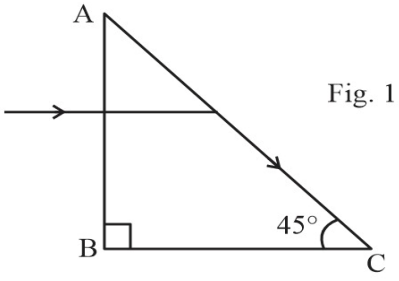


Fig. 1

(II) (a) If the side AC of the above prism is now surrounded by a liquid of refractive index $\frac{2}{\sqrt{3}}$, as shown in Fig. 2, determine if the light ray continues to graze along the interface AC or undergoes total internal reflection or undergoes refraction into the liquid.

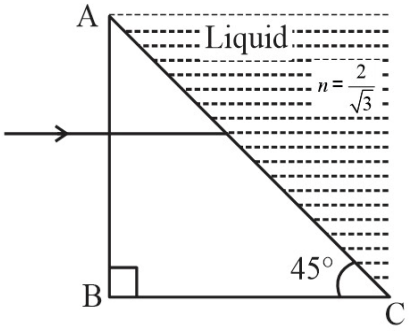


Fig. 2

(b) Draw the ray diagram to represent the path followed by the incident ray with the corresponding angle values.

(Given, $sin^{-1}(\frac{\sqrt{2}}{\sqrt{3}}) = 54.6^{\circ}$)

(for V.I. candidates)

A ray of light is incident on an equilateral prism at an angle 3/4 th of the angle of the prism. If the ray passes symmetrically through the prism, find the (a) angle of minimum deviation, and (b) refractive index of the material of the prism.

Q28. (I) State Gauss's theorem in electrostatics. Using this theorem, derive an expression for the electric field due to an infinitely long straight wire of linear charge density λ.

OR

(II) (a) Define electric flux and write its SI unit.

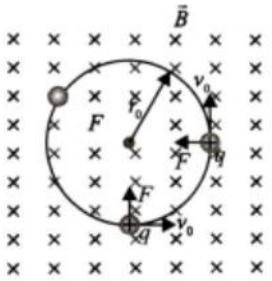
(b) Use Gauss's law to obtain the expression for the electric field due to a uniformly charged infinite plane sheet of charge.

[SECTION D] **(02x4=08 marks)**

Q29. **Case Study Based Question**: **<u>Motion of Charge in Magnetic Field</u>**

An electron with speed $v_o << c$ moves in a circle of radius r_o in a uniform magnetic field. This electron is able to traverse a circular path as the magnetic force acting on the electron is

perpendicular to both v_o and B ,as shown in the figure. This force continuously deflects the particle sideways without changing its speed and the particle will move along a circle perpendicular to the field. The time required for one revolution of the electron is T_o



(i) If the speed of the electron is now doubled to $2v_o$. The radius of the circle will change to

(A) $4r_o$ (B) $2\ r_o$ (C) r_o (D) $r_o/2$

(ii) If $v = 2v_o$, then the time required for one revolution of the electron (T_o) will change to

(A) $4\ T_o$ (B) $2\ T_o$ (C) T_o (D) $T_o/2$

(iii) A charged particle is projected in a magnetic field $\mathbf{B} = (2\ \mathbf{i} + 4\ \mathbf{j}) \times 10^2$ T . The acceleration of the particle is found to be $\mathbf{a} = (\ x\ \mathbf{i} + 2\ \mathbf{j}\ )$ m/s^2 . Find the value of x.

(A) 4 ms^{-2} (B) -4 ms^{-2} (C) -2 ms^{-2} (D) 2 ms^{-2}

(iv) If the given electron has a velocity not perpendicular to B, then trajectory of the electron is

(A) straight line (B) circular (C) helical (D) zig-zag

OR

If this electron of charge (e) is moving parallel to uniform magnetic field with constant velocity v, the force acting on the electron is

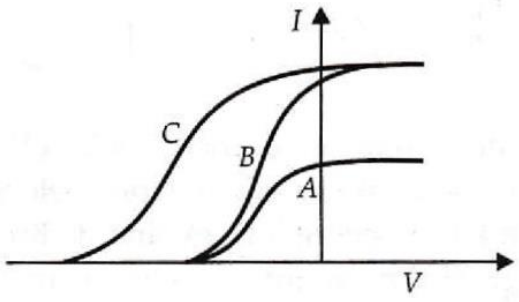
(A) Bev (B) Be/v (C) B/ev (D) Zero

Q30. Case Study Based Question: Photoelectric effect

It is the phenomenon of emission of electrons from a metallic surface when light of a suitable frequency is incident on it. The emitted electrons are called photoelectrons.

Nearly all metals exhibit this effect with ultraviolet light but alkali metals like lithium, sodium, potassium, cesium etc. show this effect even with visible light. It is an instantaneous process i.e. photoelectrons are emitted as soon as the light is incident on the metal surface. The number of photoelectrons emitted per second is directly proportional to the intensity of the incident radiation. The maximum kinetic energy of the photoelectrons emitted from a given metal surface is independent of the intensity of the incident light and depends only on the frequency of the incident light. For a given metal surface there is a certain minimum value of the frequency of the incident light below which emission of photoelectrons does not occur.

(I) In a photoelectric experiment plate current is plotted against anode potential.



(A) A and B will have same intensities while B and C will have different frequencies
(B) B and C will have different intensities while A and B will have different frequencies
(C) A and B will have different intensities while B and C will have equal frequencies
(D) B and C will have equal intensities while A and B will have same frequencies.

(II) Photoelectrons are emitted when a zinc plate is

(A) Heated
(B) hammered
(C) Irradiated by ultraviolet light
(D) subjected to a high pressure

(III) The threshold frequency for photoelectric effect on sodium corresponds to a wavelength of 500 nm. Its work function is about

(A) $4x10^{-19}$ J (B) 1 J (C) $2x10^{-19}$ J (D) $3x10^{-19}$ J

(IV) The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 6 eV fall on it is 4 eV. The stopping potential is

(A) 2 V (B) 4 V (C) 6 V (D) 10 V

OR

The minimum energy required to remove an electron from a substance is called its

(A) work function (B) kinetic energy (C) stopping potential (D) potential energy

[SECTION E] **(03X5=15)**

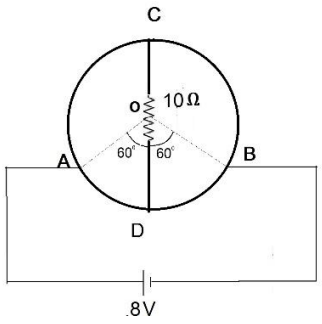
Q31. (I) a) Write two limitations of ohm's law. Plot their I-V characteristics.

b) A heating element connected across a battery of 100 V having an internal resistance of 1 Ω draws an initial current of 10 A at room temperature 20.0 °C which settles after a few seconds to a steady value. What is the power consumed by battery itself after the steady temperature of 320.0 °C is attained? Temperature coefficient of resistance averaged over the temperature range involved is 3.70×10^{-4} °C^{-1}.

OR

(II) a) Using Kirchhoff's laws obtain the equation of the balanced state in Wheatstone bridge.

b) A wire of uniform cross-section and resistance of 12 ohm is bent in the shape of circle as shown in the figure. A resistance of 10 ohms is connected to diametrically opposite ends C and D. A battery of emf 8V is connected between A and B. Determine the current flowing through arm AD.



(for V.I. Candidates)

(II) a) Using Kirchhoff's laws obtain the equation of the balanced state in Wheatstone bridge.

b) What do you understand by 'sensitivity of Wheatstone bridge' ? How the sensitivity of wheatstone bridge can be increased?

Q32. (I) Explain briefly, with the help of a labelled diagram, the basic principle of the working of an a.c. generator. In an a.c. generator, coil of N turns and area A is rotated at an angular velocity ω in a uniform magnetic field B. Derive an expression for the instantaneous value of the emf induced in coil. What is the source of energy generation in this device?

OR

(II) a) With the help of a diagram, explain the principle of a device which changes a low ac voltage into a high voltage . Deduce the expression for the ratio of secondary voltage to the primary voltage in terms of the ratio of the number of turns of primary and secondary winding. For an ideal transformer, obtain the ratio of primary and secondary currents in terms of the ratio of the voltages in the secondary and primary coils.

b) Write any two sources of the energy losses which occur in actual transformers.

c) A step-up transformer converts a low input voltage into a high output voltage. Does it violate law of conservation of energy? Explain.

Q33. (I) a) A giant refracting telescope at an observatory has an objective lens of focal length 15 m. If an eyepiece of focal length 1.0 cm is used, what is angular magnification of the telescope in normal adjustment?

b) If this telescope is used to view the moon, what is the diameter of the image of the moon formed by the objective lens? The diameter of the moon is 3.48×10^6 m, and the radius of lunar orbit is 3.8×10^8 m.

OR

(II) A compound microscope consists of an objective lens of focal length 2.0 cm and an eyepiece of focal length 6.25 cm separated by a distance of 15 cm. How far from the objective should an object be placed in order to obtain the final image at

a) the least distance of distinct vision (25 cm) and

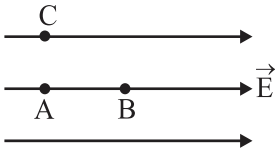
b) infinity? What is the magnifying power of the microscope in each case?

MARKING SCHEME
PHYSICS
Subject Code – 042
CLASS – XII
Academic Session 2024 – 25

Maximum Marks:70 **Time Allowed: 3hours**

[SECTION – A]

Ans.1- (B) **(1 mark)**



$V_A > V_B$ $[V_A = V_C]$

In the direction of electric field, the electric potential decreases.

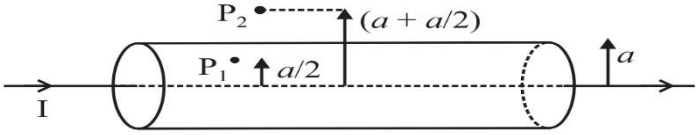
Ans.2- (B) In the state of equilibrium, **(1 mark)**

The potential on the surface of bigger sphere = the potential at the surface of the smaller sphere

$$\frac{kq_1}{r_1} = \frac{kq_2}{r_2} \Rightarrow \frac{q_1}{q_2} = \frac{r_1}{r_2}$$

$$\therefore \quad \frac{E_1}{E_2} = \frac{q_1}{q_2}\frac{r_2^2}{r_1^2} = \frac{r_1}{r_2}\cdot\frac{r_2^2}{r_1^2} = \frac{r_2}{r_1}$$

Ans.3 - (C) **(1 mark)**



At P_2, $B_2 = \frac{\mu_0 I}{2\pi\left(\frac{3a}{2}\right)} = \frac{\mu_0 I}{3\pi a}$

At P_1, $B_1 = \frac{\mu_0 (I/4)}{2\pi(a/2)} = \frac{\mu_0 I}{4\pi a}$

$$\therefore \quad \frac{B_2}{B_1} = \frac{\left(\frac{\mu_0 I}{3\pi a}\right)}{\left(\frac{\mu_0 I}{4\pi a}\right)} \Rightarrow \frac{B_2}{B_1} = \frac{4}{3}$$

Ans.4 - (D)Sound waves as well as light waves (1 mark)

Ans.5 -(A) (1 mark)

Ans.6 - (C)When all the given components are connected(1 mark)

$IR = IX_C = IX_L = 10V$

$X_C = X_L = R$

$Z = \sqrt{R^2 + (X_C - X_L)^2}$

$Z = \sqrt{R^2 + (R - R)^2}$

$Z = R$

$V_S = IZ = IR = 10\ V$

So, the source voltage is also 10 V

When the capacitor is short circuited then

$Z = \sqrt{R^2 + (X_L)^2}$

$= \sqrt{R^2 + R^2} = R\sqrt{2}$

$V_L = I' X_L = \frac{10}{\sqrt{2}R} \times R = 5\sqrt{2}\ V$

Ans.7 - (B)(1 mark)

Ans.8 - (B) The distance of closest approach**(1 mark)**

$$d = \frac{\text{const}}{V_1^2} \qquad ...(1)$$

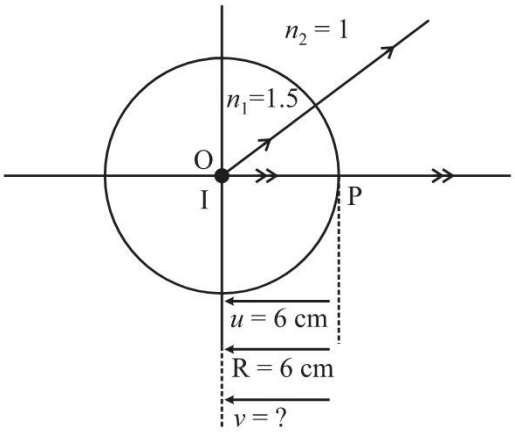
$$\frac{d}{2} = \frac{\text{const}}{V_2^2} \qquad ...(2)$$

From equations (1) and (2),

$$2 = \frac{V_2^2}{V_1^2} \Rightarrow V_2 = \sqrt{2}\ V_1$$

$\therefore$ $V_2 = \sqrt{2}\ V$ Given, ($V_1 = V$)

Ans.9 - (C)(1 mark)



$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

$$\frac{1}{v} - \frac{3}{2[-6]} = \frac{[1 - 3/2]}{-6}$$

$$\frac{1}{v}=\frac{-3}{12}+\frac{1}{12}=\frac{-2}{12}=\frac{-1}{6}$$

v= –6 cm

Ans.10 - (B)Diffraction (1 mark)

Ans.11- (A)doping level (1 mark)

Ans.12- (C)+0.4% (1 mark)

Ans.13- (A) (1 mark)

Ans.14- (A)(1 mark)

Ans.15- (D)(1 mark)

Ans.16- (A)(1 mark)

[SECTION – B]

Ans.17–

Given $\emptyset_0 = 5.63eV = 5.63 \times 1.6 \times 10^{-19}J$

$$\nu = 1.6 \times 10^{15}Hz$$

$K.E. = h\nu - \emptyset_0 = \frac{hc}{\lambda}$ ½

$\lambda = \frac{hc}{h\nu - \emptyset_0}$ ½

$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{6.63 \times 10^{-34} \times 1.6 \times 10^{15} - 5.63 \times 1.6 \times 10^{-19}}$ ½

$$= \frac{19.89 \times 10^{-26}}{1.6 \times 10^{-19}(6.63 - 5.63)}$$

$= \frac{19.89 \times 10^{-26}}{1.6 \times 10^{15}} = 12.4 \times 10^{-7}\, m$ ½

Ans.18 - $\lambda_1 = 4 \times 10^{-7}\, m \lambda_2 = 6 \times 10^{-7}\, m$

Distance at which dark fringe is observed $x = \left(n + \frac{1}{2}\right)\frac{\lambda D}{d}$ ½

First Dark fringe for $\lambda_1 d_1 = \frac{1}{2}\frac{4 \times 10^{-7}}{10^{-2}}\, m = 2 \times 10^{-5}\, m$ ½

First Dark fringe for $\lambda_2 d_2 = \frac{1}{2}\frac{6\times10^{-7}}{10^{-2}}\ m = 3\ \times\ 10^{-5}\ m$

First dark fringe will be the distance where both dark fringes will coincide i.e LCM of $d_1 \& d_1$ ½

i.e. $2\ \times\ 10^{-5}\ m\ \times\ 3\ \times\ 10^{-5}\ m$

$=\ 6\ \times\ 10^{-5}\ m$ ½

OR

(II) $Net\ I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\Phi$ **0.5 M**

Since, $I_1 = I_2 = I$

Net I = I + I + 2 I cosΦ

= 2I (1 + cosΦ)

= 2I (2 $\cos^2\frac{\emptyset}{2}$) **0.5 M**

For path difference λ/4 , phase difference is π/2 **0.5 M**

Net I = 4 I $\cos^2\frac{\pi}{4}$

Net I = 2 I **0.5 M**

(2 Marks)

Ans.19 - (I)The direction of the magnetic field is perpendicular and inward into the plane of thepaper **0.5M**

(II) For a head-on collision to take place, the radius of the path of each ion should be equal to 0.5 m.

$r = \frac{mv}{qB} = 0.5$ m **0.5M**

$\mathrm{B} = \frac{mv}{qr} = \frac{4\times10^{-26}\times2.4\times10^{5}}{4.8\times10^{-19}\times0.5}$ **0.5M**

B = 0.04 T **0.5M**

For VI Candidate

(a) As Pitch (p)=$\frac{2\Pi mv\ cos\Theta}{qB}$ **0.5M**

Or, p= $\frac{2\ X\ 3.14\ X\ 1.7X10^{-27}X\ 2\ X10^{5}\ Cos\ 30^{0}}{1.6\ X10^{-19}X1.5}$m

Or, P=7.7X10^{-3}m **0.5M**

(b)As, done by magnetic field is always zero K.E=1/2m$v^2$0.5M

KE=3.4 X 10^{-17}J **0.5M**

Ans.20 –(i) Nuclear fission –W

0.5M

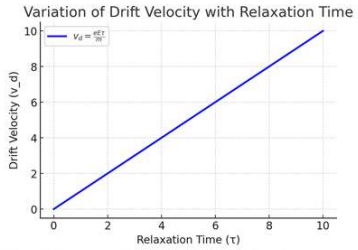
Reason: As W has binding energy per nucleon less then Y and X and nucleus is larger in size.

0.5M

(ii) Nuclear fusion-Z 0.5M

Reason: As Z has binding energy per nucleon more then Y and X and nucleus is smaller in size. **0.5M**

Ans. 21 - **(I)** The drift velocity is directly proportional to the relaxation time. This means that as relaxation time increases, the drift velocity increases linearly.



(II) Alternating current changes direction every half cycle. 0.5 M

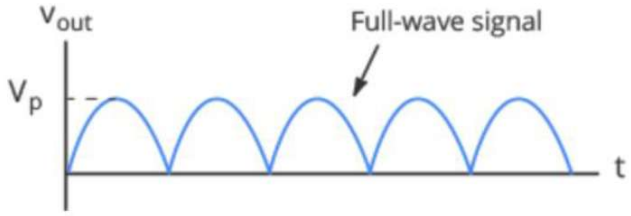
So average drift velocity is zero 0.5 M

[SECTION – C]

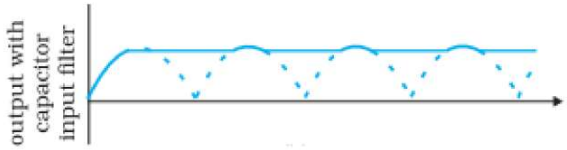
(3 Marks)

Ans.22 -(I) X = Full wave rectifier½

Y = Filter½

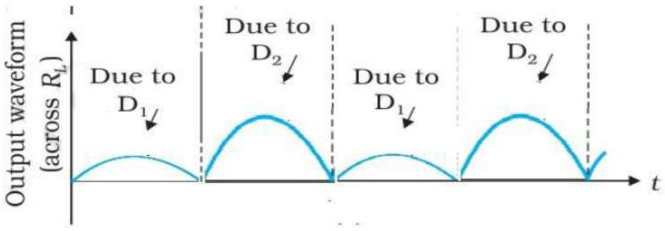


(Output Waveform for X) ½



(Output Waveform for Y) ½

(ii) 1



For VI Candidates

Rectifier 0.5M

Underlying principle of Rectifier

The basic principle of the rectifiers is the transformation of current by changing the frequency of the input signal, and diodes are used to do this.

0.5M

Working

In rectifier, one end of terminal which is connected to PN junction diode will never have negative potential, as it allows current in forward biasing only. Hence potential difference across load resistor will always be Positive or zero.

1M

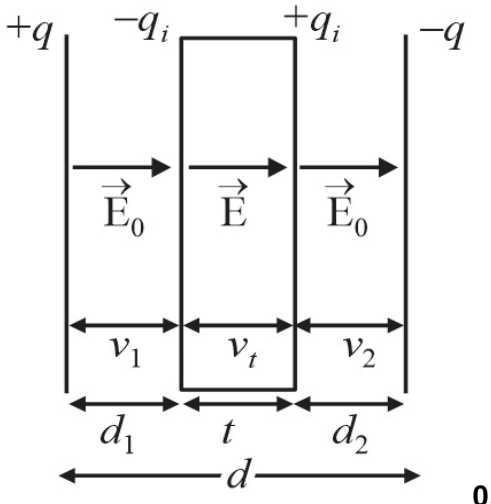
For 60 Hz input of AC, output of

Half wave rectifier will be 60Hz 0.5M

Full wave rectifier will be 120 Hz 0.5M

Ans.23 - (I)The capacitance of a parallel plate capacitor with dielectric slab (t < d)

(3 Marks)



0.5M

$+q$, $-q$ = the charges on the capacitor plates

$+q_i$, $-q_i$ = Induced charges on the faces of the dielectric slab

$E_0 \rightarrow$ electric field intensity in air between the plates

$E \rightarrow$ the reduced value of electric field intensityinside the dielectric slab.

When a dielectric slab of thickness $t<d$ is introduced between the two plates of the capacitor the electric field reduces to E due to the polarisation of the dielectric. The potential difference between the two plates is given by

$V = V_1 + V_t + V_2$

$V = E_0d_1 + Et + E_0d_2$ … (1)**0.5M**

Here E is the reduced value of electric field intensity

$\vec{E} = \vec{E}_0 + \vec{E}_i$. Here $\vec{E}_i$ is the electric field due to the induced charges [+q_i and – q_i]

$E = \sqrt{E_0^2 + E_i^2 + 2E_0E_i\cos 180°}$

$= \sqrt{(E_0 - E_i)^2}$

$E = E_0 - E_i$ **0.5M**

Also the dielectric constant K is given by

$$K = \frac{E_0}{E} \qquad \ldots (2)$$

$$E_0 = \frac{\sigma}{\varepsilon_0} = \frac{q}{A\varepsilon_0} \qquad \ldots (3)$$

From equations (1), (2) and (3)

$V = E_0[d_1 + d_2] + \frac{E_0}{K}t$

$V = \frac{q}{A\varepsilon_0}\left[d - t + \frac{t}{K}\right]$ … (4)

The capacitance of the capacitor on the introduction of the dielectric slab is

$$C = \frac{q}{V} \qquad \ldots (5)$$

From (4) and (5)

$C = \frac{\varepsilon_0 A}{d - t + \frac{t}{K}}$ **0.5M**

If $t = d$, then $C = K\frac{\varepsilon_0 A}{d} \Rightarrow C = KC_0$ Here $C_0 = \frac{\varepsilon_0 A}{d}$

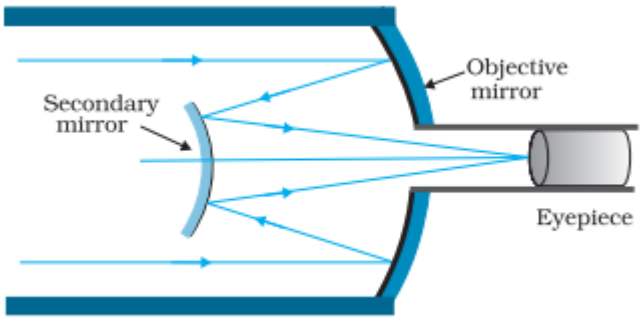
Since K >1 therefore $C > C_0$

(II) For a metallic slab K is infinitely large, therefore $C = \frac{\varepsilon_0 A}{d - t}$ **1M**

(3 Marks)

Ans.24 -(i)

2



(ii) 1

- It has mirror objective, which is free from chromatic and spherical aberrations.
- It can gather more light as objectives can be made larger, hence images can be brighter.

Any other two equivalent examples can be accepted.

For V.I Candidates

Objective mirror,

Radius of curvature, R_1=200mm

Focal Length, $f_1=R_1/2$=100mm **0.5M**

Secondary Mirror,

Radius of curvature, R_1=150mm

Focal Length, $f_1=R_1/2$=75mm **0.5M**

Distance between two mirror, x=20mm

For object at infinity, image is formed by objective lens will act as virtual object for secondary mirror

U_2=(100-20)mm=80mm **0.5M**

Applying, mirror formula for secondary mirror

$$\frac{1}{v_2} + \frac{1}{u_2} = \frac{1}{f_2}$$ **0.5M**

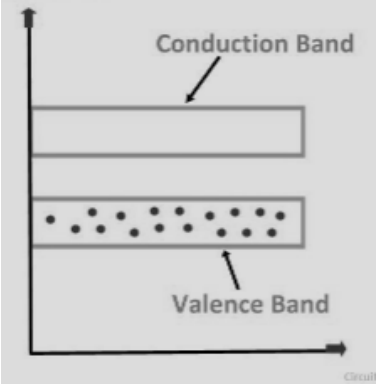
Or, $$\frac{1}{v_2} = \frac{1}{f_2} - \frac{1}{u_2}$$

$$= \frac{1}{75} - \frac{1}{80} = \frac{1}{1200}$$ **0.5M**

V_2=1200mm **0.5M**

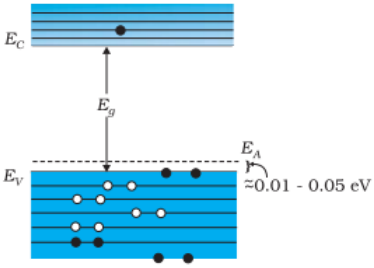
Ans.25 -

(a). T = 0 K



1M

(b) T = Room Temperature



1M

(ii) Answer will be (a) when switch is open **0.5M**

as when switch is closed diode will be forward biased and current will by-pass the bulb. **0.5M**

For V.I. Candidate

(i) A potential barrier is formed in a p-n junction due to the depletion layer, which is a layer of unmovable positive and negative charges that develops on either side of the junction. The depletion layer is created when holes move towards electrons, causing a layer of electrons on the p-type side and a layer of holes on the n-type side. The potential difference across this region is called the barrier potential **2M**

(ii)(a) In forward biasing width of depletion region decreases. 0.5M

(b) In reverse biasing width of depletion region increases. 0.5M

Ans.26 - (3 Marks)

Given

$B = 2\,T$, $q = 10mC$, $mass\ of\ the\ ball =$ 10^{-2}kg , $g = 9.8\ {}^{m}/_{s^2}$

Magnetic force $(qvB\sin\theta) = gravitational\ force\ (mg)$

$v = \frac{mg}{qB\sin\theta}$ ½

For min. velocity $\sin\theta = 1$

$v = \frac{mg}{qB\sin\theta} = v = \frac{mg}{qB}$ ½

$= \frac{10^{-2} \times 9.8}{10^{-2} \times 2}$m/s ½

=4.9m/s

$v = 4.9\ {}^{m}/_{s^2}$ ½

As force is in upward direction so from Fleming's Left-hand rule, magnetic field will be along North to South. 1

(3 Marks)

Ans.27 - (I)Since the light ray enters perpendicular to the face AB, the angle of incidence onface AC will be45°. **0.5M**

So,

$\sin\theta_C = \frac{1}{n}$

$sin\,45^{\circ} = \frac{1}{n} = \frac{1}{\sqrt{2}}$ So, $n = \sqrt{2}$ **0.5M**

(II)In fig.2, the face AC of the prism is surrounded by a liquid so$n = \frac{ng}{n_l} = \frac{\sqrt{2}}{\left(\frac{2}{\sqrt{3}}\right)} = \frac{\sqrt{3}}{\sqrt{2}}$

$\sin\theta_C = \frac{1}{n} = \frac{\sqrt{2}}{\sqrt{3}}\ \theta_C = sin^{-1}(\frac{\sqrt{2}}{\sqrt{3}}) = 54.6^\circ$

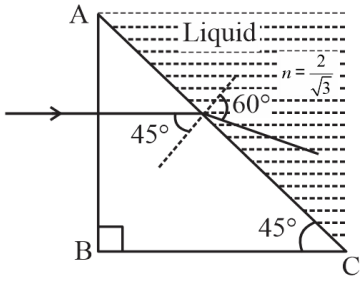
Since the angle of incidence on the surface AC is 45°, which is less than the critical angle for the pair of media (glass and the liquid), the ray neither undergoes grazing along surface AC, nor does it suffer total internal reflection **1M**

Instead it passes through the surface AC and undergoes refraction into the liquid.

For refracting interface AC, $n_1 \sin i = n_2 \sin r$

$n_1.sin45^\circ = \left(\frac{2}{\sqrt{3}}\right) sin\, r$

$sin\, r = \frac{\sqrt{3}}{2} \therefore\ r = 60^\circ.$



1M

(3 Marks)

For V.I. candidates

(a) Let the angle of incidence of light at prism, I = x

So, angle of emergence as per question, e = x

Angle of prism, A = $\frac{4}{3}x$

0.5M

Since prism Is equilateral

$3A=180^0$

0.5M

Or, $A= 60^0$

Or, $X=45^0$

From prism formulaeδ

δ= i+e-A

0.5M

or, $\delta=45+45-60=30^0$ **0.5M**

(b) $\boldsymbol{\mu = \frac{sin\frac{A+\delta m}{2}}{sin\frac{A}{2}}}$ **0.5M**

Or, $\boldsymbol{\mu=\frac{sin\frac{60+30}{2}}{sin\frac{60}{2}}}$

Or, $\boldsymbol{\mu=\sqrt{2}}$ **0.5M**

Ans.28– (I)Gauss'stheorem: The flux of electric field through any closed surface is $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the closed surface.

$\phi = \frac{q}{\varepsilon_0}$ … (1)

By definition, the total electric flux through the closed surface is given by

$\phi = \oint \vec{E}.\overrightarrow{ds}$ … (2)

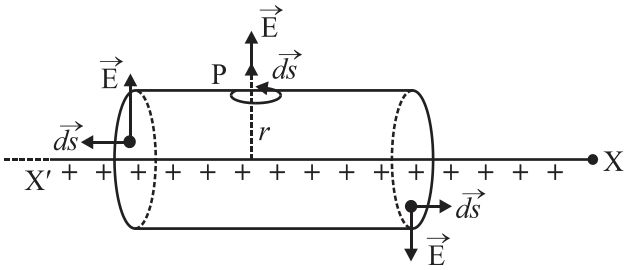
∴ From (1) and (2), Gauss's theorem may be expressed as follows

$$\phi = \oint \vec{E}.\overrightarrow{ds} = \frac{q}{\varepsilon_0}$$

∴ The surface integral of electric field over a closed surface is equal to $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface. **1M**

Application of Gauss's theorem

To find electric field due to a line charge let us consider an infinitely long line charge placed along XX' axis with linear charge density λ. Our aim is to find electric field intensity at a point P distant *r* from the line charge. We draw a cylindrical surface of radius *r* and length *l* coaxial with the line charge. The net flux through the cylindrical gaussian surface i.e.



0.5M

$\phi = \oint \vec{E}.\overrightarrow{ds} = \int_{LCF} \vec{E}.\overrightarrow{ds} + \int_{CS} \vec{E}.\overrightarrow{ds} + \int_{RCF} \vec{E}.\overrightarrow{ds}$ **0.5M**

$= \int_{LCF} Eds\cos 90° + \int_{CS} Eds\cos 0° + \int_{RCF} Eds\cos 90°$ **0.5M**

$\phi = \int_{CS} Eds\cos 0° = E.2\pi rl$ … (1)

The charge enclosed by the gaussian surface is $q = \lambda l$… (2)

Using Gauss's theorem from equations(1) and (2)

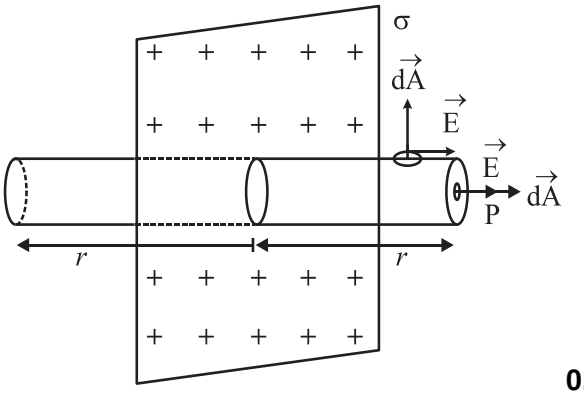
$$E(2\pi rl) = \frac{\lambda l}{\varepsilon_0} \Rightarrow E = \frac{\lambda}{2\pi\varepsilon_0 r}$$ **0.5M**

OR

(II) (a) Definition of electric flux and its SI unit **1M**

(b)Electric field due to an infinite plane sheet of charge.

Let us consider an infinite thin plane sheet of positive charge having a uniform surface charge density σ. Let P be the point where electric field E is to be found. Let us imagine a cylindrical gaussian surface of length 2*r* and containing P as shown. The net flux through the cylindrical gaussian surface.



0.5M

$\phi = \oint \vec{E} \cdot \overrightarrow{dA}$

$= \int_{RCF} \vec{E} \cdot \overrightarrow{dA} + \int_{LCF} \vec{E} \cdot \overrightarrow{dA} + \int_{CS} \vec{E} \cdot \overrightarrow{dA}$ **0.5M**

$= \int_{RCF} EdA\cos 0° + \int_{LCF} EdA\cos 0° + \int_{CS} EdA\cos 90°$ **0.5M**

= E A + EA + 0

ϕ = 2 EA ...(1)

Here A is the area of cross-section of each circular face*i.e.* LCF and RCF.

The total charge enclosed by the gaussian cylinder

= σA ...(2)**0.5M**

Using Gauss's theorem, from (1) and (2),

$2\,EA = \frac{\sigma A}{\varepsilon_0}$

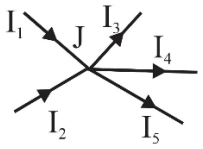
$E = \frac{\sigma}{2\varepsilon_0}$

Ans.29 -I(B) II(C) III(B) IV (C) 0R IV (D) **(4X1=4)**

Ans.30 - I(D) II(C) III (A) IV(B) 0R IV (A) **(4X1=4)**

(5 Marks)

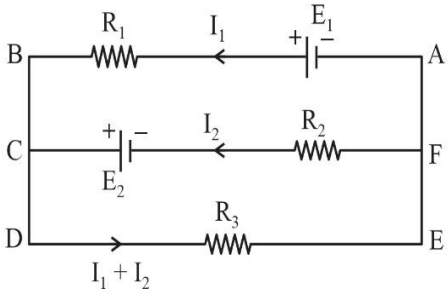
Ans.31–(I) (a) Kirchhoff's I Law :The algebraic sum of all the currents meeting at a point in an electrical circuit is always equal to zero.**1M**



$[+I_1] + [+I_2] + [-I_3] + [-I_4] + [-I_5] = 0$

Or $I_1 + I_2 = I_3 + I_4 + I_5$

Kirchhoff's II Law :The algebraic sum of the changes in potential around any closed resistor loop must be zero.**1M**



For closed mesh ABCFA

$[+E_1] [-I_1R_1] + [-E_2] + [+I_2R] = 0$ … (1)

For closed mesh FCDEF

$[+E_2] + [-(I_1+I_2)]R_3 + [-I_2R_2] = 0$ … (2)

(b).$I = \frac{\varepsilon}{R_0 + r}$ $Where\ R_0\ is\ resistance\ at\ room\ temperature\ 20^0$ ½

$\Rightarrow R_0 = \frac{\varepsilon}{I}$ -1

OR $R_0 = \frac{100}{10}$ -1 = $R_0 = 9\Omega$ ½

Now Final temperature is 320^0C

So, $R = R_0\ (1 + \alpha\Delta T)$ ½

= 9 ($(1 + 3.7 \times 10^{-4} \times 300)$

= 10 Ohm ½

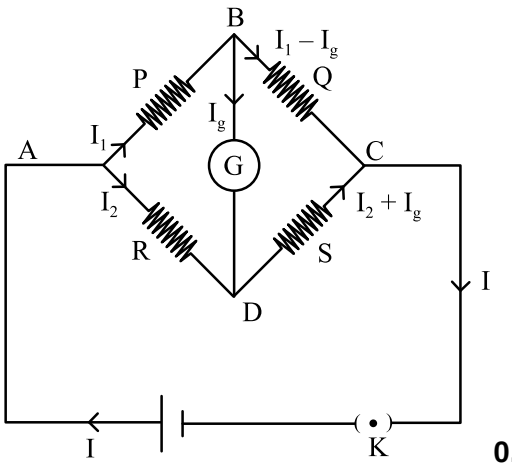
Power Consumed by cell $(P) = i^2 r$ ½

= $(\frac{\varepsilon}{R+r})^2 \times r \quad Watt$

= $(\frac{100}{11})^2$ = 82.64 W ½

OR

(II)(a) The Wheatstone bridgeis as shown in the figure **1M**



0.5M

Applying Kirchhoff's II law to mesh ABDA

$I_1P + I_gG - I_2R = 0$ .....(1) **0.5M**

For the mesh BCDB

$(I_1 - I_g)Q + [-(I_2 + I_g)S] + [-I_gG] = 0$ (2) **0.5M** When the bridge is balanced, no current flows through the galvanometer

i.e. $Ig = 0$ (3)

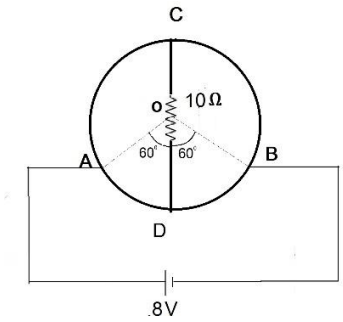
∴From equations (1) and (2) and (3)

$I_1P = I_2R$ … (4)

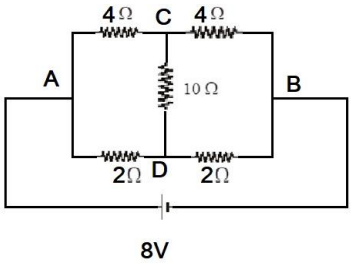
$I_1Q = I_2S$ … (5)

From equations (4)and (5), P/Q = R/S. **0.5M**

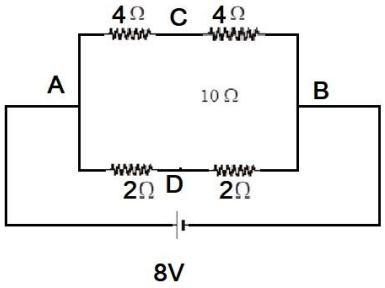
(b).



This circuit is balanced wheat stone bridge that can be drawn as below,



As it is balanced wheatston bridge ,so circuit will be as below 1



$V_{AB} = 8V$, *hence Current through* $ADB = \frac{8}{4} = 2A$ 1

(for V.I. Candidates)

(II) (a) question is same

(b) The sensitivity of a Wheatstone bridge is the amount of deflection in the attached galvanometer for every unit change in the unknown resistance **1M**

A Wheatstone bridge is most sensitive when its four arms have resistances that are of the same order of magnitude. This means that all four resistors provide the same output resistance. A Wheatstone bridge is in a balanced state when its galvanomater shows zero deflection **1M**

Ans.32 - (I) AC Generator **(5 Marks)**

It is a device used to convert mechanical energy into electrical energy

Principle: It is based on the principle of electromagnetic induction. When a closed coil is rotated rapidly in a strong magnetic field, the magnetic flux linked with the coil changes continuously. Hence an emf is induced in the coil and a current flows in it. In fact, the mechanical energy expended in rotating the coil appears as electrical energy in the coil.

1M

Construction: Main Parts **1M**

1. **Armature**: It is a rectangular coil ABCD having a large number of turns of insulated copper wire wound on a soft-iron core. The use of soft-iron core increases the magnetic flux linked with the armature.

2. **Field Magnet:** It a strong electromagnet having concave pole pieces N and S. The armature is rotated between these pole pieces about an axis perpendicular to the magnetic field.

3. **Slip Rings:** The leads from the armature coil ABCD are connected to two copper rings R_1 and R_2 called the 'slip rings'. These rings are concentric with the axis of the armature coil and rotate with it.

4. **Brushes:**These are two carbon pieces B_1 and B_2 called brushes which remain stationary pressing against the slip rings R_1 and R_2 respectively. The brushes are connected to an external circuit.

Working Theory : When the coil ABCD is rotated inside the field, an emf is induced between its two ends. Let the plane of the coil be at right angles to the magnetic field at $t = 0$ and angular speed of the rotation of the coil be ω. Then at time t, $\theta = \omega t$. The magnetic flux linked with the coil at time t is

$\phi = n\,BA\cos\omega t$

Induced emf $e = \dfrac{-d\phi}{dt} = \dfrac{-d}{dt}\left[nBA\cos\omega t\right]$

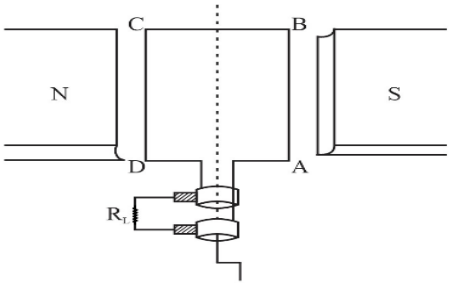
$\Rightarrow e = n\,BA\,\omega\sin\omega t$

$e = e_0\sin\omega t$ Where $e_0 = n$BAω is the peak value of emf.

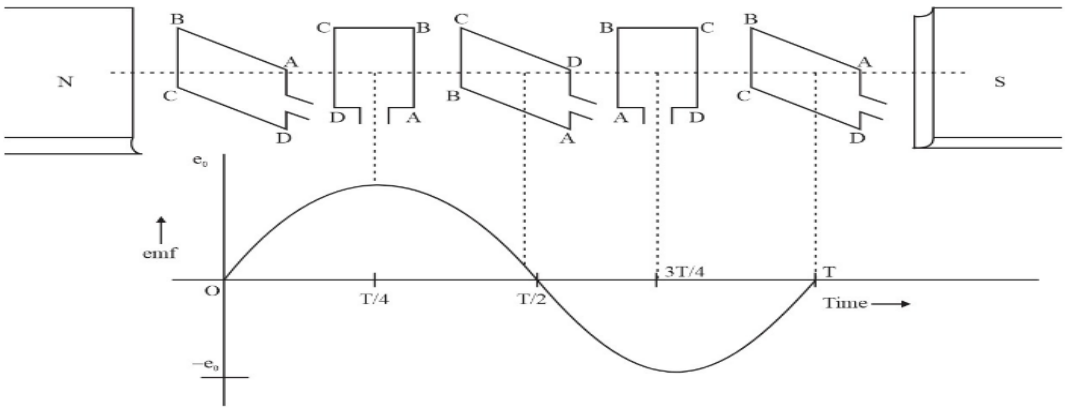
The current in the external load is given by

$$i = \frac{e_0\sin\omega t}{R_L}$$

$i = i_0\sin\omega t$Here i_0 is the peak value of the current **1M**



1M



1M

In an ac generator the source of electrical energy is the mechanical energy.

OR

(II)

(a)TRANSFORMER

Use: It is a device which converts low ac voltage at high current into high ac voltage at low current and vice – versa.

Principle: It consists of two coils P and S wound on a closed soft iron core. The coil which is fed from the ac supply is called primary coil (P) and the other connected to the load is called secondary coil (S). The core of the transformer is made of soft -iron toreduce hysteresis loss and is laminated to reduce eddy current losses.**1M**

Working: When an alternating emf e_p is impressed on the primary winding it sends an ac current through it which sets up an alternating magnetic flux in the core. This induces an alternating emf e_s in the secondary. If N_P and N_s are the number of turns in primary and secondary coil, their linkages with the flux are

$\phi_P = N_P BA$ B → Magnetic induction

$\phi_S = N_s BA$ A → Area of cross section**0.5 M**

The magnitude of the emf induced in the secondary

$$e_s = \frac{d\phi_S}{dt} = N_S A\frac{dB}{dt} \quad \ldots (1)$$

The changing flux also induces an emf in the primary, whose magnitude

$$e_P = \frac{d\phi_P}{dt} = N_P A\frac{dB}{dt} \quad \ldots (2)$$

From equations (1) and (2)

$$\frac{\text{emf induced in secondary}}{\text{voltage applied to primary}} = \frac{e_s}{e_P} = \frac{N_s}{N_P} \quad \ldots (3)$$**0.5 M**

$\frac{N_S}{N_P}$ = turns ratio or transformation ratio.

If $N_s > N_P$, $e_S > e_P$ → Such a transformer is called step-up transformer

If $N_S < N_P$, $e_s < e_P$ → Such a transformer is called step-down transformer

In an ideal transformer

Instantaneous output power = instantaneous input power

$e_s i_s = e_P i_P$ … (4)

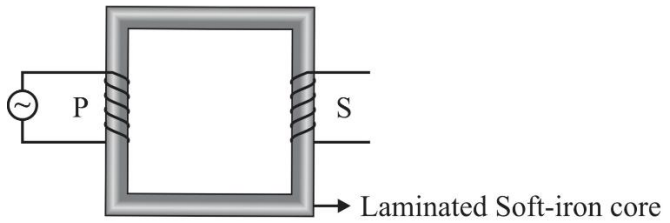
From equations (3) and (4)

$$\frac{e_s}{e_p} = \frac{i_p}{i_s} = \frac{N_s}{N_p}$$ **0.5 M**

In a step- up transformer $N_s > N_p$, $e_s > e_p$ but $i_s < i_p$

In a step-down transformer $N_s < N_p$, $e_s < e_p$ but $i_s > i_p$

At the generating station a step-up transformer is used for stepping up the voltage and at the various receiving substations a step-down transformer is used



0.5M

(b) The two sources of energy losses are eddy current losses and flux leakage losses. **1M**

(c) There is no violation of the principle of the conservation of energy in a stepup transformer. When output voltage increases the output current decreases automatically keeping the power the same.**1M**

(5 Marks)

Ans.33–(I) Givenf_0=15m, f_e=1cm=0.01m

(i) Angular magnification of the telescope M =$\frac{f_0}{f_e}$=$\frac{15}{0.01}$=1500 **1M**

(ii) Let d be thediameter ofmoon'simage formed by the objective lens.

Therefore, Angle subtended by the moon at the objective lens

$$\alpha = \frac{diameter\ of\ the\ moon}{Radius\ of\ lunar\ orbit} = \frac{3.48\times10^6}{3.8\times10^8} \quad (1)$$ **1.5M**

Similarly, the angle subtended by moon's image (formed by the objective) at the objective

$$\alpha = \frac{diameter\ of\ moon's\ image}{f_0} = \frac{d}{15} (2)$$ **1.5M**

Comparing equations (1) and (2) we have

$$\frac{d}{15} = \frac{3.48\times10^6}{3.8\times10^8}$$

$$d = \frac{3.48\times10^6}{3.8\times10^8} \times 15 = 0.137m = 13.7cm$$ **1M**

OR

(II) (a) For eyepiece,v_e=-25cm,f_e=6.25cm, u_e=?

Using $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\frac{1}{u_e}=\frac{1}{v_e}-\frac{1}{f_e}=\frac{1}{-25}-\frac{1}{6.25}=\frac{-1}{5}$ **0.5M**

u_e=-5cm **0.5M**

Therefore the image formed by the objective is formed at a distance of 10 cm towards the eyepiece.

Hence for the objective,v_0=+10 cm,f_0=2cm, v_0=?

$\frac{1}{u_0}=\frac{1}{v_0}-\frac{1}{f_0}=\frac{1}{10}-\frac{1}{2}$ **0.5M**

u_0=-2.5cm **0.5M**

Therefore the magnifying power M=$\frac{v_0}{|u_0|}(1+\frac{D}{f_e})=\frac{10}{2.5}(1+\frac{25}{6.25})$=20 **0.5M**

(b) When the final image is formed at infinity the object for the eyepiece must lie at its principal focus.Thereforethe distance of the image formed by the objective from its optical center,

v_0=15-6.25=8.75cm **0.5M**

$\frac{1}{u_0}=\frac{1}{v_0}-\frac{1}{f_0}=\frac{1}{8.75}-\frac{1}{2}=\frac{6.75}{17.50}$ **0.5M**

$u_0=\frac{-17.5}{6.75}$=-2.6cm **0.5M**

M=$\frac{v_0}{|u_0|}.\frac{D}{f_e}=\frac{8.75}{2.6}\times\frac{25}{6.25}$=13.5 **1M**