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

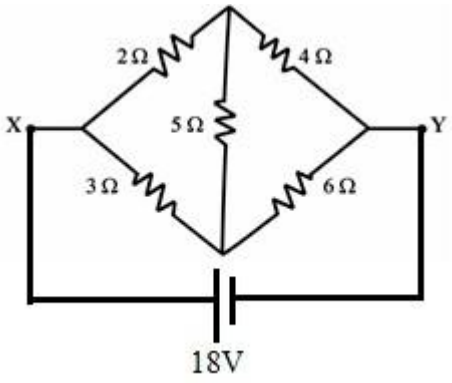
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2.	If two identical heaters each rated as (1000 W, 220 V) are connected in parallel to 220 V, then the total power consumed is- A. 200 W B. 250 W C. 2000 W D. 2500 W	1
3.	An infinitely long cylinder is kept parallel to a uniform magnetic field B directed 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

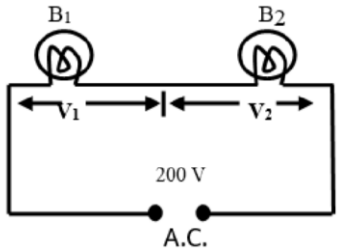
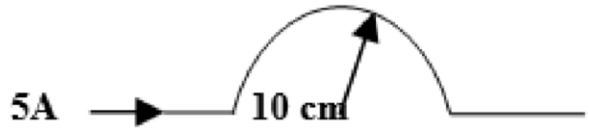
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7.	The binding energy per nucleon curve shows a maximum around mass number A=56. What does this imply about nuclei near iron (Fe)? A. They are the least stable nuclei. B. They are the most tightly bound nuclei. C. They undergo spontaneous fission releasing 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

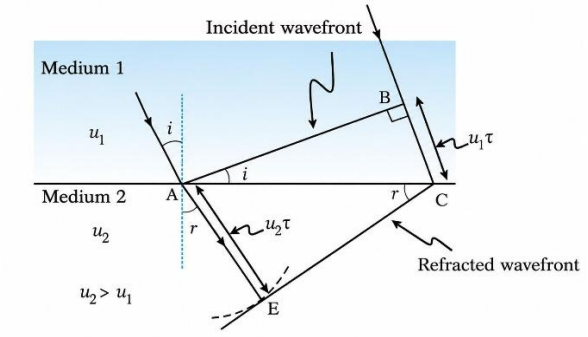
8.	D. Away from the bar magnet and opposite to that of bar magnet As the ball is dipped in liquid nitrogen, its temperature becomes less than the critical temperature and it becomes a superconductor. In this state, the ball becomes diamagnetic.	1
9.	B. 5 A The Wheatstone bridge is balanced, because $\frac{2\Omega}{4\Omega} = \frac{3\Omega}{6\Omega}$. 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 <

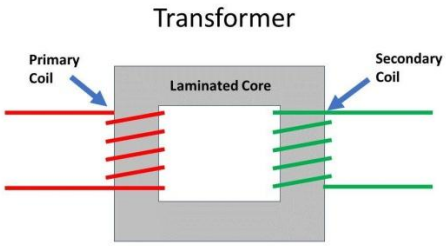
	n = $\frac{c}{v}$ hence, $\frac{v_1}{v_2} = \frac{n_1}{n_2}$ Therefore, $$n_1 \sin i = n_2 \sin r$$ This is Snell's law of refraction. Prediction of wave theory later experimentally verified The wave theory of light (from Huygens' construction) predicted that light travels more slowly in an optically 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