CBSE

ADDITIONAL PRACTICE QUESTIONS

Physics-Theory

Class XII | 2023–24

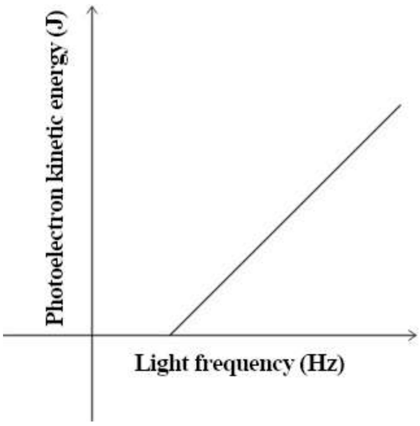
Maximum marks: 70 **Time Allowed: 3 hours**

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.

Q.No	Questions	Marks
	SECTION A	
1	An electric dipole having a dipole moment of 4×10^{-9} C m is placed in a uniform electric field such that the dipole is in stable equilibrium. If the magnitude of the electric field is 3×10^{3} N/C, what is the work done in rotating the dipole to a position of unstable equilibrium? A. zero B. 1.2×10^{-5} J C. 2.4×10^{-5} J D. $- 1.2 \times 10^{-5}$ J	1
2	An infinite line of charge has a linear charge density of 10^{-7} C/m. What will be the magnitude of the force acting on an alpha particle placed at a distance of 4 cm from the line of charge? A. 14.4×10^{-15} N B. 7.2×10^{-15} N C. 4.5×10^{4} N D. 9×10^{4} N	1

3 The graph below shows the variation of the maximum kinetic energy of the emitted photoelectron with the frequency of the incident radiation for a given metal. 1



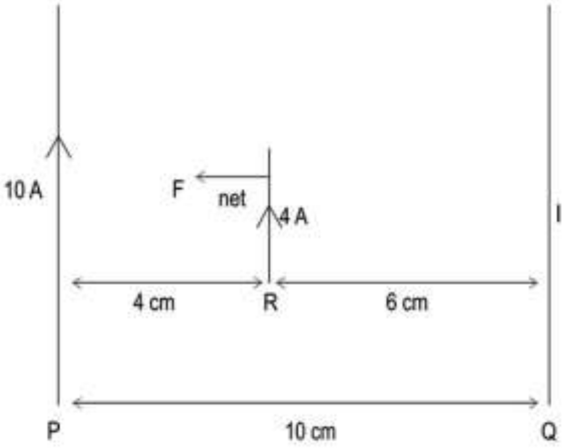
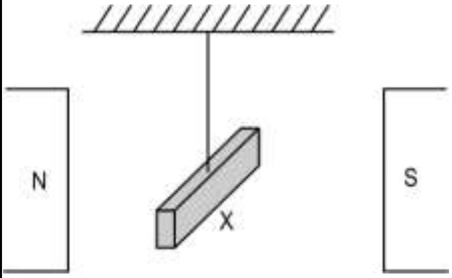
Which of the following gives the work function of the metal?

A. x-intercept
B. y-intercept
C. the slope of the graph
D. the area under the graph

4 When an electron in an atom moves from the ground state to a higher energy level what happens to its kinetic and potential energies? 1

	kinetic energy	potential energy
A	increases	Increases
B	increases	Decreases
C	decreases	Increases
D	decreases	Decreases

5 Two long and straight current-carrying wires, P and Q are placed parallel to each other separated by a distance of 10 cm. A wire 'R' of length 8 cm and carrying a current of 4 A is placed between the two wires P and Q as shown below. 1

	 If the wire R, experiences a net force towards wire P, then which of the following is definitely TRUE about the current 'I' in wire Q? A. Current I cannot be in the upward direction. B. Current I can have any magnitude greater than 0 A in the upward direction. C. Current I cannot have a magnitude of more than 15 A in the upward direction. D. Current I cannot have a magnitude of more than 10 A in the upward direction.	
6	A rod when suspended in a uniform magnetic field aligns itself perpendicular to the magnetic field as shown below.  Which of the following statements is/are true for the rod? P) Every atom in the rod, has a zero magnetic moment. Q) The rod is attracted when taken near the poles of a strong magnet. R) The relative permeability of the material of the rod is slightly less than 1. S) The susceptibility of the material of the rod is directly proportional to temperature. A. only Q B. only P and R C. only Q and S D. only R and S	1

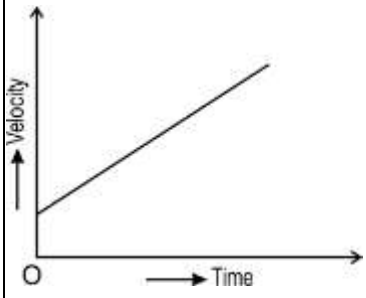
7 Three students construct a solenoid of length 35 cm. They are each given insulated copper wire of the same length. The table below lists some details about the solenoids made by them. 1

	Magnetic field produced	Radius of solenoid	Core of solenoid
Student 1	B_1	3 cm	air
Student 2	B_2	3 cm	iron
Student 3	B_3	6 cm	air

Compare the magnetic field produced by the solenoids made by the three students.

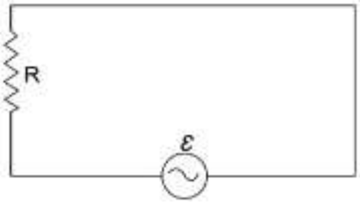
A. $B_1=B_3<B_2$
B. $B_3<B_1<B_2$
C. $B_1<B_2<B_3$
D. $B_1=B_2>B_3$

8 A charged particle '+q' having a mass 'm' moves in a uniform electric and magnetic field. In which of the following scenarios will the path of the charged particle be linear and described by the velocity time graph shown below? 1

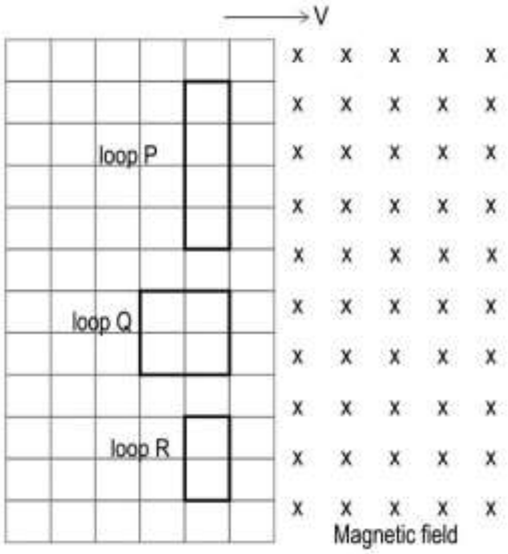


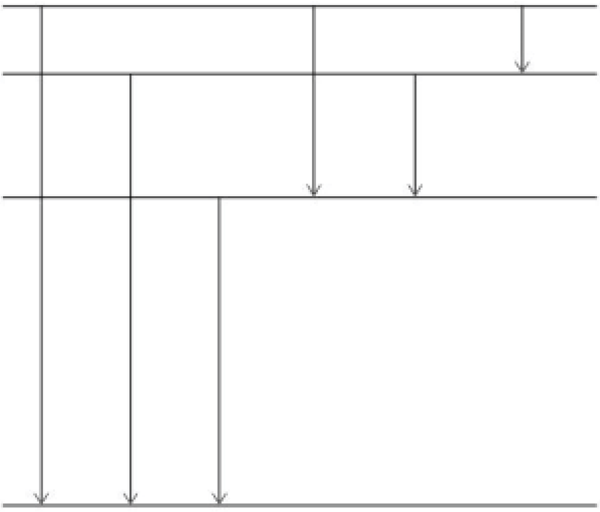
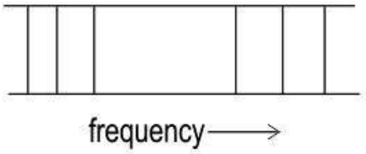
A. E ⊥ B ⊥ velocity of the particle
B. E || B and the particle is initially at rest
C. E || B and the particle has an initial velocity along the electric field
D. E ⊥ B and the particle has an initial velocity along the electric field

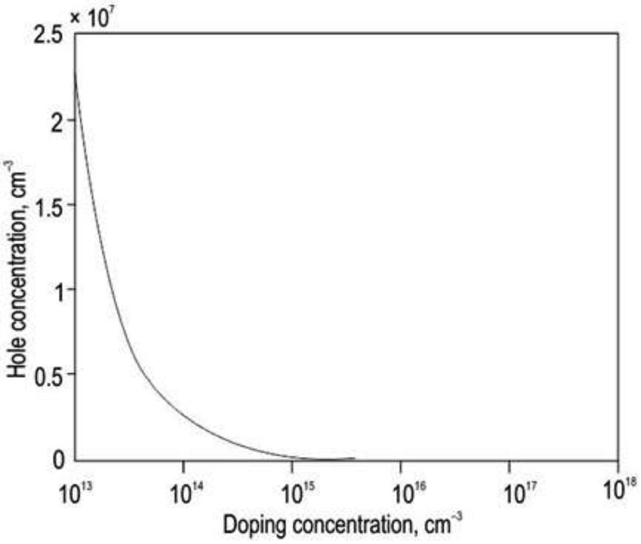
9 A pure resistor is connected to an AC power source as shown below. 1

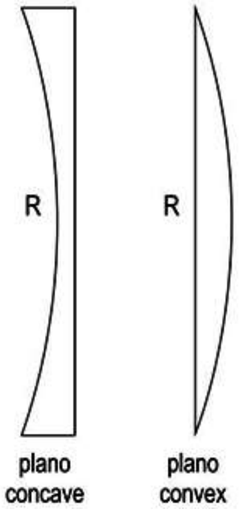
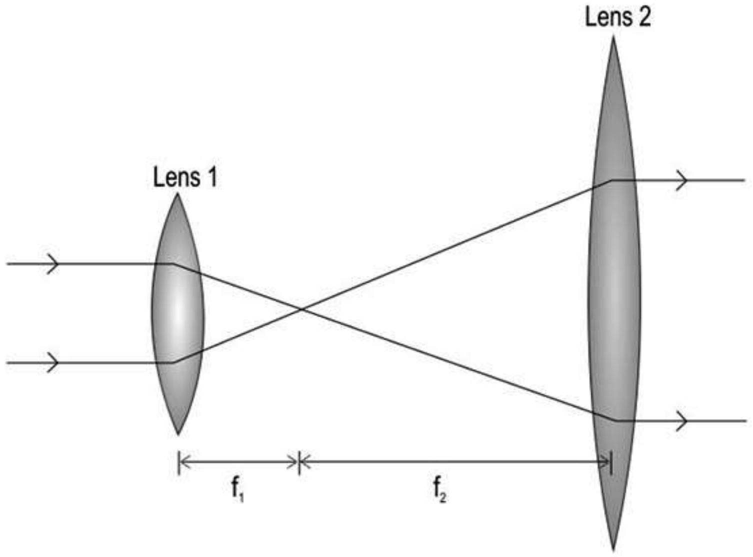


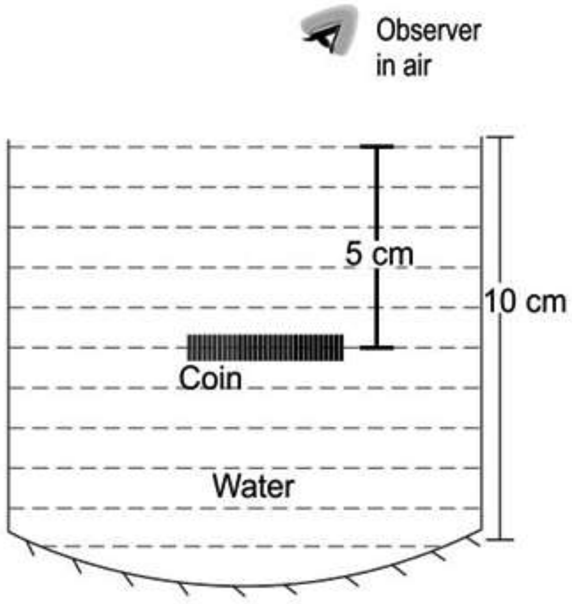
Which of the following statement(s) is/are TRUE?
I: The average current flowing through the circuit during one full cycle is zero.

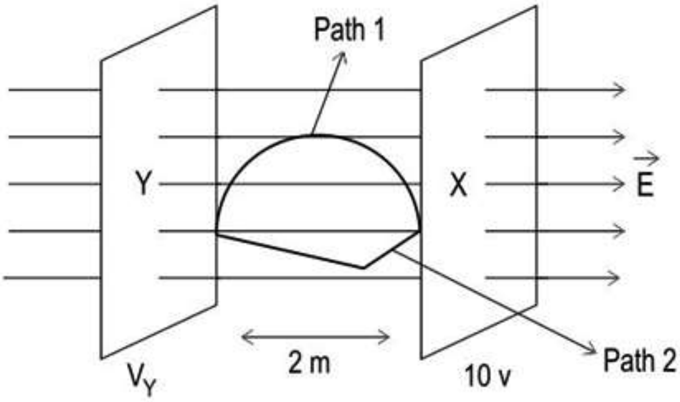
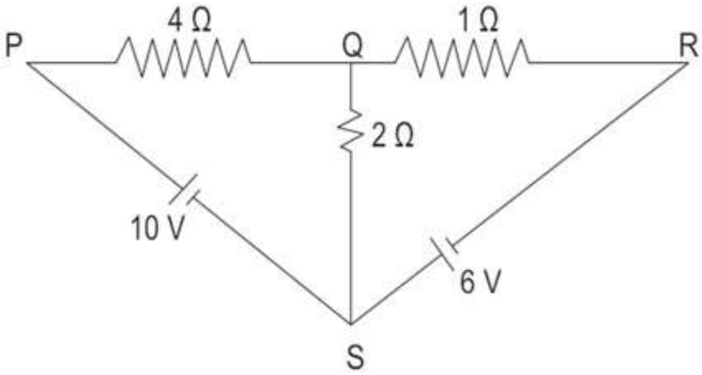
	II: The current in the resistor leads the voltage by $\pi/2$. III: The average power dissipated by the resistor is zero. A. only I B. only I and II C. only II and III D. all - I, II and III	
10	At what rate does the electric field change between the plates of a square capacitor of side 5 cm, if the plates are spaced 1.2 mm apart and the voltage across them is changing at a rate of 60 V/s? A. 7.2 x 10^{-2} $Vm^{-1}s^{-1}$ B. 30 x 10^{-1} $Vm^{-1}s^{-1}$ C. 12 x 10^{2} $Vm^{-1}s^{-1}$ D. 5 x 10^{4} $Vm^{-1}s^{-1}$	1
11	Three loops as shown below move into the magnetic field with a velocity v.  In which loop(s) will the induced emf be the **largest** at the instant when the loops enter the magnetic field? A. only P B. only Q C. only P and Q D. only Q and R	1
12	The emission spectrum of an element is the spectrum of frequencies of em radiations emitted due to electrons making a transition from a higher energy state to a lower energy state. The diagram below shows electrons transitioning from higher energy states to lower energy states.	1

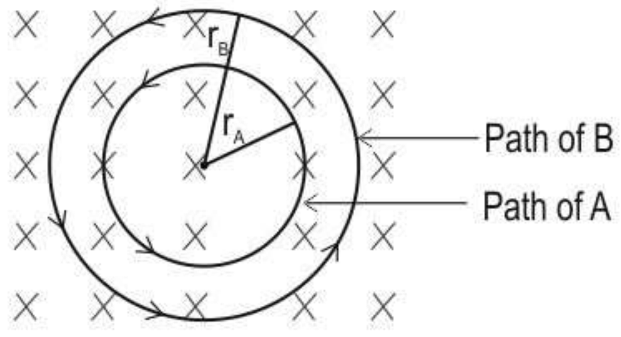
	 Which of the following spectrums most closely corresponds to the above transitions? A  B  C  D 	
	For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below. **A. Assertion and Reason are true and Reason is the correct explanation of Assertion.** **B. 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): The work function of a given material increases with an increase in the frequency of the incident radiation.	1

	Reason (R): As per Einstein's photoelectric equation $h\nu = \varphi + KE$, work function φ is directly proportional to the frequency ν of the incident radiation.	
14	Assertion (A): The conductivity of intrinsic semiconductors increases with an increase in temperature. Reason (R): Increase in temperature decreases the average time between collisions of electrons.	1
15	Assertion (A): The direction of the electric field is always perpendicular to the equipotential surface. Reason (R): Work is done by the electric force in moving a charge between any two points on an equipotential surface is zero.	1
16	Assertion (A): If the focal length of two convex lenses is the same, the lens with the larger diameter will produce brighter images. Reason (R): Convex lenses with larger diameters are able to focus light better.	1
	SECTION B	
17	The graph shows the variation in hole concentration with doping concentration in an extrinsic semiconductor doped with pentavalent impurities.  Why does the hole concentration reduce when pentavalent doping is increased?	2
18	λ_α and λ_p are the wavelengths associated with a moving alpha particle and a proton respectively. Obtain the relation between velocities of the two particles for which, (a) $\lambda_\alpha > \lambda_p$ (b) $\lambda_\alpha = \lambda_p$	2

19	Compare the focal lengths of the two lenses shown below if the radius of curvature of the curved surface is the same in both lenses.  	2
20	(a) Two copper wires, P and Q of the same area of cross-section are joined in parallel. The combination of wires is connected across a battery of potential difference V. If the length of the wires, P and Q are in the ratio 1:2, find the ratio of drift velocities of electrons in wires P and Q.	2
21	The image below shows a setup of a device that is used to increase the diameter of a light beam from a laser.  Show how a combination of a convex and a concave lens can also be arranged to increase the diameter of a light beam. Your answer should include how the two lenses should be arranged and the distance between the two lenses. *(Note that the rays in both the incident and emergent beam are parallel.)* **OR** A glass beaker of height 10 cm, completely filled with water (refractive index = 4/3), has a curved bottom which is silvered as shown below.	2

	 A plastic coin remains submerged in water at a depth of 5 cm from the top of the beaker. An observer sees the coin in the water and its image in the mirror. If the image formed by the curved mirror is seen by the observer at a distance of 15 cm from the surface of the water, what is the focal length of the curved surface? *(Assume the silvered curved surface acts as a spherical mirror.)*	
	SECTION C	
22	Identify if the two nuclear reactions mentioned below are endothermic or exothermic. Show your calculations. ${}^{1}_{1}\text{p} + {}^{7}_{3}\text{Li} \rightarrow 2({}^{4}_{2}\text{He})$ ${}^{7}_{3}\text{Li} + {}^{4}_{2}\text{He} \rightarrow {}^{1}_{0}\text{n} + {}^{10}_{5}\text{B}$ Use the information below to answer the question: ${}^{1}_{1}\text{p} = 1.00728\ amu$ ${}^{7}_{3}\text{Li} = 7.0160\ amu$ ${}^{4}_{2}\text{He} = 4.0026\ amu$ ${}^{1}_{0}\text{n} = 1.0087\ amu$ ${}^{10}_{5}\text{B} = 10.01294\ amu$	3
23	X and Y are two equipotential surfaces separated by a distance of 2 m in a uniform electric field of 10 V/m. Surface X has a potential of 10 V (a) Calculate the potential of surface Y. (b) What is the work done in moving a +2 C charge from surface Y to surface X along path 1? How will this work change when the charge is moved along Path 2? Give a reason for your answer.	3

		
24	(a) Compare the de Broglie wavelength associated with the electron in the third orbit to the circumference of the orbit. (b) In which of the following will the electrons have the same de Broglie wavelength? (i) Third orbit of He atom (ii) Fourth orbit of He atom (iii) Third orbit of Li atom (iv) Sixth orbit of Be atom Show your calculations.	3
25	Using Kirchhoff's laws, calculate the current flowing through 4 Ω, 1 Ω, and 2 Ω resistors in the circuit shown below. 	3
26	Two charges A and B, each having a velocity of v, traverse circular paths in a uniform magnetic field as shown below.	3



(a) Compare the charge-to-mass ratio of the two particles A and B. Show the necessary mathematical calculations.
(b) Which of the two particles is likely to be a proton if the other is an alpha particle? Give reason.

27 (a) A radio wave and an infrasonic wave have the same wavelength when travelling through air. Are their frequencies the same or different? Give a reason for your answer. 3

(b) An electromagnetic wave traveling east has a magnetic field that oscillates vertically and has a frequency of 60 kHz and an rms strength of 8×10^{-9}T. Determine the frequency and the rms strength of the electric field. What is the direction of the electric field?

28 A circular ring of diameter 0.2 m is placed in a uniform magnetic field of 0.4 T. The ring is rotated about its diameter at a frequency of 60 Hz. 3
(a) If the ring has 50 turns, then what is the maximum induced emf in the ring?
(b) State one condition under which the induced emf in the circular ring will be zero?

OR

Given below are a few characteristics of solenoids p and q.

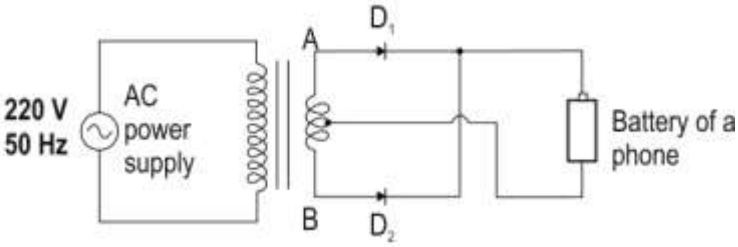
	solenoid p	**solenoid q**
length of the solenoid	l (m)	l (m)
number of turns (N)	200	50
cross-sectional area of the wire	A (m^2)	A (m^2)
relative permeability of the core material	1	500
self-inductance	2 (mH)	?

What is the self-inductance of the solenoid q?

SECTION D

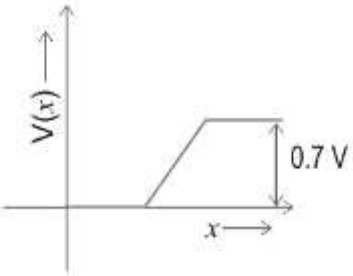
29 **Read the following paragraph and answer the questions that follow.** 4

For most mobile devices, the voltage to recharge the battery is typically 5 volts of direct current. In India, the current supplied to our homes is alternating current at 220V and at a frequency of 50 Hz. Fatima designed a simplified version of a mobile phone charger. She made a circuit using a centre tap transformer and two similar silicon diodes D_1 and D_2 as shown below. Study the diagram below and answer the questions that follow.



(a) Can Fatima also charge the battery of a phone by connecting the battery directly to the ac power supply? Give reason.

(b) The graph of the potential barrier (V) vs width of the depletion region (x), when D_1 is unbiased at room temperature, is shown below.



Plot a comparative graph of the potential barrier (V) vs width of the depletion region (x) of D_1 at room temperature when the voltage at A is negative with respect to voltage at centre tap. Give reason.

OR

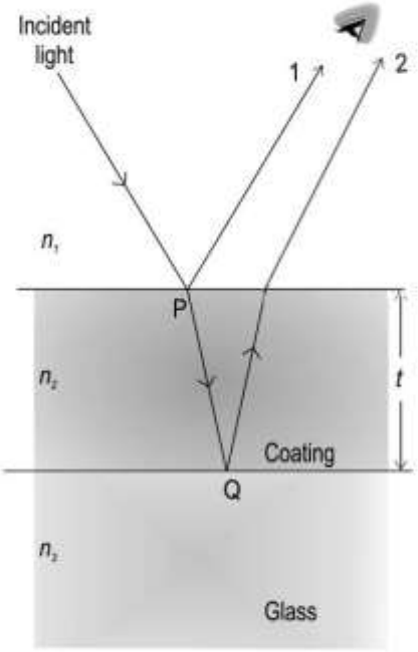
If the battery of the phone is directly connected to the output terminals of the secondary coil of the transformer, will it get charged? Justify your answer.

(c) What will be the output frequency across the phone's battery when the orientation of D_2 is reversed in fig. 1 and the centre-tapped three-output transformer is replaced by a two-output step-down transformer? Justify your answer.

30 **Read the following paragraph and answer the questions that follow.** 4

When light rays fall on glass, about 4% of the light gets reflected. To eliminate this reflection, the glass display cases in museums usually have an anti-reflective coating.

This works on the principle of interference. When light falls on the coated glass, the light gets reflected from the top and bottom surfaces of the coating and these two reflected light rays can interfere. To reduce reflection, the thickness and refractive index of the coating are adjusted such that the light rays undergo destructive interference.



Reflected light undergoes a 180° phase shift when it falls on a denser medium from a rarer medium and no phase shift when it falls on a rarer medium from a denser medium. (Note: The thickness of coating is much less than the glass.) To answer the questions below, consider a monochromatic light of wavelength λ incident on the coating of thickness t at a small angle of incidence and n1<n2<n3. Also Consider PQ ≈ t.

(i) Which of the following occurs, if there is no coating on the glass?

A. The object behind the case looks distorted.
B. The colours of the object behind the glass case appear dull.
C. A reflection of the objects in front of the glass case is seen on the case.
D. Multiple reflections of the object behind the glass case are seen on the case

(ii) What is the path difference between rays 1 and 2? (Consider PQ ≈ t.)

A. t
B. 2t
C. λ
D. 2 λ

(iii) For what minimum thickness of the coating, do the two rays 1 and 2 undergo destructive interference? *(Remember the wavelength of the light ray changes as it moves from one media to another.)*

A. n_2 λ/2
B. n_2 λ/4
C. λ/(2n_2)
D. λ/(4n_2)

OR

For what minimum thickness of the coating, do the two rays 1 and 2 undergo constructive interference? *(Remember the wavelength of the light ray changes as it moves from one media to another.)*

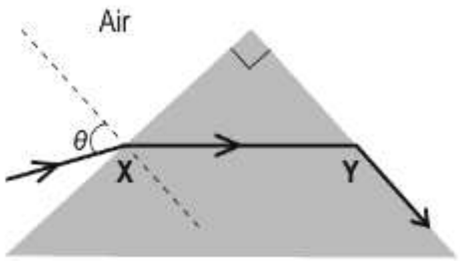
A. $n_2 \lambda$
B. $n_2 \lambda/2$
C. $\lambda/(n_2)$
D. $\lambda/(2n_2)$

(iv) If the material of the coating is changed such that $n_2 > n_3$, what will be the additional path difference compared to the path difference identified in question (b)?

A. t
B. π
C. $\lambda/2$
D. (There will be NO additional path difference.)

SECTION E

31 (a) A ray of light is incident at angle θ on a right-angled prism at point X. At point Y, it emerges along the prism surface. Calculate the refractive index of the prism in terms of the incident angle. 5

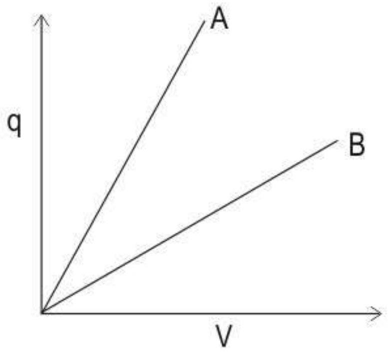


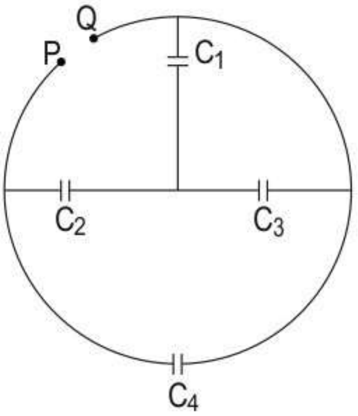
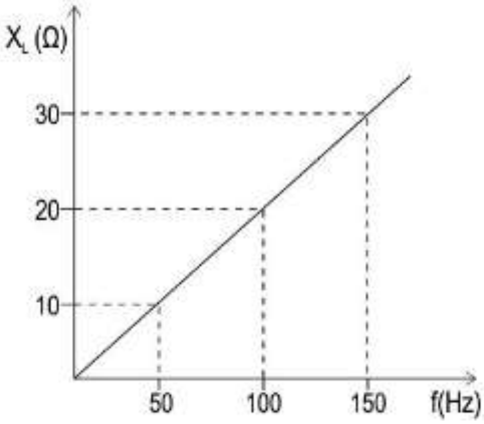
(b) Show that for an equilateral prism kept in air, minimum deviation occurs when the angle of incidence $i = \sin^{-1}(n/2)$, where n is the refractive index of the material of the prism.

OR

(a) A Young's double slit setup is illuminated with monochromatic light. If the intensity of light passing through one of the slits is reduced, explain the changes that can be seen in the appearance of the bright and dark fringes?

(b) (i) A single slit diffraction setup is illuminated with green light of wavelength 500 nm. If the width of the slit is 1 mm and the screen is 2 m away from the slits, calculate the width of the central maximum.
(ii) What will happen to the width of the central maximum, if the green light is replaced with the red light? Give a reason for your answer.

	(c) A student wishes to study the diffraction of sound using the single slit setup. He replaces the light source with a sound source. What other change should he do to study the diffraction pattern?	
32	(a) A camera usually operates at 1.5 V and this potential difference is not sufficient to emit light energy using flash. For this purpose, the flash circuit of the camera has a capacitor that is charged to 300 V-330 V using various electrical components. If the voltage generated across the plates of the capacitor is 300 V and the capacitance of the parallel plate capacitor used is 100 µF, then find the energy released when the trigger button on the camera is pressed. (a) How much charge does the 100 µF capacitor charged to 300 V hold? (b) If the distance between the parallel plate capacitor of capacitance 100 µF is increased two times, then calculate the capacitance of the capacitor. (c) The graph below shows the variation of charge 'q' with potential difference 'V' for a parallel plate capacitor 'C' for scenarios P and Q. Scenario P - the space between the capacitor 'C' is filled with air. Scenario Q - the space between the capacitor 'C' is filled with a substance of dielectric constant K. Which of the two lines A or B corresponds to scenario Q? Give a reason for your answer.  **OR** (a) Find the effective capacitance between points P and Q, if each capacitor has a capacitance of 6µF.	5

	 (b) Find the ratio of charges on capacitors C_1 and C_4, if the potential difference between points P and Q is 10 V.	
33	An inductor of inductance 'L' is connected to an AC source, V = 100 sin ωt. The graph below represents the variation of inductive reactance (X_L) of the inductor with the frequency of an alternating source.  (a) What is the self-inductance of the inductor? (b) If the ac source is replaced by a battery such that V = 100 V, then what is the inductive reactance of the inductor? Give reason. (c) When the frequency is 50 Hz, what is the average power dissipated by the inductor over a complete cycle in the circuit? Justify your answer. (d) This inductor is connected in series with a resistance of 15 Ω and a capacitor of 5 μF. The frequency of the alternating source is varied such that the power dissipated in the circuit becomes maximum. Calculate the frequency and the phase difference between alternating voltage and current when the power dissipated is the maximum. **OR** An ideal transformer having a ferromagnetic core consists of two coils having 500 turns (primary) and 50 turns (secondary) respectively. (a) What is the voltage across the secondary coil, if the rms voltage across the primary coil is 240 V? (b) What will be the individual currents in the two coils (primary and secondary), if the secondary has a resistive load of 20 ohms?	5

CBSE

ADDITIONAL PRACTICE QUESTIONS

Physics-Theory (Marking Scheme)

Class XII | 2023–24

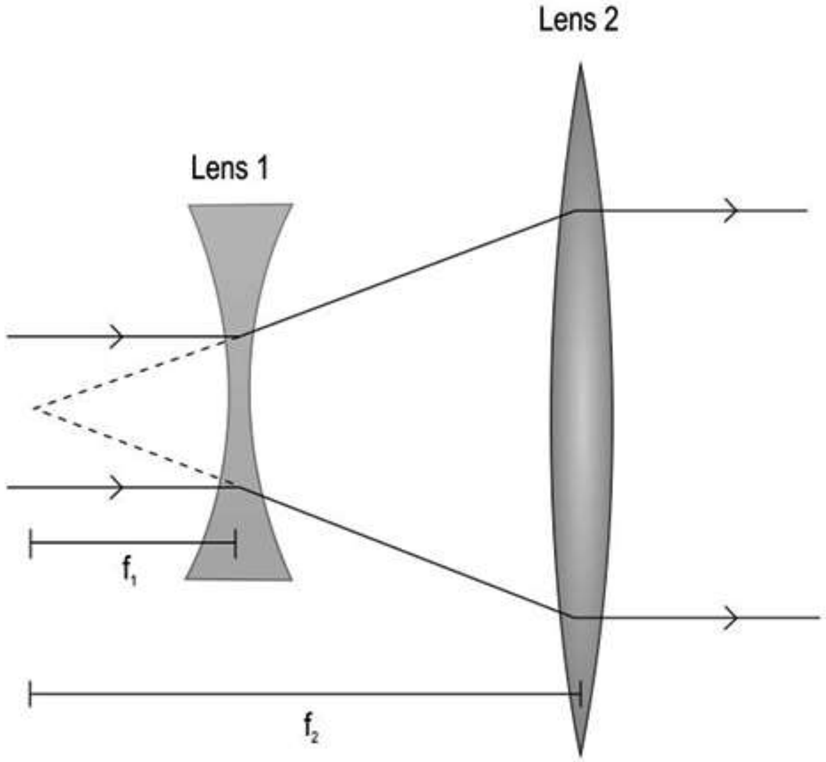
Maximum marks: 70 **Time Allowed: 3 hours**

General instructions:

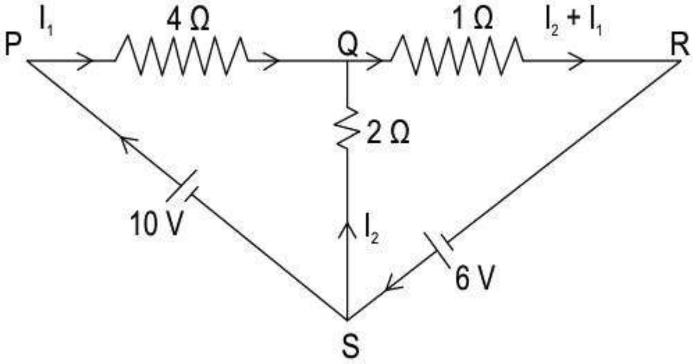
<table>
<tr><th>Q.No</th><th>Answers</th><th>Marks</th></tr>
<tr><td></td><td>SECTION A</td><td></td></tr>
<tr><td>1</td><td>C. 2.4×10^{-5} J</td><td>1</td></tr>
<tr><td>2</td><td>A. 14.4×10^{-15} N</td><td>1</td></tr>
<tr><td>3</td><td>B. y-intercept</td><td>1</td></tr>
<tr><td>4</td><td><table><tr><td></td><td>kinetic energy</td><td>potential energy</td></tr><tr><td>C</td><td>decreases</td><td>increases</td></tr></table></td><td>1</td></tr>
<tr><td>5</td><td>C. Current I cannot have a magnitude of more than 15 A in the upward direction.</td><td>1</td></tr>
<tr><td>6</td><td>B. only P and R</td><td>1</td></tr>
<tr><td>7</td><td>B. $B_3 < B_1 < B_2$</td><td>1</td></tr>
<tr><td>8</td><td>C. E || B and the particle has an initial velocity along the electric field</td><td>1</td></tr>
<tr><td>9</td><td>A. only I</td><td>1</td></tr>
<tr><td>10</td><td>D. 5×10^4 $Vm^{-1}s^{-1}$</td><td>1</td></tr>
<tr><td>11</td><td>A. only P</td><td>1</td></tr>
<tr><td>12</td><td>B. </td><td>1</td></tr>
<tr><td>13</td><td>D. Both Assertion and Reason are false.</td><td>1</td></tr>
<tr><td>14</td><td>B. Assertion and Reason are true but Reason is NOT the correct explanation of Assertion.</td><td>1</td></tr>
<tr><td>15</td><td>A. Both assertion and reason are true and reason is the correct explanation for assertion.</td><td>1</td></tr>
<tr><td>16</td><td>C. Assertion is true but Reason is false.</td><td>1</td></tr>
<tr><td></td><td>SECTION B</td><td></td></tr>
<tr><td>17</td><td>When an intrinsic semiconductor is doped with pentavalent impurities, the number of electrons increases much more than the thermally produced electrons. <i>(0.5 marks)</i>
This causes the thermally generated holes to recombine with the electrons generated, thereby decreasing the number of holes. <i>(1 mark)</i></td><td>2</td></tr>
</table>

	As the doping concentration increases, more electrons are produced, causing more electron-hole recombination and hence hole concentration decreases *(0.5 marks)*	
18	(a) $\lambda_\alpha > \lambda_p$ $\lambda_p = \frac{h}{m_p v_p}$ $\lambda_\alpha = \frac{h}{m_\alpha v_\alpha}$ $\text{Since}, m_\alpha = 4m_p$ $\lambda_\alpha = \frac{h}{4m_p v_\alpha}$ $\text{For}, \lambda_\alpha > \lambda_p$ $\frac{h}{4m_p v_\alpha} > \frac{h}{m_p v_p}$ $v_p > 4v_\alpha$ For the above condition of $v_p > 4v_\alpha$, λ_α will be greater than λ_p. *(0.5 marks for writing the expression for λ, 0.5 marks for writing the relationship between the masses of the two particles, and 0.5 marks for final velocity relation.)* (b) $\lambda_\alpha = \lambda_p$ $\text{For}, \lambda_\alpha = \lambda_p$ $\frac{h}{4m_p v_\alpha} = \frac{h}{m_p v_p}$ $v_p = 4v_\alpha$ For the above condition of $v_p = 4v_\alpha$, λ_α will be equal to λ_p. *(0.5 marks for final velocity relation.)*	2
19	Lens maker's formula $\frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ *(0.5 marks)* For the plano-concave lens, $\frac{1}{f_1} = (n_{21} - 1)\left(\frac{1}{-R} - \frac{1}{\infty}\right)$ $f_1 = -\frac{R}{n_{21}-1}$ *(0.5 marks)* For the plano-convex lens,	2

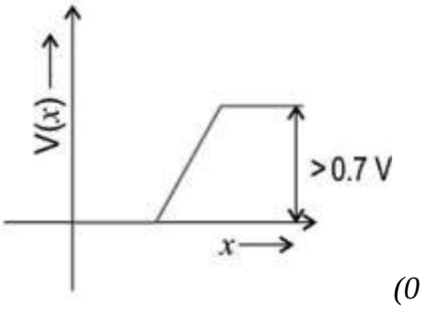
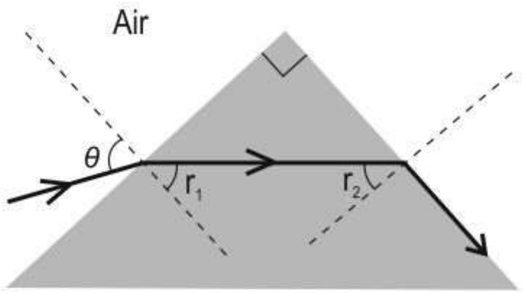
	$\frac{1}{f_2} = (n_{21} - 1)\left(\frac{1}{\infty} - \frac{1}{-R}\right)$ $f_2 = \frac{R}{n_{21}-1}$ *(0.5 marks)* $f_1:f_2$ = -1:1 *(0.5 marks)*	
20	(a) Since the wires are connected in parallel, the potential difference 'V' across both wires will be the same. The wires have the same resistivity ρ Let the length of wires P and Q be L_1 and L_2 respectively. Let the drift velocities electrons in wires P and Q be v_{d1} and v_{d2} respectively. $I = neAv_d$ *(0.5 marks)* v_d - drift velocity $L_1/L_2 = 1/2$ $V = RI = (\rho L/A)\ I$ For wire P: $V = (\rho L_1/A)\ neAv_{d1}$ ....(i) *(0.5 marks)* For wire Q: $V = (\rho L_2/A)\ neAv_{d2}$ ....(ii) *(0.5 marks)* Equating (i) and (ii) $L_1v_{d1} = L_2v_{d2}$ $v_{d1}/v_{d2} = L_2/L_1$ $v_{d1}/v_{d2} = 2/1$ Hence, the ratio of drift velocities of electrons in wires P and Q is 2:1.*(0.5 marks)*	2
21	Concave lens should be placed before the convex lens. *(1 mark)* The distance between the lenses should be f_2-f_1, where f_2 is the focal length of the convex lens and f_1 is the focal length of the concave lens. *(1 mark)* (OR)	2

	 *(1 mark for drawing the concave lens before the convex lens. 1 mark for marking the focal lengths correctly.)*	
OR	Apparent depth of image = 15 cm Real depth = n × apparent depth = 4/3 × 15 = 20 cm *(1 mark)* For the concave mirror, u = -5 cm, v = 20 - 10 cm $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ $\frac{1}{f} = \frac{1}{10} + \frac{1}{-5}$ $f = -10cm$ *(1 mark)*	2
	SECTION C	
22	For the first reaction mass of reactants = 1.00728 + 7.0160 = 8.12328 amu mass of products = 2 × 4.0026 = 8.0052 mass of reactants > mass of products *(1 mark)* Hence, the reaction is exothermic. *(0.5 marks)* For the second reaction mass of reactants = 7.0160 + 4.0026= 11.0186 amu mass of products = 1.0087 + 10.1294 = 11.1381 mass of reactants < mass of products *(1 mark)* Hence, the reaction is endothermic. *(0.5 marks)*	3

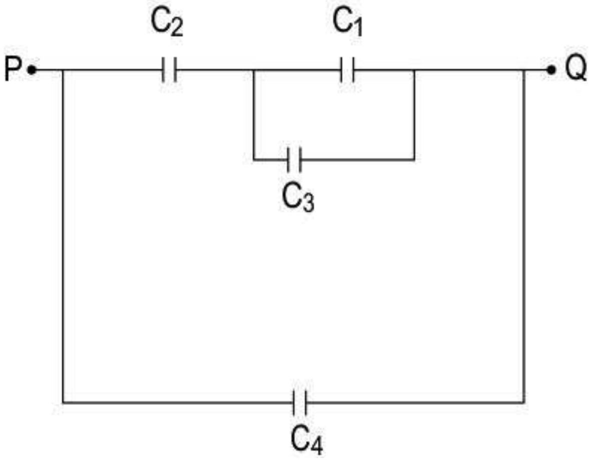
23	(a) Given E = 10 V/m V_x = 10 V Δ r = 2 m $|\Delta V| = \vec{E}.\Delta\vec{r}$ = 10 x 2 = 20 V *(0.5 marks)* Since, the potential decreases in the direction of the electric field, the potential at surface Y will be more than the potential at surface X. V = 20 + 10 = 30V *(0.5 marks)* (b) Given: q = 2 C Work done in moving charge from Y to X along Path 1= (V_x - V_y)q W = (10 - 30) × 2 W = -20 × 2 = - 40 J *(1 mark)* Work done in moving charge along Path 2 will be the same as work done along Path 1. *(0.5 marks)* This is because the work done between two surfaces is independent of the path since the force acting on the charge is conservative in nature. *(0.5 marks)*	3
24	(a) $\lambda = 2\pi r/n$ *(0.5 marks)* If n = 3, λ = circumference /3 *(0.5 marks)* (b) $\lambda = 2\pi r/n$ Since $r \propto n^2/Z$ $\lambda \propto n/Z$ *(0.5 marks)* (i) For the third orbit of He atom, n/Z = 3/2 (ii) For the fourth orbit of He atom, n/Z = 4/2 =2 (iii) For the third orbit of Li atom n/Z = 3/3 = 1 (iv) For the sixth orbit of Be atom n/Z = 6/4 = 3/2 *(1 mark for correct calculation of all n/Z)* Therefore, an electron in the third orbit of He atom will have the same de Broglie wavelength as the electron in the sixth orbit of Be atom. *(0.5 marks)* *(Full marks will be awarded if calculations are done based on velocity of electrons.)*	3

25	Give 0.5 marks for the correct representation of current in the circuits.  By using Kirchhoff's second law for closed-loop PQS we get $- 4I_1+ 2I_2 + 10 = 0$ $4I_1 - 2I_2 = 10$ $2I_1 - I_2= 5$....(i) *(0.5 marks)* By using Kirchhoff's second law for closed-loop QRS we get $- (I_1 + I_2)1 + 6 - 2I_2 =0$ $I_1 + 3I_2 = 6$.....(ii) *(0.5 marks)* solving (i) and (ii), we get $7I_1 = 21$ $\therefore I_1= 21/7 = 3$ A *(0.5 marks)* $I_2= 1$ A *(0.5 marks)* $I_1 + I_2 = 3 + 1 = 4$ A *(0.5 marks)* Therefore, the current across 4 Ω resistor is 3 A, across 2 Ω resistor is 1 A, and across 1 Ω resistor is 4 A.	3
26	(a) For a charged particle executing a circular path, $\theta = 90°$ $\therefore$ F = qvB *(0.5 marks)* Since the charged particle executes a circular path $mv^2/r = qvB$ $q/m = v/rB$ *(0.5 marks)* Since, v and B are constant for both the particles, $q/m \propto 1/r$ q/m: charge-to-mass ratio As $r_B > r_A$, particle A has a greater charge-to-mass ratio than B. *(1 mark)* (b) A proton has a greater charge-to-mass ratio than an alpha particle. *(0.5 marks)* Hence, particle A is likely to be a proton. *(0.5 marks)*	3
27	(a) Their frequencies will be different. A radio wave is an EM wave and an infrasonic wave is a sound wave. Since they have different speeds in air, their frequencies are different. (or) $f = v/\lambda$; since they have different speeds in air, they will have different frequencies.	3

	(1 mark for the correct answer. No marks will be awarded if reason is not written.) (b) Frequency of electric field = frequency of magnetic field = 60 kHz *(0.5 marks)* $E_{rms} = c\ B_{rms}$ $E_{rms} = 3 \text{ x } 10^8 \text{ x } 8 \text{ x } 10^{-9} = 2.4$ V/m *(1 mark for the correct answer with the unit. Accept any correct unit.)* Direction of electric field - along the horizontal north-south line. *(0.5 marks)*	
28	(a) Maximum induced emf (ε_{max}) = N × B × A × ω *(0.5 marks)* where, N = 50, B = 0.4 T, ω = 2πf = 2×π×60, r = d/2 = 0.2/2 = 0.1 m Therefore, $A = \pi r^2 = \pi \times (0.1)^2$ *(0.5 marks)* Substituting we get, $\varepsilon_{max} = 50 \times 0.4 \times (3.14 \times 0.1 \times 0.1) \times (2 \times 3.14 \times 60)$ = 236.63 V (0.5 marks each for the substitution and final answer.) (b) if the ring is rotated about its axis or the ring is translated in the magnetic field *(1 mark for any one correct answer)* *[Accept any other valid correct answer.]*	3
OR	$L_p = [\frac{\mu_o \mu_r N_p^2 A_p}{l_p}] = [\frac{\mu_o \times 1 \times (200)^2 \times A}{l}]$ $L_q = [\frac{\mu_o \mu_r N_q^2 A_q}{l_q}] = [\frac{\mu_o \times 500 \times (50)^2 \times A}{l}]$ $[\frac{L_p}{L_q}] = [\frac{200^2}{500x50^2}]$ $= 0.032$ *Therefore,* $L_q = [\frac{L_p}{0.032}]$ $= [\frac{2}{0.032}]$ $L_q = 62.5mH$ *(1 mark for correct formula. 0.5 marks for substitution. 0.5 mark for the calculation. 1 mark for the correct answer)*	3
	SECTION D	
29	(a) No, Fatima cannot charge the battery of a phone by connecting it directly to ac power supply. *(0.5 marks)* The mobile devices require a 5V DC to get charged. Connecting the battery	4

	directly to 220V ac power supply will cause an excess flow of current produces a large amount of heat which can destroy the phone. *(0.5 marks)* (b) D_1 is reverse biased, hence the width of its depletion region increases, and the potential barrier also increases. *(0.5 marks)*  *(0.5 marks)* OR The secondary coil of the transformer provides alternating current. Hence if the battery of the phone is directly connected to the output terminals of the transformer, for one-half cycle the battery will get charged and for the next half, it will get discharged. *(0.5 marks)* Hence, the charging of the battery will not take place. *(0.5 marks)* (c) Both D_1 and D_2 will be forward-biased for one-half of the cycle of ac voltage and reverse-biased for the next half cycle. Hence, the combination of D_1 and D_2 behaves as a half-wave rectifier. *(1 mark)* Thus only one-half of the ac voltage gets rectified in a cycle. *(0.5 marks)* Hence, the frequency of output voltage will be 50 Hz. *(0.5 marks)*	
30	(i) C. A reflection of the objects in front of the glass case is seen on the case. (ii) B. 2t (iii) D. $\lambda/4n_2$ **OR** D. $\lambda/2n_2$ (iv) $\lambda/2$	4
	SECTION E	
31	(a)  At the 1st surface, using Snell's law $\sin\theta = n \sin r_1$	5

	$\sin r_1 = \sin \theta/n$ *(0.5 marks)* $r_2 = A - r_1 = 90 - r_1$ *(0.5 marks)* At the second interface, $\sin r_2 = \sin 90/n$ $\sin r_2 = 1/n$ *(0.5 marks)* $\sin (90 - r_1) = 1/n$ $\cos r_1 = 1/n$ *(0.5 marks)* Squaring both sides $\cos^2 r_1 = 1/n^2$ $1 - \sin^2 r_1 = 1/n^2$ $1 - (\sin^2\theta/n^2) = 1/n^2$ Solving, $n = \sqrt{(1+\sin^2\theta)}$ *(1 mark)* (b) For an equilateral prism A = 60° *(0.5 marks)* Using Snell's law at the first surface, $\sin i = n \sin r$ *(0.5 marks)* At minimum deviation $r = A/2 = 60/2 = 30°$ *(0.5 marks)* $\sin i = n \sin(30)$ $\sin i = n(1/2)$ $i = \sin^{-1}(n/2)$ *(0.5 marks)*	
OR	(a) The bright fringes will appear less bright because the intensity of light from one of the slits is reduced. *(1 mark)* The dark fringes will appear less dark/brighter because the intensity of light from the two slits is not the same and the intensities do not completely cancel each other out. *(1 mark)* (b) (i) $\lambda = 500$ nm $= 500 \times 10^{-9}$ m; D = 2 m; d= 1 mm $= 1 \times 10^{-3}$ m Width of central maximum $= 2\lambda D/d$ *(0.5 marks)* $=2 \times 500 \times 10^{-9} \times 2/(1 \times 10^{-3})$ = 2 mm *(0.5 marks)* (ii) Since the wavelength of red light is more the green light and the width of the central maximum is directly proportional to wavelength, the width of the central maximum will increase when red light is used. (1 mark for full answer.) (c) (i) Increase slit width, so that the slit width is comparable to the wavelength of sound. *(0.5 marks)* (ii) Replace the screen with a sound detector. *(0.5 marks)*	5

32	(a) V = 300 V C = 100 µF Energy = $1/2\ CV^2$ *(0.5 marks)* = $1/2 \times 100 \times 10^{-6}\ (300)^2$ = 4.5 J *(0.5 marks)* (b) q = CV *(0.5 marks)* q = $100 \times 10^{-6} \times 300$ = 0.03 C *(0.5 marks)* (c) Capacitance of a parallel plate capacitor C = $(\in_0 A)/d$ *(0.5 marks)* C = 100 µF $d' = 2d$ $C' = (\in_0 A)/d'$ $C' = (\in_0 A)/2d$ = 100/2 = 50 µF Hence, if the distance between the plates of the capacitor is increased two times the capacitance of the capacitor decreases by 1/2 ie becomes 50 µF. *(0.5 marks)* (c) The slope of the q vs V graph gives the capacitance of a parallel plate capacitor. When the space between the plates of a capacitor is filled with a substance of dielectric constant K, its capacitance increases K times. *(0.5 marks)* Greater the slope of the q vs V graph, the higher the capacitance. *(0.5 marks)* As line A has a greater slope it represents greater capacitance and corresponds to scenario *(1 mark)*	5
OR	(a) The arrangement of capacitors is equivalent to:  C_1 and C_3 are in parallel. C_p = 6 + 6 = 12 µF C_p and C_2 are in series *(0.5 marks)* $1/C_s$ = 1/12 + 1/6 = 1/12 + 2/12 = 3/12 C_s = 4 µF *(0.5 marks)* C_s and C_4 are in parallel	5

	$C_{net} = 4 + 6 = 10\ \mu F$ *(1 mark)* (b) We know that $C = Q/V$ Charge on C_4 $Q_4 = 10 \times 6 = 60\ \mu C$ *(0.5 marks)* Net capacitance of C_1 and $C_3 = 6 + 6 = 12\ \mu F$ Net capacitance of C_1, C_3 ,and C_2 is : $1/C = 1/12 + 1/6 = 3/12 = 1/4$ $C = 4\ \mu F$ Net charge across C_1, and C_3 ,and C_2 $Q = C\ V = 4 \times 10 = 40\ \mu C$ *(0.5 marks)* Since the charge in the series combination is the same, Net charge across C_1 and $C_3 = 40\ \mu C$ *(0.5 marks)* Potential across C_1 and $C_3 = Q/C = 40/12 = 10/3\ V$ Charge across C_1 $Q_1 = C_1 \times V = 6 \times 10/3 = 20\ \mu C$ *(0.5 marks)* Ratio of charges across C_1 and C_4 $Q_1/ Q_4 = 20/60 = 1:3$ *(1 mark)*	
33	(a) $X_L = 2\pi f\, L$ *(0.5 marks)* $L = X_L /2\pi f$ $L = 20/(2 \times 3.14 \times 100) = 0.032\ H$ *(0.5 marks)* (b) A battery is a source of direct current and thus $f = 0$ Hz. *(0.5 marks)* As $X_L = 2\pi fL$, the inductive reactance of the inductor becomes zero. *(0.5 marks)* (c) $P_{avg} = V_{rms}I_{rms} \cos\varphi$ where φ is the phase difference between current and voltage in the circuit. Phase difference is 90° for pure inductive circuit. *(0.5 marks)* $\therefore P_{avg}= 0$ *(0.5 marks)* (d) Power dissipated in an LCR circuit is maximum when $X_L= X_C$ $f = 1/2\pi\sqrt{(LC)}$ $f = 0.398 \times 10^3$ Hz $f = 398$ Hz *(1 mark)* Under this condition of resonance, the circuit behaves as a pure resistive circuit. Hence phase difference between current and voltage is 0°. *(1 mark)*	5
OR	(a) The voltage across the secondary coil is given by: $N_p/N_s = V_p/V_s$ *(1 mark)* where $N_p = 500$, $N_s = 50$ and $V_p = 240$ V Therefore, $V_s = V_p \times (N_s/N_p)$	5

	$= 240 \times (50/500)$ $= 24$ V *(1 mark)* (b) Current in the secondary coil is given by: $I_s = V_s/R_s$ *(0.5 marks)* where $V_s = 24$ V and Rs = 20 ohms Therefore, $I_s = 24/20$ $= 1.2$ A *(1 mark)* Current in the primary coil is given by: $I_p/I_s = N_s/N_p$ *(0.5 marks)* where $I_s = 1.2$ A, $N_s = 500$ and $N_p = 50$ Therefore, $I_p = (N_s/N_p) \times (I_s)$ $= (50/500) \times (1.2)$ $= 0.12$ A *(1 mark)*	