

PHYSICS
CLASS - XII
SAMPLE PAPER
BLUE PRINT

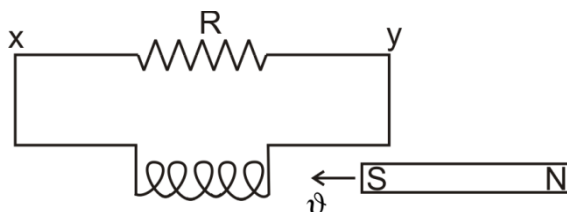
S. No.	Unit	VSA (1 mark)	SA I (2 marks)	SA II/VBQ* (3 marks)	LA (5 marks)	TOTAL
1.	Electrostatics	1 (1)	4 (2)	3 (1)	–	8 (4)
2.	Current Electricity	2 (2)	2 (1)	3 (1)	–	7 (4)
3.	Magnetic effect of current & Magnetism	1 (1)	4(2)	3 (1)	–	8 (4)
4.	Electromagnetic Induction and Alternating Current	1 (1)	2 (1)	–	5 (1)	8 (3)
5.	Electromagnetic Waves	–	–	3 (1)	–	3 (1)
6.	Optics	1 (1)	2 (1)	6 (2)	5 (1)	14 (5)
7.	Dual nature of Radiation and matter	–	4 (2)	–	–	4 (2)
8.	Atoms and Nuclei	–	–	3 (1) 3 (1)*	–	6 (2)
9.	Electronic Devices	–	2 (1)	–	5 (1)	7 (2)
10.	Communication Systems	2 (2)	–	3 (1)	–	5 (3)
	Total	8 (8)	20 (10)	27 (9)	15 (3)	70 (30)

The question paper will include value based question(s) to the extent of 3–5 marks.

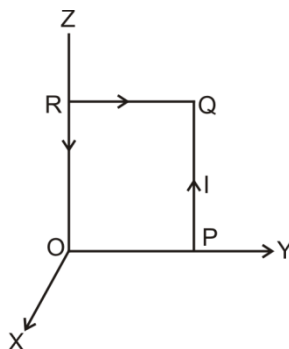
PHYSICS CLASS-XII

SAMPLE PAPER-1

- Q1. A magnet is being moved towards a coil with a uniform speed v as shown in the figure. State the direction of the induced current in the resistor R. 1



- Q2. A square coil, OPQR, of side a , carrying a current I , is placed in the Y-Z plane as shown here. Find the magnetic moment associated with this coil. 1



- Q3. Give one example each of a 'system' that uses the

- (i) Sky wave (ii) Space wave

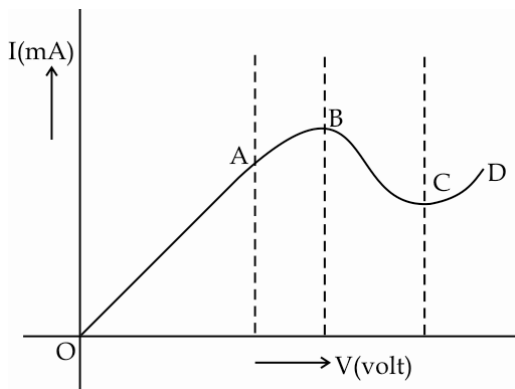
mode of propagation

1

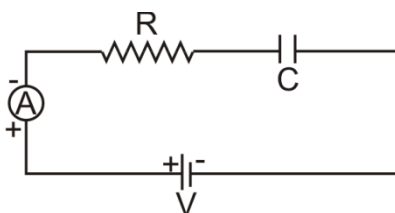
- Q4. A concave mirror, of aperture 4cm, has a point object placed on its principal axis at a distance of 10cm from the mirror. The image, formed by the mirror, is not likely to be a sharp image. State the likely reason for the same. 1

- Q5. Two dipoles, made from charges $\pm q$ and $\pm Q$, respectively, have equal dipole moments. Give the (i) ratio between the 'separations' of the these two pairs of charges (ii) angle between the dipole axis of these two dipoles. 1

- Q6. The graph, shown here, represents the V-I characteristics of a device. Identify the region, if any, over which this device has a negative resistance. 1



- Q7. Define the term 'Transducer' for a communication system. 1
- Q8. State the steady value of the reading of the ammeter in the circuit shown below.



1

- Q9. The following table gives data about the single slit diffraction experiment:

Wave length of Light	Half Angular width of the principal maxima
λ	θ
$p \lambda$	$q \theta$

Find the ratio of the widths of the slits used in the two cases. Would the ratio of the half angular widths of the first secondary maxima, in the two cases, be also equal to q ? 2

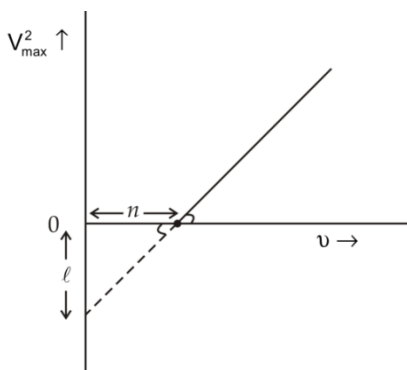
- Q10. N spherical droplets, each of radius r , have been charged to have a potential V each. If all these droplets were to coalesce to form a single large drop, what would be the potential of this large drop?

(It is given that the capacitance of a sphere of radius r equals $4 \pi \epsilon_0 k r$.)

OR

Two point charges, q_1 and q_2 , are located at points $(a, 0, 0)$ and $(0, b, 0)$ respectively. Find the electric field, due to both these charges, at the point, $(0, 0, c)$. 2

Q11. When a given photosensitive material is irradiated with light of frequency ν , the maximum speed of the emitted photoelectrons equals $v_{\max}$. The square of $v_{\max}$, i.e., $v_{\max}^2$, is observed to vary with ν , as per the graph shown here.



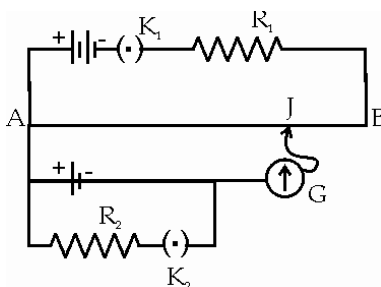
Obtain expressions for

- (i) Planck's constant, and
 - (ii) The work function of the given photosensitive material,
- in terms of the parameters, ℓ , n and the mass, m , of the electron.

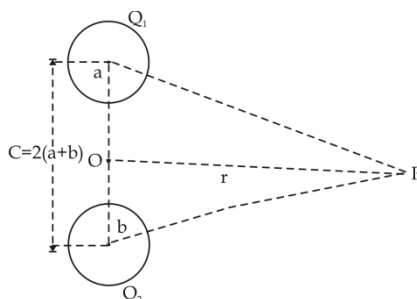
Q12. For the circuit shown here, would the balancing length increase, decrease or remain the same, if 2

- (i) R_1 is decreased
- (ii) R_2 is increased

without any other change, (in each case) in the rest of the circuit. Justify your answers in each case.



- Q13. Find the P.E. associated with a charge 'q' if it were present at the point P with respect to the 'set-up' of two charged spheres, arranged as shown. Here O is the mid-point of the line $O_1 O_2$. 2



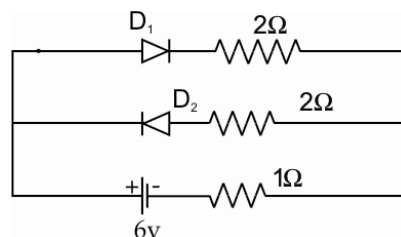
- Q14. An athlete peddles a stationary tricycle whose pedals are attached to a coil having 100 turns each of area 0.1m^2 . The coil, lying in the X-Y plane, is rotated, in this plane, at the rate of 50 rpm, about the Y-axis, in a region where a uniform magnetic field, $\vec{B} = (0.01) \hat{k}$ tesla, is present. Find the

- (i) maximum emf (ii) average e.m.f

generated in the coil over one complete revolution. 2

- Q15. A monochromatic source, emitting light of wave length, 600 nm, has a power output of 66W. Calculate the number of photons emitted by this source in 2 minutes. 2

- Q16. For the circuit shown here, find the current flowing through the 1Ω resistor. Assume that the two diodes, D_1 and D_2 , are ideal diodes.



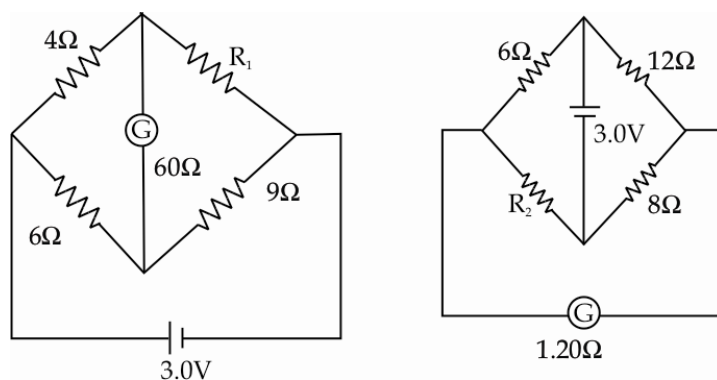
- Q17. The following table shows the range of values of susceptibility and relative magnetic permeability of two different type of magnetic substances

Substance	Susceptibility	Magnetic Permeability
X	-1 to 0	0 to 1
Y	$\gg 1$	$\gg 1$

- (a) Identify the type of magnetic materials X and Y.
- (b) How does the susceptibility and permeability of X and Y vary with rise in temperature? 2

Q18. Two wires are aligned parallel to each other. One is carrying an electric current and the other is not. Will there be any kind of electromagnetic force between the two? Give reason for your answer. 2

Q19. The galvanometer, in each of the two given circuits, does not show any deflection. Find the ratio of the resistors R_1 and R_2 , used in these two circuits. 3



- Q20. The electron, in a hydrogen atom, initially in a state of quantum number n_1 makes a transition to a state whose excitation energy, with respect to the ground state, is 10.2 eV. If the wavelength, associated with the photon emitted in this transition, is 487.5 nm, find the
- (i) energy in eV, and (ii) value of the quantum number, n_1 of the electron in its initial state. 3

OR

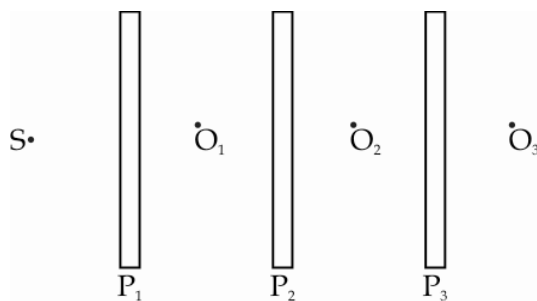
The spectrum of a star in the visible and the ultraviolet region was observed and the wavelength of some of the lines that could be identified were found to be

824 Å, 970 Å, 1120 Å, 2504 Å, 5173 Å, 6100 Å.

Which of these lines cannot belong to hydrogen atom spectrum? Support your answer with suitable calculations.

Take Rydberg constant $R = 1.03 \times 10^7 \text{ m}^{-1}$ and $\frac{1}{R} = 970 \text{ Å}$.

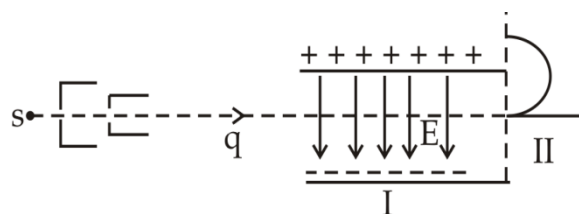
- Q21. Three identical polaroid sheets P_1 , P_2 , and P_3 are oriented so that the (pass) axis of P_2 and P_3 are inclined at angles of 60° and 90° , respectively, with respect to the (pass) axis of P_1 . A monochromatic source, S , of intensity I_0 , is kept in front of the polaroid sheet P_1 . Find the intensity of this light, as observed by observers O_1 , O_2 , and O_3 , positioned as shown below.



- Q22. A fine pencil of β -particles, moving with a speed v , enters a region (region I), where a uniform electric and a uniform magnetic field are both present. These β -particles then move into region II where only the magnetic field, (out of the two fields present in region I), exists. The path of the β -particles, in the two regions, is as shown in the figure.

- State the direction of the magnetic field.
- State the relation between 'E' and 'B' in region I.
- Derive the expression for the radius of the circular path of the β -particle in region II.

If the magnitude of magnetic field, in region II, is changed to n times its earlier value, (without changing the magnetic field in region I)



find the factor by which the radius of this circular path would change. 3

- Q23. Draw an appropriate ray diagram to show the passage of a 'white ray', incident on one of the two refracting faces of a prism. State the relation for the angle of deviation, for a prism of small refracting angle.

It is known that the refractive index, μ , of the material of a prism, depends on the wavelength, λ , of the incident radiation as per the relation

$$\mu = A + \frac{B}{\lambda^2}$$

where A and B are constants. Plot a graph showing the dependence of μ on λ and identify the pair of variables, that can be used here, to get a straight line graph. 3

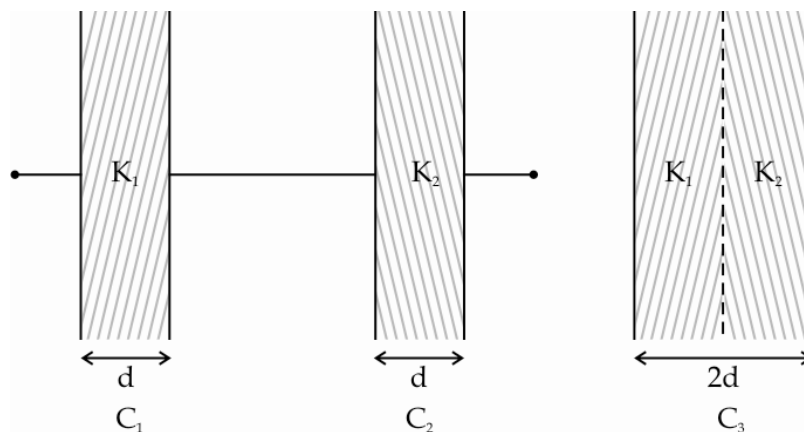
- Q24. Excessively large amount of energy is released in an uncontrolled way in a nuclear bomb explosion. Some scientists have expressed fear that a future nuclear war on Earth would be followed by a severe 'nuclear winter' with a devastating effect on life on Earth. 3

Answer the following questions based on above possible scenario:

- Name the basic principle responsible for release of large amount of energy in a nuclear bomb explosion. How will the nuclear bomb explosion result in 'nuclear winter'?
 - Which two human values need to be promoted in individuals so that such a situation of nuclear winter does not arise?
 - Suggest any one method to promote these values in school students.
- Q25. The modulation index of an amplitude modulated wave is 0.5. What does it mean?

Calculate the modulation index for an AM wave for which the maximum amplitude is 'a' while the minimum amplitude is 'b'. 3

- Q26. The capacitors C_1 , and C_2 , having plates of area A each, are connected in series, as shown. Compare the capacitance of this combination with the capacitor C_3 , again having plates of area A each, but 'made up' as shown in the figure. 3



- Q27. (a) Write the formula for the velocity of light in a material medium of relative permittivity ϵ_r and relative magnetic permeability μ_r . 1

- (b) The following table gives the wavelength range of some constituents of the electromagnetic spectrum.

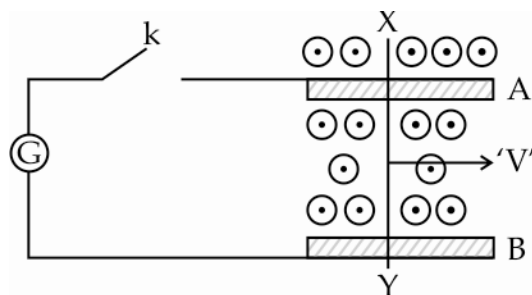
S.No.	Wavelength Range
1.	1mm to 700nm
2.	0.1m to 1mm
3.	400 nm to 1nm
4.	$< 10^{-3}$ nm

Select the wavelength range, and name the (associated) electromagnetic waves, that are used in

- (i) Radar systems for Aircraft navigation
(ii) Earth satellites to observe growth of crops.

2

- Q28. A conducting rod XY slides freely on two parallel rails, A and B, with a uniform velocity 'V'. A galvanometer 'G' is connected, as shown in the figure and the closed circuit has a total resistance 'R'. A uniform magnetic field, perpendicular to the plane defined by the rails A and B and the rod XY (which are mutually perpendicular), is present over the region, as shown.

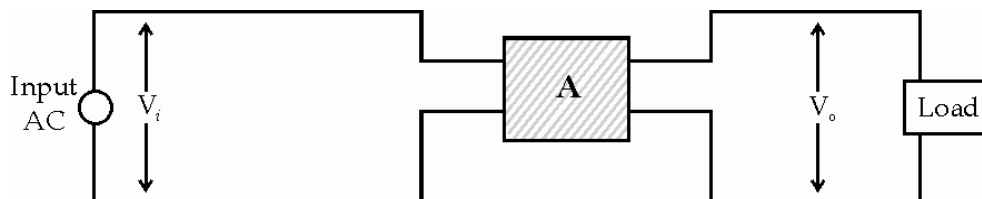


- (a) With key k open:
- Find the nature of charges developed at the ends of the rod XY.
 - Why do the electrons, in the rod XY, (finally) experience no net force even though the magnetic force is acting on them due to the motion of the rod?
- (b) How much power needs to be delivered, (by an external agency), to keep the rod moving at its uniform speed when key k is (i) closed (ii) open?
- (c) With key k closed, how much power gets dissipated as heat in the circuit? State the source of this power.

OR

'Box' A, in the set up shown below, represents an electric device often used/needed to supply, electric power from the (ac) mains, to a load.

It is known that $V_o < V_i$.



- (a) Identify the device A and draw its symbol.
 - (b) Draw a schematic diagram of this electric device. Explain its principle and working. Obtain an expression for the ratio between its output and input voltages.
 - (c) Find the relation between the input and output currents of this device assuming it to be ideal.
- 5

Q29. Define the terms 'depletion layer' and 'barrier potential' for a P-N junction diode. How does an increase in the doping concentration affect the width of the depletion region?

Draw the circuit of a full wave rectifier. Explain its working.

OR

Why is the base region of a transistor kept thin and lightly doped?

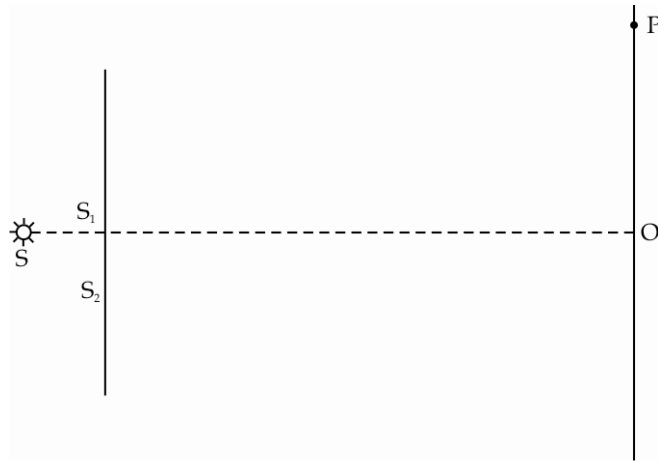
Draw the circuit diagram of the 'set-up' used to study the characteristics of a npn transistor in its common emitter configuration. Sketch the typical (i) Input characteristics and (ii) Output characteristics for this transistor configuration.

How can the out put characteristics be used to calculate the 'current gain' of the transistor?

Q30. (i) A thin lens, having two surfaces of radii of curvature r_1 and r_2 , made from a material of refractive index μ_2 , is kept in a medium of refractive index μ_1 . Derive the Lens Maker's formula for this 'set-up'

- (ii) A convex lens is placed over a plane mirror. A pin is now positioned so that there is no parallax between the pin and its image formed by this lens-mirror combination. How can this observation be used to find the focal length of the convex lens? Give appropriate reasons in support of your answer.

OR



The figure, drawn here, shows a modified Young's double slit experimental set up. If $SS_2 - SS_1 = \lambda/4$,

- (i) state the condition for constructive and destructive interference
- (ii) obtain an expression for the fringe width.
- (iii) locate the position of the central fringe.

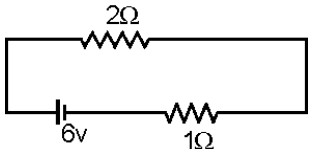
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MARKING SCHEME

Q.No.	Value point/ expected points	Marks	Total
1.	From X to Y	1	1
2.	The magnetic moment, associated with the coil, is $\vec{\mu}_m = Ia^2 \hat{i}$	1	1
3.	(i) Short wave broadcast services (ii) Television broadcast (or microwave links or Satellite communication)	$\frac{1}{2}$ $\frac{1}{2}$	1
4.	The incident rays are not likely to be paraxial.	1	1
5.	As $qa = Qa'$, we have $\frac{a'}{a} = \frac{q}{Q}$ and $\theta = 0^\circ$	$\frac{1}{2}$ $\frac{1}{2}$	1
6.	Region BC	1	1
7.	A 'transducer' is any device that converts one form of energy into another	1	1
8.	Zero	1	1
9.	Let d and d' be the width of the slits in the two cases. $\therefore \theta = \frac{\lambda}{d} \text{ and } q\theta = \frac{p\lambda}{d'}$ $\therefore \frac{d}{d'} = \frac{q}{p}$ Yes, this ratio would also equal q	$\frac{1}{2} + \frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	2
10.	Total (initial) charge on all the droplets		

	$= N \times (4\pi \epsilon_0 k r V)$ Also $N \times \frac{4}{3} \pi r^3 = \frac{4}{3} \pi R^3$ $\therefore R = N^{1/3} r$ If V' is the potential of the large drop, we have $4\pi \epsilon_0 R \times V' = N \times 4\pi \epsilon_0 k r \times V$ $\therefore V' = \frac{Nr}{R} V = N^{2/3} V$ OR We have $\vec{E}_{\text{net}} = \vec{E}_1 + \vec{E}_2$ $= \frac{1}{4\pi \epsilon_0} \frac{q_1}{r_1^3} \vec{r}_1 + \frac{1}{4\pi \epsilon_0} \frac{q_2}{r_2^3} \vec{r}_2$ where $\vec{r}_1 = -a \hat{i} + c \hat{k}$ and $\vec{r}_2 = -b \hat{j} + c \hat{k}$ $\vec{E}_{\text{net}} = \frac{1}{4\pi \epsilon_0} \left[\frac{q_1 (-a \hat{i} + c \hat{k})}{(a^2 + c^2)^{3/2}} + \frac{q_2 (-b \hat{j} + c \hat{k})}{(b^2 + c^2)^{3/2}} \right]$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ 1	 2 2
11.	According to Einestein's Equation: $K_{\text{max}} = \frac{1}{2} m v_{\text{max}}^2 = h\nu - \phi_0$ $\therefore v_{\text{max}}^2 = \left(\frac{2h}{m}\right) \nu - \frac{2\phi_0}{m}$ This is the equation of a straight line having a slope $2h/m$ and an intercept (on the v_{max}^2 axis) of $\left(-\frac{2\phi_0}{m}\right)$. Comparing these, with the given graph, we get $\frac{2h}{m} = \frac{\ell}{n}$ or $h = \frac{\ell m}{2n}$ and $\ell = \frac{2\phi_0}{m}$ or $\phi_0 = \frac{m\ell}{2}$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2} + \frac{1}{2}$	 2
12.	(i) decreases (The potential gradient would increase)	$\frac{1}{2} + \frac{1}{2}$	

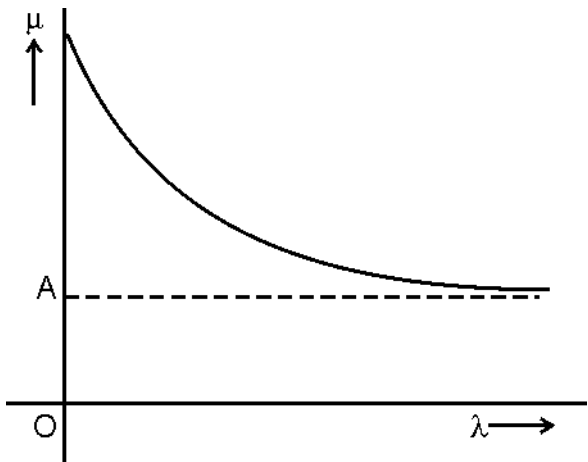
	(ii) increases (The terminal p.d across the cell would increase)	$\frac{1}{2} + \frac{1}{2}$	
13.	$r_1 = O_1P = \sqrt{r^2 + (2a + b)^2}$ $r_2 = O_2P = \sqrt{r^2 + (a + 2b)^2}$ $\therefore V = \frac{1}{4\pi\epsilon_0} \left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2} \right]$ $\therefore$ P.E of charge , q, at P = qV $= \frac{q}{4\pi\epsilon_0} \left[\frac{Q_1}{[r^2 + (2a + b)^2]^{1/2}} + \frac{Q_2}{[r^2 + (a + 2b)^2]^{1/2}} \right]$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	2
14.	(i) The maximum emf ' ϵ ' generated in the coil is, $\epsilon = N B A \omega$ $= N B A 2\pi f$ $= [100 \times 0.01 \times 0.1 \times 2\pi \frac{(5)}{6}] V$ $= \frac{\pi}{6} V \approx 0.52 V$ (ii) The average emf generated in the coil over one complete revolution = 0	$\frac{1}{2}$ 1 $\frac{1}{2}$	2
15.	Energy of one photon = $E = \frac{hc}{\lambda}$ $E = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{6 \times 10^{-7}}$ $\approx 3.3 \times 10^{-19} J$ $E_1 =$ energy emitted by the source in one second = 66J $\therefore$ number of photons emitted by the source in 1s = $n = \frac{66}{3.3 \times 10^{-19}} = 2 \times 10^{20}$ $\therefore$ Total number of photons emitted by	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	2

	source in 2 minutes $= N = n \times 2 \times 60$ $= 2 \times 10^{20} \times 120 = 2.4 \times 10^{22}$ photons	$\frac{1}{2}$	
16.	Diode D_1 is forward biased while Diode D_2 is reverse biased Hence the resistances, of (ideal) diodes, D_1 and D_2, can be taken as zero and infinity, respectively. The given circuit can, therefore, be redrawn as shown in the figure.  $\therefore$ Using ohm's law, $I = \frac{6}{(2+1)} \text{ A} = 2\text{A}$ $\therefore$ current flowing in the 1Ω resistor, is 2A.	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	2
17.	(a) X-Diamagnetic, Y-Ferromagnetic (b) X- No change (c) Y- Decreases with temperature		
18.	No - Since there is only one magnetic field, there is no interaction and hence no force between the two wires.		
19.	For circuit 1, we have, (from the Wheatstone bridge balance condition),		

	$\frac{R_1}{9} = \frac{4}{6}$ $\therefore R_1 = 6\Omega$ In circuit 2, the interchange of the positions of the battery and the galvanometer, does not change the (wheatstone Bridge) balance condition. $\therefore \frac{R_2}{8} = \frac{6}{12}$ or $R_2 = 4\Omega$ $\therefore \frac{R_1}{R_2} = \frac{6}{4} = \frac{3}{2}$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	3
20.	In a hydrogen atom, the energy (E_n) of electron, in a state, having principal quantum number 'n', is given by $E_n = \frac{-13.6}{n^2} \text{ eV}$ $\therefore E_1 = -13.6\text{eV}$ and $E_2 = -3.4 \text{ eV}$ It follows that the state $n=2$ has an excitation energy of 10.2 eV. Hence the electron is making a transition from $n=n_1$ to $n=2$ where ($n_1>2$). Now $E_{n1} - E_2 = \frac{hc}{\lambda}$ But $\frac{hc}{\lambda} = \frac{6.63 \times 10^{-24} \times 3 \times 10^8}{487.3 \times 10^{-9} \times 1.6 \times 10^{-19}} \text{ eV} = 2.55 \text{ eV}$ $\therefore E_{n1} = (-3.4 + 2.55) \text{ eV}$ $\simeq -0.85 \text{ eV}$ But we also have $E_{n1} = \frac{-13.6}{n_1^2} \text{ eV}$ $\therefore$ we get $n_1 = 4$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	3

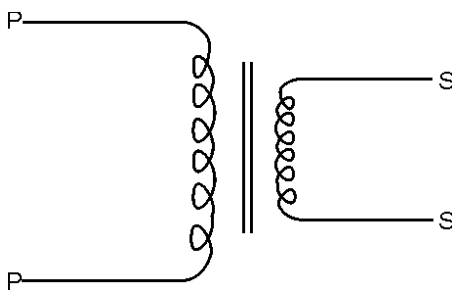
	OR $\bar{\nu} = \frac{1}{\lambda} = R \left[\frac{1}{n_2^2} - \frac{1}{n_1^2} \right]$ $\lambda = \frac{\frac{1}{R}}{\left[\frac{1}{n_2^2} - \frac{1}{n_1^2} \right]} = \frac{970 \text{ Å}}{\left[\frac{1}{n_2^2} - \frac{1}{n_1^2} \right]}$ If we take $n_2 = 1$ (Lyman series of Hydrogen Spectrum) λ can take values $\frac{970 \text{ Å}}{3/4}$, $\frac{970 \text{ Å}}{8/9}$, $\frac{970 \text{ Å}}{15/16}$, ..., ..., $\frac{970 \text{ Å}}{1}$ Corresponding to $n_1 = 2, 3, 4, \dots$ Thus, permitted values of λ are 1293 Å, 1091 Å, 1034 Å, ..., 970 Å. Similarly if we take $n_2 = 2$ (Balmer Series of Hydrogen Spectrum), corresponding to $n_1 = 3, 4, 5, \dots$ λ can have values $\frac{970 \text{ Å}}{\frac{5}{36}}$, $\frac{970 \text{ Å}}{\frac{3}{16}}$, $\frac{970 \text{ Å}}{\frac{21}{100}}$, ..., ..., $\frac{970 \text{ Å}}{\frac{1}{4}}$ i.e. 6984 Å, 5173 Å, 4619 Å, ..., 3880 Å. Hence out of the given values $\lambda = 824 \text{ Å}, 1120 \text{ Å}, 2504 \text{ Å}, 6100 \text{ Å}$ cannot belong to the hydrogen atom spectrum.	$1/2$ $1/2$ $1/2$ $1/2$ $1/2$ $1/2$ $1/2$	3
21.	Intensity observed by (i) Observer $O_1 = \frac{I_0}{2}$ (ii) Observer $O_2 = \frac{I_0}{2} \cos^2 60^\circ$	$1/2$ $1/2$	3

	$= \frac{I_0}{8}$	$\frac{1}{2}$	
	(iii) Observer $O_3 = \left(\frac{I_0}{8}\right) \cos^2 (90^\circ - 60^\circ)$ $= \frac{I_0}{8} \times \frac{3}{4} = \frac{3I_0}{32}$	1 $\frac{1}{2}$	
22.	(i) The magnetic field is perpendicular to the plane of page and is directed inwards (ii) In region I $ \vec{F}_e = \vec{F}_m $ $qE = qvB$ $\therefore E = vB$ (iii) In region II $\frac{mv^2}{r} = qvB \Rightarrow r = \frac{mv}{qB}$ Substituting the value of v , we get $r = \frac{mE}{qB^2}$ Let B' ($=nB$) denote the new magnetic field in region II. If r' is the radius of the circular path now, we have $\Rightarrow r' = \frac{mv}{qB'} = \frac{mE}{qnB^2}$ Hence radius of the circular path, would decrease by a factor n .	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	3
23.	See (fig 9.25, Page 332 Part II NCERT) For a small angled prism, of refracting angle α : Angle of deviation $\alpha = (\mu - 1) \alpha$ where μ is	1 $\frac{1}{2}$	

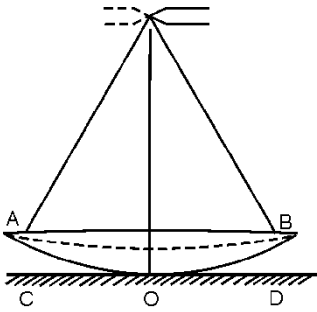
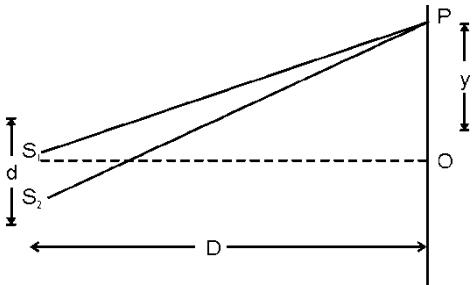
	the refractive index of the material of the prism.  To get a straight line graph, we need to use μ and $1/\lambda^2$ as the pair of variables.	1 $1/2$	3
24.	a) - Uncontrolled nuclear chain reaction. - The thick smoke produced due to nuclear explosion would perhaps cover substantial parts of the sky preventing solar light from reaching many parts of the Earth resulting in lowering of atmospheric temperature. b) - International understanding and Brotherhood. - Love for humanity/non violence c) - Group discussion for value clarification - Vigorous campaign for spreading awareness using mass media.	$1/2$ $1/2$ $1/2$ $1/2$	3
25.	It means that the ratio of peak value of the modulating signal to the peak	2	

	value of carrier wave is 0.5. If A_m is the peak value of modulating signal and A_c is the peak value of carrier wave. We have $a = A_c + A_m$ and $b = A_c - A_m$ Thus, $A_c = \frac{a+b}{2}$ and $A_m = \frac{a-b}{2}$ Therefore modulation index $\mu = \frac{A_m}{A_c} = \frac{a-b}{a+b}$	1	3
26.	We have $C_1 = \frac{A\epsilon_0 K_1}{d}$ and $C_2 = \frac{A\epsilon_0 K_2}{d}$ $\therefore C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{A\epsilon_0}{d} \left(\frac{K_1 K_2}{K_1 + K_2} \right)$ Now, capacitor C_3 can be considered as made up of two capacitors C_1 and C_2, each of plate area A and separation d, connected in series. We have : $C_1' = \frac{A\epsilon_0 K_1}{d}$ and $C_2' = \frac{A\epsilon_0 K_2}{d}$ $\Rightarrow C_3 = \frac{C_1' C_2'}{C_1' + C_2'} = \frac{A\epsilon_0}{d} \left(\frac{K_1 K_2}{K_1 + K_2} \right)$ $\therefore \frac{C_3}{C_{eq}} = 1$ Hence net capacitance of the combination is equal to that of C_3.	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	3

27.	(a) We have $\vartheta = \frac{1}{\sqrt{\mu\epsilon}} = \frac{1}{\sqrt{\mu_0\mu_r\epsilon_0\epsilon_r}}$ (b) (i) Wavelength range: [0.1m to 1mm] (Microwaves) (ii) Wavelength range: [1mm to 700 nm] (Infrared waves)	$\frac{1}{2} + \frac{1}{2}$ $\frac{1}{2} + \frac{1}{2}$ $\frac{1}{2} + \frac{1}{2}$	3
28.	(a) (i) X : negative , Y: positive (ii) Magnetic force, F_m, experienced by the moving electrons, gets balanced by the electric force due to the electric field, caused by the charges developed at the ends of the rod. Hence net force on the electrons, inside the rod, (finally) become zero. (b) The power, that needs to be delivered by the external agency, when key k is closed, is $P = F_m V = (I l B) V = \frac{BlV}{R} \cdot IBV$ $= B^2 l^2 V^2 / R$ When k is open, there is an induced emf, but no induced current. Hence power that needs to be delivered is zero. (c) Power, dissipated as heat $= i^2 R = \frac{B^2 l^2 V^2}{R}$ The source of this power is the mechanical work done by the external agency.	$\frac{1}{2}$ $1 + \frac{1}{2}$ $\frac{1}{2} + \frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2} + \frac{1}{2}$ $\frac{1}{2}$	5

	OR (a) Step down transformer.  (b) Diagram Principle Working Obtaining the expression (c) Input power = output power $\therefore V_p i_p = V_s i_s$ $\Rightarrow \frac{i_p}{i_s} = \frac{V_s}{V_p} = \frac{N_s}{N_p}$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ 2 $\frac{1}{2}$	5
29.	The space charge region, on either side of the junction (taken together), is known as the depletion layer. The p.d across the depletion layer is known as the barrier potential The width of the depletion region decreases with an increase in the doping concentration. The circuit of a full-wave rectifier is shown below.	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $1\frac{1}{2}$	5

	Working details OR The base region of a transistor is thin and lightly doped so that the base current (I_B) is very small compared to emitter current (I_E). (Circuit for studying the characteristics of a npn transistor in its CE configuration) INPUT CHARACTERISTIC OUTPUT CHARACTERISTIC	2 1 1 1 1	5
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	The current gain (β) of a transistor in common emitter configuration is $\beta = \frac{\Delta I_C}{\Delta I_B}$ ΔI_C and ΔI_B can be obtained, from the two curves, in the output characteristics.	1	
30.	(i) Diagram Derivation (ii) The rays must fall normally on the plane mirror so that the image of the pin coincides with itself  Hence rays, like CA and DB, form a parallel beam incident on the lens. $\therefore$ P is the position of the focus of the lens $\therefore$ Distance OP equals the focal length of the lens OR 	1 2½ ½ ½ ½ 1	5

$\Delta_o = \text{initial path different between } S_1 \text{ and } S_2$ $= SS_2 - SS_1 = \lambda/4$	$1/2$	
$\Delta = S_2P - S_1P = \text{path difference between disturbance from } S_1 \text{ and } S_2, \text{ at point P}$ $= \frac{yd}{D}$	$1/2$	
$\Delta_T = \text{Total path difference between the two disturbances at P}$ $= \Delta_o + \Delta = \frac{\lambda}{4} + \frac{yd}{D}$	1	
$\therefore \text{For constructive interference:}$ $\Delta_T = \left(\frac{\lambda}{4} + \frac{yd}{D}\right) = n\lambda; n = 0, 1, 2, \dots$ $\therefore \frac{yd}{D} = \left(n - \frac{1}{4}\right) \lambda \dots (i)$	1	
For destructive interference $\Delta_T = \left(\frac{\lambda}{4} + \frac{yd}{D}\right) = (2n-1) \frac{\lambda}{2} \dots (ii)$ $\therefore \frac{Y_n d}{D} = \left(2n - 1 - \frac{1}{2}\right) \frac{\lambda}{2}$ $\therefore \frac{Y_n d}{D} = \left(2n - \frac{3}{2}\right) \frac{\lambda}{2}$ $\beta = \text{fringe width} = y_{n+1} - y_n = \frac{\lambda D}{d}$ The position Y_o of central fringe is obtained by putting $n=0$ in Eqn (i). Therefore, $\therefore y_o = - \frac{\lambda D}{4d}$ [Negative sign shows that the central fringe is obtained at a point below the (central) point O.]	1	5