PHYSICS

Paper-I

(Theory)

(*Three hours)*

(Candidates *are allowed additional 15 minutes for* **only** *reading the paper,*

They must NOT start writing during this time)

Answer all questions in ***Part I*** *and six questions from* ***Part II****, Choosing* **two** *questions from* ***each of*** *the Sections* ***A, B*** *and* ***C.***

All working including rough work should be done on the same sheet as, and adjacent to, the rest of the answer.

The intended marks for questions or parts of questions are given in brackets [ ].

(Material to be supplied: Log tables including Trigonometric functions)

A list of useful physical constants is given at the end of this paper.

PART I

Answer all questions

Question 1

A Choose the correct alternative A, B , C or D for each of the questions given below: [5]

(i) A body has a positive charge of 8×10^{-19} C, It has:

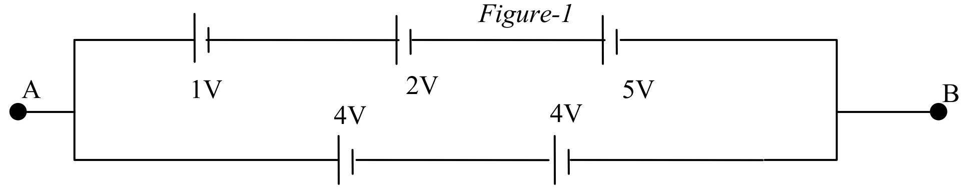
(A) an excess of 5 electrons (B) a deficiency of 5 electrons

(C) an excess of 8 electrons (D) a deficiency of 8 electrons

Ans:- (D). [*Concept: law of conservation of charge*]

(ii) *Figure I* below shows five dc sources (cells). Their emf's are shown in the figure.

Figure-1



Emf of the battery AB is :

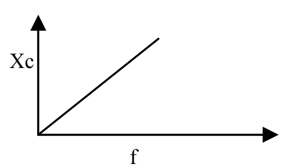
(A) 8V (B) 16V

(C) 4V (D) 2V

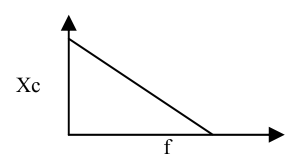
Ans:- (A). [*Concept: In series connection of cells, add the emf's in each branch. Both branches are connected at the same points hence the effective emf must be 8V*]

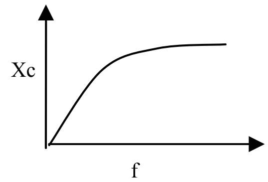
(iii) Which one of the following graphs in figure 2 represents variation of reactance 'X_c' of a capacitor with frequency 'f' of an ac supply:

(A)



(B)



(C) 

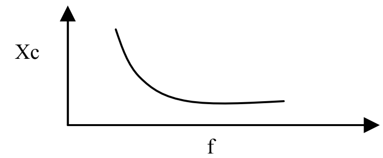
(D) 

Figure 2

Ans:- (D). [*Concept: The capacitive reactance is given by:* $X_c = \frac{1}{\omega C} = \frac{1}{2\pi f C}$. *It shows that Capacitive reactance is inversely proportional to the frequency of the voltage source. Thus the curve is a rectangular hyperbola.]*

(iv) White light is passed through sodium vapour contained in a thin walled glass flask and the transmitted light is examined with the help of a spectrometer. The spectrum so obtained is:

(A) Absorption spectrum (B) Solar spectrum
(C) Band spectrum (D) Continuous spectrum

Ans:- (A). [*Concept: White light contains all the seven colours. When it passes through sodium vapour the yellow component is absorbed since sodium vapour would have emitted its own characteristic colour that is yellow in an excited state*.]

(v) Binding energy of a nucleus is of the order of:

(A) Electron volt (eV) (B) Kilo electron volt (keV)
(C) Mega electron volt (MeV) (D) a joule (J)

Ans:- (C) . [*Concept: Ref. graph of binding energy per nucleon against mass number of nucleus of atoms.]*

B Answer **all** questions briefly and to the point: [15]

(i) A point charge of 5 x 10^{-6} C experiences a force of 2 x 10^{-3} N when kept in a uniform electric field of intensity E. Find E.

Ans:- E = F/q. E = 4.0 x 10^{2} N/C [*Caution: do not omit the unit; you will not get any mark for the value alone.]*

(ii) Which conservation principle is involved in Kirchoff's **first law** of electric circuit?

Ans:- The law of conservation of electric charge. *[Concept: When current flow takes place no charge is accumulated at any region of the circuit.]*

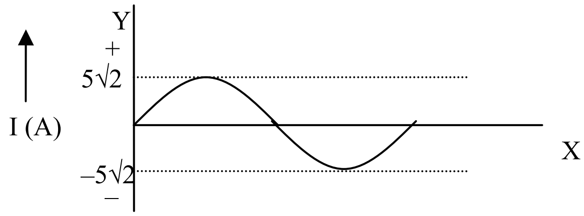
(iii) Write an expression of magnetic flux density '**B**' at a point in end-on position or an axial position of a magnetic dipole. (Derivation not required.)

Ans:- $B = \frac{\mu_o 2Mr}{4\pi(r^2 - l^2)^2}$, where M is the magnetic moment of the dipole, *l* is the half length of the magnet and *r* is the distance from the centre of the magnet to the point concerned on the axial line of the magnetic dipole. (*Make sure that you write terms of the symbols used in the expression always)*

(iv) In a moving coil galvanometer, what is meant by a radial magnetic field?

Ans:- The magnetic field lines always makes 90^o with the plane of the coil so that maximum torque will be acting on the coil in any orientation.

(v) Variation of alternating current 'I' with time 't' is shown in the graph below:



What is the **rms** value of this current?

Ans:- $I_{rms} = I_{max}/\sqrt{2} = 5$ A.

(vi) Which electromagnetic radiation has wavelength greater than that of X-rays and smaller that that of visible light?

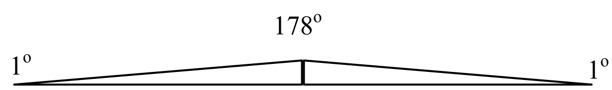
Ans:- Ultra violet. (*You need not draw the spectrum*)

x-rays	UV	Visible light	IR	Micro wave	TV wave	Radio wave

Increasing λ →

(vii) How did Fresnel construct a biprism in order to study **interference of light**?

Ans:- By cementing two right-angled prisms of 89^o-90^o-1^o in such away as to produce the base angles of the combined prism is 1^o each.



(viii) State Brewster's law of polarisation of light.

Ans:- It states that the refractive index of the medium produces plane polarised light is equal to the tangent of the angle of polarisation. ($\mu = \tan i_p$.)

(ix) A thin convex lens (L_1) of focal length 80cm and a thin concave lens (L_2) of focal length *f* are kept co-axially, 20 cm apart as shown in figure 3 below. When a narrow and parallel beam of light is incident on the convex lens, beam emerging from the concave lens is also a parallel beam. Find *f*.

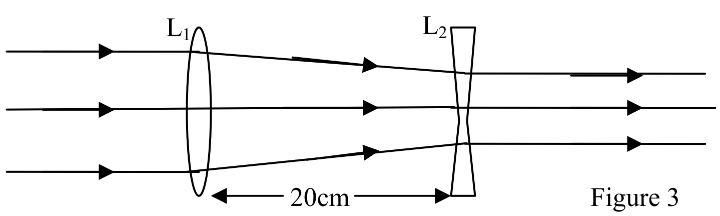


Figure 3

Ans:- The lens L_1 produces a real image at 80cm from it. Thus the distance between L_2 and the image due to L_1 is 60cm. Since rays from L_2 are parallel the image due to L_1 acts as a virtual object kept at the focal point of lens L_2. Hence the focal length of L_2 is $f = -60$ cm

(x) What condition must be satisfied by two thin lenses kept in contact so that they form an achromatic doublet, ie. a combination free from chromatic aberration?

Ans:-

$$\frac{\omega}{f_y} = -\frac{\omega'}{f_y'}$$ where ω and ω' are the dispersive powers of the materials

of the lenses between *violet* and red, and f_y and f_y' are the respective focal lengths for the mean colour (yellow).

(xi) Threshold frequency of a certain metal for photo-electric emission is 5 X 10^{14} Hz. Calculate its work function.

Ans:- Work function W = hf_o. W= 6.6 X10^{-34} * 5 X10^{14} =3.3 x10^{-19} J

(xii) What conclusion was drawn by Rutherford based on Geiger-Marsden's experiment on scattering of alpha particles?

Ans:- Rutherford concluded that the centre of atom concentrates most of mass of an atom and it is positive in charge called the nucleus. The negative electrons orbiting outside the nucleus.

(xiii) Write a balanced nuclear reaction showing emission of a β^- particle by $^{234}_{90}Th$. (Symbol of daughter nucleus formed in the process is Pa.)

Ans:- $^{234}_{90}Th \rightarrow \beta^- + ^{234}_{91}Pa$. [*note that β^- emission is electron emission and β^+ is that of positron emission]*

(xiv) What is the essential difference between the working of nuclear reactor and that of a fission bomb?

Ans:- In a nuclear reactor controlled nuclear chain reaction takes place where as in a fission bomb uncontrollable chain reaction takes place.

(xv) State on e important use of a **Zener** diode.

Ans:- It is used in voltage control device.

PART II

Answer six questions in this part, choosing ***two*** *questions from each of the Sections A, B and C.*

SECTION A

Answer any two questions

Question 2

(a) Three point charges Q_1 = 25 μC, Q_2 = 50 μC and Q_3 =100 μC, are kept at the corners A , B and C respectively of an equilateral triangle ABC having each side equal to 7.5 cm. Calculate the total electrostatic potential energy of the system. [4]

Ans:-

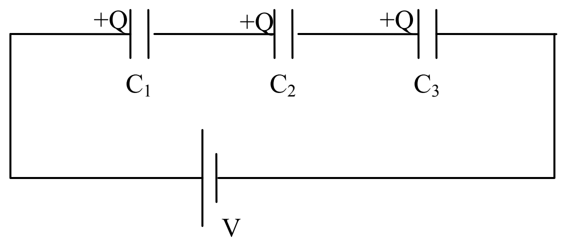
$$U = k\left(\frac{Q_1Q_2}{r} + \frac{Q_1Q_3}{r} + \frac{Q_2Q_3}{r}\right) = \frac{1}{4\pi\varepsilon_o r}\left(Q_1Q_2 + Q_1Q_3 + Q_2Q_3\right)$$

$$U = 9\times10^9\left(\frac{25\times50 + 25\times100 + 50\times100}{7.5\times10^{-2}}\right)\times10^{-12}$$

U =1.050 x 10^3 J.

(b) Obtain an expression for equivalent capacitance C, when three capacitors having capacitance C_1, C_2 and C_3 are connected in **series**. [3]

Ans:-



For series circuit: $V = V_1 + V_2 + V_3$ ………(1)

$$\frac{Q}{C_1}+\frac{Q}{C_2}+\frac{Q}{C_3}=Q\left(\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}\right)$$

$$=\therefore\frac{V}{Q}=\left(\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}\right)$$

$$\frac{1}{C}=\left(\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}\right)$$

Where C is the equivalent capacitance of the combination.

(c) When a potential difference of 3V is applied between the two ends of a 60cm long metallic wire, current density in it is found to be $1x10^{-7}Am^{-2}$. Find conductivity of the material of the wire in SI system. [2]

Ans:-Conductivity σ = J l/V.

$$=\frac{1\times10^{-7}}{3}\times60\times10^{-2}=2.0\times10^{-8}\Omega^{-1}m^{-1}$$

(J = I /A= V /RA
lJ = V l/RA
lJ =V σ
σ = lJ/V)(Note that the current density is given as $1x10^{-7}Am^{-2}$. I think it should be $1x10^{7}$ A m^{-2}. There may be typographical mistake in the question. The value of conductivity σ should be 10 raised to a positive integer!)

Question 3

(a) In the circuit shown in ***Figure 4*** below, E is a battery of emf 6 V and internal resistance 1 Ω. Find the reading of the ammeter A, if it has negligible resistance: [4]

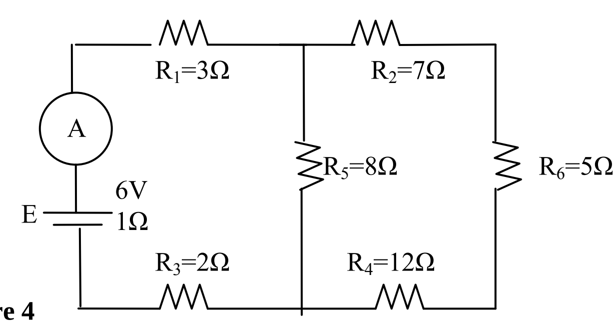
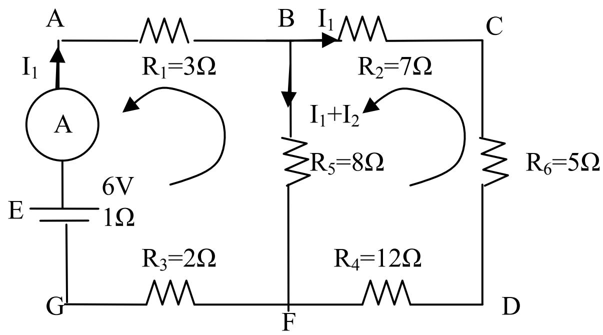


Figure 4

Ans:- (*You must draw a diagram with certain labels and current directions in each branch in this case*)



Applying Kirchoff's mesh rule for ABFGA:(*The curved arrow inside goes in an anti-clockwise direction. When the direction of this arrow is opposite to the current direction in the resistor; the product IR becomes +ive. If they are in the same direction then the product IR is –ive. This is very important. Also, if the curved arrow enters the cell from the positive terminal of the cell, take E as negative. If the arrow enters from the negative side of the cell, then E is +ive.* ***It is better to follow a single rule in writing the Kirchoff's mesh equations to avoid confusion)***

$+I_1R_1+(I_1+I_2)R_5+I_1R_3+I_1*1+E=0$

$3I_1+8I_1+8I_2+2I_1+I_1–6=0$

$14I_1+8I_2= 6$

$7I_1+4I_2= 3$ …………(1)

Applying Kirchoff's mesh rule for BCDFB:

$+I_1R_2+I_1R_6+I_1R_4–(I_1+I_2)R_5=0$

$7I_1+5I_1+12I_1–8I_1–8I_2=0$

$16I_1–8I_2=0$

$2 I_1 –I_2 =0$………….(2)

From equation (2) $I_2 = 2I_1$

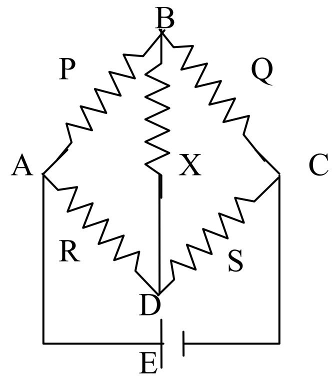
Substituting the value of I_2 in equation (1):

I_1 = 1/5 A.

Thus the reading of the ammeter is 0.2 A.

(b) With the help of a neatly drawn and labelled diagram, obtain balancing condition of **Wheatstone** bridge. [3]

Ans:-



When the values of resistors P, Q, R, and S are adjusted such that the potential at B and D will be the same, no current will pass through the resistor X. Then; the ratio P/Q =R/S. This called the balance condition in Wheatstone bridge.

(c) State any two differences between **Peltier** effect and **Joule** effect. [2]

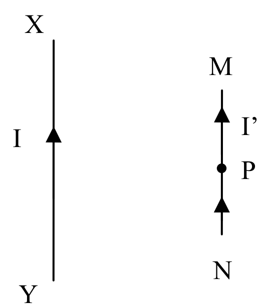
Ans:- 1.Joule effect is irreversible where as Peltier effect is reversible.

2. In Joule effect heat is always evolved; where as in Peltier effect heat is evolved at one junction and heat is absorbed at the other junction.

(*Do not write more than required number; you are wasting your time. No extra marks will be awarded.*)

Question 4

(a) Figure 5 below shows a point P near a long conductor XY carrying a current I. MN is a short current carrying conductor, kept at the point P, parallel to the conductor XY. [2]



(i) What is the direction of magnetic flux density '**B**' at the point P due to the current flowing through XY?

(ii) What is the direction of the force experienced by the conductor MN due to the current flowing through XY?

Ans:- (i) The direction of **B** is perpendicular to the plane of the paper and away from the reader. (*Use the right hand rule cork screw rule*)

(ii) The force on MN is towards the wire XY (*Use the left hand rule. No need to draw the diagram and waste your time in this case)*

(b) What are **four** different types of energy losses in a transformer? State [3] how to reduce/minimize any **one** of them.

Ans:- The energy losses are:

1. Due to eddy current loss.
2. Magnetic coupling loss.
3. Copper loss (loss due to resistance of wire).
4. Hysteresis loss.

Eddy current loss can be minimised by laminating the core of the transformer. (*Watch for bold letters in the question. If you write more than the required answer you are not going to any grace mark. You must read the questions carefully to give the required answer.*)

(c) A 50μF capacitor, a 30Ω resistor and a 0.7 H inductor are connected in series to an ac supply which generates an emf 'e' given by e = 300 Sin(200t) volt. Calculate peak value of the current flowing through the circuit. [4]

Ans:- Peak voltage e_o = 300 V and the angular frequency ω=200

The impedance of the circuit

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} = \sqrt{30^2 + \left(200 \times 0.7 - \frac{1}{200 \times 50 \times 10^{-6}}\right)^2}$$

$$Z = \sqrt{900 + (140 - 100)^2} = \sqrt{900 + 40^2} = \sqrt{900 + 1600} = 50\Omega$$

The peak current $i_o = e_o/Z$ =300/50 = 6A

(*The given equation e = 300 Sin(200t) is compared with the standard equation:*
$e = e_o$ Sin ωt)

SECTION B

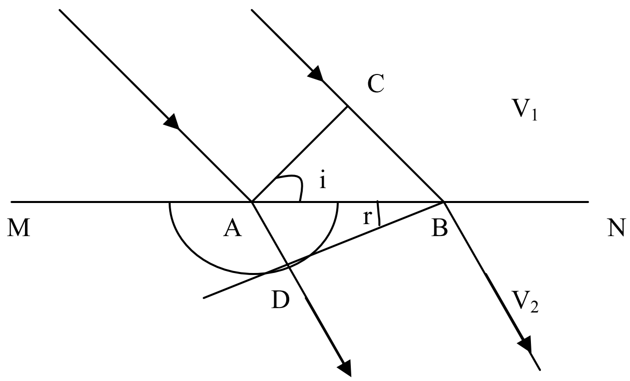
Answer any two questions

Question 5

(a) On the basis of Huygen's wave theory, prove Snell's law of refraction of light. Draw a neat diagram and labelled diagram. (Postulates of Huygen's wave theory not required). [4]

Ans:- Let MN be the surface of separation between two mediums(media). AC represents the incident wave front and i, the angle of incidence. Vi and V2 are the speed of light in the two media respectively.

According to Huygen's wave theory the point A becomes a point of disturbance at the surface before the disturbance at C reaches the surface MN. Let t be the time taken by the disturbance at C reaches B. By this time the disturbance at A will reach a distance of AD in the second medium. With A as centre and AD =V_2 t draw a semi-circle. Draw a straight line from B to touch the envelope of the semicircle. BD will be the refracted wavefront.



From the diagram:

$$In\Delta ABC : Sini = \frac{CB}{AB} = \frac{V_1 t}{AB} ....(1)$$

$$In\Delta ABD : Sinr = \frac{AD}{AB} = \frac{V_2}{AB} ....(2)$$

$$\frac{Sini}{Sinr} = \frac{V_1}{V_2} = \mu$$

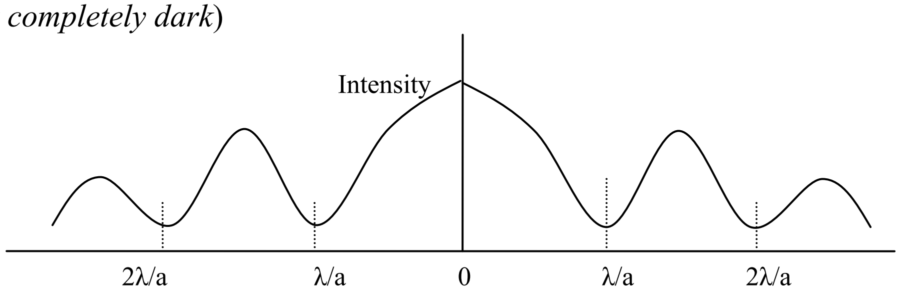
ie.Sini/Sinr = speed of light in the first medium/the speed of light in the second medium' which is the Snell's law.

(b) In Young's double slit experiment, using monochromatic light of wavelength 600nm, interference pattern was obtained on a screen kept 1.5 m away from the plane of the two slits. Calculate the distance between the two slits, if fringe separation/ fringe width was found to be 1.0mm. [2]

Ans:- $\beta = \frac{D\lambda}{d} \therefore d = \frac{D\lambda}{\beta} = \frac{1.5 \times 600 \times 10^{-9}}{1.0 \times 10^{-3}} = 9.0 \times 10^{-4} m$

(c) Draw a labelled graph to show variation in intensity of diffracted light with angular position, in a single slit diffraction experiment. [2]

Ans:-(*The graph is drawn above the horizontal line, showing that the dark bands are not completely dark*)



Angular position (θ), where 'a' is the slit width and 'λ' the wavelength of

Question 6

(a) You are provided with a narrow and parallel beam of light. State how you will determine **experimentally**, whether it is a beam of ordinary (unpolarised) light, partially polarized light or completely polarized light. [3]

Ans:- Fix a polaroid in front of the beam of light and rotate it with its axis perpendicular to the direction of the beam.

(i) If the beam is ordinary light, the intensity of the beam coming out through the polaroid remains the same as it is rotated in any orientation.

(ii) If the beam is partially polarized, the intensity of the beam coming out through the polaroid will be less than the original intensity of the beam, what ever may be its orientation.

(iii) If the beam is completely polarized, the intensity of the beam coming out of the polaroid decreases gradually and becomes zero and then gradually increases to a maximum as the polaroid is rotated continuously in any direction.

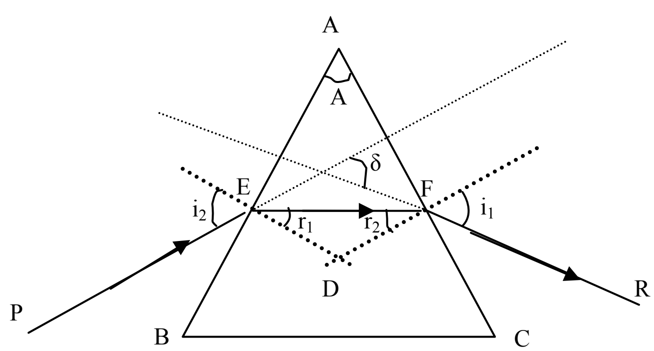
(*Note that a diagram is not required in this case*.)

(b) For any prism, show that refractive index of its material is given by : [3]

$$n \ \ or \ \ \mu = \frac{Sin\left(\frac{A+\delta_m}{2}\right)}{Sin\left(\frac{A}{2}\right)}$$

, where the terms have their usual meaning.

Ans:-In the figure, PEFR shows the path of the ray before and after refraction.
By Snell's law of refraction:



$$\mu = \frac{Sini_1}{Sinr_1} = \frac{Sini_2}{Sinr_2}............(1)\text{ From the cyclic quadrilateral AEDF} : \angle D = 180^\circ - \angle A$$

$$\text{i.e } 180^\circ - (r_1 + r_2) = 180^0 - \angle A \text{ (from the triangle EDF)} \therefore \angle A = r_1 + r_2............(2)$$

$$And \quad \text{the deviation}: \quad \delta = (i_1 - r_1) + (i_2 - r_2).............(3)$$

$$\text{When the deviation } \delta \text{ is minimum} = \delta_m \text{ , } i_1 = i_2 = i \text{ and } r_1 = r_2 = r$$

$$\therefore \angle A = r_1 + r_2 = 2r; \text{ i.e } r = \frac{\angle A}{2}..........(4)$$

$$And \ \ \delta_m = (i - r) + (i - r) = 2i - 2r = 2i - \angle A........\text{using equation(4)}$$

$$\therefore i = \frac{\angle A + \delta_m}{2}..................(5)$$

Using equations (4) and (5) in equation (1) we get :

$$\mu = \frac{\text{Sin}\left(\frac{A + \delta_m}{2}\right)}{Sin\left(\frac{A}{2}\right)}$$

(c) ***Figure 6*** below shows a parallel beam of monochromatic light incident on a convex spherical surface, radius of curvature R=30 cm, which separates glass (refractive index =1.6) from air. Find the position of the image formed due to refraction of light at this single spherical surface. [2]

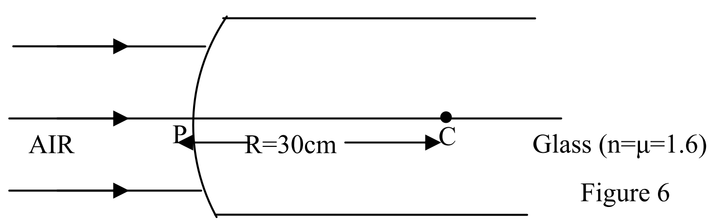


Figure 6

Ans:-For refraction at the convex surface: $\frac{n}{v} - \frac{1}{u} = \frac{n-1}{R}$.Here $u = \infty$

$$\therefore \frac{n}{v} = \frac{n-1}{R}; \therefore v = \frac{nR}{n-1} = \frac{1.6 \times 30}{1.6 - 1} = 80cm$$

Hence the image will be formed at 80 cm from P.

(There is no need to copy the diagram and show where the image is formed. No mark is awarded for the diagram.)

Question 7

(a) (i) What is meant by: [3]

(A) Spherical aberration?

(B) Chromatic aberration?

(ii) How can spherical aberration be reduced/ minimized? Suggest **any one** method.

Ans:- (i) (A) When the rays of light from all parts of the lens are not focused at a single point, it leads to blurring of the image formed. This is called spherical aberration. (*You do not write the cause producing it.)*

(B) When the image of a white object in white light formed by a lens is coloured the defect is called chromatic aberration. *(You do not write the cause producing it)*

(ii) Spherical aberration can be minimised by using plano-convex lens.
(*Note that only one method need to be mentioned; no other explanation or diagram required for the answer*)

(b) A compound microscope consists of an objective of focal length 2 cm and an eye piece of focal length 5 cm. When an object is kept 2.4 cm from the objective, final image formed is virtual and 25 cm from the eye-piece. Determine magnifying power of this compound microscope in this set up i.e. in normal use. [3]

Ans:- $M = -\frac{v_o}{u_o}\left(1+\frac{D}{f_e}\right)$ ….(1). Given that D = 25cm; f_e=5cm, and u_o = – 2.4cm.

To find v_o:

$$\frac{1}{f_o} = -\frac{1}{u_o} + \frac{1}{v_o}$$

$$\therefore v_o = \frac{f_o u_o}{f_o + u_o} = \frac{2\times -2.4}{2-2.4} = 12cm$$

Substituting the values in equation (1): $M = -\frac{12}{(-2.4)}(1+\frac{25}{5}) = 30$

(c) (i) Define resolving power of a simple microscope. [2]
(ii) State one advantage of a reflecting telescope over refracting telescope

Ans:- (i) Resolving power of a simple microscope is defined as reciprocal of the minimum distance between two point objects, whose images are seen as separate. (*Note that the minimum distance 'd' is (i) directly proportional to the wavelength of light falling on the objects. (ii) inversely as the cone of angle of light rays from any one object entering the objective of the microscope and (iii) inversely as the refractive index of the medium in which the object is observed.*

Thus: $d = \frac{\lambda}{2\mu Sin\theta}$. There for resolving power $= \frac{1}{d} = \frac{2\mu Sin\theta}{\lambda}$)

(ii) Reflecting telescope does not suffer from chromatic aberration.

SECTION C

Answer any two questions

Question 8

(a) Electrons having a velocity $\vec{v}$ of 2 x 10^6 ms^{-1} pass undeviated through a uniform electric field $\vec{E}$ of intensity 5 x 10^4 Vm^{-1} and a uniform magnetic field $\vec{B}$. [2]
(i) Find the magnitude of magnetic flux density B of the magnetic field.

(ii) What is the direction of $\vec{B}$, if $\vec{v}$ is towards right and $\vec{E}$ is vertically downwards in the plane of this paper?

Ans:- (i) *(The condition that the electron is undeviated in both electric and magnetic fields is that the fields must be crossed; the force due to the magnetic field is equal and opposite to the force due to the electric field)*

$$B = \frac{E}{v} = \frac{5 \times 10^4}{2 \times 10^6} = 2.5 \times 10^{-2} T$$

(ii) The direction of $\vec{B}$ is in the upward direction of the plane of the paper.

(*Since the direction of $\vec{E}$ is vertically downwards in the plane of the paper; the electron beam deflects vertically upwards. Thus the force due to $\vec{B}$ must be downwards. Use the left hand rule and remember that the movement of electron towards right is equivalent to current towards the left.)*

(b) Monochromatic light of wavelength 198 nm is incident on the surface of a metal whose work function is 2.5eV. Calculate the **stopping potential**. [3]

$$h\nu = W_o + eV_o$$

Ans:- $\frac{hc}{\lambda} = W_o + eV_o \quad \therefore V_o = \left(\frac{hc}{\lambda e} - \frac{W_0}{e}\right) \quad ; V_o = \left(\frac{6.6 \times 10^{-34} \times 3 \times 10^8}{198 \times 10^{-9} \times 1.6 \times 10^{-19}} - 2.5\right)$

$$\therefore V_o = 6.25 - 2.5 = 6V$$

The stopping potential = 6 volt.

(c) Energy levels of **H** atom are given by: $E_n = -\frac{13.6}{n^2} eV$, where 'n' is Principal Quantum number. Calculate the wavelength of electromagnetic radiation emitted by hydrogen atom resulting from the transition: n = 2 to n = 1. [3]

Ans:-

$$E_n = -\frac{13.6}{n^2} eV, \quad E_2 = -\frac{13.6}{2^2} eV = -3.4eV \quad \text{and} \quad E_1 = -\frac{13.6}{1^2} eV = -13.6eV$$

$$\therefore E_2 - E_1 = h\nu = -3.4 - (-13.6) = 10.2eV$$

$$\therefore \frac{hc}{\lambda} = 10.2 \times 1.6 \times 10^{-19} \quad \therefore \lambda = \frac{hc}{10.2 \times 1.6 \times 10^{-19}} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{10.2 \times 1.6 \times 10^{-19}} = 1.21 \times 10^{-7} = 121nm$$

Question 9

(a) (i) What is **Compton effect**? [3]

(ii) In Coolidge X-Ray tube (Modern X-Ray tube) how will you vary:

(1) intensity of emitted X-rays?

(2) penetrating power of emitted X-Rays?

Ans:- (i) When X-Rays fall on matter, along with the unmodified scattering, scattered radiation of lower frequency (higher wavelength) than the incident ration are also produced. This phenomenon is known as Compton effect.

(ii) (1).The intensity of the emitted X-Rays is increased by increasing the current through the filament which produces thermionic emission of electrons in the Coolidge tube.

(2).The penetrating power of X-rays can be increased by increasing the potential difference between the cathode and the target metal in the Coolidge tube.

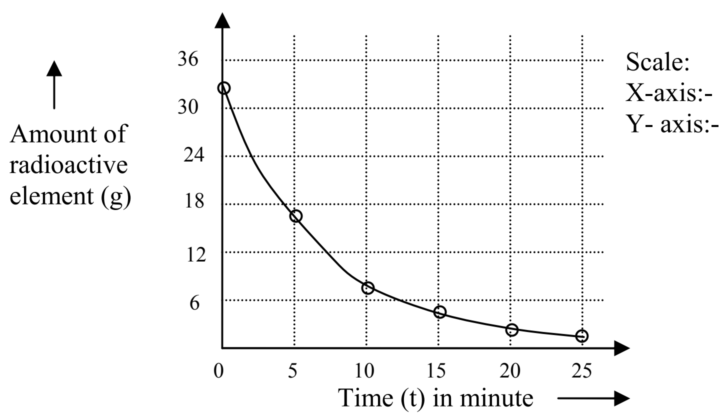
(b) Complete the following table for a radioactive element whose half life is 5 minutes. Assume that you have 32 g of this element at start, i.e. at t = 0. [3]

Time 't' in minutes	0	5	10	15	20	25
Amount of radioactive element left in grams	32					

Now, using this data, plot the "**decay curve**".

Ans:-Data is shown as below:

Time 't' in minutes	0	5	10	15	20	25
Amount of radioactive element left in grams	32	16	8	4	2	1



(*You must draw the graph in a graph paper only. Do not try other wise; a lot of time will be wasted and the graph obtained may not be accurate. Scale chosen must be written*)

(c) Calculate the energy released when an electron annihilates a positron. [2]

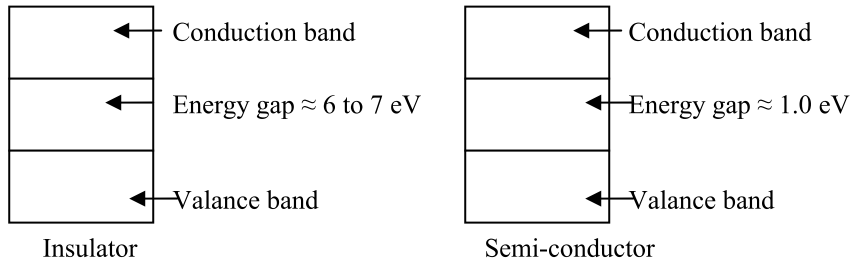
Ans:-The combined mass of electron and positron 'm'= 2x $9\text{x}10^{-31}$ kg.

The energy released = E = mc^2.= 2x $9\text{x}10^{-31}\text{x}(3\text{x}10^{8})^2$ = $1.62 \text{ x } 10^{-13}$ J.

Question 10

(a) Draw a labelled energy band diagram for a solid which is an insulator. What is the main difference between this diagram and that of a semi-conductor? 3]

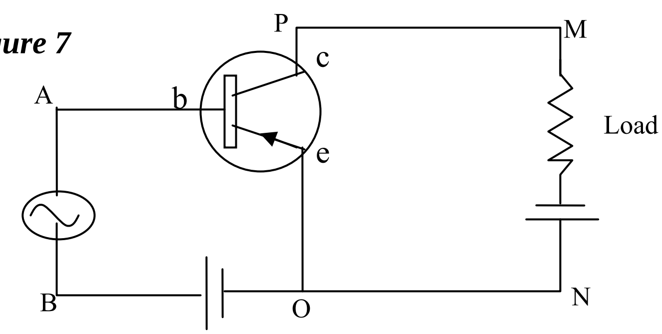
Ans:-



The energy gap in semiconductor is only about 1.0 eV

(b) **Figure 7** below shows the circuit of an electronic device: [3]

Figure 7



(i) Which electronic device: a rectifier, an amplifier or an oscillator does the above circuit represent?

(ii) State where the input voltage is applied and where the out put voltage is available.

(iii) Compare the output voltage of this circuit with its input voltage.

Ans:- (i) It is an amplifier. (*It is a common emitter amplifier*)

(ii) The input is applied between A and B and the output is available between the terminals of the load.(*Input is applied between the base (b) and the emitter(e) and the output is available between the collector (c) and the emitter(e))*

(iii)The output voltage has a phase shift of 180^{o} related to the input voltage.

(c) Prepare a table for the combination of gates shown in ***Figure 8*** below: [2]

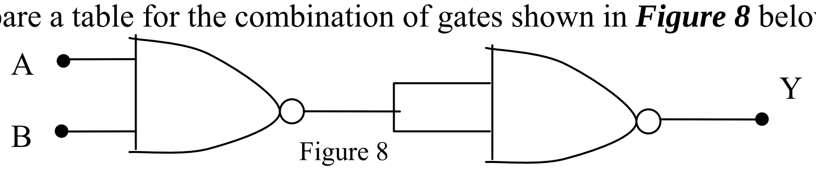


Figure 8

Ans:-(*The first part is a NAND gate and the second section is a NOT gate. Thus NOT of NAND gate is an AND gate*)

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

Useful Constants and Relations:

1	Sped of light in vacuum	(c)	=	3.0×10^{8} ms^{-1}
2	Plank's constant	(h)	=	6.6×10^{-34} Js
3	Constant for Columb's law	$\left(\frac{1}{4\pi\varepsilon_o}\right)$	=	9×10^{9} mF^{-1}
4	Charge of an electron	(–e)	=	-1.6×10^{-19} C
5	Mass of an electron	(m_e)	=	9×10^{-31}kg.
6	1 electron volt	(1 eV)	=	1.6×10^{-19} J
7		1 nm	=	10^{-9} m