Sample Question Paper

(Issued by the CBSE for Exam 2024)

PHYSICS (042) | Class-XII

SOLVED

Times Allowed : 3 Hours **Maximum Marks : 70**

General Instructions:

(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: 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) Three is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
(6) Use of calculators is not allowed.
(7) You may use the following values of physical constants where ever necessary
   i. $c = 3 \times 10^8$ m/s
   ii. $m_e = 9.1 \times 10^{-31}$ kg
   iii. $e = 1.6 \times 10^{-19}$ C
   iv. $\mu 0 = 4\pi \times 10^{-7}$ TmA−1
   v. $h = 6.63 \times 10^{-34}$ Js
   vi. $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N-1\ m^{-2}$
   vii. Avogadro's number = 6.023×10^{23} per gram mole

SECTION-A

1. **Which of the following is not the property of an equipotential surface?** [1]
   (*a*) They do not cross each other.
   (*b*) The work done in carrying a charge from one point to another on an equipotential surface is zero.
   (*c*) For a uniform electric field, they are concentric spheres.
   (*d*) They can be imaginary spheres.

2. **An electric dipole placed in an electric field of intensity 2×10^5 N/C at an angle of 30° experiences a torque equal to 4 Nm. The charge on the dipole of dipole length 2 cm is** [1]
   (*a*) 7 μC
   (*b*) 8 mC
   (*c*) 2 mC
   (*d*) 5 mC

3. **A metallic plate exposed to white light emits electrons. For which of the following colours of light, the stopping potential will be maximum?** [1]
   (*a*) Blue
   (*b*) Yellow
   (*c*) Red
   (*d*) Violet

4. **When alpha particles are sent through a thin gold foil, most of them go straight through the foil, because** [1]

(*a*) alpha particles are positively charged
(*b*) the mass of an alpha particle is more than the mass of an electron
(*c*) most of the part of an atom is empty space
(*d*) alpha particles move with high velocity

5. **An electron is moving along positive x-axis in a magnetic field which is parallel to the positive y-axis. In what direction will the magnetic force be acting on the electron?**

(*a*) Along –x axis
(*b*) Along –z axis
(*c*) Along +z axis
(*d*) Along –y axis

6. **The relative permeability of a substance X is slightly less than unity and that of substance Y is slightly more than unity, then**

(*a*) X is paramagnetic and Y is ferromagnetic
(*b*) X is diamagnetic and Y is ferromagnetic
(*c*) X and Y both are paramagnetic
(*d*) X is diamagnetic and Y is paramagnetic

7. **An ammeter of resistance 0.81 ohm reads up to 1 A. The value of the required shunt to increase the range to 10 A is**

(*a*) 0.9 ohm
(*b*) 0.09 ohm
(*c*) 0.03 ohm
(*d*) 0.3 ohm

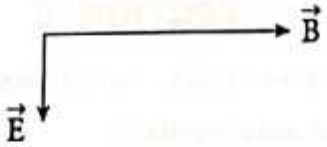
8. **An electron with angular momentum L moving around the nucleus has a magnetic moment given by**

(*a*) e L/2m
(*b*) e L/3m
(*c*) e L/4m
(*d*) e L/m

9. **The large scale transmission of electrical energy over long distances is done with the use of transformers. The voltage output of the generator is stepped-up because of**

(*a*) reduction of current
(*b*) reduction of current and voltage both
(*c*) power loss is cut down
(*d*) a and c both

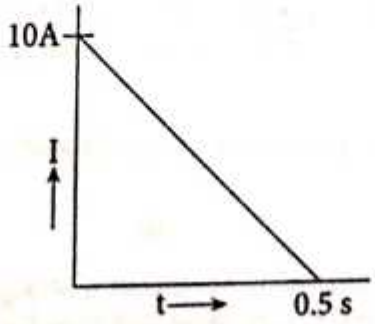
10. **The diagram below shows the electric field (E) and magnetic field (B) components of an electromagnetic wave at a certain time and location.**



The direction of the propagation of the electromagnetic wave is

(*a*) perpendicular to E and B and out of plane of the paper
(*b*) perpendicular to E and B and into the plane of the paper
(*c*) parallel and in the same direction as E
(*d*) parallel and in the same direction as B

11. **In a coil of resistance 100 Ω a current is induced by changing the magnetic flux through it. The variation of current with time is as shown in the figure. The magnitude of change in flux through coil is**



(*a*) 200 Wb
(*b*) 275 Wb
(*c*) 225 Wb
(*d*) 250 Wb

12. The energy of an electron in n^{th} orbit of hydrogen atom is $En = -13.6/n^2 eV$. The negative sign of energy indicates that
    (*a*) electron is free to move.
    (*b*) electron is bound to the nucleus.
    (*c*) kinetic energy of electron is equal to potential energy of electron.
    (*d*) atom is radiating energy.

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

(*a*) If both Assertion and Reason are true and Reason is correct explanation of Assertion.

(*b*) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(*c*) If Assertion is true but Reason is false.

(*d*) If both Assertion and Reason are false.

13. Assertion (A): For the radiation of a frequency greater than the threshold frequency, photoelectric current is proportional to the intensity of the radiation.
    Reason (R) : Greater the number of energy quanta available, greater is the number of electrons absorbing the energy quanta and greater is number of electrons coming out of the metal.
14. Assertion (A) : Putting p type semiconductor slab directly in physical contact with n type semiconductor slab cannot form the pn junction.
    Reason (R) : The roughness at contact will be much more than inter atomic crystal spacing and continuous flow of charge carriers is not possible.
15. Assertion (A) : An electron has a higher potential energy when it is at a location associated with a negative value of potential and has a lower potential energy when at a location associated with a positive potential.
    Reason (R) : Electrons move from a region of higher potential to a region of lower potential.
16. Assertion (A) : Propagation of light through an optical fibre is due to total internal reflection taking place at the core-cladding interface.
    Reason (R): Refractive index of the material of the cladding of the optical fibre is greater than that of the core.

SECTION–B

17. (*a*) Name the device which utilizes unilateral action of a pn diode to convert ac into dc.
    (*b*) Draw the circuit diagram of full wave rectifier. [2]

18. The wavelength λ of a photon and the de Broglie wavelength of an electron of mass m have the same value. Show that the energy of the photon is $2\lambda mc/h$ times the kinetic energy of the electron, where c and h have their usual meanings. [2]

19. A ray of monochromatic light passes through an equilateral glass prism in such a way that the angle of incidence is equal to the angle of emergence and each of these angles is 3/4 times the angle of the prism. Determine the angle of deviation and the refractive index of the glass prism. [2]

20. A heating element using nichrome connected to a 230 V supply draws an initial current of 3.2 A which settles after a few seconds to a steady value of 2.8 A. What is the steady temperature of the heating element if the room temperature is 27.0 °C and the temperature coefficient of resistance of nichrome is 1.70×10^{-4} °C^{-1}? [2]

21. Show that the least possible distance between an object and its real image in a convex lens is 4f, where f is the focal length of the lens. [2]

OR

In an astronomical telescope in normal adjustment a straight black line of length L is drawn on the objective lens. The eyepiece forms a real image of this line whose length is *l*. What is the angular magnification of the telescope? [2]

SECTION–C

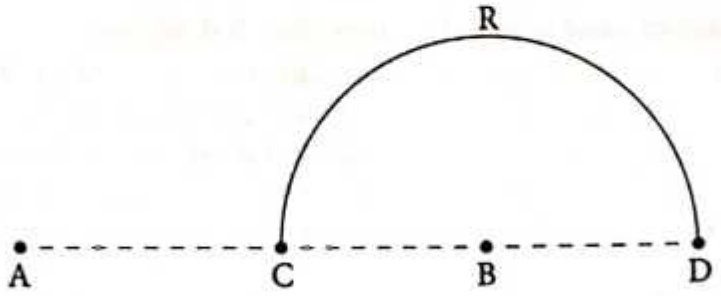
22. A given coin has a mass of 3.0 g. Calculate the nuclear energy that would be required to separate all the neutrons and protons from each other. For simplicity assume that the coin is entirely made of $^{63}_{29}Cu$ atoms (of mass 62.92960 u). [3]

Given $m_p = 1.007825u$ and $m_n = 1.008665u$.

OR

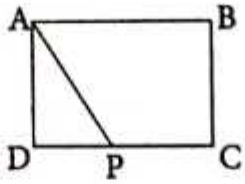
Draw the graph showing the variation of binding energy per nucleon with mass number. Write two inferences which can be drawn from this graph.

23. Charges $(+q)$ and $(-q)$ are placed at the points A and B respectively which are a distance 2L apart. C is the midpoint between A and B. What is the work done in moving a charge +Q along the semicircle CRD. [3]

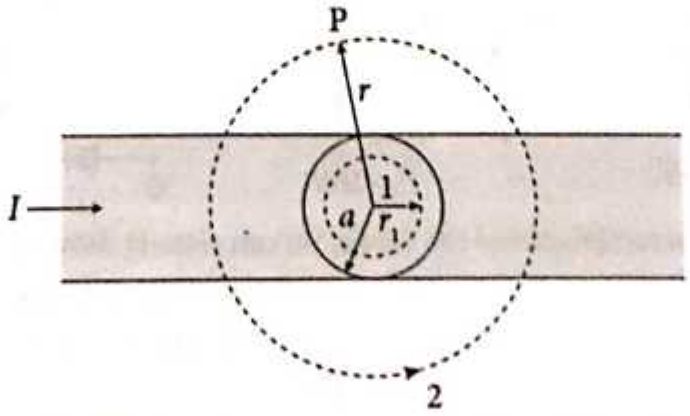


24. The total energy of an electron in the first excited state of the hydrogen atom is about –3.4 eV. [3]
   (*a*) What is the kinetic energy of the electron in this state?
   (*b*) What is the potential energy of the electron in this state?
   (*c*) Which of the answers above would change if the choice of the zero of potential energy is changed?

25. A wire of uniform cross-section and resistance 4 ohm is bent in the shape of square ABCD. Point A is connected to a point P on DC by a wire AP of resistance 1 ohm. When a potential difference is applied between A and C, the points B and P are seen to be at the same potential. What is the resistance of the part DP? [3]



26. The given figure shows a long straight wire of a circular cross-section (radius a) carrying steady current I. The current I is uniformly distributed across this cross- section. Calculate the magnetic field in the region r < a and r > a. [3]



27. Identify the part of the electromagnetic spectrum which: [3]
   (*a*) produces heating effect,

(i) Two thin lenses are kept coaxially in contact with each other and the focal length of the combination is 80 cm. If the focal length of one lens is 20 cm, the focal length of the other would be

(a) −26.7cm (b) 60cm (c) 80cm (d) 30cm

(ii) A spherical air bubble is embedded in a piece of glass. For a ray of light passing through the bubble, it behaves like a

(a) converging lens (b) diverging lens

(c) mirror (d) thin plane sheet of glas

(iii) Lens generally used in magnifying glass is

(a) single concave lens

(b) single convex lens

(c) combination of convex lens of lower power and concave lens of lower focal length

(d) Planoconcave lens

(iv) The magnification of an image by a convex lens is positive only when the object is placed

(a) at its focus F (b) between F and 2F

(c) at 2F (d) between F and optical centre

OR

A convex lens of 20 cm focal length forms a real image which is three times magnified. The distance of the object from the lens is

(a) 13.33 cm (b) 14 cm (c) 26.66 cm (d) 25 cm

SECTION-E

31. (i) Draw a ray diagram for the formation of image of a point object by a thin double convex lens having radii of curvature R_1 and R_2. Hence derive lens maker's formula.

(ii) A converging lens has a focal length of 10 cm in air. It is made of a material of refractive index 1.6. If it is immersed in a liquid of refractive index 1.3, find its new focal length. [5]

OR

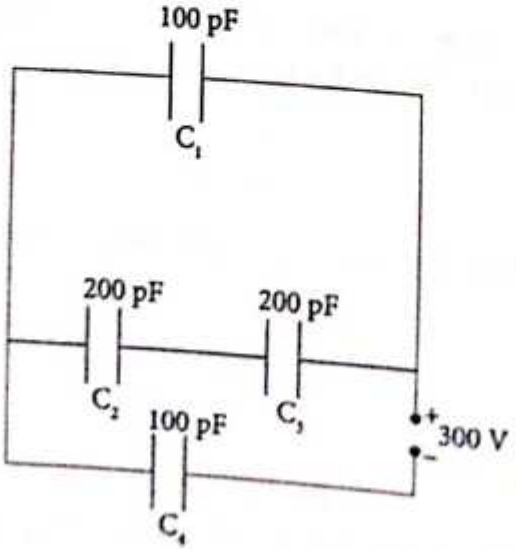
(i) Define a wavefront. How is it different from a ray?

(ii) Using Huygens's construction of secondary wavelets draw a diagram showing the passage of a plane wavefront from a denser to a rarer medium. Using it verify Snell's law.

(iii) In a double slit experiment using light of wavelength 600nm and the angular width of the fringe formed on a distant screen is 0.1°. Find the spacing between the two slits. Write two differences between interference pattern and diffraction pattern.

32. (i) Derive an expression for the capacitance of a parallel plate capacitor with air present between the two plates.

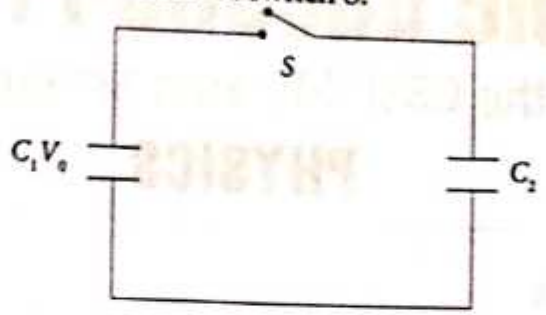
(ii) Obtain the equivalent capacitance of the network shown in figure. For a 300 V supply, determine the charge on each capacitor. [5]



OR

(i) A dielectric slab of thickness 't' is kept between the plates of a parallel plate capacitor with plate separation 'd' ($t < d$). Derive the expression for the capacitance of the capacitor.

(ii) A capacitor of capacity C_1 is charged to the potential of V_0. On disconnecting with the battery, it is connected with an uncharged capacitor of capacity C_2 as shown in the adjoining figure. Find the ratio of energies before and after the connection of switch S.



33. (*a*) Draw graphs showing the variations of inductive reactance and capacitive reactance with frequency of applied ac source.

(*b*) Draw the phasor diagram for a series LRC circuit connected to an AC source.

(*c*) When an alternating voltage of 220V is applied across a device X, a current of 0.25A flows which lags behind the applied voltage in phase by $\pi/2$ radian. If the same voltage is applied across another device Y, the same current flows but now it is in phase with the applied voltage.

(i) Name the devices X and Y.

(ii) Calculate the current flowing in the circuit when the same voltage is applied across the series combination of X and Y. [5]

OR

(*a*) A series LCR circuit is connected to an ac source. Using the phasor diagram, derive the expression for the impedance of the circuit.

(*b*) Plot a graph to show the variation of current with frequency of the ac source, explaining the nature of its variation for two different resistances R_1 and R_2 ($R_1 < R_2$) at resonance. [5]

2 SAMPLE PAPER

Time Allowed: 3 Hours | *Maximum Marks: 70*

General Instructions:

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

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

(3) All the sections are compulsory.

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

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

(6) Use of calculators is not allowed.

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

(*i*) $c = 3 \times 10^8$ m/s

(*ii*) $m_e = 9.1 \times 10^{-31}$ kg

(*iii*) $e = 1.6 \times 10^{-19}$ C

(*iv*) $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}

(*v*) $h = 6.63 \times 10^{-34}$ Js

(*vi*) $\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 $N^{-1}m^{-2}$

(*vii*) Avogadro's number = 6.023×10^{23} per gram mole

SECTION – A

1. A particle of mass 1.96×10^{-15} kg remains suspended between two horizontal metallic plates, kept one above the other 2 cm apart, when the potential difference between them is 800 V. The charge on the particle is:

(*a*) $2e$ (*b*) $3e$

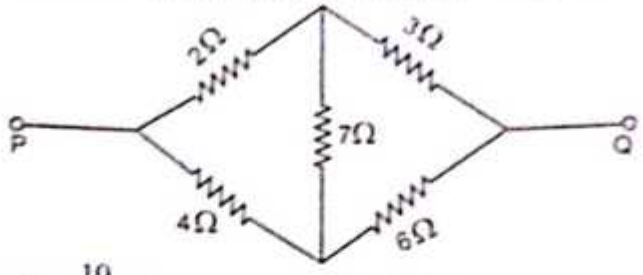
(*c*) $4e$ (*d*) $5e$

2. A metallic hemisphere of radius r is placed in a region having a uniform electric field E perpendicular to its cross-section. The electric flux ϕ passing through the hemisphere is:

(*a*) $\frac{2}{3}\pi r^3 E$ (*b*) $\pi r^2 E$

(*c*) $2\pi r E$ (*d*) $2\pi r^2 E$

3. Find the effective resistance between the points P and Q in the given circuit.



(a) $\frac{20}{3}\ \Omega$ (b) $\frac{10}{3}\ \Omega$ (c) 15 Ω (d) 6 Ω

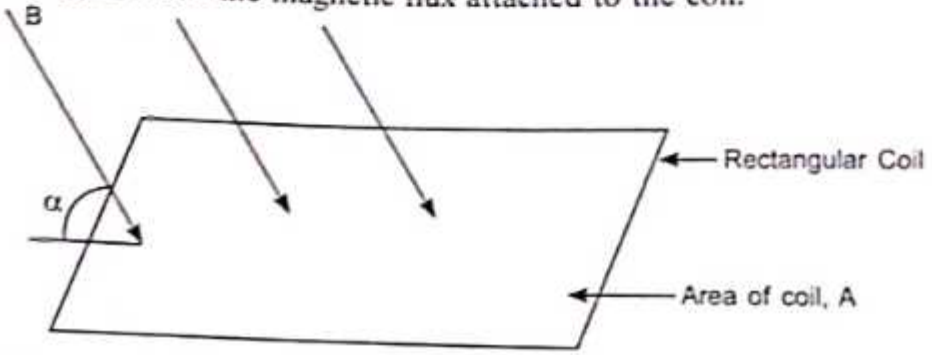
4. W units of work are required to turn a magnetic needle lying parallel to a magnetic field by 60° angle. Find the torque required to maintain the same position of the needle.

(a) W (b) 2 W (c) $\sqrt{3}$ W (d) $\sqrt{\frac{3}{2}}$ W

5. The susceptibility of a magnetic material is 0.9853. Identify the type of the magnetic material.

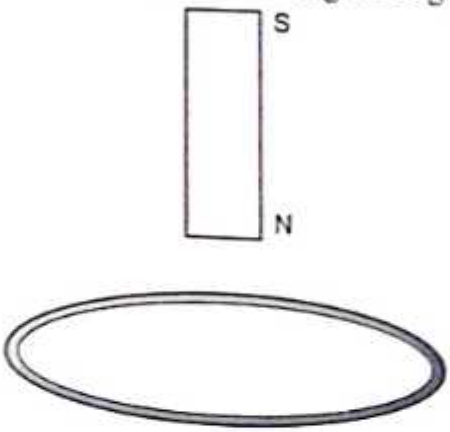
(a) Diamagnetic (b) Paramagnetic (c) Ferromagnetic (d) Data insufficient

6. The cross-sectional area of a rectangular coil is A and it is kept in a uniform magnetic field B as shown in the figure. Find the magnetic flux attached to the coil.



(a) BA sin α (b) BA cos α (c) BA (d) Zero

7. A bar magnet is falling down with its N-Pole downwards towards a closed metallic ring as shown below. Find the direction of induced current flowing through the ring.



(a) Clockwise
(b) Anticlockwise
(c) First clockwise and then anticlockwise
(d) First anticlockwise and then clockwise

8. The peak value of an alternating current is 14.14 A. If the frequency of the current is 50 Hz, find the time the current takes in reaching its maximum value from zero.

(a) $\frac{1}{50}$ sec (b) $\frac{1}{100}$ sec (c) $\frac{1}{150}$ sec (d) $\frac{1}{200}$ sec

9. Which of the following statements is not correct about interference of light?
   (*a*) The amplitudes of two interfering wave trains should be equal or very nearly equal.
   (*b*) In interference of light, the two sources should be very narrow.
   (*c*) To avoid the interference bands to be very close, the two sources should be far away.
   (*d*) None of the above.

10. One a.m.u. is equal to
   (*a*) 931 MeV. (*b*) 1.49×10^{-10} J. (*c*) 1.66×10^{-27} kg. (*d*) all of the above.

11. The wavelength of series limit in Balmer Series is:
   (*a*) $\frac{R}{4}$ (*b*) $\frac{4}{R}$ (*c*) $\frac{5R}{36}$ (*d*) $\frac{36}{5R}$

12. A monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. The power emitted is 2.0×10^{-3} W. The approximate number of photons emitted per second by the source is :
   (*a*) 5×10^{15} photons/sec (*b*) 6.6×10^{14} photons/sec
   (*c*) 5.8×10^{14} photons/sec (*d*) None of the above

For Q.13 to 16, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (*a*), (*b*), (*c*) and (*d*) as given below.

(*a*) If both Assertion and Reason are true and Reason is correct explanation of Assertion.
(*b*) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(*c*) If Assertion is true but Reason is false.
(*d*) If both Assertion and Reason are false.

13. **Assertion (A):** A proton and an alpha particle having the same kinetic energy are moving in circular paths in a uniform magnetic field. The radii of their circular paths will be equal.
   Reason (R): Any two charged particles having equal kinetic energies and entering a region of uniform magnetic field B in a direction perpendicular to B, will describe circular trajectories of equal radii.

14. **Assertion (A):** Right-angled isosceles glass prisms are used as reflectors of light in optical instruments.
   Reason (R): In total internal reflection, almost 100% of light is reflected against about 80% for a silvered mirror.

15. **Assertion (A):** The minimum negative potential given to anode at which photoelectric current becomes zero is called cut-off voltage.
   Reason (R): The minimum frequency of incident radiation below which no emission of photoelectrons takes place is called the threshold frequency.

16. **Assertion (A):** An extrinsic semiconductor is a doped semiconductor either with trivalent or pentavelant impurity.
   Reason (R): The electrical conductivity is low in intrinsic semiconductor.

SECTION – B

17. Two long straight parallel conductors '*a*' and '*b*' carrying currents i_a and i_b along the same direction are separated by a distance d. Explain the force of attraction between them. A third wire '*c*' carrying a current i_c in the opposite direction is situated in the middle of these parallel conductors. Find the resultant force acting on the wire kept in the middle.

18. Two thin convex lenses L_1 and L_2 of focal lengths f_1 and f_2 respectively are placed coaxially in contact. An object is placed beyond the focus of lens L_1. Draw a ray diagram to show the image formation by the combination and hence derive the expression for the focal length of the combined system.

19. In Young's double slit experiment, plot a graph showing the variation of fringe width versus the distance of the screen from the plane of the slits keeping other parameters the same. What does the slope of the curve mean?

20. When four hydrogen nuclei combine to form a helium nucleus, calculate the amount of energy in MeV released in the process of fusion. Given that:

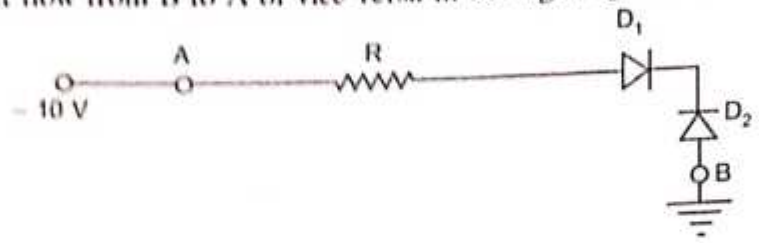
(*i*) Mass of ^1_1H = 1.007825 u

(*ii*) Mass of helium nucleus = 4.002603 u and 1 u = 931 MeV/c^2

21. Explain how does a depletion region is formed in a junction diode.

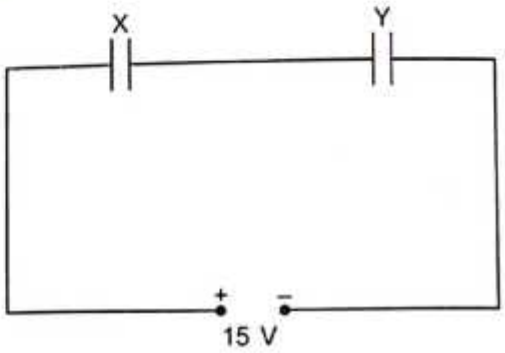
Or

Does any current flow from B to A or vice versa in the figure given below? Explain.



SECTION – C

22. Two parallel plate capacitors X and Y have the same area of plates and same separation between them. X has air between the plates while Y contains a dielectric medium $\varepsilon_r = 4$.



(*i*) Calculate the capacitance of each capacitor if equivalent capacitance of the combination is 4 μF.

(*ii*) Calculate the potential difference between the plates of X and Y.

(*iii*) Estimate the ratio of electrostatic energy stored in X and Y.

23. Derive an expression for the magnetic field due to a solenoid of length '2*l*' radius '*a*' having '*n*' number of turns per unit length and carrying a steady current '*I*' at a point on its axial line, distance '*r*' away from the centre of the solenoid. How does this expression compared with the axial magnetic field due to a bar magnet?

24. Find the expression for magnetic field intensity along the equitorial position of a bar magnet. Show that for a small bar magnet the intensity of magnetic field in equitorial position is half in magnitude of axial position.

25. (*a*) State the principle of working of a transformer.

(*b*) Define the efficiency of a transformer.

(*c*) Calculate the current drawn by the primary of a 90% efficient transformer which steps down 220 V to 22 V, if the output resistance is 440 Ω.

26. (*a*) Arrange the following electromagnetic waves in the order of their increasing wavelength.

(*i*) Microwaves

(*ii*) X-rays

(*iii*) Radio waves

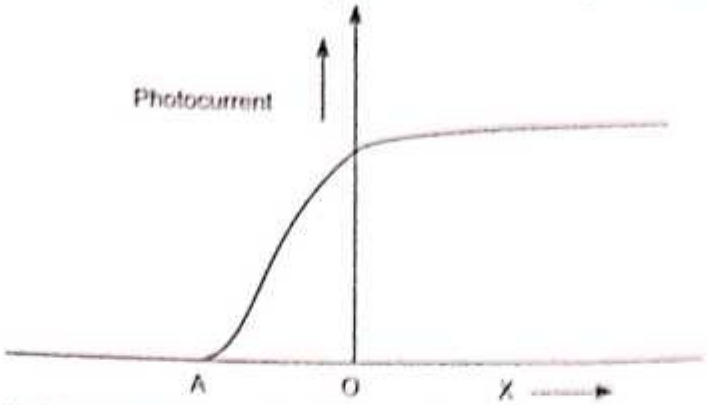
(*iv*) γ-rays.

(*b*) How are infrared waves produced? What is the role of infrared radiation in

(*i*) physical therapy?

(*ii*) maintaining the Earth's warmth?

27. The following graph shows the variation of photocurrent for a photosensitive metal.



(*a*) Identify the variables X and A on the horizontal axis.

(*b*) Draw this graph for three values of frequencies of incident radiation ν_1, ν_2 and ν_3 ($\nu_1 > \nu_2 > \nu_3$) for the same intensity of incident beams.

(*c*) Draw this graph for three different values of intensities of incident radiation I_1, I_2 and I_3 ($I_1 > I_2 > I_3$) having the same wavelengths.

Or

Plot a graph showing the variation of photocurrent with intensity of light.

The work function for the given metals Na and Mo are 2.75 eV and 4.17 eV respectively. Which of these will not give photoelectronic emission from a radiation of wavelength 3300 Å from a laser beam. What happens when the source is brought closer?

28. (*a*) Draw a plot showing the variation of potential energy of a pair of nucleons as a function of their separation. Mark the regions where the nuclear force is (*i*) attractive and (*ii*) repulsive.

(*b*) In this nuclear reaction,

$$n + {}^{235}_{92}U \longrightarrow {}^{a}_{54}X + {}^{94}_{b}Sr + 2n$$

determine the values of a and b.

SECTION – D

29. **Case study**

Read the following paragraph and answer the questions that follow.

The bending of light waves around the corners of obstacles or apertures and spreading into the regions of geometrical shadow is called diffraction of light. The size of the obstacle or aperture should be of the order of wavelength of the light used. Interference is the superposition of light waves from two different wavefronts originating from the same source, while the diffraction is the interaction of light waves from different parts of the same wavefront.

(*i*) The essential condition for diffraction of light to occur is that the size of the aperture

(*a*) must be less when compared to the wavelength of light.

(*b*) must be more when compared to the wavelength of light.

(*c*) must be comparable to the wavelength of light.

(*d*) should not be compared to the wavelength of light.

(*ii*) Single slit diffraction is completely immersed in water without changing any other parameter. How is the width of the central maximum affected?

(*a*) Insignificant (*b*) Increases (*c*) Decreases (*d*) Becomes zero

(*iii*) The main difference in interference and diffraction is

(*a*) diffraction is due interaction of light from the same wavefront whereas interference is the interaction of waves from two isolated sources.

(*b*) diffraction is due to the interaction of light from the wavefront, whereas interference is the interaction of two waves derived from the same source.

(c) diffraction is due to the interaction of waves derived from the same source, whereas interference is the bending of light from the same wavefront.
(d) there is no difference between interference and diffraction.

(iv) The phenomenon of interference is based on
(a) conservation of momentum. (b) conservation of energy.
(c) quantum nature of light. (d) conservation of momentum and energy.

Or

(iv) To observe diffraction the size of the obstacle
(a) should be $x/2$, where x is the wavelength.
(b) should be of the order of wavelength.
(c) has no relation to wavelength.
(d) should be much larger than the wavelength.

30. Case study

Read the following paragraph and answer the questions that follow.

If a donor impurity is diffused into one side of a crystal and an acceptor impurity into the other, the boundary between those regions is called a *p-n* junction. Due to diffusion, free electrons of '*n*' section combine with holes of '*p*' section. This produces an electric field and prevents the electrons and holes from crossing the junction. The small region in the vicinity of *p-n* junction is called depletion layer.

(i) In an intrinsic semiconductor,
(a) there are no free electrons. (b) there are only holes.
(c) free electrons are thermally produced. (d) None of these.

(ii) What causes the barrier layer in a *p-n* junction?
(a) Doping (b) Recombination (c) Barrier potential (d) Ions

(iii) When a diode is forward biased, the recombination of the free electrons and holes may produce
(a) heat. (b) light. (c) radiation. (d) all of these.

(iv) When the reverse voltage increases from 5 V to 10 V, the depletion layer
(a) becomes larger. (b) becomes smaller. (c) is unaffected. (d) breaks down.

Or

(iv) If the temperature of a piece of germanium increases its conductance
(a) increases (b) decreases (c) remains unchanged (d) becomes zero

SECTION – E

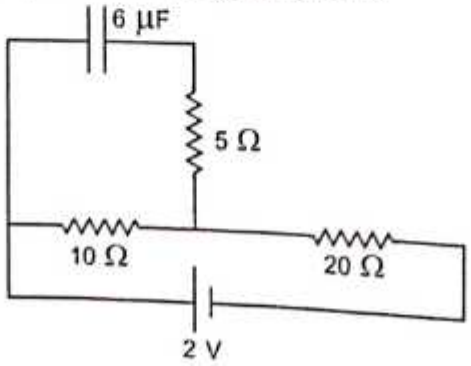
31. (a) Derive an expression for electrical energy density in electric field of a parallel plate capacitor.

(b) Using Gauss's law, find the electric field intensity due to a linear charge distribution of infinite length at a point r distance away from it.

Or

(a) How would you connect four capacitors, each of capacitance 1 μF to obtain a net capacitance of 0.75 μF? Draw a diagram to show the combination.

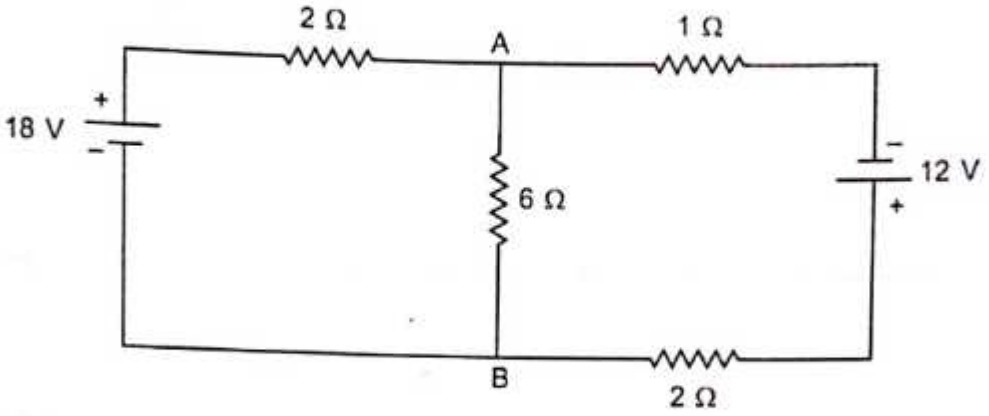
(b) Find the charge on the capacitor in the given circuit.



32. (*a*) Show that when a current is divided between two resistances in accordance with Kirchhoff's laws, the heat produced is minimum.

(*b*) Why is the long distance power transmission carried out at high voltage?

(*c*) Calculate the current in each part of the circuit shown below. Also find the potential difference between points A and B.

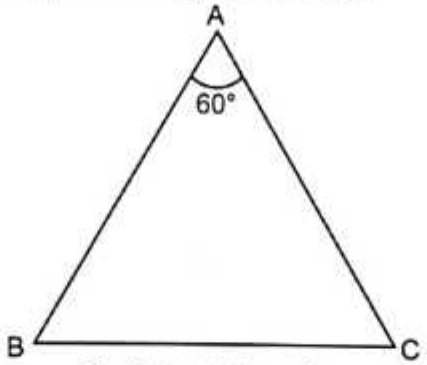


Or

(*a*) Identical cells each of emf E and internal resistance 'r' are arranged in a mixed grouping. One row in the combination has 'n' cells and there are 'm' rows in parallel. An external resistance R is joined with this combination. Find the expression for the total current in the circuit.

(*b*) Show that in the above case the current in the external circuit will be maximum when the total internal resistance of the battery equals to the joined external resistance of combined cells. Find its value.

33. (*a*) A ray of light incident on face AB of an equilateral glass prism, shows minimum deviation of 30°. Calculate the speed of light through the prism.



Equilateral glass prism

(*b*) Find the angle of incidence at face AB so that the emergent ray grazes along the face AC.

(*c*) Draw a ray diagram for the formation of image by a reflecting telescope.

Or

(*a*) A point object is placed on the principal axis of a convex spherical surface of radius of curvature R, which separates the two media of refractive indices n_1 and n_2 ($n_2 > n_1$). Draw the ray diagram and deduce the relation between the object distance 'u', image distance 'v' and the radius of curvature R for refraction to take place at the convex spherical surface light going from rarer to denser medium.

(*b*) A converging lens has a focal length of 20 cm in air. It is made of a material of refractive index 1.6. It is immersed in a liquid of refractive index 1.3, find its new focal length.

3 SAMPLE PAPER

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.

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

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

(6) Use of calculators is not allowed.

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

(*i*) $c = 3 \times 10^8$ m/s

(*ii*) $m_e = 9.1 \times 10^{-31}$ kg

(*iii*) $e = 1.6 \times 10^{-19}$ C

(*iv*) $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}

(*v*) $h = 6.63 \times 10^{-34}$ Js

(*vi*) $\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1}m^{-2}

(*vii*) Avogadro's number = 6.023×10^{23} per gram mole

SECTION – A

1. The value of the total electric flux due to a unit positive charge kept in vacuum is:

(*a*) $\frac{1}{4\pi\varepsilon_0}$ (*b*) ε_0 (*c*) $\frac{1}{\varepsilon_0}$ (*d*) $4\pi\varepsilon_0$

2. Both electrons and protons with negligible initial velocities are accelerated through a certain potential difference. Then the emergent

(*a*) protons have larger kinetic energy.

(*b*) electrons have smaller velocity.

(*c*) protons have larger momentum.

(*d*) electrons have larger momentum.

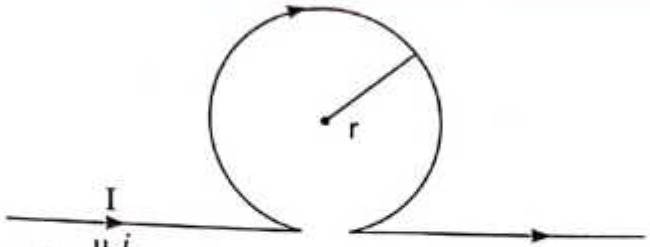
3. Find the diameter of a spherical conductor having 1 μF capacity.

(*a*) 1.8×10^4 m (*b*) 1.8×10^3 m (*c*) 1.8 m (*d*) 18 m

4. The current in an electric bulb decreases by 0.5%. The percentage reduction in the power of the bulb is:

(a) 1 (b) 0.5 (c) 2 (d) $\frac{1}{4}$

5. I current flows through an infinitely long straight wire with a circular loop of radius r as shown in the diagram. Find the value of the magnetic induction at the centre of the circular loop.



(a) $\frac{\mu_0 i}{2\pi r}(\pi + 1)$ (b) $\frac{\mu_0 i}{2\pi r}(\pi - 1)$ (c) Zero (d) Infinity

6. An electron is revolving in an orbit of radius 3.14×10^{-15} m. Its angular velocity is 5×10^{11} cycles/sec. The magnetic field produced at the centre is:

(a) $\frac{16}{\pi}$ T (b) 16 T (c) 4 T (d) π T

7. A straight conductor of length 0.4 m is moved in a magnetic field of induction 0.9 Wb/m^2 with a velocity of 7 m/s. The maximum emf induced in the conductor is:

(a) 22.5 V (b) 2.52 V (c) 52.2 V (d) Data insufficient

8. The force of attraction between the plates of a parallel plate capacitor filled with dielectric material of constant K is:

(a) $\frac{q^2}{2\varepsilon_0 AK}$ (b) $\frac{q^2}{2\varepsilon_0 A}$ (c) $\frac{q}{\varepsilon_0 AK}$ (d) $\frac{q^2}{2\varepsilon_0 A^2 K}$

9. A capacitor of 1 pF is connected to an a.c. source of 220 V and 50 Hz. Find the reactance of the capacitor.

(a) $10^{10}\ \Omega$ (b) $\frac{10^{10}}{\pi}\ \Omega$ (c) $10^{12}\ \Omega$ (d) $\frac{10^{12}}{\pi}\ \Omega$

10. Nuclides with the same mass number A but with different atomic number Z are called

(a) isotopes. (b) isobars. (c) isotones. (d) isomers.

11. The minimum potential required to accelerate a bombarding electron to provoke excitation from the ground state is called

(a) resonance potential. (b) excitation potential.
(c) ionisation potential. (d) none of the above.

12. Calculate the frequency of a photon having energy equal to 7.5 eV.

(a) 1.81×10^{14} Hz (b) 1.81×10^{15} Hz (c) 1.81×10^{-14} Hz (d) None of these

For Q.13 to Q.16, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.
(b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) If Assertion is true but Reason is false.
(d) If both Assertion and Reason are false.

13. **Assertion (A):** In reflecting telescope, the image is free from chromatic aberration.
Reason (R): Chromatic aberration persists in the image formed by a lens as in refracting telescope.

14. **Assertion (A):** In Young's double slit experiment, if a thin film is introduced in front of the upper slit, then the fringe pattern shifts in the downward direction.
Reason (R): In Young's double slit experiment, if the slit widths are unequal, the minima will be completely dark.

15. **Assertion (A):** If the intensity of the incident light on a photosensitive surface is doubled, the kinetic energy of the emitted electrons is also doubled.
Reason (R): The intensity of incident light is more for faster emitted electrons.

16. **Assertion (A):** An ideal rectifier may be thought as a switch for electronic circuits.
Reason (R): A rectifier closes a load circuit whenever the a.c. is positive and opens whenever it is of negative polarity.

SECTION – B

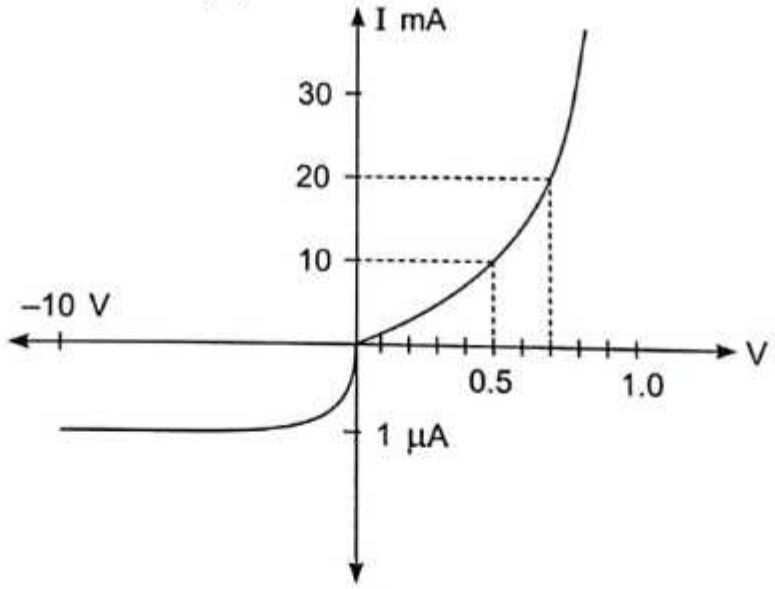
17. A parallel plate capacitor is charged to a potential difference V. After disconnecting it from the battery, it is reconnected with an uncharged capacitor of the same capacitance. Find the ratio of the energy stored in the combination to the initial energy of the single capacitor.

18. An object is placed 15 cm in front of a convex lens of focal length 10 cm. Find the nature and position of the image formed. Where should a convex mirror of radius of curvature 20 cm be placed so that the final image is formed at the position of the object itself ?

19. Find the ratio of intensities at points on a screen in Young's double slit experiment, where the interfering waves have a path difference (*i*) 0 and (*ii*) $\frac{\lambda}{4}$.

20. Show that the radius of the nth orbit of H-atom is directly proportional to the square of the principal quantum number.

21. The *V-I* characteristic of a silicon diode is shown in the figure below. Calculate the resistance of the diode at (*i*) $I = 15$ mA and (*ii*) $V = -10$ V.



Or

Write two points of difference between intrinsic and extrinsic semiconductors.

SECTION – C

22. An α-particle and a proton of the same kinetic energy are in turn allowed to pass through a magnetic field $\vec{B}$, acting normal to the direction of motion of the particles. Calculate the ratio of radii of the circular paths describe by them.

23. A long straight wire of circular cross-section of radius '*a*' carries a steady current *I*. The current is uniformly distributed across the cross-section. Apply Ampere's circuital law to calculate the magnetic field at a point, *r* distance away from the axis of the current carrying wire for (*i*) $r < a$ and (*ii*) $r > a$

24. A galvanometer with a coil of resistance 12 Ω shows full scale deflection for a current of 2.5 mA. How will you convert it into a voltmeter of range 7.5 V? Calculate the total resistance of voltmeter.

25. Three circuit elements X, Y and Z are given. When the element X is connected across an a.c. source of a given voltage, the current and the voltage are in the same phase. When the element Y is connected in series with X across the source, the current lags behind the voltage in phase by $\frac{\pi}{4}$. But the current leads the voltage by phase $\frac{\pi}{4}$ when Z is connected in series with X across the source. Identify the circuit elements X, Y and Z.

When all the three elements are joined in series across the same source, determine the impedance of the circuit.

Or

An ideal capacitor having a charge $q = q_0 \cos \omega t$ is connected across an ideal inductor through a switch. On closing the switch, show that the sum of the energies in the capacitor and inductor is constant in time in the free oscillations of the *LC* circuit.

26. Answer the following questions.

(*a*) Name the electromagnetic waves which are produced during radioactive decay of a nucleus. Write their frequency range.

(*b*) Welders wear special glass goggles while working. Why?

(*c*) Why are infrared waves often called heat waves? Give their one application.

27. Write Einstein's photoelectric equation and mention which important features in photoelectric effect can be explained with the help of this equation.

The maximum kinetic energy of the photoelectrons gets doubled when the wavelength of incident light on the surface changes from λ_1 to λ_2. Derive the expressions for the threshold wavelength λ_0 and work function for the metal surface.

28. (*a*) Draw a graph showing the variation of binding energy per nucleon (BE/A) v/s mass number A for the nuclei in $20 \leq A \leq 170$.

(*b*) A nucleus of mass number 240 and having binding energy/nucleon 7.6 MeV splits into two fragments Y and Z of mass numbers 110 and 130 respectively. If the binding energy/nucleon of Y and Z is equal to 8.5 MeV each, calculate the energy released in the nuclear reaction.

SECTION – D

29. **Case Study**

Read the following paragraph and answer the questions that follow.

An optical fibre transmits light introduced at one end to the opposite end with little loss of the light through the sides of the fibre. It consists of a cylindrical central core of diameter of the order of a few micro meter made up of thousands of long and extremely thin strands of high quality glass or quartz. The core is clad by a slightly lower refractive index material.

(*i*) What is the principle of fibre optical communication?

(*a*) Huygen's principle
(*b*) Young's double slit experiment
(*c*) Total internal reflection
(*d*) None of these

(*ii*) Total internal reflection takes place when light travels from

(*a*) a rarer to a denser medium.
(*b*) a denser medium to a rarer medium.
(*c*) a rarer medium to a denser medium with angle of incidence greater than critical angle.
(*d*) a denser medium to a rarer medium with angle of incidence greater than critical angle.

(iii) If the critical angle for total internal reflection from a medium to vacuum is 30°, then the speed of light in the medium is:

(a) 6×10^8 m/s (b) 3×10^8 m/s (c) 2×10^8 m/s (d) 1.5×10^8 m/s

(iv) In total internal reflection when the angle of incidence is equal to the critical angle for the pair of media in contact, what will be the angle of refraction?

(a) 90° (b) 180°

(c) 0° (d) equal to the angle of incidence

Or

(iv) If i_{c_1}, i_{c_2} and i_{c_3} are the critical angles of glass-air interface for red, violet and yellow colour respectively, then

(a) $i_{c_3} > i_{c_2} > i_{c_1}$ (b) $i_{c_1} > i_{c_2} > i_{c_3}$ (c) $i_{c_1} = i_{c_2} = i_{c_3}$ (d) $i_{c_1} > i_{c_3} > i_{c_2}$

30. Case Study

Read the following paragraph and answer the questions that follow.

Insulators are those materials in which valence electrons are bound very tightly to their parent atoms and thus requiring very large electric field to remove them against the attraction of their nuclei. The insulators have a full valence band, an empty conduction band and a large energy gap between the valence and conduction bands.

(i) The resistivity of a semiconductor _____ conductors and insulators.

(a) is more than that of (b) lies between

(c) is less than that of (d) does not lie near or between

(ii) Addition of trivalent impurity to a pure semiconductor creates many

(a) free electrons. (b) valence electrons. (c) holes. (d) bound electrons.

(iii) In a semiconductor, current conductions is due _____

(a) to only holes. (b) to holes and free electrons.

(c) to only free electrons. (d) none of these.

(iv) The barrier voltage at a *pn* junction for germanium is about

(a) 0.3 V (b) 3.5 V (c) 3 V (d) zero

Or

(iv) A *pn* junction acts as a

(a) unidirectional switch. (b) bidirectional switch.

(c) controlled switch. (d) none of these

SECTION – E

31. (a) A 10 MeV, α-particle moves head on towards a stationary gold nucleus (Z = 79). Calculate the distance of the closest approach.

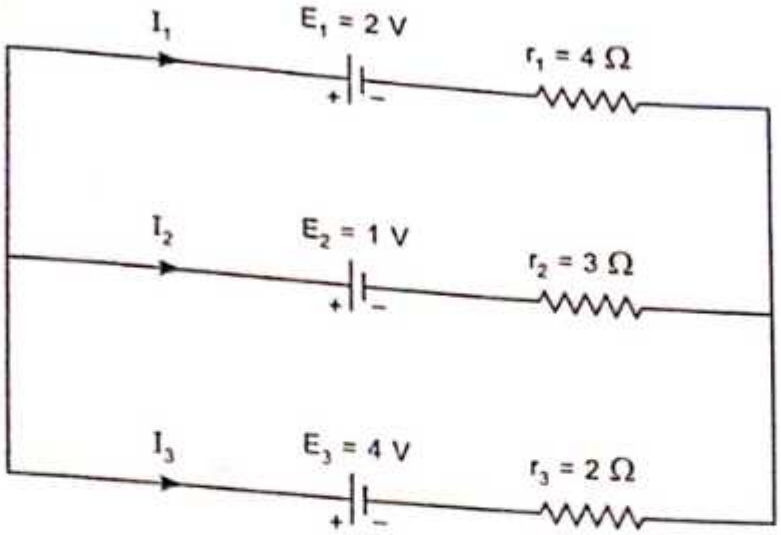
(b) '*n*' identical drops each charged to V volt coalesce to form a big drop. Calculate the potential of the big drop.

Or

(a) A charge Q is distributed over two concentric hollow spheres of radii a and b $(b > a)$ such that their surface charge densities are equal. Find the potential at the common centre of the spheres.

(b) Show that there is always a loss of energy when two charged conductors at different potentials are connected together.

32. State Kirchhoff's rules. Use these rules to write the expressions for the currents I_1, I_2 and I_3 in the circuit diagram shown.



Or

(*a*) Define the terms (*i*) drift velocity, (*ii*) relaxation time.

A conductor of length L is connected to a d.c. source of emf ε. If this conductor is replaced by another conductor of same material and same area of cross-section but of length $3L$, how will the drift velocity change?

(*b*) (*i*) Two materials Ge and Al are cooled from 300 K to 60 K. What will be the effect on their resistivity?

(*ii*) Plot a graph showing the variation of resistance of a conducting wire as a function of its radius, keeping the length of the wire and its temperature unchanged.

33. (*a*) Draw a labelled ray diagram of a compound microscope.

(*b*) Derive an expression for its magnifying power.

(*c*) Why the objective lens of a microscope is of short aperture and short focal length?

(*d*) Deduce the relation $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ for two thin lenses kept in contact coaxially.

Or

(*a*) A convex lens of focal length 20 cm is placed coaxially with a concave mirror of focal length 10 cm at a distance of 50 cm apart from each other. A beam of light coming parallel to the principal axis is incident on the convex lens. Find the position of the final image formed by this combination. Draw the ray diagram showing the formation of the image.

(*b*) A small illuminated bulb is at the bottom of a tank, containing a liquid of refractive index μ upto a height H. Find the expression for the diameter of an opaque disc, floating symmetrically on the liquid surface in order to cut-off the light from the bulb.