CBSE Sample Paper 7

Class XII Exam 2022-23

Physics

Time: 3 Hours **Max. Marks: 70**

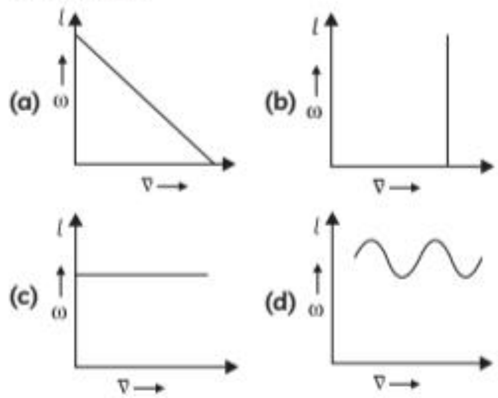
General Instructions:

1. There are 35 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. All the sections are compulsory.
3. Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.
4. There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

SECTION - A

18 Marks

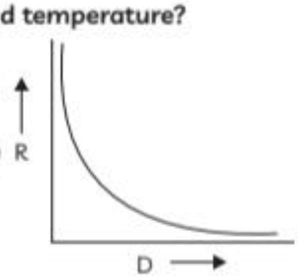
1. Which of the given graph shows correct relation between wave number and angular frequency?



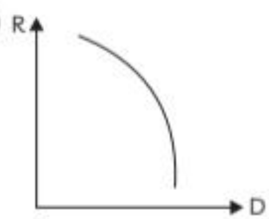
1

2. Which of the following graph shows the variation of resistance of a metal wire as a function of its diameter with constant length and temperature?

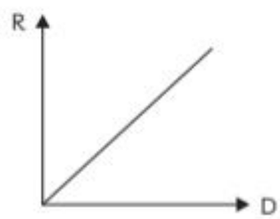
(a)



(b)



(c)



(d)

1

3. The magnetic field at a point 15cm away from a straight wire carrying 6A current will be:

(a) 4×10^{-6} T (b) 8×10^{-6} T
(c) 12×10^{-6} T (d) 2×10^{-6} T 1

4. The magnetic field at the centre of circular coil of 100 turns and radius 0.5m carrying 8A current will be:

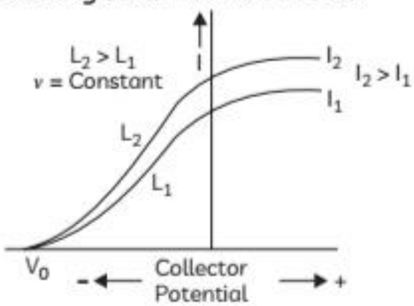
(a) 1.89×10^{-3} T (b) 2.6×10^{-3} T
(c) 8.5×10^{-3} T (d) 4×10^{-4} T 1

5. Prism of refractive index 2 deviates in incident ray through an angle of 1°, then the refractive index of the prism's material will be:

(a) 1.5 (b) 3

(c) 2.5 (d) 1 1

6. Considering the graph given below, which of the following statement is correct?



(a) The maximum kinetic energy of the emitted photoelectrons is independent of intensity of light.

(b) Saturation current is less than the intensity of light.

(c) Maximum kinetic energy with which photo electrons are emitted from a metal surface is independent of frequency of incident light.

(d) All of the above. 1

7. Which of the following statement is true?

(a) Electrostatic force is a conservative force.

(b) Potential at a point is the work done per unit charge in bringing a charge from any point to infinity

(c) Electrostatic force is non-conservative

(d) Potential is the product of charge and work 1

8. A dipole is placed in a uniform electric field directed from west to east. If the position of dipole is along the electric field what will be the torque acting on the dipole?

(a) – 1 (b) No torque acting

(c) 1 (d) ∞ 1

9. In an electronic circuit, having in a charged capacitor, the current through connecting wire is:

(a) displacement

(b) conduction current

(c) direct current

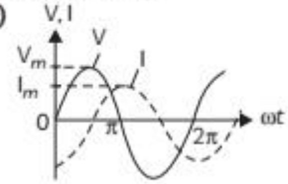
(d) altermating current 1

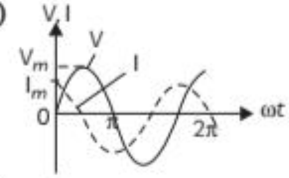
10. What will be the current through the conductor at the instant of $t = 5s$, if the charge through the cross-section of the conductor is given by, $Q = (3t^2 + 2t)$C.

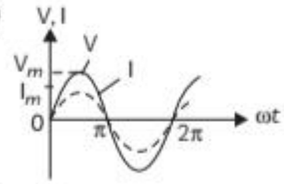
(a) 16 A (b) 32 A

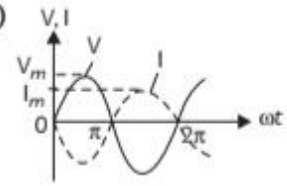
(c) 20 A (d) 64 A 1

11. The phase relationship between current and voltage in a pure resistive circuit is best represented by:

(a)


(b)


(c)


(d)


1

12. In a Wheatstone bridge, three resistances P, Q and R are connected in the three arms and the fourth arm is formed by two resistances S_1 and S_2 connected in parallel. The condition for the bridge to be balanced will be:

(a) $\frac{P}{Q} = \frac{2S}{S_1 + S_2}$ (b) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{S_1 S_2}$

(c) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{2S_1 S_2}$ (d) $\frac{P}{Q} = \frac{R}{S_1 S_2}$ 1

13. A parallel plate capacitor C has a charge Q. The actual charges on the plates are:

(a) Q, Q (b) $\frac{Q}{2}, \frac{Q}{2}$

(c) Q, – Q (d) $\frac{Q}{2}, -\frac{Q}{2}$ 1

14. While performing a young's double slit experiment, interference fringes of width X obtained from a light of wavelength 800nm. The wavelength of light is increased to 1600nm and the separation between the slits is halved. What will be the ratio of the distance between the screen and the plane of interfering sources into arrangement for one to observe the fringe width on the screen be same?

(a) 1 (b) 2

(c) 3 (d) 4 1

15. Laser operates at a frequency of 3×10^{12} Hz and has an aperture of 10^{-1}. What will be the angular spread of light?

(a) 1.5×10^{-3} rad (a) 1.22×10^{-6} rad

(a) 1.22×10^{-3} rad (a) 1.22×10^{-6} rad 1

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) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is NOT the correct explanation of A.

(c) A is true but R is false.

(d) A is false and R is also false.

16. Assertion (A): For larger magnification a simple microscope of magnification 10 can be used.

Reason (R): The second lens in simple microscope is for enhancing the effect of other. 1

17. Assertion (A): When AC current is flowing through LCR circuit and $\omega L = \omega C$, current and emf are in phase with each other.

Reason (R): Impedance of the circuit becomes equal to the R. 1

18. Assertion (A): Dispersion takes place because the refractive index of refractive medium is different for different frequency.

Reason (R): As per Cauchy's relation refractive Index of a material directly depends on the frequency. 1

SECTION - B

14 Marks

19. Verify the Gauss's law for magnetic field of a point dipole of dipole moment m at the origin for the surface which is a sphere of radius R? 2

20. Two wires of aluminium and copper of radius 0.12cm are connected in series carrying current.

(A) What will be the current density in aluminium wire and

(B) Drift velocity of electrons in copper wire. 2

21. A bulb and a capacitor are connected in series to a variable frequency alternating current source. How will the brightness of the bulb vary as the frequency of the alternating current source is increased? Give an explanation.

OR

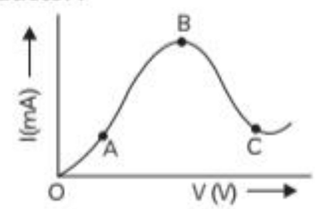
In an LC circuit, what happens if the repeated magnetic energy appears as the electric energy across the capacitor? 2

22. Strong current is not passed through semiconductor as it in damages the semiconductors. Explain the relation of bonds behind the above statement. 2

23. On what factors will the magnitude of photoelectric current and velocity of ejected electrons depend during photoelectric emission from a metal surface.

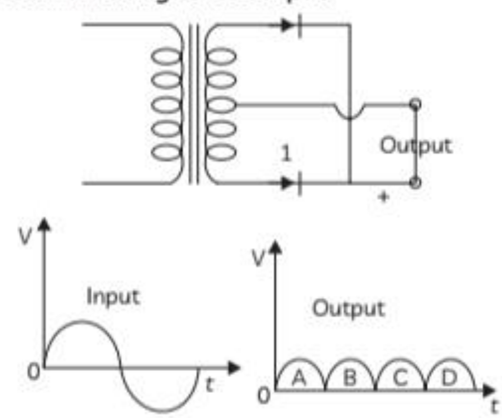
OR

V-I graph is plotted for a given semiconductor. Which region of the graph points the negative resistance of the semiconductor?



2

24. A full wave rectifier circuit is shown along with its output characteristics. Which diode is contributing to its output?



2

25. Define and explain the role of delayed neutrons in a nuclear reactor. 2

SECTION - C

15 Marks

26. Explain the conversion of a galvanometer into a voltmeter.

OR

Two short bar magnets identical to each other have magnetic moment $24 Am^2$ are placed perpendicular to each other at a separation of 10cm. Calculate the magnetic field at the midpoint of the two magnets. 3

27. Define the "electric flux." Write its SI units. What is the flux due to an electric field $\vec{E} = 3 \times 10^3 \hat{i}$ N/C passing through a square with a side of 10 cm when kept normal to $\vec{E}$? 3

28. Mass number of A nucleus of an atom is A, by neglecting the mass of the orbital electrons find the nuclear density of the nucleus.

OR

What will be the maximum wavelength of the radiation which can create a hole for a *p*-type having energy levels 32 meV above the valence band? 3

29. An optical instrument comprises a 100 D optic objective lens and a 40 D eyepiece. When the instrument's tube length is fixed at 20 cm, the final picture is created at Infinity. Determine the optical instrument. Determine the angular magnification of the instrument. 3

30. Specific type of material preferred for manufacturing of solar cells. By stating their bandgap, name the different materials used for solar cells manufacturing. 3

SECTION - D

15 Marks

31. With the help of a diagram, explain the construction and working of an astronomical telescope forms final image at the least distance of distinct vision and at infinity.

OR

With the wavefront diagram, explain what should be the approximate size of the aperture to observe the diffraction of light. Distinguish between Fresnel and Fraunhoffer diffraction. 5

32. Using a phasor diagram of AC voltage applied to a resistor find the average value of power over a cycle.

OR

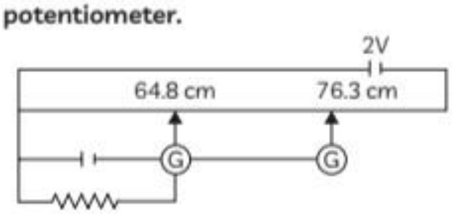
If a source of emf is connected to an inductor L and current starts growing inducing an opposite emf in the inductor, what will be the energy spent by the source to send current through the circuit against the induced EMF? 5

33. Demonstrate that when a current is split between two resistances using Kirchhoff's principles, the heat provided is hardly any.

OR

(A) Define EMF. of a cell? On what factors does it depend?

(B) Figure below shows a 2.0 v potentiometer used for the determination of internal resistance of a 1.5 v cell. The balance point of the cell in open circuit is 76.3 cm. When a resistance of 9.5Ω is used in external circuit of the cell the balance point shifts to 64.8 cm length of the potentiometer.



5

Determine the internal resistance of the cell.

SECTION - E

8 Marks

34. *De-Broglie hypothesis show that wave particle duality was not only a behaviour of light but was a fundamental principle exhibited by both radiation and matter. It is possible to use Wave Equation to describe material behaviour as long as one properly applies the de Broglie wavelength. Though the broglie hypothesis predicts wavelength of matter of any size, there are realistic limits only when it's useful. A cricket ball shot towards the boundary has de Broglie wavelength smaller than the diameter of a proton by about 20 orders of magnitude.*

(A) If the velocity of an electron is doubled then how will the de-Broglie frequency vary? 1

(B) Two cars A and B are moving. Car A is moving with speed v having de Broglie wavelength λ. Car B is moving with twice the speed of car A having kinetic energy twice than that of car A. What will be the de broglie wavelength of car B? 1

(C) A cricket ball of 60g is moving with velocity 11 ms^{-1}. Find the de-Broglie wavelength of the ball.

OR

Which equation perfectly describes the association between de-Broglie wavelength λ and absolute temperature, T? 2

35. *When two tuning forks are struck simultaneously, they produce sound waves almost in the same phase. There phase difference varies slowly with time. Such variations can be detected easily by human ear. The phase difference between two independent light bulb changes 10^8 x for second. Therefore, we can observe interference of sound using our senses but we cannot observe the interference pattern of light.*

(A) If we use monochromatic source in young's double slit experiment, what is the shape of interference fringes formed at the screen? 1

(B) During the young's double slit experiment, mica is added, read the path of one of the interfering beams. How will the fringe width be affected? 1

(C) If the ratio of two intensities of two waves is 9:1 then find the ratio of amplitudes of two waves.

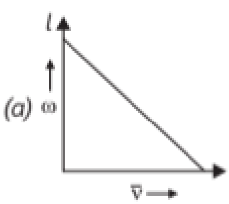
OR

Two parallel slits in young's double slit experiment are made 1mm a part and the screen is placed 2m away. What will be the fringe separation when a light of 600nm is used? 2

SOLUTION

SECTION - A

1. (a)

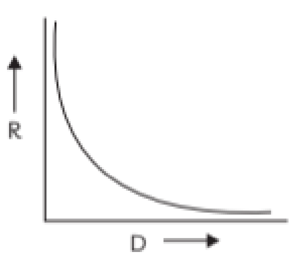


Explanation: $\nu = \frac{1}{\lambda} = \frac{v}{\nu} = \frac{\omega}{2\pi\nu}$

or $\omega = 2\pi v$

Graph between wavenumber and angular frequency is a straight line with slope equal to $2\pi v$.

2. (a)



Explanation: We know that,

$$R = \rho\frac{l}{A} = \rho\frac{1}{\pi D^2/4}$$

$$R \propto \frac{1}{D^2}$$

Related Theory

For small percentage change (< 5%) in the length of the wire by stretching or folding the wire,

$$\frac{\Delta R}{R} = \frac{2\Delta l}{l}$$

3. *(b) 8×10^{-6} T*

Explanation: Here I = 6A

a = 15 cm = 0.15m

We know that,

Magnetic Field, $B = \frac{\mu_0 2I}{4\pi a}$

$$B = \frac{10^{-7} \times 2 \times 6}{0.15}$$

$$= 8 \times 10^{-6} \text{ T.}$$

4. *(d) 4×10^{-4} T*

Explanation: n = 100

a = 0.5m and I = 8A

As we know,

Magnetic field, $B = \frac{\mu_0}{4\pi}\frac{2\pi nI}{a}$

$$= \frac{10^{-7}\times\pi}{4\pi}\times\frac{100\times 8}{0.5}$$

$$= 4 \times 10^{-4}\ \text{T}$$

5. *(a) 1.5*

Explanation: Deviation through a Prism of small angle is given by,

$$\delta = (\mu - 1)A$$

$$A = 2, \delta = 1°,$$

$$\mu = \frac{\delta}{A}+1 = \frac{1}{2}+1 = 1.5$$

Caution

- *Students must know that the above formula is used for a Prism of small angle and independent of the angle of incidence. The given expression indicates that thin sheets of glass with A, almost equal to 0°, cannot deviate light rays.*

6. *(a) The maximum kinetic energy of the emitted photoelectrons is independent of intensity of light.*

Explanation: The graph is between potential of the capacitor and the photoelectric current for incident light of two different intensities with different frequency. It follows that the value of stopping potential remains the same when the light of different intensity with same frequency is incident. Therefore, there is no effect of intensity of incident light shown on the kinetic energy of the emitted photoelectrons.

7. *(a) Electrostatic force is a conservative force.*

Explanation: The electrostatic force's work is independent of the direction it takes and totally depend on the initial and final coordinates. The work done in transmitting a unit positive charge in a closed loop of an electric field, is zero. As a result, electrostatic force is a conservative force.

8. *(b) No torque acting*

Explanation: The toque acting on a dipole placed in a uniform electric field is given by,

$$\vec{\tau} = \vec{p}\times\vec{E}$$

If the electric dipole makes an angle ϕ with the direction of the electric field.

$$\tau = p.E\sin\phi$$

No torque acts on a dipole when it is aligned along the direction of electric field.

Related Theory

- *The torque acting on the dipole is maximum when it is perpendicular to the electric field and zero, when it is parallel to the direction of the field.*
- *Value of torque can be determined by looking at the angle. When the angle between electric field and dipole is 90°, the torque will be maximum at $\sin\phi$ is maximum at 90°.*

9. *(b) Conduction Current*

Explanation: In an electric circuit having in a charged capacitor, the current through the connecting wires is called conduction current, while that flowing through the gap between the plates of capacitor is called displacement current.

Related Theory

- *The conduction and displacement current are entirely different from each other but both current produce magnetic field in the same number.*
- *The displacement current owes its origin to the varying electric field between the two plates of a charged capacitor.*

10. *(b) 32 A*

Explanation: Charge is given by,

$$Q = (3t^2 + 2t)C$$

We know that,

instantaneous current is,

$$I = \frac{dQ}{dt} = \frac{d}{dt}(3t^2+2t)$$

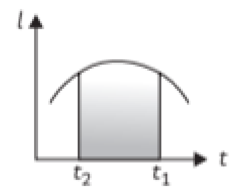
$$= 6t + 2$$

At $t = 5s$

$$I = 6(5) + 2 = 32\ \text{A}$$

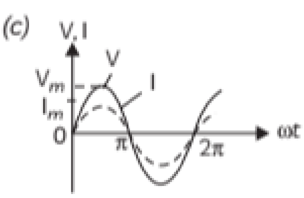
Related Theory

- *Total charge in the interval t_1 to t_2 $Q = \int_{t_1}^{t_2} Idt =$ Area below I versus t graph in the interval t_1 to t_2 as shown in figure. Average current in the interval t_1 to t_2.*



$$I_{av} = \frac{Q}{t_2 - t_1} = \frac{\int_{t_1}^{t_2} Idt}{t_2 - t_1} = \frac{\textit{Area below I versus t graph}}{\textit{Time interval}}$$

11. *(c)*



Explanation: In the pure resistive circuit current and voltage, both are in same phase. Therefore, the current and the voltage both will have their peak values at the same instant.

Hence graph (c) is correct.

12. *(d)* $\frac{P}{Q}=\frac{R}{S_1S_2}$

Explanation: The balanced condition for Wheatstone bridge is,

Here, $$S = \frac{S_1S_2}{S_1+S_2}$$

(as S_1 and S_2 are connected in parallel in S arm)

So, $$\frac{P}{Q} = \frac{R(S_1+S_2)}{S_1S_2}$$

13. *(c) Q, – Q*

Explanation: When a capacitance C parallel plate capacitor is connected across a potential difference V battery, the charge produced by the plate is equal to Q = CV. The whole charge is collected on both plates of a perfect capacitor. This charge will be equally distributed on both plates but will be of opposing charge, i.e. equal and opposite. As a result, the charge will be +Q and –Q. Q is the Coulomb charge on each plate. The charge on the positive plate is +Q, whereas the charge on the negative plate is –Q.

14. *(b) 2*

Explanation: Let D_1 be the distance between the screen and the sources to obtain the same fringe width, light of wavelength 800nm is used.

$$\beta = \frac{D\lambda}{d}$$

$$\therefore \quad \frac{D_1 \times 800 \times 10^{-9}}{d} = X$$

Let D_2 be the distance between the screen and the sources to obtain the same fringe width, light of wavelength 1600nm is used.

$$= \frac{D_2 \times 1600 \times 10^{-9}}{d}$$

From the above equations

$$\frac{D_1}{D_2} = \frac{1600 \times 10^{-9}}{800 \times 10^{-9}} = 2.$$

15. *(c) 1.22×10^{-3} rad*

Explanation: Here $\nu = 3 \times 10^{12}$ Hz and $d = 10^{-1}$

$$c = 3 \times 10^8 \text{ m/s}$$

$$\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{3 \times 10^{12}} = 10^{-4}$$

Angular spread,

$$\theta = \frac{1.22\lambda}{d} = \frac{1.22 \times 10^{-4}}{10^{-1}}$$

$$= 1.22 \times 10^{-3} \text{ rad}$$

16. *(d) A is false and R is also false.*

Explanation: A simple microscope has a limited maximum magnification for realistic focal lengths. For much larger magnification compound lens is used to enhance the effect of objective lens which is used in compound microscope.

Related Theory

- *The magnifying power is expressed with the unit of X. If magnifying glass produces angular magnification of 10, it is called 10X magnifier.*

17. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: When a rectangular coil is inside a magnetic field, one end of the coil becomes positive while the other end of the coil becomes negative. Thus, the potential difference between the two ends will be the same. It will look like two cells of equal emf connected together.

18. *(d) A is false and R is also false.*

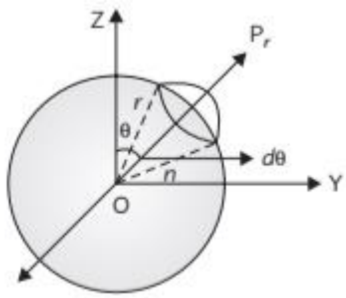
Explanation: Dispersion takes place because of refractive index of refracting medium is different for different wavelengths. As per Cauchy's relation refractive Index of a material is given by,

$$\mu = a + \frac{b}{\lambda^2} + \frac{c}{\lambda^4}$$

Where *a*, *b* and *c* are constant whose value depend on the nature of the material.

SECTION - B

19.



We have to prove that $\oint B.dS = 0$. This is called Gauss law in magnetisation.

According to the question,

Magnetic moment of the dipole at origin O is

$$M = M\hat{k}$$

Let P be a point at distance r from O and OP makes an angle θ with Z-axis.

Component of M along OP = M cos θ

Now, the magnetic field induction at P due to dipole of moment M cos θ is $B = \frac{\mu_0}{4\pi}.\frac{2M\cos\theta}{r^3}\hat{i}$

From the diagram, r is the radius of sphere with centre at O lying in PZ-plane. Take an elementary area dS of the surface at P. Then, $dS = r\,(r \sin\theta d\theta)\,\hat{r} = r^2 \sin\theta d\theta\,\hat{r}$

$$\oint B.dS = \oint \frac{\mu_0}{4\pi}.\frac{2M\cos\theta}{r^3}\hat{r}\,(r^2 \sin\theta d\theta\,\hat{r})$$

$$= \frac{\mu_0}{4\pi}.\frac{M}{r}\int_0^{2\pi} \sin 2\theta d\theta$$

$$= \frac{\mu_0}{4\pi}.\frac{M}{r}\left(\frac{-\cos 2\theta}{2}\right)_0^{2\pi}$$

$$= \frac{\mu_0}{4\pi}.\frac{M}{2r} \qquad [\cos 4\pi - \cos 0]$$

$$= \frac{\mu_0}{4\pi}.\frac{M}{2r}\,[1-1] = 0.$$

20. (A) Area of cross section,

$A = \pi r^2 = 3.14 \times (0.12 \times 10^{-2}) = 4.5 \times 10^{-6}\,m^2$

Current density is given by,

$$j = \frac{I}{A}$$

$$j = \frac{20}{4.5 \times 10^{-6}}$$

$$= 4.45 \times 10^6\,Am^2$$

(B) Area of cross section,

$$A = \pi r^2 = 3.14 \times (0.12 \times 10^{-2})$$

$$= 4.5 \times 10^{-6}\,m^2$$

Drift velocity of electrons is given by,

$$v_d = \frac{I}{enA}$$

$e = 1.6 \times 10^{-19}$ C,

$n = 8.4 \times 10^{28}\,m^{-3}$ and I = 20 A

By putting the values in the given formula, we get

$$v_d = \frac{20}{1.6 \times 10^{-19} \times 8.4 \times 10^{28} \times 4.5 \times 10^{-6}}$$

$$v_d = 3.3 \times 10^{-4}\,ms^{-1}.$$

21. When the ac frequency is raised, the impedance of the circuit decreases as

$Z = \sqrt{R^2 + (1/2\pi f C)^2}$ As a result, the current and, as a result, the brightness of the bulb will improve.

OR

When a charged capacitor in an LC circuit discharges through the inductor, the electric energy stored between the plates of capacitor appears as the magnetic energy inside the inductor. When the capacitor has discharged, the magnetic field linked with the inductor starts collapsing due to which EMF is produced in the inductor and capacitor start charging again. Polarity of the plates of capacitor keeps on shifting which gives rise to LC oscillations.

22. When a strong current is passed through a semiconductor, it heats up the semiconductor and covalent bonds break up. It results in the number of free electrons.As the temperature rises, the kinetic energy of electrons also increases which will cause an increase in the number of collisions between electrons themselves and between the electrons and atoms or ions of the metal. It will cause the material to behave like a conductor and use the property of low conduction.

23. During photoelectric emission from a metal surface the magnitude of photoelectric current depends upon the intensity of incident radiation.

The velocity of ejected electrons depends on the frequency of incident radiation and the work function of the metal.

OR

Negative resistance is a property of semiconductor in which when increase in voltage across the devices terminals result in decrease in current through it.

The slope of the current versus voltage graph for the given semiconductor gives its resistance. As the slope of the part BC of the graph is negative, the semiconductor has a negative resistance in the region BC.

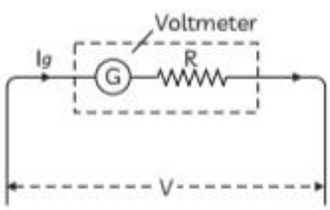
24. During the positive half cycle, the upper diode gets forward biased and conducts current while the lower diode 1 gets reverse-biased and does not conduct current. During the negative half of the cycle diode 1 gets forward biased and conduction current. Therefore, the contribution for output is from diode 1 are B and D type.

25. The neutrons produced by the subsequent decay of the initial fission fragments are called delayed neutrons.

The production of delayed neutrons is crucial to the mechanical control of the reactor. If all fission neutrons were produced instantly in fission, there would be no time for the minute adjustments required in a nuclear reactor to keep it critical.

SECTION - C

26. Suppose that the galvanometer is to be converted into a voltmeter of range 0 to V volt. Further, suppose that the galvanometer gives full scale deflection, when current I_g is passed through it. The resistance R is connected in series to the galvanometer so as to convert it into the voltmeter of the required range. For this, the value of R is adjusted so that when a battery of V volt (maximum value of potential difference to be measured) is connected across the series combination of galvanometer and resistance R, the galvanometer gives full scale deflection *i.e.*, current equal to I_g flows through it.



If G is the resistance of the galvanometer, then

$$I_g = \frac{V}{G+R}$$

$$R = \frac{V}{I_g} - G$$

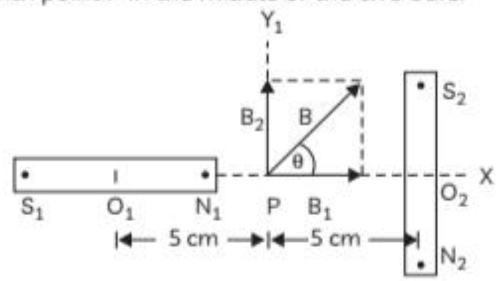
Knowing the value of V, I_g and G, the value of R can be found. When the resistance of this value is connected in series to the coil of the galvanometer, it will work as a voltmeter of range 0 to V volt.

Related Theory

➥ *In practice, it is found that R_V is very large as compared to the value of G. Hence, a voltmeter is a high resistance instrument. An ideal voltmeter should possess infinite resistance.*

OR

Let the two magnets N_1S_1 and N_2S_2 be placed with point P in the middle of the two bars.



It is given that,

$$M_1 = M_2 = 24\ Am^2 = M$$

Point P is on the axial line of the magnet $N_1 S_1$

Magnetic field due to bar one N_1S_1 will be,

$$B_1 = \frac{\mu_0}{4\pi}\frac{2M_1}{(O_1P)^2} = \frac{10^{-7} \times 2 \times 24}{(0.05)^2}$$

$$= 0.04T \text{ (along the PX direction)}$$

Point P is on the equatorial line of the magnet N_2S_2

Magnetic field due N_2S_2 will be,

$$B_2 = \frac{\mu_0}{4\pi}\frac{M_2}{(O_2P)^2} = \frac{10^{-7} \times 24}{(0.05)^2}$$

$$B_2 = 0.02T \text{ (along the PY direction)}$$

The resultant magnetic field at point P will be

$$B = \sqrt{B_1^2 + B_2^2}$$

$$\sqrt{(0.04)^2 + (0.02)^2} = 4.4 \times 10^{-2}\ T$$

27. The number of electric field lines travelling through a particular area is referred to as electric flux.

Given: $\vec{E} = 3 \times 10^3 \hat{i}$ N/C, $A = (10\ cm)^2 = (0.1\ m)^2$

and $\theta = 0°$

$\phi = EA\cos\theta$

$\phi = E.A = 3 \times 10^3 \times (0.1)^2 = 30\ NC^{-1}\ m^2$

28. Mass of the nucleus of the atom of mass number, A = A a.m.u = 1.660565×10^{-27} kg.

If R is the radius of the nucleus, then

$$\text{volume of nucleus} = \frac{4}{3}\pi R^3 = \frac{4}{3}\pi(R_0A^{1/3})^3$$

$$= \frac{4}{3}\pi R_0^3 A$$

Taking $R_0 = 1.1 \times 10^{-15}$ m,

we have volume of the nucleus

$$= \frac{4}{3}\pi(1.1 \times 10^{-15})^3 \times A\ m^3$$

Density of the nuclues,

$$\rho = \frac{\text{mass of nucleus}}{\text{volume of nucleus}}$$

$$= \frac{A \times 1.660565 \times 10^{-27}}{\frac{4}{3}\pi(1.1 \times 10^{-15})^3 \times A}$$

$$= 2.97 \times 10^{17}\ kg\ m^{-3}$$

(independent of A)

The density of the nuclei of all atoms is same as it is independent of mass number.

OR

Energy required to create a hole is equal to energy required to transfer an electron from the valence band to the conduction band.

$$32\ MeV = 32 \times 10^{-3} \times 1.6 \times 10^{-19}\ J$$

If λ is the wavelength of the radiation, which can create a hole, then

$$\frac{hc}{\lambda} = 32 \times 10^{-3} \times 1.6 \times 10^{-19}\ J$$

$$\lambda = \frac{hc}{32 \times 10^{-3} \times 1.6 \times 10^{-19}}$$

$$\lambda = \frac{6.62 \times 10^{-32} \times 3 \times 10^8}{32 \times 10^{-3} \times 1.6 \times 10^{-19}}$$

$$\lambda = 3.8 \times 10^{-5}\ m$$

29. The optical instrument is therefore a compound microscope.

When the final image is formed at infinity, the magnification of a compound microscope equals.

L = 25 cm D = 25 cm

$f_0 = 1$ cm

$f_e = 2$ cm

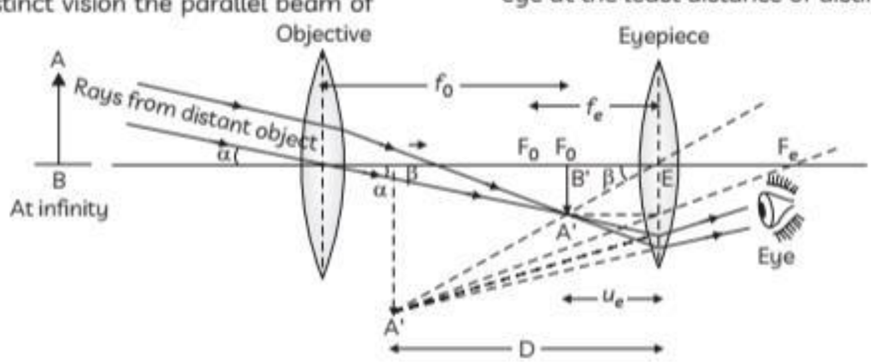
$$m = \left(\frac{L}{f_0}\right)\left(\frac{D}{f_e}\right) = \left(\frac{25}{1}\right)\left(\frac{25}{2}\right) = 312.5$$

30. *The energy for maximum intensity of the solar radiation is nearly 1.5 eV. In order to have photoexcitation, the energy radiation must be greater than the energy band gap of about 1.5 eV or lower than it and with higher absorption coeffiicient is likely to give better solar conversion efficiency. The energy band gap for Silicon is about 1.1 eV, while for GaAs, it is of about 1.53 eV. The GaAs is better in spite of higher band gap and silicon because it absorbs relatively more energy from the incident solar radiation relatively higher absorption coefficient.*

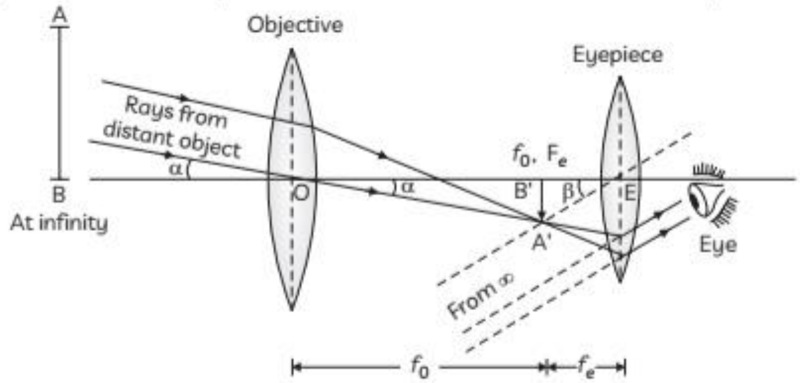
SECTION - D

31. An astronomical telescope consists of two converging lenses mounted coaxially at the outer ends of two sliding tubes. One lens is called objective lens which is a convex lens of large focal length and a much bigger an aperture it can gather suffiicient light from the distant object which it faces. The second lens is called an eyepiece which is also a convex lens of small focal length and small aperture so that whole light of the telescope may enter the eye.

When the final image is formed at the least distance of distinct vision the parallel beam of light it comes from the distant object falls on the objective l ens at angle . Planes focuses The Beam in its focal plane and forms a real, inverted and diminished image A'B'. This image acts as an object for the eye piece. The distance of the eyepiece is adjusted so that the image A'B' lies within the focal length. The eyepiece magnifies this image so the final image A"B" his magnified and inverted with respect to the object. The final image is seen distinctly by the eye at the least distance of distinct vision.



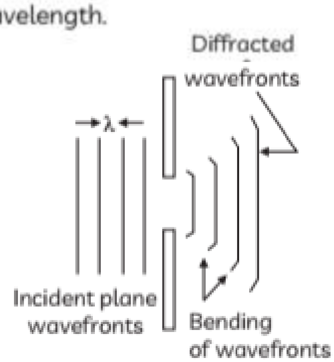
When the final image is formed at infinity, a parallel beam of light is incident on the objective, it forms a real, inverted and diminished image A'B' in its focal plane. The eyepiece is no adjust that the image A'B' lies exactly at its focus. Therefore, the final image is formed at infinity e and is highly magnified and inverted with respect to the object.



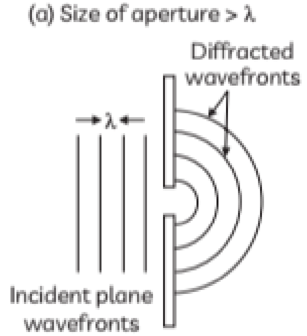
OR

If plane waves are made to fall on a screen having a smaller aperture, the Waves emerging out of the aperture are observed to be slightly curved at the edges. This phenomenon is known as diffraction. If the size of the aperture is as large as compared to the wavelength of the waves, the amount of bending waves is small but if the size of the aperture is small compared to the wavelength of the Waves, then the distracted waves are almost spherical. Hence, the deflection effect is more pronounced If the size of the aperture is of the order of wavelength of the Waves.

As the wavelength of light is much smaller than the size of the objects around us, diffraction of light is not easily seen but sound waves are easily distracted because of their large wavelength.



(a) Size of aperture > λ

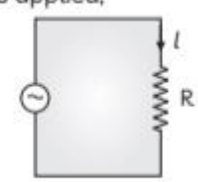


(b) Size of aperture ≈ λ

In Fresnel diffraction, the source and the screen are placed close to the aperture and light after deflection of a converging towards the screen and hence no length is required to observe it. The incident wave fronts are either spherical or cylindrical.

In Fraunhoffer Diffraction, the source and the screen are placed at large distances from the aperture the converging lens is used to observe the diffraction pattern the wavefront is planar in nature.

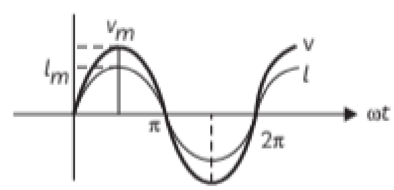
32. If AC voltage is applied,



$$v = v_m \sin \omega t$$

Where, v_m is the maximum value of the applied voltage or amplitude of oscillating potential difference and ω is the angular frequency.

$$I = \left(\frac{v_m}{R}\right) \sin \omega t = i_m \sin \omega t$$



Where, $I = \left(\frac{v_m}{R}\right)$ is the amplitude of current.

From the above equations, we can see that the voltage across the resistor and current through the resistor are in the same phase.

The sum of the instantaneous current values over one complete cycle is zero and thus the average of the current over one complete cycle is zero.

Thus, instantaneous power dissipated in the resistor is,

$$P = I^2R = I^2_m R \sin^2 \omega t$$

The average value of 'p' over a cycle is,

$$\bar{P} = I^2_m \times R = \frac{I^2_m}{2} R$$

OR

At t = 0, there is 0 current in the inductor. At any instant, the current I is passed into the inductor. The growth rate of current at that instant will be dI/dt.

Then induced emf produced in the inductor is given by,

$$e = L\frac{di}{dt}$$

If the source of emf sends a constant current I through the inductor for a small time dt, then small work done by the source is given by

$$dW = eIdt = \left(L\frac{dI}{dt}\right)Idt = LIdI$$

Total amount of work done by the source of EMF till current increases from its initial value I = 0 to I_0 is stored inside the inductor in the form of energy. Therefore, energy stored in the inductor will be,

$$U = \frac{1}{2}LI^2$$

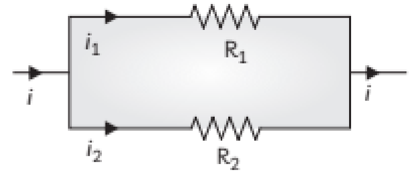
It can be pointed out that the energy stored in the inductor at the expense of the energy of the source of EMF.

Energy resides in the inductor in the form of magnetic field. In case of an alternating source of emf, during one half cycle energy stored in the inductor from the source and during the next half cycle, same amount of energy is returned to the source. It is for this reason that average electric power of an inductor is zero.

33. Consider two resistance R_1 and R_2 in parallel and i_1 and i_2 be the current.

Using Kirchhoff's first law,

$$i = i_1 + i_2 \quad ...(1)$$



Kirchoff's second law

$$i_1R_1 - i_2R_2 = 0$$

$$\frac{i_1}{i_2} = \frac{R_2}{R_1} \quad ...(2)$$

Heat produced in the circuit in t second is

$$H = i_1^2 R_1t + i^2_2R_2t$$

$$H = i^2_1 R_1t + (i - i_1) R_2t$$

(using eg. (1))

If the heat produced is minimum then $\frac{dH}{di_1} = 0$

$$\therefore \quad 0 = 2i_1R_1t + 2(i - i_1)(-1) R_2t$$

$$2(i - i_1) R_2t = 2i_1 R_1t$$

$$(i - i_1) R_2 = i_1R_1$$

$$\frac{i_1}{i_2} = \frac{R_2}{R_1}$$

This is in accordance with kirchoff's law.

OR

(A) It is defined as the potential difference between the two electrodes of the cell in open circuit (when no current is drawn) It depends on the following factors:

(i) Nature of Electrodes

(ii) Nature and concentration of the Electrolytes

(iii) Temperature of the cell.

(B) Internal resistance of the cell.

$$r = R\left(\frac{\ell_1 - \ell_2}{\ell_2}\right)$$

Here $\ell_1 = 76.3$ cm

$\ell_2 = 64.8$ cm

$R = 9.5\ \Omega$

$$\Rightarrow \quad r = 9.5\left(\frac{76.3 - 64.8}{64.8}\right)$$

$$r = 1.68\Omega.$$

SECTION - E

34. (A) De-Broglie wavelength is inversely proportional to the velocity of an electron but is also proportional to the de- Broglie frequency. Therefore, there will be no change in de-Broglie frequency.

(B) We know that,

Momentum, p = mv

Then, $$p = \frac{\frac{1}{2}mv \times v}{\frac{1}{2} \times v} = \frac{2KE}{v}$$

If kinetic energy as well as speed are doubled, the momentum will remain unchanged. Hence. the de-Broglie wavelength will remain the same.

(C) We know that,

$$\lambda = \frac{h}{mv}$$

$$\lambda = \frac{6.63 \times 10^{-34}}{60 \times 10^{-3} \times 11} = 10^{-33} m$$

OR

As we know,

$$K = \frac{3}{2}kT$$

$$\lambda = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{3mKT}}$$

$$\lambda \propto \frac{1}{\sqrt{T}}$$

35. (A) In small interference pattern, the fringes appear to be straight in line but while using monochromatic source, fringes obtained in young's double slit experiment of hyperbolic in shape

(B) When a thin film of mica is inserted in the path of one beam, entire fringe pattern shifts towards the side of which the film is inserted.

(C) We know that, $\frac{a_1}{a_2} = \sqrt{\frac{I_1}{I_2}}$

$$= \sqrt{\frac{9}{1}} = \frac{3}{1} = 3 : 1$$

OR

Given:

$d = 1$ mm $= 10^{-3}$ m, D = 2 m

$\lambda = 600$ nm

$= 600 \times 10^{-9}$ m

Fringe width, $\beta = \frac{D\lambda}{d}$

$$= \frac{2 \times 600 \times 10^{-9}}{10^{-3}}$$

$= 12 \times 10^{-4}$ m.