Stage III

Sample Question Paper

Fully Solved *(Questions-Answers)*

PHYSICS-XII

A highly Simulated Practice Question Paper for ***CBSE Class XII*** *Examination*

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

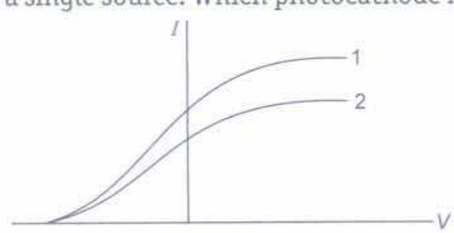
General Instructions

1. All questions are compulsory.
2. There are 29 questions in total. Questions 1 to 8 are very short answer questions and carry one mark each.
3. Questions 9 to 16 carry two marks each, questions 17 to 25 carry three marks each, question 26 carry four marks and questions 27 to 29 carry five marks each.
4. There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions of five marks each. You have to attempt only one of the given choices in such questions.
5. Use of calculator is not permitted. However, you may use log tables if necessary.
6. You may use the following values of physical constants wherever necessary
$c = 3 \times 10^8\,ms^{-1}$, $h = 6.63 \times 10^{-34}$ Js, $e = 1.6 \times 10^{-19}$ C, $\mu_0 = 4\pi \times 10^{-7}\,TmA^{-1}$, $1/4\pi\varepsilon_0 = 9 \times 10^9\,Nm^2\text{-}C^{-2}$, $m_e = 9.1 \times 10^{-31}$ kg

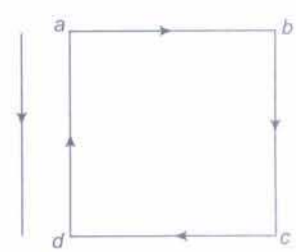
1. Draw electrostatic field lines for a positive charge Q.

2. What is the range of frequencies allotted
(i) to FM radio?
(ii) to VHF TV?

3. The figure shows photoemissive characteristics of two photocathodes illuminated by the light emitted by a single source. Which photocathode has higher work function?



4. Explain in which direction will the current loop *abcd* move when kept near an infinitely long rectilinear current.



5. A carbon resistor is marked in a green, red and orange bands. What is the approximate resistance of the resistor?

6. State the two reasons why high-frequency carrier waves are employed for transmission?

7. Taking the case of a long solenoid state the factors on which the self-inductance depends?

8. The wires of the same material having lengths in the ratio 1 : 2 and radii 2 : 3 are connected in series with a battery. What is the ratio of potential difference across them? **(Ans. 9 : 8)**

9. Define relaxation time. What is the effect of increase in temperature on the relaxation time of electrons in metals? What is the effect on the drift velocity of electrons?

10. What is a photon? Discuss the wavelength of electromagnetic radiation would be equal to the wavelength of a photon.

11. A conducting rod *ab* is moved parallel to the *x*-axis in a uniform magnetic field pointing in the positive *z*-direction. What is the induced polarity of the end *a*? State the reason.

12. How is the interference pattern in Young's double slit experiment affected when
    (i) the width of the two slits is increased equally?
    (ii) the apparatus is kept in a denser medium?

13. An equiconvex lens of focal length 15 cm is cut into two equal halves, as shown in the figure. What is the focal length of each half?

(Ans. 30 cm)

14. What are moderators? Name the materials used as moderators in nuclear reactors and write the reasons for their use as moderator.

15. Define capacitance of a capacitor. Give its SI unit. For a parallel plate capacitor, prove that the total energy stored in a capacitor is $\frac{1}{2}CV^2$.

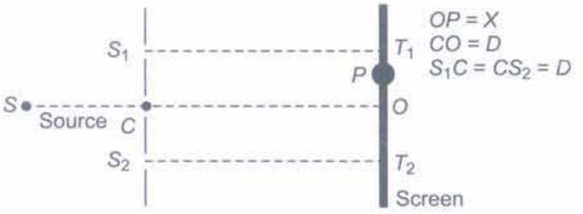
16. State Huygen's principle. For reflection of a plane wavefront at a plane surface, construct the corresponding reflected wavefront. Using this diagram, prove that angle of incidence is equal to angle of reflection.

OR

What is the shape of fringe in Young's double slit experiment? In Young's double slit experiment, the width of the fringes obtained from a source of light of wavelength 5000 Å is 3.6 mm. Calculate the fringe width if the apparatus is immersed in a liquid of refractive index 1.2. **(Ans. 3 mm)**

17. Differentiate between interference and diffraction of light.

Consider a two slit interference arrangement (figure) such that the distance of the screen from the slits is half the distance between the slits obtain the value of D in terms of λ such that the first minima on tescreen falls at a distance D from the centre O.



18. Draw the curves showing the variation of inductive reactance and capacitive reactance, with applied frequency of an AC source.

A capacitor, resistor of 5Ω, and an inductor of 50 mH are in series with an AC source marked 100 V, 50 Hz. It is found that voltage is in phase with the current. Calculate the capacitance of the capacitor and the impedance of the circuit.

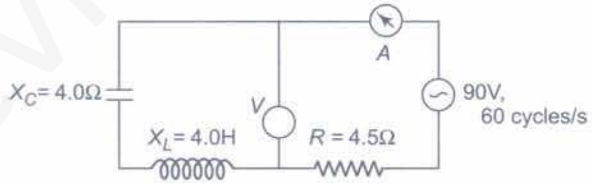
(Ans 2×10^{-4} F, 5 Ω)

19. What is LED? Briefly describe its operational principle.

20. Define dipole moment of an electric dipole. Show mathematically that the electric field intensity due to a short dipole at a distance d along its axis is twice the intensity at the same distance along the equatorial axis.

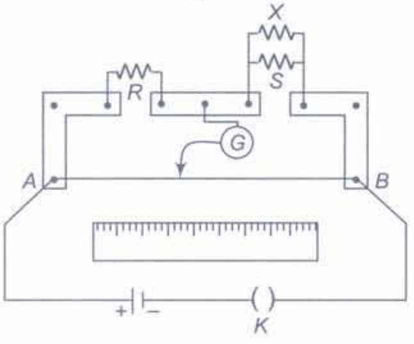
21. A proton and an alpha particle of the same velocity enters in d a region of uniform magnetic field acting in a plane perpendicular to the magnetic field. Deduce the ratio of the radii of the circular paths described by the particles. Explain why the kinetic energy of the particle after emerging from the magnetic field remains unaltered.

22. What will be the reading of voltmeter and ammeter in the figure?



(Ans 0 V, 20 A)

23. In a meter bridge, the null point is found at a distance of l_1 cm from A. If now a resistance of X is connected in parallel with S, the null point occurs at l_2 cm. Obtain a formula for X in terms of l_1, l_2 and S.



24. What is the principle of a transformer? How is electrical power generally transmitted over long distance at high AC voltage? Explain the use of transformer in such transmission?

25. What is space wave propagation? Which two communication methods make use of this mode of propagation? If the sum of the heights of transmitting and receiving antennas in line of sight of communication is fixed at h, show that the range is maximum when the two antenna have a height $\frac{h}{2}$ each.

26. One child found that a comb attracts the small piecess of paper after it get passed through hair. He wanted to know its reason that by what phenomenon it happens, but no one made him understand the same or did not answered satisfactorily. Next day he got ready for the school more early as he was eager to know the answer of the question which was disturbing him. As soon as he reached the school he asked the question from his teacher and got satisfied with the answer. He continued his day happily.

(a) Write about the child's nature. What answer could be given by the teacher?

(b) Write about piece rubbed with the wool is found to have a negative charge of 3×10^7 C. Estimate the numbers of electrons transformed. **(Ans. 1.872×10^{12})**

27. Define the terms (i) work function (ii) threshold frequency and (iii) stopping potential, with reference to photoelectric effect.

Calculate the maximum kinetic energy of electrons emitted from a photosensitive surface of work function 3.2 eV, for the incident radiation of wavelength 300 nm. **(Ans. 0.8 eV)**

OR

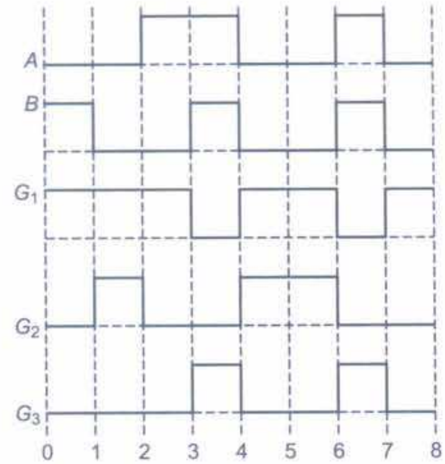
Draw a circuit diagram of an *n-p-n* transistor with its emitter base Junction forward and base collector junction reverse biased. Describe briefly its working. Explain how a transistor in active state exhibits a low resistance at its emitter base junction and high resistance at its base collector junction. Draw a circuit diagram and explain the operation of transistor as a switch.

28. Derive the expression for the de-Broglie wavelength of an electron moving under a potential difference of V volt. Describe Davisson and Germer experiment to establish the wave nature of electrons. Draw a labelled diagram of the apparatus used.

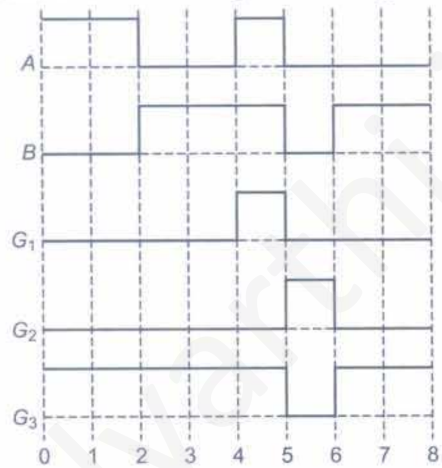
OR

Draw a labelled ray diagram of an astronomical telescope. Write mathematical expression for its magnifying power. How does the magnifying power get affected on increasing the aperture of the objective lens and why?

29. (a) The inputs, A and B shown here, are used as the inputs for three different gates, G_1, G_2, and G_3. The outputs, obtained in the three cases, have the forms shown. Identify the three gates and write their truth tables.



(b) The inputs, A and B, shown here, are used as the inputs for three different gates, G_1, G_2 and G_3. One by one. The outputs, obtained in the three cases, have the forms shown. Identify the three gates and write their symbols.



OR

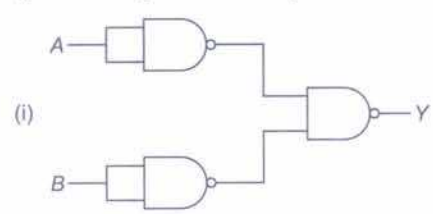
(a) The same input signal is applied to both the (input) terminals of a given logic gate. If the output is the

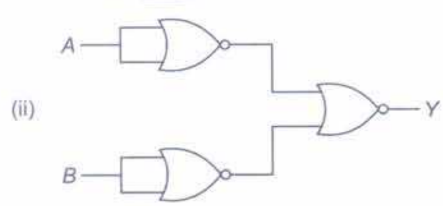
(i) same as the (common) input signal.

(ii) inverted with respect to the (common) input signal.

Identify the logic gates involved in each case.

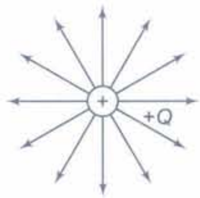
(b) Write the truth tables for each of the 'combinations' shown below. Also identify the logic operations performed by them.





Sample Question Paper 15

1. Field line are radially outward to the charge, $+Q$



(1)

2. Range allotted

(i) 88-108 MHz (ii) 47-230 MHz (1)

3. From the graph it is clear that photo cathode 2 has higher work function as compare to photo cathode 1. (1)

4. As we know that the parallel current attracts and antiparallel current repell the conductors.

The force per unit length on one of these two by another one is given by

$$\frac{dF}{dL} = \frac{I_1 I_1 I_2}{2\pi d}$$

So, from the analysis of figure given in the question loop will move towards the long wire.

Here I_1 and I_2 are currents in conductors and d is separation between them. (1)

5. The value of resistance would be

$$R = 52 \times 10^3 \Omega \quad (1)$$

6. Reasons that high frequency carrier waves are employed for transmission are

(i) High frequency waves require antenna of reasonable length.

(ii) It requires carrier wave can travel long distance without any appreciable power loss. (1)

7. As we know that the self inductance of coil is given as

$$L = \mu_r \mu_0 n^2 Al$$

This indicates the self inductance depends on the geometry of the coil and on the permeability of the medium. The value of self inductance remains constant for a certain geometry in a medium. (1)

8. Given

$$l_1 : l_2 = 1:2$$

and $$r_1 : r_2 = 2:3$$

$$\Rightarrow \quad \frac{V_1}{V_2} = \frac{IR_1}{IR_2} = \frac{\rho \frac{l_1}{A_1}}{\rho \frac{l_2}{A_2}} \quad (1/2)$$

(ρ is fixed for same material)

$$\Rightarrow \quad \frac{V_1}{V_2} = \frac{l_1 A_2}{l_2 A_1}$$

$$= \frac{l_1 \pi r_2^2}{l_2 \pi r_1^2} = \frac{l_1}{l_2}\left(\frac{r_2}{r_1}\right)^2$$

$$= \frac{1}{2} \times \frac{9}{4} = \frac{9}{8}$$

$$\Rightarrow \quad V_1 : V_2 = 9:8 \quad (1/2)$$

9. The time during the electron makes two successive collision inside a material is called the relaxations time. As the temperature increases the relaxation time of electron inside the metal decreases. The drift velocity of free electron

$$v_d \propto \tau$$

So, the drift velocity of electron decreases with increase in temperature. (2)

10. Momentum of a photon of frequency ν (wavelength λ) is given by

$$p = \frac{h\nu}{c} = \frac{h}{\lambda}$$

∴ Wavelength of electromagnetic radiation,

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

∴ de-Broglie wavelength,

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

Thus wavelength of electromagnetic radiation is equal to de-Broglie wavelength of its quantum *i.e.*, proton. (2)

11. The polarity of a would be negative because when *ab* moves parallel to *X*-axis, an emf induced in the rod *ab* which associates a current induced in the rod from *b* to *a*. As we know that electric current always flow from high potential to low potential, this indicates terminal *a* must be at negative potential with respect to terminal *b*. (Here must be noted that motional emf, $\varepsilon = VBl$). (2)

12. (i) For interference pattern, the slit should be point sources. When width of the slits is increased, fringes will not be of equal density. **(1)**

(ii) When apparatus is kept in a denser medium the wavelength of light is decreased and therefore fringe width $\left(\beta = \frac{\lambda D}{d}\right)$ would be reduced. **(1)**

13. As we know that,

$$\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \quad \text{...(i)}$$

Here lens equiconvex of focal length 15 cm, showing that if $R_1 = +R$ then $R_2 = -R$

∴ From Eq. (i)

$$\frac{1}{f} = (\mu - 1)\left[\frac{1}{R} + \frac{1}{R}\right]$$

$$= (\mu - 1) \times \frac{2}{R}$$

$$f = \frac{R}{2(\mu - 1)} \quad \textbf{(1)}$$

Now, if lens is cut into two parts the focal length of one of the face is ∞

Then $\frac{1}{f'} = (\mu - 1)\left[\frac{1}{R} - \frac{1}{\infty}\right]$

$\Rightarrow \quad \frac{1}{f'} = \frac{\mu - 1}{R}$

$\Rightarrow \quad f' = \frac{R}{(\mu - 1)}$

We see that, $f' = 2f$

$= 2 \times 15 = 30$ cm **(1)**

14. So that the fission reaction in a nuclear reactor, does not stop the neutrons produced in fission of U^{235} nuclei are slowed down by moderator.

The substance which is used as moderators in nuclear relators are graphite rods or heavy water (D_2O) or water such substances are rich in hydrogen nuclei. When fast moving neutrons collide against them, neutron almost come to rest. So, such substances used for slowing down the neutrons. The moderator does not under goes the nuclear fission by the collision of neutrons. **(2)**

15. If charge q is given to an insulator conductor,it leads to increase its electric potential by V, then

$$q \propto V$$

$\Rightarrow \quad q = CV$

where, C is known as capacitance of the conductor depending upon size, shape and geometry of conductor as well as surrounding medium and presence of other conductor in the neighbourhood of it.

Its SI unit is CV^{-1} (coulomb per volt or farad charged stored in a capacitor having capacitance C)

Let charge and potential difference across the capacitor at any instant during charging of capacitor are q and V respectively.

$\Rightarrow \quad q = CV \quad$ ...(i) **(1)**

Let dq additional charge be transferred by the battery at potential difference V and work done is given by

$$dW = Vdq$$

$\Rightarrow \quad dW = \frac{q}{C}dq \quad$ [From Eq. (i)]

∴ Total work done over capacitor is charging the capacitor from 0 to q is

$$W = \int_0^q \frac{q}{C}dq$$

$$= \frac{1}{C}\left[\frac{q^2}{2}\right]_0^q$$

$$W = \frac{q^2}{2C}$$

∴ This work done is stored in the form of electrostatic potential energy in capacitor.

$$U = \frac{q^2}{2C} = \frac{1}{2}CV^2 = \frac{1}{2}qV \quad \textbf{(1)}$$

[Using $q = CV$]

16. **Huygen's Principle** Huygen gave a hypothesis for geometrical construction of the position of the common wavefront at any instant, during the propagation of waves in a medium. This principle tells the way in which the wavefront is propagated further in medium. According to him

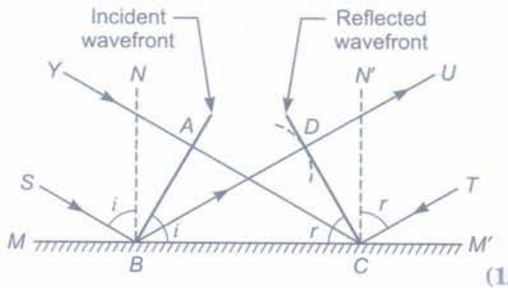
1. Every point on the given wavefront (called primary wavefront) acts as a fresh source of new disturbance, called secondary wavelets, which travel in all directions, with the velocity of light, in the medium.

2. A surface touching these secondary wavelets, tangentially in the forward direction at any instant gives the new wavefront at that instant. This is called secondary wavefront. **(1/2)**

Let a plane wavefront AB is incident on plane mirror MM'. As per Huygen's wave theory, every point on wavefront again behaves like a light source and emits secondary wavelets. In the time taken by the wave from A to reach at C, the secondary wavelets from B gets spread over a light source and emits secondary wavelets. In the time taken by the wave from A to reach at C, the secondary wavelets from B gets spread over a hemisphere of radius

$$AB = BD = ct \quad \text{... (i)}$$

(1/2)



(1/2)

where, c is velocity of light and t is the time taken by wave in going from A to C. The tangent plane CD drawn from the point C over this hemisphere of radius ct gives new reflected wavefront CD corresponding to incident wavefront AB.

Let i and r be angles of incidence and reflection.

Now, in ΔABC and ΔDCB

$\angle BAC = \angle CDB$

(Each 90°, ray perpendicular wavefront)

$BC = BC$ (Common)

$AC = DB$ [From Eq. (i)]

$\Rightarrow$ $\Delta ABC \cong \Delta DCB$ (RHS congruence)

$\Rightarrow$ $\angle ABC = \angle DCB$

$i = r$

[$\because SB \perp AB \Rightarrow \angle NBA = 90° - i$ and $BN \perp BC$

$\Rightarrow$ $\angle ABC = i$; similarly, $\angle N'CT = \angle DCB = r$]

$\Rightarrow$ Angle of incidence = Angle of reflection

Also, incident ray, reflected ray and normal meet at one point in a plane.

Thus, laws of reflection are verified using Huygen's principle. (1/2)

OR

In Young's double slit experiment, when spherical waves emanating from two coherent sources, interfere with each other, the dark and bright band shaped pattern appears on the screen which are known as fringes.

The distance between two consequetive dark or bright fringes is same and called its fringe width which is given by

$$\beta = \frac{\lambda D}{d} \quad (1)$$

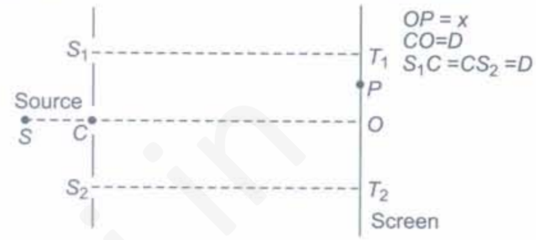
Now, if the whole system of Young's double slit experiment is immersed in water then new fringe width will be

$$\beta' = \frac{\beta}{\mu}$$

$$\Rightarrow \beta' = \frac{3.6\,\text{mm}}{1.2} \Rightarrow \beta' = 3\,\text{mm} \quad (1)$$

17. Difference between interference and diffraction

	Interference	Diffraction
(i)	It is due to the superposition of two waves coming from two coherent sources.	It is due to the superposition of secondary wavelets originating from different parts of the same wavefront.
(ii)	The width of the interference bands is equal.	The width of the diffraction bands is not the same.
(iii)	The intensity of all maxima (fringes) is same.	The intensity of central maximum is a maximum and goes on decreasing rapidly with increase of order of maxima. (1)



$$T_2P = D + x,\ T_1P = D - x$$

$$S_1P = \sqrt{(S_1T_1)^2 + (PT_1)^2}$$

$$= [D^2 + (D - x)^2]^{1/2}$$

$$S_2P = \sqrt{(S_2T_2)^2 + (PT_2)^2} = [D^2 + (D + x)^2]^{1/2}$$

(1)

Minima will occur when

$$\text{Path difference } = S_2P - S_1P = \frac{1\lambda}{2} \quad (n = 1)$$

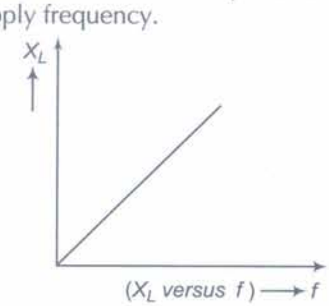
$$[D^2 + (D + x)^2]^{\frac{1}{2}} - [D^2 + (D - x)^2]^{1/2} = \frac{\lambda}{2}$$

If $x = D$

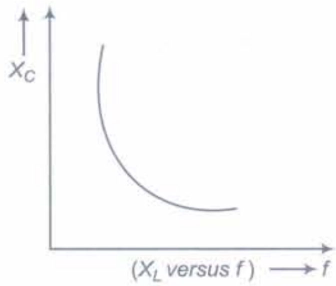
$$(D^2 + 4D^2)^{\frac{1}{2}} - D = \frac{\lambda}{2} \text{ or } (5D^2)^{\frac{1}{2}} - D = \frac{\lambda}{2}$$

$$\therefore \quad D = \frac{\lambda}{2\sqrt{5} - 1} \quad (1)$$

18. The following curves representing the variations of inductive reactance and capacitive reactance with the supply frequency.



(1)



Given $R=5\Omega$, $L=50\text{mH}=50\times10^{-3}\text{H}$

$V=100\text{ V}$ and $f=50\text{Hz}$

When voltage is in phase with current, it is possible when resonance is occured.

i.e., $X_L=X_C$

$\Rightarrow$ $L\omega=\dfrac{1}{\omega C}$

$\therefore$ $f=\dfrac{1}{2\pi\sqrt{LC}}$ [as $\omega = 2\pi f$]

$\Rightarrow$ $C^2=\dfrac{1}{4\pi^2 f^2 L}$ (1)

$$=\frac{1}{4\times9.86\times50^2\times50\times10^{-3}}$$

$$=2\times10^{-4}\text{F}$$

$\therefore$ Impedance of the circuit

$$Z=\sqrt{R^2+0^2}=R \quad \text{(at resonance)}$$

$\Rightarrow$ $Z=5\,\Omega$ (1)

19. LED is a forward biased *p-n* junction which converts electrical energy into optical energy (*i.e.,* light energy) of infrared and visible light. (1)

When we apply sufficient voltage to LED, electron move across the junction into the *p*-region and get attracted to the holes there. Thus, electrons and holes recombine. During each recombination, electric potential energy is converted into electromagnetic energy and a photon of light with a characteristic frequency is emitted, this is LED works. (2)

20. When two equal and opposite charges are separated by a small distance. These are together with called a electric dipole .

This electric dipole have its dipole moment which is given by

$$\mathbf{p}=\mathbf{q}d$$

Here q = magnitude of either charge,

d = distance between two charges. (1)

The dipole moment $\mathbf{p}$ is a vector quantity whose direction is from negative to positive charge.

As we know that the intensity due to an electric dipole at a point whose distance is r from the central point of the dipole, is given by

$$E=\frac{1}{4\pi\varepsilon_0}\frac{p}{r^3}\sqrt{3\cos^2\theta+1}$$ (1)

When $\theta=0°$ [end-on-position]

$$E_1=\frac{1}{4\pi\varepsilon_0}\frac{p}{r^3}\sqrt{3+1}$$

$$=\frac{1}{4\pi\varepsilon_0}\frac{2p}{r^3}$$

When $\theta=90°$ [equatorial position]

$$E_2=\frac{1}{4\pi\varepsilon_0}\frac{p}{r^3}\sqrt{3\times0+1}=\frac{1}{4\pi\varepsilon_0}\frac{p}{r^3}$$

$\Rightarrow$ For same distance, $E_2=2E_1$ (1)

21. Let mass of α- particle $=m_\alpha$

Mass of proton $=m_p$

Magnetic field $=B$

Common velocity $=v$

As we know that

$$qvB=\frac{mv^2}{r}$$

$\therefore$ $r=\dfrac{mv}{qB}$ (1)

$\Rightarrow$ $r_p=\dfrac{m_p v}{qB}$

and $r_\alpha=\dfrac{4m_p v}{2qB}=\dfrac{2m_p v}{qB}$

$\therefore$ $\dfrac{r_p}{r_\alpha}=\dfrac{m_p v}{qB}\times\dfrac{qB}{2m_p v}=\dfrac{1}{2}$ (1)

The particle will imerge from the magnetic field with a constant velocity because there is no acceleration (or retardation) in the direction of v, hence velocity will remain constant, this implies the kinetic energy of the particle will also remain constant (as only mass and speed are involved in the kinetic energy). (1)

22. Given $R=4.5\,\Omega$

$V=90\text{ V}$

$X_C=4.0\,\Omega$

$x_L=4.0\text{H}$

$f=60\text{ Hz}$

$\therefore$ $\omega=2\pi f=120\pi$ (1)

Impedance of the circuit

$$Z=\sqrt{R^2+(X_L-X_C)^2}$$

$$=\sqrt{(4.5)^2+(4-4)^2}$$

$$=4.5\,\Omega$$ (1)

Current in the circuit

$$I=\frac{V}{Z}=\frac{90}{4.5}=20\text{ A}$$

$\therefore$ Reading of ammeter = 20 A

And reading of the voltmeter

$$= V_L - V_C$$
$$= iX_L - iX_C$$
$$= i(X_L - X_C) \quad [\because X_L = X_C = 4]$$
$$= 0 \text{ V} \quad \textbf{(1)}$$

23. In first case,

$$\frac{R}{S} = \frac{l_1}{100 - l_1} \quad \text{... (i)}$$

When X and S are in parallel, let resistance,

$$S' = \frac{XS}{X + S} \quad \textbf{(1)}$$

In second case,

$$\frac{R}{\left(\frac{XS}{X+S}\right)} = \frac{l_2}{100 - l_2} \quad \text{... (ii)} \quad \textbf{(1)}$$

Dividing Eq. (ii) by Eq. (i), we get

$$\frac{X+S}{X} = \frac{l_1}{l_2}\left(\frac{100-l_1}{100-l_2}\right)$$

$$\Rightarrow \quad X = \frac{S}{\frac{l_2}{l_1}\left(\frac{100-l_1}{100-l_2}\right) - 1}$$

This is the required value of resistance X. **(1)**

24. Principle of Transformer A transformer is based on the principle of mutual induction *i.e.,* whenever the amount of magnetic flux linked with a coil changes, an emf is induced in the neighbouring coil. **(1)**

Power Transmission Electric power is transmitted over long distances at high voltage. So, step-up transformers are used at power stations to increase the voltage of power whereas a series of step-down transformers are used to decrease the voltage to 220 V. **(1)**

Step-up Transformer It increases the voltage level of the power upto a desired value. In it number of winding in primary side is less than that of secondary side.

Step-down Transformer It decreases the voltage level of the power to a desired value. In it number of winding in primary side is more than that of secondary side. **(1)**

25. Space Wave Propagation

It is also known as Line Of Sight (LOS) propagation. The radio wave transmitted by antenna directly reaches the receiving antenna by travelling along a straight line.

TV waves (80 MHz - 200 MHz) propagates through space wave propagation. **(1)**

Examples of communication system which use space wave mode of porpagation are television channel UHF, VHF etc.

The maximum distance upto which the signals can be transmitted is given as

$$d_M = \sqrt{2h_T R} + \sqrt{2h_R R}$$

where h_T = height of receiving tower

and h_R = height of transmitting tower

Here, $h_T + h_R = h$ **(1)**

In order to maximum d_M

$$\frac{d(d_M)}{dh} = \frac{d(\sqrt{2h_T R})}{dh} + \frac{d(\sqrt{2h_R R})}{dh} = 0$$

$$\therefore \quad \sqrt{2R}\left(\frac{1}{2\sqrt{h_T}} + \frac{1}{2\sqrt{h_R}}\right) = 0$$

$$\Rightarrow \quad h_T = h_R$$

If $h_T + h_R = h$ then either $h_T = \frac{h}{2}$ or $h_R = \frac{h}{2}$ **(1)**

26. (a) The teacher's answer should be

Whenever a comb passes through hair, it gets positively charged *i.e.,* electron movement starts from one body to the other.

When that comb is brought near small pieces of paper, paper gets attracted towards the comb due to electrostatic force of attraction. **(1)**

Note *Paper is having negative charge due to induction.*

Child here is showing his observing nature which makes him curious for knowing the reasons of the things that happened. Every question has an answer, but the answer should be correct and must be understood logically. **(1)**

(b) Here, $q = -3 \times 10^{-7}$ C

Charge on electron $= 1.6 \times 10^{-19}$C

$\therefore$ Required number of electron, $N = \frac{q}{e}$

$$\Rightarrow \quad N = \frac{-3\times10^{-7}}{-1.6\times10^{-19}} = 1.872\times10^{12} \quad \textbf{(1)}$$

27. (i) **Work Function** It is the minimum amount of energy required to just eject an electron from the given metal surface. **(1)**

(ii) **Threshold Frequency** The minimum value of frequency of light wave which can eject an electron from the metal surface. **(1)**

(iii) **Minimum Potential** applied to the anode to just prevent the ejection of electron from the metal surface is known as stopping potential with reference to a particular arrangement of photo electric effect. **(1)**

Given

$$\lambda = 300 \text{ nm} = 300 \times 10^{-9} \text{ m}$$

$$\therefore \quad E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{300 \times 10^{-9}}$$

$$\Rightarrow \quad E = 6.62 \times 10^{-19} \text{ J}$$

$$= \frac{6.62 \times 10^{-19}}{1.67 \times 10^{-19}} \text{ eV}$$

$$\Rightarrow \quad E \approx 4 \text{ eV}$$ **(1)**

Now, from photoelectric equation

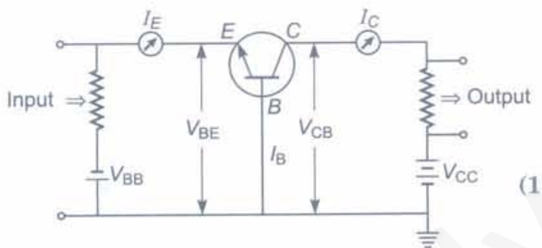
$$KE_{max} = E - \phi$$

$$\therefore \quad KE_{max} = 4 - 3.2$$

$$\Rightarrow \quad KE_{max} = 0.8 \text{ eV}$$ **(1)**

OR

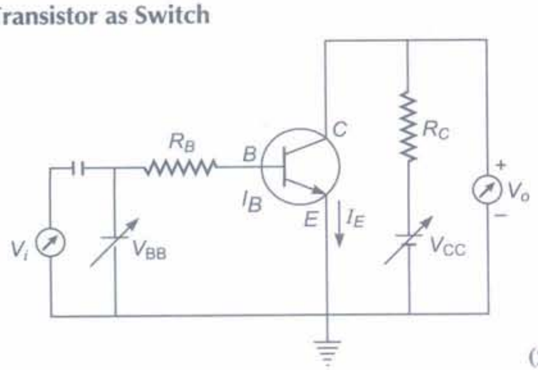
***n*-*p*-*n* Transistor in CB Configuration** Since, the base is common in input and output circuits, therefore transistor is connected in CB configuration.



(1)

Working When input voltage V_{EB} is sufficient to make flow of emitter current, collector current flows in output circuit. In this condition, the circuit is said to be in active state. The small change in V_{EB}, produces sufficient change in emitter current and hence, in collector current. The input circuit offers very small resistance as ample change in emitter current occurs corresponding to small change in input voltage. This lead to produce large change in output voltage inspite of smaller charge in collector current ($I_E < I_C$). This shows that output circuit offer high resistance. **(2)**

Transistor as Switch



(2)

28. As from the Bohr postulates for an electron moving in *n*th orbit (orbital angular momentum)

$$m_e vr = \frac{nh}{2\pi}$$

$$\therefore \quad r = \frac{nh}{m_e v 2\pi} \quad \text{... (i)}$$

But for a circular path

$$2\pi r = n\lambda$$

$$\therefore \quad r = \frac{n\lambda}{2\pi} \quad \text{... (ii)}$$

(1)

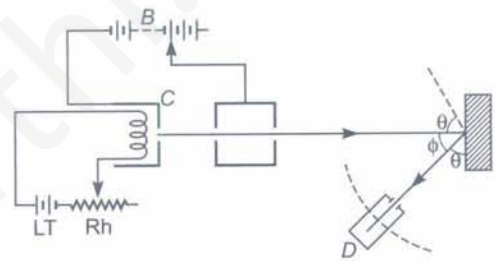
Comparing Eqs. (i) and (ii), we get

$$\frac{nh}{m_e v 2\pi} = \frac{n\lambda}{2\pi}$$

$$\Rightarrow \quad \frac{nh}{p 2\pi} = \frac{n\lambda}{2\pi} \quad \text{[Here } p = \text{momentum]}$$

$$\Rightarrow \quad \lambda = \frac{h}{p} \quad \text{... (iii)}$$

Eq. (iii) is known as de-Broglie equation.



(1)

The accelerated electron beam strikes to nickel crystal and get scattered in different directions. The intensity of scattered electron beam can be obtained by detecter.

It was found experimentally that sharp peak of intensity of electron beam is obtained at 5.4 V accelerating potential and 50° scattering angle. **(1)**

By geometry, angle of glancing θ is

$$\theta + \phi + \theta = 180°$$

$$2\theta = 180° - \phi = 180 - 50 = 130°$$

$$\Rightarrow \quad \theta = 65°$$

For nickel crystal, $d = 0.91$ Å

By Bragg's law

$$2d \sin\theta = 1 \times \lambda$$

For Ist diffraction maximum

$$\lambda = 2 \times 0.91 \times 10^{-10} \times \sin 65°$$

$$\lambda = 1.65 \text{ Å} \quad \text{...(i)}$$

(1)

But by de-Broglie equation

$$\lambda = \frac{12.27}{\sqrt{V}} \text{ Å} = \frac{12.27}{\sqrt{54}} = 1.66 \text{ Å} \quad \text{...(ii)}$$

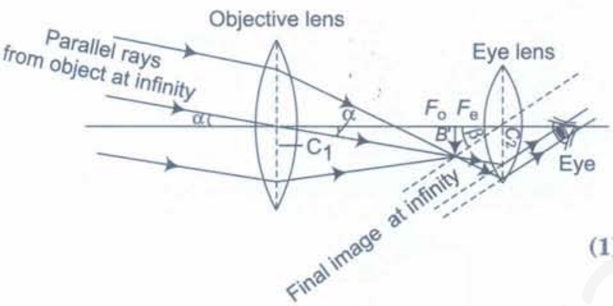
Eqs. (i) and (ii) are very close to each other. This explains that sharp peak in due to the constructive interference of electron beam reflected by different layers of atom of crystal.

Hence, waves nature of accelerated electron beam established experimentally by Divission and Germer.

The main apparatus used in Divission and Germer experiment are electron gun, nikel crystal and electron detector. **(1)**

OR

Refracting Astronomical Telescope It consists of an objective lens of large focal length (f_o) and large aperture and eye lens of small aperture and focal length. Magnification when final image is formed at D. **(1/2)**



(1)

$$\Rightarrow \quad m = -\frac{f_o}{u_e}$$

$$\Rightarrow \quad m = -\frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) \quad \textbf{(1)}$$

and length of telescope

$$L = |f_o| + |u_e|$$

Magnification when final image is formed at infinity (normal adjustment)

$$M = -\frac{f_o}{f_e}$$

$$L = |f_o| + |u_e| \quad \textbf{(1)}$$

As magnifying power of the astronomical telescope is given by

$$m = \frac{-f}{f_e}\left(1 + \frac{f_e}{D}\right) \quad \textbf{(1)}$$

If aperture of the objective lens is increased, the focal length will be increased and hence the magnifying power would be increased. **(1/2)**

29. For G_1 Gate NAND gate

Truth Table

0	0	1
0	1	1
1	0	1
1	1	0

(1)

For G_2 Gate NOR gate

Truth Table

0	0	1
0	1	0
1	0	0
1	1	0

(1)

For G_3 Gate AND gate

Truth Table

0	0	0
0	1	0
1	0	0
1	1	1

(1)

Principle for an AC Oscillator Thus, comprises of

(i) Tank circuit (LC circuit)

(ii) Transistor amplifier in CE configuration.

Feedback Network Mutual induction is used in feedback network.

In order to compensate the energy losses in the tank circuit, a part of output power of transistor amplifier is taken back to the tank circuit in phase with the input signal. Thus, process is known as positive feedback which is turn produces undamped oscillation. **(1)**

(i) G_1 : AND gate (ii) G_2 : NOR gate

(iii) G_3 : OR gate

Truth Table

0	0	0	1	0
0	1	0	0	1
1	0	0	0	1
1	1	1	0	1

(1)

OR

(a) (i) The logic gate involved may be OR or AND gate as for $A = B = 0$ or $A = B = 1$

$Y = D$ or 1 is OR and AND gate.

OR gate

AND gate (1)

(ii) The logic gate involved may be NOR or NAND gates.

NOR gate

NAND gate (1)

(b) (i) The logic operation performed by the combination of gates is of OR gate

$$Y = \overline{\overline{A} \cdot \overline{B}} = A + B \quad (1)$$

Truth Table

0	0	0
0	1	1
1	0	1
1	1	1 (1)

(1)

(ii) The logic operation performed by the combination of gates is of AND gate

$$Y = \overline{\overline{A} + \overline{B}} = A \cdot B$$

Truth Table

0	0	0
0	1	0
1	0	0
1	1	1

(1)