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

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1. A dipole of dipole moment p, is kept in a uniform electric field E. Write the value of the angle between p and E for which the torque, experienced by the dipole, is (i) minimum (ii) maximum.

2. How electron mobility changes for a good conductor when the temperature of the conductor is decreased at constant potential difference?

3. In an experiment on meter bridge, if the balancing length AC is x, what would be its value, when the radius of the meter bridge wire AB is doubled?

4. An electron is moving along positive x-axis in the presence of uniform magnetic field along positive y-axis. What is the direction of the force acting on it.

5. Two identical loops, one of copper and the other of aluminium, are rotated with the same angular speed in the same magnetic field. Compare the induced emf in two coil loops. **(Ans. 1 : 1)**

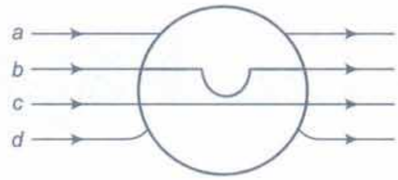
6. Name the part of electromagnetic spectrum of wavelength 10^{-2} m and mention its one application.

7. Calculate the speed of light in a medium whose critical angle is 30°.

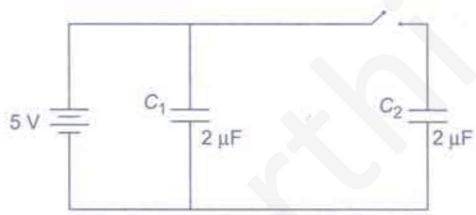
(Ans. $3 \times 10^8 \, ms^{-1}$)

8. State the relation the frequency ν of radiation, emitted by a LED and the band gap energy E of the semiconductor used to fabricate it.

9. A metallic sphere is placed in a uniform electric field as shown in the figure. Which path is followed by electric field lines and why?



10. Figure shows two identical capacitors C_1 and C_2, each of 2 μF capacitance, connected to a battery of 5 V. Initially switch S is closed. After some time S is left open and dielectric slabs of dielectric constant $K = 5$ are used inserted to fill completely the space between the plates of the two capacitors. How will the (i) charge and (ii) potential difference between the plates of the capacitors be affected after the slabs are inserted?



11. A cell of emf E and internal resistance r is connected across a variable resistor R. How the terminal potential V vary with resistance R.

12. Depict the field-line pattern due to a current carrying solenoid of finite length.
 (i) In what ways do these lines differ from those due to an electric dipole?
 (ii) Why cannot two magnetic field lines intersect each other?

13. A source of emf is used to establish a current I, through a coil of self-inductance L. Show that the work done by the source to build up the current I is $\frac{1}{2}LI^2$.

14. In an electromagnetic wave propagating along the x-direction, the magnetic field oscillates at a frequency of 3×10^{10} Hz and has an amplitude of 10^{-7} T, acting along the y-direction.
 (i) What is the wavelength of the wave? **(Ans. 1 cm)**
 (ii) Write the expression representing the corresponding oscillating electric field.
 (Ans. 30 sin $(6\pi \times 10^{10} t - 2\pi \times 10^2 \pi)$ k)

15. (i) A plane wavefront approaches a plane surface separating two media. If medium 'one' is optically denser and medium 'two' is optically rare, using Huygen's principle, explain and show how a refracted wavefront is constructed?
 (ii) When a light wave travels from a rare to a denser medium, the speed decreases. Does it imply reduction in its energy? Explain.

16. Write Einstein's photoelectric equation. State clearly the three salient features observed in photoelectric effect, which can be explained on the basis of the above equation.

OR

Plot a graph showing the variation of stopping potential with the frequency of incident radiation for two different *photosensitizes* materials having work functions W_1 and $W_2 (W_1 > W_2)$. On what factors does the
(i) slope and
(ii) intercept of the lines depend?

17. Deduce an expression for the electric potential due to an electric dipole at any point on its axis. Mention one contrasting feature of electric potential of a dipole at a point as compared to that of due to a single charge.

18. Four identical cells, each of emf 8 V and internal resistance 2.5 Ω are connected in series and charged by a 100 V DC supply, using a 24 Ω resistor in series.

Calculate the following
(i) Charging current in the circuit **(Ans. 2 A)**
(ii) Potential difference across the cells during recharging. **(Ans. 52 V)**

19. 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?

20. In a Young's double slit experiment, the two slits are kept 2 mm apart and the screen is positioned 140 cm away from the plane of the slits. The slits are illuminated with light of wavelength 600 nm. Find the distance of the third bright fringe, from the central maximum, in the interference pattern obtained on the screen. **(Ans. 126 mm)**

If the wavelength of the incident light were changed to 480 nm, find out the shift in the position of third bright fringe from the central maximum. **(Ans. 0.252 mm)**

OR

What are coherent sources of light? Why are coherent sources required to obtain sustained interference pattern?

State three characteristic features which distinguish the interference pattern due to two coherently illuminated sources as compared to that observed in a diffraction pattern due to a single slit.

21. Draw the curve showing variation of binding energy/nucleon with mass number of different nuclei. Briefly state, how nuclear fusion and nuclear fission can be explained on the basis of this graph.

22. If the nucleons of a nucleus are separated for apart from each other, the sum of masses of all these nucleons is larger than the mass of the nucleus. Where does this mass difference come from? Calculate the energy released if ^{238}U nucleus emits an α-particle.

Given, atomic mass of $^{238}U = 238.05084$ amu

Atomic mass of $^{234}U = 234.04363$ amu

Atomic mass of α-particle $= 4.00260$ amu

and $1 \text{ amu} = 931 \text{ MeV}/c^2$ **(Ans. 4.25 MeV)**

23. Draw the circuit diagram of a full wave rectifier. Explain briefly its working principle. Plot the graphs of the input and output waveforms.

24. Draw transfer characteristics of a common emitter *n-p-n* transistor. Point out the region in which the transistor operates as an amplifier. Define the following terms used in transistor amplifiers

(i) Input resistance (ii) Output resistance

(iii) Current amplification factor

25. (i) Using de-Broglie's hypothesis, explain with the help of a suitable diagram, Bohr's second postulate of quantization of energy levels in a hydrogen atom.

(ii) The ground state energy of hydrogen atom is −13.6 eV. What are the kinetic and potential energies of the electron in this state?

26. Ramesh and his younger brother Raju went to a shopping mall whose doors were automatic with self close and open. Raju asked Ramesh, that, "Why these doors are automatically opening and closing without even a single touch?". Ramesh was a graduate but, he did not know the exact reason behind this. Ramesh asked the same from his friend Rakesh who was junior to him Rakesh explained the whole phenomenon agilely to Ramesh and told that this whole phenomenon is based on photo-electric effect given by the great scientist Einstein.

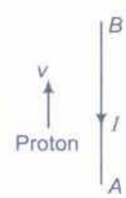
(a) After reading the passage, what are your opinions about the education of Ramesh and describe about all three characters Ramesh, Rakesh and Raju in your words.

(b) Write photoelectric equation given by Einstein and define photoelectric current.

27. (a) Derive an expression for the force between two long parallel current carrying conductors.

(b) Use this expression to define SI unit of current.

(c) A long straight wire *AB* carries a current I. A proton P travels with a speed v, parallel to the wire, at a distance d from it, in a direction opposite to the current as shown in the figure. What is the force experienced by the proton and what is its direction?



OR

With the help of a neat and labelled diagram, explain the underlying principle and working of a moving coil galvanometer. What is the function of

(i) uniform radial field and

(ii) soft iron core in such a device?

28. (i) With the help of a labelled diagram, describe briefly the underlying principle and working of a step-up transformer.

(ii) Write any two sources of energy loss in a transformer.

(iii) A step-up transformer converts a low input-voltage into a high output-voltage. Does it violate law of conservation of energy? Explain.

OR

(i) State the working principle of an AC generator with the help of a labelled diagram.

(ii) Derive an expression for the instantaneous value of the emf induced in the coil.

(iii) Why is the emf maximum when the plane of the armature is parallel to the magnetic field?

29. (i) Define a 'linearly polarized' or 'plane polarized' light. Why is the phenomenon of polarization not observed by sound waves?

(ii) What does a polaroid consist of? How does an unpolarized light incident on a polaroid get linearly polarized?

(iii) A beam of unpolarized light is made to fall from air on it bronday, on another transparent medium of refractive index. The reflected light is viewed through a rotating analyzer.

Show, with the help of a graph, the variation of intensity of light transmitted through the analyzer with the angle between the pass axis of the analyzer and the direction of the reflected beam.

OR

A parallel beam of monochromatic light falls normally on a narrow slit and the light, coming out of the slit, is obtained on a screen, kept behind, parallel to the slit plane.
What kind of pattern do we observe on the screen and why? How does the

(i) angular width

(ii) linear width of the principal maximum, in this pattern change when the screen is moved, pattern change when the screen is moved, parallel to itself, away from the slit plane?

State two points of difference between this pattern and the interference pattern observed in the Young's double slit experiment.

Sample Question Paper 11

1. Torque experienced by the dipole in uniform electric field $\tau = pE\sin\theta$

(i) For minimum torque $\theta = 0°$

$$\tau_{min} = pE\sin 0° = 0 \quad [\because \sin 0° = 0]$$

(ii) For maximum torque $\theta = 90°$

$$\tau_{max} = pE\sin 90° = pE \quad [\because \sin 90° = 1]$$

2. Electron mobility $\mu_e = \frac{e\tau}{m}$

With the decrease in temperature, the relaxation time (τ) will increase and finally will result into increase of mobility.

3. The balancing length continue to be x even on doubling the radius of meter bridge wire as it does not affect the ratio of length of two parts of meter bridge wire.

4. Direction of force acting on a charged particle moving in uniform magnetic field is in the direction of $\mathbf{v} \times \mathbf{B}$ (where $\mathbf{v}$ is velocity of particle and $\mathbf{B}$ is magnetic field).

$$\text{Force } \mathbf{F} = -e(\mathbf{v} \times \mathbf{B}) = -e(\mathbf{i} \times \mathbf{j}) = -e\,\mathbf{k}$$

$\mathbf{v}$ is along $+X$-axis and $\mathbf{B}$ is along $+Y$-axis. So, force will be directed towards $-Z$-axis.

5. As both the loops are rotated with the same field, so change in magnetic flux for both the loops will be same. Hence, induced emf in the two loops will be same.

$$\therefore \quad e_1 : e_2 = 1:1$$

6. The part of electromagnetic of wavelength 10^{-2} m is microwave, they are used in RADAR communication.

7. Refractive index $\mu = \frac{1}{\sin C}$

Again, $\mu = \frac{c}{v}$

where, c = speed of light in vacuum $= 3 \times 10^8$ m/s^{-1}

$$\therefore \quad \frac{c}{v} = \frac{1}{\sin C}$$

$$\frac{3 \times 10^8}{v} = \frac{1}{\sin 30°}$$

$$\frac{3 \times 10^8}{v} = \frac{1}{1/2}$$

$$\Rightarrow \quad v = 1.5 \times 10^8 \text{ ms}^{-1}$$

8. Photo energy $\leq$ Band gap

$$h\nu \leq E$$

9. Electric lines of force fall normally on the left part and start normally from the right part. Therefore, path d is correct.

10. Initially, switch S is closed.

$\therefore$ Charge on C_1, $q_1 = C_1V = 2 \times 5 = 10\,\mu C$

Charge on C_2, $q_2 = C_2V = 2 \times 5 = 10\,\mu C$

(Here capacitors C_1 and C_2 are connected in parallel, so, both will have same potential difference.)

When switch is open then C_1 is connected to the circuit but C_2 is not. So, charge on C_1 will increase due to insertion of dielectric slab C on insertion of dielectric slab, capacity will increase and hence the change). Charge on C_2 will remain same because it is not connected to the battery.

Similarly, C_1 is connected with the battery, so its potential difference will remain same 5 V, but potential difference on C_2 will decrease.

11. Terminal potential difference $V = E - ir$

$$\text{Current } i = \frac{E}{R + r}$$

$$V = E - \left(\frac{E}{R + r}\right)r = \frac{ER}{R + r}$$

As R will increase, V will also increase.

12. Field lines due to a current carrying solenoid are parallel lines inside the solenoid which emerge from its one end and enters at the other end.

(i) Field lines due to an electric dipole are not closed continuous curve like magnetic lines of force due to current carrying solenoid.

(ii) Two magnetic lines of force cannot intersect each other, because in this condition there will be two directions of magnetic field at the point of intersection which is not possible.

13. Emf induced in the inductor at any instant $e = -L\frac{dI}{dt}$

This emf tends to prevent the growth of current. To maintain growth of current, power has to be supplied from the external source.

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Power supplied at instant t

$$\frac{dW}{dt} = EI = L\frac{dI}{dt}.I$$

Small amount of work done in a small time dt

$$dW = \frac{LdI}{dt} I\,dt$$

$$= LI\,dI$$

$\therefore$ Total work done by the external source in building up current from 0 to I is

$$W = \int_0^I LI\,dI = L\left[\frac{I^2}{2}\right]_0^I = \frac{1}{2}LI^2$$

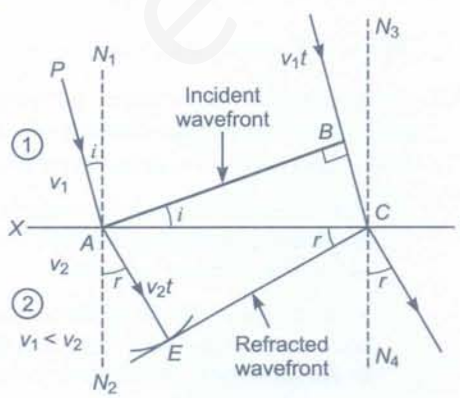
14. (i) Wavelength $\lambda = \frac{c}{v}$

$$= \frac{3\times10^8}{3\times10^{10}} = 10^{-2}\text{ m} = 1\text{ cm}$$

(ii) Expression representing the corresponding oscillating electric field

$$E = E_0 \sin\omega\,(t - x/c)\mathbf{k}$$
$$= cB_0 \sin\omega\,(t - x/c)\mathbf{k}$$
$$= 3\times10^8 \times 10^{-7} \sin 2\pi\nu\,(t - x/c)\mathbf{k}$$
$$= 30 \sin 2\pi \times 3\times10^{10}(t - x/c)\mathbf{k}$$
$$= 30 \sin 6\pi \times 10^{10}\,(t - x/c)\mathbf{k}$$
$$= 30 \sin\left(6\pi\times10^{10}t - \frac{6\pi\times10^{10}x}{3\times10^8}\right)\mathbf{k}$$
$$= 30 \sin(6\pi\times10^{10}t - 2\pi\times10^2 x)\mathbf{k}$$

15. (i) Let a plane wavefront AB is incident at the interface XY separating two media such that medium one is optically denser than medium two. Let time t taken by the wave from B to C, then



$$BC = v_1 t \quad \text{...(i)}$$

where, v_1 is the velocity of light in medium one. In the duration of time t, the secondary wavelets emitted from point A gets spread over a hemisphere of radius

$$AE = v_2 t \quad \text{...(ii)}$$

in the medium two and $v_2 > v_1$.

The tangent plane CE from C over this hemisphere of radius v_2t will be new refracted wavefront of AB. It is evident that angle of refraction r is greater than angle of incidence i.

(ii) No, energy carried by the wave does not depend on its speed. Instead, it depends on the amplitude of wave.

16. Einstein's photo electric equation

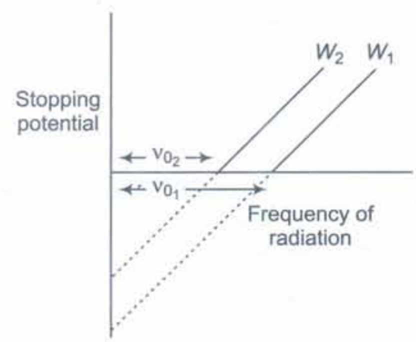
$$\frac{1}{2}mv^2 = h\nu - \omega_0 \text{ or KE} = h(\nu - \nu_0)$$

The three salient features observed in photo electric effect, which can be explained on the basis of the above equation are

1. For a given metal and frequency of incident radiation, the number of photo electrons ejected per second is directly proportional to the intensity of the incident light.
2. For a given metal, there exists a certain minimum frequency of incident radiation below which no emission of photo electrons takes place. This frequency is called the **threshold frequency**.
3. Above the threshold frequency, the maximum kinetic energy of the emitted photo electrons is independent of the intensity of incident light but depends only upon the frequency (or wavelength) of the incident light.

OR

The graph showing the variation of stopping potential with the frequency of incident radiation is shown below



(i) The slope of stopping potential *versus* frequency of incident radiation gives the ratio of Planck's constant (h) and electronic charge (e).

$$\text{Slope} = \frac{h}{e}$$

(ii) Intercept on the frequency axis gives the value of threshold frequency ν_0.

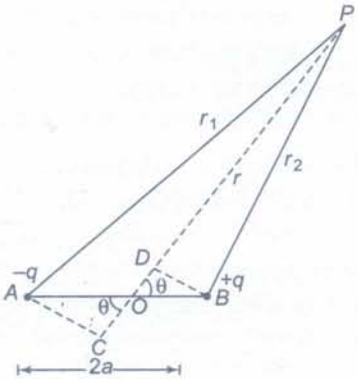
$$\text{Intercept on the potential axis} = -\frac{h\nu_0}{e}$$

17. Potential at a Point due to an Electric Dipole

Let an electric dipole consist of two equal and unlike poing charges $-q$, at A and $+q$ at B, separated by a small distance $AB = 2a$, with centre at O. The dipole moment

$$|\mathbf{p}| = q \times 2a \qquad \ldots\text{(i)}$$

We have to calculate potential at any point P, wherem $OP = r$ and $\angle BOP = \theta$.



Let $AP = r_1$ and $BP \perp r_2$

Draw $AC \perp PO$ produced and $BD \perp PO$

In ΔAOC,

$$\cos\theta = \frac{OC}{OA} = \frac{OC}{a}$$

$\therefore \qquad OC = a\cos\theta$

Similarly, $\qquad OD = a\cos\theta$

$\therefore$ Net potential at P due to the dipole

$$V = \frac{q}{4\pi\,\varepsilon_0\, r_2} - \frac{q}{4\pi\,\varepsilon_0\, r_2}$$

$$V = \frac{q}{4\pi\,\varepsilon_0}\left[\frac{1}{r_2} - \frac{1}{r_1}\right]$$

Now, $r r_1 = AP \simeq CP$

$$= OP + OC = r + a\cos\theta$$

and $r_2 = BP \simeq DP$

$$= OP - OD = r - a\cos\theta$$

$$\therefore \qquad v = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r - a\cos\theta} - \frac{1}{r + a\cos\theta}\right]$$

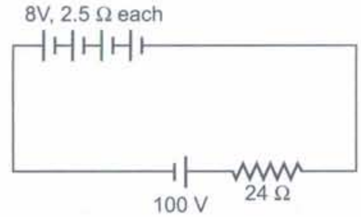
$$= \frac{q}{4\pi\,\varepsilon_0}\left[\frac{r + a\cos\theta - r + a\cos\theta}{r^2 - a^2\cos^2\theta}\right]$$

$$V = \frac{q}{4\pi\,\varepsilon_0}\left[\frac{2a\cos\theta}{r^2 - a^2\cos^2\theta}\right]$$

i.e., $$V = \frac{p\cos\theta}{4\pi\,\varepsilon_0\,(r^2 - a^2\cos^2\theta)} \qquad \ldots\text{(ii)}$$

Electric potential at a point due to single charge does not depend on its alignment with the reference point, as compared to electric dipole.

18. During the charging of batteries, current enters the positive end and leaves the negative end.



Net emf of the circuit $= 100 - 8 \times 4 = 68$ V

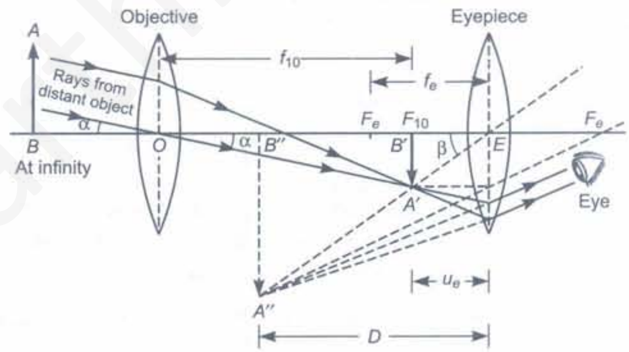
Total resistance $= 24 + 4 \times 2.5 = 34\Omega$

(i) Charging current $= \dfrac{68}{34} = 2$ A

(ii) Potential difference during recharging

$$V = E - IR = 100 - 2 \times 24 = 52\,\text{V}$$

19. Magnifying power $(m) = -\dfrac{L}{f_o}\left(1 + \dfrac{D}{f_e}\right)$



Astronomical Telescope

where, f_o and f_e focal length of objective and eye lens and D = least distance of distinct vision.

There is no effect of increase of aperture of objective lens as magnifying power is given by

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

where D = least distance of distinct vision which is independent of aperture = 25 cm

20. Distance of n^{th} bright fringe from central maximum

$$y = \frac{n\lambda D}{d}$$

Here $n = 3$, $\lambda = 600$ nm,

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

$$d = 2\,\text{mm} = 2 \times 10^{-3}\ \text{m}$$

$$D = 140\ \text{cm} = 1.4\ \text{m}$$

$$\therefore \quad y = 3 \times \frac{600 \times 10^{-9} \times 1.4}{2 \times 10^{-3}}$$

$$= 1.26 \text{ mm}$$

$$\text{Again } y' = \frac{3 \times 480 \times 10^{-9} \times 1.4}{2 \times 10^{-3}} = 1.008 \text{ m}$$

$\therefore$ Shift in position $= 1.26 - 1.008 = 0.252\,\text{mm}$

OR

Coherent Sources of Light Two coherent sources of light are those sources which emit light waves of same frequency and same wavelength with a constant initial phase difference between them.

To have the sustained interference pattern, there should be a constant phase difference between the interfering light waves, that is the reason why coherent sources are required.

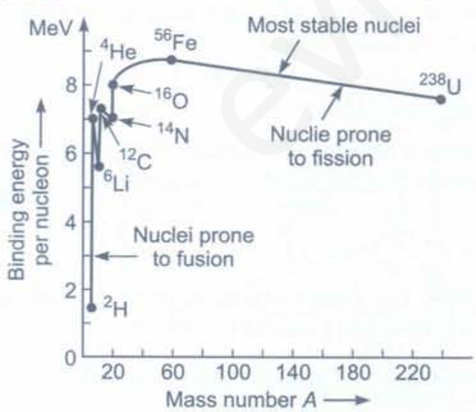
Three characteristic features which distinguish the interference pattern due to two coherently illuminated sources as compared to that observed in a diffraction pattern due to a single slit are

(i) In interference pattern, the fringes may or may not be of the same width, while in diffraction, the fringes are always of varying width.

(ii) In interference, the fringes of minimum intensity are perfectly dark, whereas in diffraction, the fringes of minimum intensity are not perfectly dark.

(iii) In interference, all the bright fringes are of same intensity, while in diffraction, the bright fringes are of varying intensity.

21. The binding energy curve per nucleon is shown below.



Binding energy per nucleon as a function of mass number A

Explanation of Release of Energy in Nuclear Fission and Fusion The curve reveals that binding energy per nucleon is smaller for heavier nuclei than the middle level nuclei. This shows that heavier nuclei are less stable than middle level nuclei. In nuclear fission, binding energy per nucleon of reactants (heavier nuclei) change from nearly 7.6 MeV to 8.4 MeV (for nuclei of middle level mass).

Higher value of binding energy of the product nuclear results in the liberation of energy during the phenomena of nuclear fission.

In nuclear fusion, binding energy per nucleon of lighter nuclei into heavier one changes from low value of binding energy per nucleon to high and release of energy take place in fusion e.g., two $_1H^2$ (Be $\approx$ 1.5 MeV/nucleon) combine to form $_2He^4$ (binding energy per nucleon $\simeq$ 7 MeV/ nuclei) and therefore energy liberate during nuclear fusion.

22. The difference in the total mass of nucleons and the mass of nucleus is known as mass difference.

This mass difference occuring in the nucleus converts to energy as per Einstein's equation $E = mc^2$ and produces binding energy. This energy binds the nuclear together inside the nucleus, in spite of the repulsive forces between protons.

Energy released $E = \Delta mc^2$

where Δm = mass defect

If Δm is in amu then, $E = \Delta m \times 931\,\text{MeV}$.

Here $\quad ^{238}U \longrightarrow ^{234}U + \alpha(_2He^4)$

Mass defect $\Delta m = m(^{238}U) - [m(^{234}U) + m(\alpha)]$

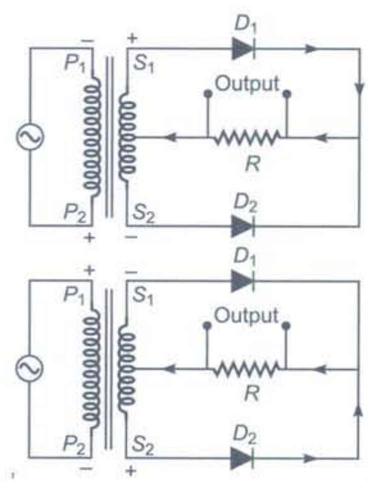
$$= 238.05084 - [234.04363 + 4.00260]$$

$$= 238.05084 - 238.04623 = 0.00461$$

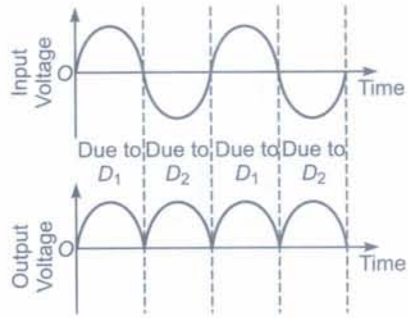
$\therefore$ Energy released $E = \Delta m \times 931\,\text{MeV}$

$$= 0.00461 \times 931 = 4.25 \text{ MeV}$$

23. The circuit diagram of full wave rectifier is shown below.

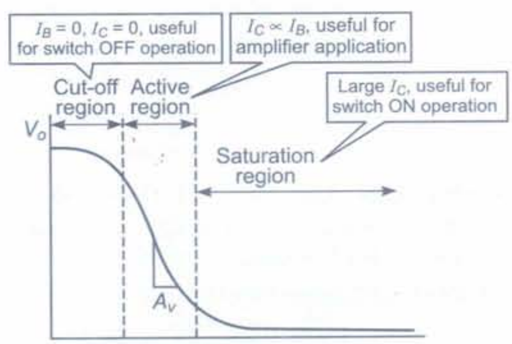


The input and output waveforms have been given below.



Its working based on the principle that junction diode offer very low resistance in forward bias and very high resistance in reverse bias.

24.



The active region of transfer characteristic curve operates as an amplifier.

(i) **Input Resistance** The input resistance r_i of a transistor in CE configuration is defined as the ratio of small change in base-emitter voltage to the corresponding small change in the base current, when the collector emitter voltage is kept constant.

$$r_i = \left(\frac{\Delta V_{EB}}{\Delta I_B}\right)_{V_{CE} = \text{constant}}$$

(ii) **Output Resistance** The ratio of variation of collector emitter voltage (V_{CE}) and corresponding change in collector current (ΔI_C), when base current remains constant, is called output resistance.

$$r_o = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)_{I_B = \text{constant}}$$

(iii) **Current Amplification Factor** The current amplification factor of a transistor in common emitter configuration is equal to the the ratio of the small change in the collector current (ΔI_C) to the small change in base current when collector emitter voltage is kept constant *i.e.*

$$B = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE} = \text{constant}}$$

25. (i) As the de-Broglie equation is

$$\lambda = \frac{h}{p} = \frac{h}{mv} \quad \text{... (i)}$$

for a circular of waves, it can be writen as

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

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

Put the value of λ in Eq. (ii) we get,

$$\frac{2\pi r}{n} = \frac{h}{mv} \Rightarrow mvr = \frac{nh}{2\pi}$$

This is required angular momentum for the electron revolving in the certain orbits.

(ii) Given total ground state energy for hydrogen, TE = − 13.6 eV

$\therefore$ Kinetic energy = − TE

= − (−13.6) eV = 136 eV

Now potential energy = 2(TE) = 2 × (−13.6)

= − 27.2eV

26. (i) It is not only about education but also about the general awareness that each and every individual should be aware of the happenings around him and should notice the things which they see regularly.

Ramesh was a graduate, but was not able to answer his younger brother's question which is the matter of shame for him. Rakesh was a keen learner who study the things with a practical approach that is why he observe the things that happens around him and even at undergraduate level he was able to answer Ramesh.

On the other hand, Raju at a very young age was a observer and was even having the curiosity to know the reason of situations happening around him. Observance power is very much required now-a-days, it has become a necessity to be aware to the technology that is being in use.

(ii) Photo electric equation, by Einstein

$$\frac{1}{2}mv^2 = KE_{max} = E - \phi$$

where, KE_{max} = maximum kinetic energy of photoelectron,

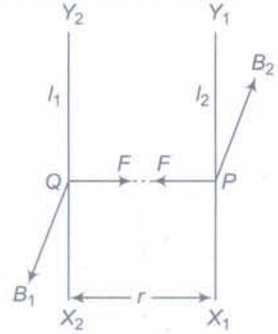
E = Energy of photon incidented on the metal surface

ϕ = Work function for the metal.

Photo Current It is current developed at the time of flow of photo electrons in the conductor wire.

27. (i) Force between two long parallel current carrying conductors

Consider two infinitely long conductors X_1Y_1 and X_2Y_2 placed parallel to each other at a distance r apart. The currents I_1 and I_2 are flowing through the two conductors X_1Y_1 and X_2Y_2 in the same direction as shown in figure



Let us find the force experienced per unit length by the current carrying conductor X_1Y_1 due to the magnetic field produced by the current carrying conductor X_2Y_2.

Magnetic field at point P (on the conductor X_1Y_1) due to current I_2 flowing through the infinitely long conductor X_2Y_2 is given by

$$B_2 = \frac{\mu_0}{4\pi} \cdot \frac{2I_2}{r}$$

According to the right hand thumb rule, the direction of the magnetic field B_2 at point P is perpendicular to the plane of paper and in inward direction. Now, the conductor X_1Y_1 carrying current I_1 lies in the magnetic field B_2 produced by the conductor X_2Y_2. Since $F = BIl$, the force experienced by the *unit length* of the conductor X_1Y_1 due to magnetic field B_2 is given by

$$F = B_2 \times (I_1 \times 1) = \frac{\mu_0}{4\pi} \cdot \frac{2I_2}{r} \times I_1$$

or $$F = \frac{\mu_0}{4\pi} \cdot \frac{2I_1 I_2}{r}$$

(ii) **Definition of SI Unit of Current** SI unit of current is ampere.

Let $I_1 = 1\,\text{A}, I_2 = 1\,\text{A}, r = 1\,\text{m}$

$$\therefore \quad F = \frac{\mu_0}{4\pi} \times \frac{2 \times 1 \times 1}{1}$$

$$= \frac{2\mu_0}{4\pi} = 2 \times 10^{-7}\,\text{Nm}^{-1}$$

i.e., one ampere in that current, which when flowing through each of two parallel conductors of infinite length and placed in free space at a distance of 1 m from each other, produces between them a force of 2×10^{-7} N/m of their lengths.

(iii) Here the proton is moving in the magnetic field produced by long straight wire.

Magnetic field due to straight wire at distance d

$$B = \frac{\mu_0 I}{2\pi d}$$

Force acting on changed particle moving in magnetic field $F = qvB$

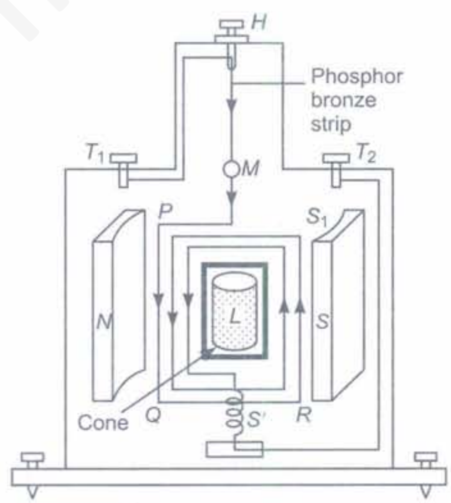
Here $q = e$ (for proton), $B = \dfrac{\mu_0 I}{2\pi d}$

$$F = ev\frac{\mu_0 I}{2\pi d} = \frac{\mu_0}{2\pi} \frac{evI}{d}$$

The direction of this force will be perpendicular to both velocity (v) and magnetic field (B). From Fleming's left hand, direction of force will be along $+Z$ direction.

OR

Moving Coil Galvanometer The moving coil galvanometer was first devised by Kelvin and later on modified by D Arsonaval. It is also known as *American type galvanometer.*



It is a device used to detect small current flowing in an electric circuit. With suitable modifications, a moving coil galvanometer can be used to measure current and potential difference.

Principle When a current carrying coil is placed in a magnetic field, it experiences a torque.

Theory Suppose that the rectangular coil $ABCD$ having n turns is of length l (= AB or CD) and breadth b (= AD or BC). Let B the strength of the magnetic field due to the magnet NS. Initially *i.e.,* (before passing the current through the galvanometer), the plane of the coil is parallel to the magnetic field. When current is passed through the coil, forces act on the arms of the coil. The forces on arms DA and BC being equal and opposite, cancel the effect of each other. if current is passed in the direction of $ABCD$, then force on arm $AB, F = nBIl$ (normally outwards) and force on arm $CD, F = nBIl$ (normally inwards)

The two forces are equal, opposite, parallel and act at different points as shown in figure. Hence, the two forces constitute a torque. As the coil rotates under the effect of the torque, the suspension wire gets twisted and a restoring torque is developed in the suspension wire.

The coil will rotate, till the deflecting torque acting on the coil due to flow of current is balanced by the restoring torque developed in the suspension wire due to twisting. Therefore, in equilibrium,

deflecting torque = restoring torque (in magnitude)

Supposethat the coil comes thorest after rotating through an angle α. In this position, the plane of the coil makes angle α with the direction of the field [Fig. 2.15]. The perpendicular distance between the forces acting on the arms AB and CD is given by

$$DK = AD \cos\alpha = b\cos\alpha$$

Therefore, deflecting torque acting on coil = either force × DK = $nBIl \times b\cos\alpha$

$$= nBIA\cos\alpha, \quad \ldots(2.36)$$

where $A = l \times B$ is the area of the coil. If k is the restoring torque per unit twist for the material of the suspension wire, then

restoring torque = $k\alpha$

Since in equilibrium, the restoring torque is just equal and opposite to the defelecting torque,

$$nBIA\cos\alpha = k\alpha$$

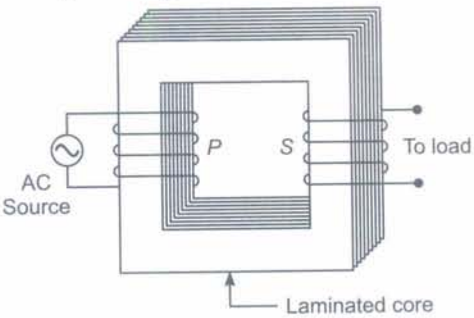
or $$I = \frac{k}{nBA} \cdot \frac{\alpha}{\cos\alpha}$$

Since the factor $\frac{k}{nBA}$ is constant for the given galvanometer, $I \propto \frac{\alpha}{\cos\alpha}$

(i) The poles of the magnet are made concave so as to produce radial magnetic field. In such field, the plane of the coil is parallel to the magnetic lines of force in all positions.

(ii) Soft iron core increases the magnetic induction due to its high permeability and hence the sensitivity of galvanometer.

28. (i) **Principle of Transformer** It is a device which converts high voltage AC to low voltage AC and *vice-versa*. It is based on the principle of mutual induction. When alternating current is passed through a coil, an induced emf is set up in the neighbouring coil.



Working When an alternating current is passed through the primary, the magnetic flux through the iron core changes, which does two things. It produces emf in the primary and an induced emf is also set up in the secondary. If we assume that the resistance of primary is negligible, then the back emf will be equal to the voltage applied to the primary. **(1)**

$$\therefore \quad V_1 = -N_1\frac{d\phi}{dt}$$

and $$V_2 = -N_2\frac{d\phi}{dt}$$

where, N_1 and N_2 are number of turns in the primary and the secondary respectively and V_1 and V_2 are their voltages respectively.

$$\therefore \quad \frac{V_2}{V_1} = \frac{N_1}{N_2}$$

In a step-up transformer $N_2 > N_1$, therefore, $V_2 > V_1$. **(1)**

(ii) Energy losses occur in transformers

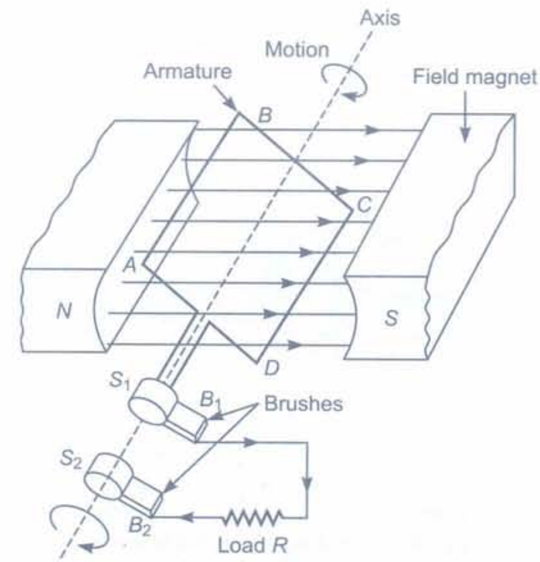
(a) **Flux Leakage** Not all of the flux due to primary coil passes through the secondary due to poor design of the core or the air gap in the core. **(1/2)**

(b) **Eddy Currents** The alternating magnetic flux induces eddy currents in the iron core and causes heating. **(1/2)**

(iii) No, it does not violates the law of conservation of energy because voltage increase is accompanied by decrease. In alterative current, in such a way for ideal transformer input power equals output power.

OR

(i) Labelled diagram of AC generator is shown below.



Principle AC generator works on the principle of electromagnetic induction. Whenever amount of magnetic flux linked with a coil changes an emf induced in the coil. It lasts so long as the change in magnetic flux through the coil continues. **(1)**

Working When a closed armature coil rotates in a uniform magnetic field with its axis perpendicular to the magnetic field, the magnetic flux linked with the loop changes and emf induces in coil. Let initially angle between area vector of coil and magnetic field B is $0°$. Thereafter, AB comes downward and CD upward then by Fleming's right hand rule induced current flows from B to A. During the next half revolution when CD comes downward end AB upward than current flows C to D. During the first half rotation current flows $BAS_2B_2RB_1\,DC$ and next half rotation along $CD\,B_1\,RB_2\,S_2\,AB$.

Thus, the direction of flow of current in resistance R get changed alternatively after every half cycle. Thus, AC is produced in coil. **(1)**

(ii) Let at any instant total magnetic flux linked with the armature coil is given by

$$\phi = NBA\cos\theta = NBA\cos\omega tc$$

(where $\theta = \omega t$ is the angle made by area vector of coil with magnetic field.)

$$\therefore \quad \frac{d\phi}{dt} = -NBA\omega\sin\omega t$$

$$-\frac{d\phi}{dt} = NBA\omega\sin\omega t \quad \textbf{(1)}$$

By Faraday's law of EMI

$$e = -\frac{d\phi}{dt}$$

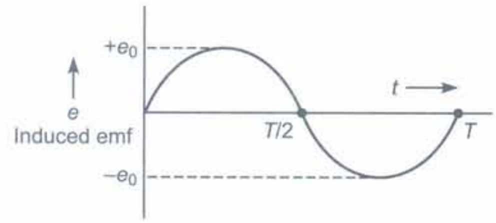
Induced emf in coil is given by

$$e = NBA\omega\sin\omega t$$

$$e = e_0\sin\omega t \quad \text{...(i)}$$

where, $e_0 = NBA\omega$

= peak value of induced emf



The mechanicla energy spent in rotating the coil in magnetiv field appears in the form of electrical energy. **(1)**

(iii) When plane of the armature coil is parallel to the magnetic field then angle made by the area vector of coil with magnetic field is 90°. In this $\sin\omega t$ is maximum hence induced emf is maximum.

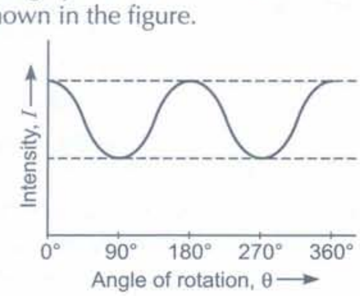
29. (i) **Linearly Polarized Light** It is the light wave in which the vibration of electric field vectors are confined in one plane and parallel to one direction.

The sound waves are longitudinal in nature. The longitudinal waves cannot be polarized therefore sound waves cannot be polarized.

(ii) A polaroid consists of the crystals of iodosulphate of quinine symmetrically arranged over a thin layer of nitro cellulose keeping the optic axis of crystals parallel to each other.

When an unpolarised light beam is incident on polaroids then only those vibrations of electric field vector which are parallel to crystallographic axis of polaroid are allowed to pass through it and remaining are being absorbed by the crystals due to property of dichroism. Thus, the light transmitted from the polaroid is plane polarised or linearly polarised light. **(2)**

(iii) The graph of the variation of intensity of light is shown in the figure.



(1)

OR

When a parallel beam of monochromatic light falls normally on a narrow slit and the light coming out of the slit, it obtained on a screen, kept behind parallel to the slit plane, then in the condition diffraction of light takes place and diffraction pattern is obtained on the screen.

(i) Angular width of central maximum $B = \frac{D\lambda}{d}$

where D = Distance between screen and slit

δ = Size of slit

λ = Wavelength of light

When screen is moved parallel to itself away from the slit then D will increase and hence the angular width.

(ii) Linear width of central maximum $= \frac{2D\lambda}{d}$

When screen is moved away from slit plane the fringe width decreases.

The light waves are diffracted by the edge of tiny circular obstacle. These diffracted waves interfere constructively at the centre of shadow and appears in the form of bright spot at the centre.

Difference between the Interference Pattern and the Diffraction Pattern

Characteristics	Interference	Diffraction
Fringe width	All bright and dark fringe are of equal width	The central bright fringe have got double width to that of width of secondary maxima or minima.
Intensity of bright fringes	All bright fringes are of same intensity	Central fringe is the brightest and intensity of secondary maxima decreases with the increase of order of secondary maxima either side of control maxima.

(2)