2023-24 II PUC ANNUAL EXAMINATION

PHYSICS

PART – A

I. Pick out correct option among the four options for all of the following questions: (15 × 1 =15)

1. The electric dipole placed in uniform electric filed is unstable, if the angle between electric field and dipole moment is
   A) 0^0 B) 60^0 C) 90^0 D) 180^0

   Ans: D) 180^0

2. The capacitance of a capacitor is 6×10^{-6} farad. It is connected to 200-volt cell. The energy released on discharging is fully, will be
   A) 0.12 J B) 0.24 J C) 0.6 J D) 12 J

   Ans: A) 0.12 J

3. The current density is a
   A) Scalar and its SI unit is Am^2
   B) Vector and its SI unit is A/m^3
   C) Vector and its SI unit is A/m^2
   D) Scalar and its SI unit is A/m

   Ans: C) Vector and its SI unit is A/m^2

4. A current I flow along the length of an infinitely long, straight thin-walled pipe, then the magnetic field
   A) At all points inside the pipe is same but not zero.
   B) At any point inside the pipe is zero.
   C) Is zero only on the axis of the pipe.
   D) Is different at different points inside the pipe.

   Ans: B) At any point inside the pipe is zero.

5. The universal property among all the substance is
   A) Diamagnetism B) Paramagnetism
   C) Ferromagnetism D) Non-magnetism

   Ans: A) Diamagnetism

6. A bar magnet is kept along the axis of a circular coil. If the magnet is rotated about its axis, then
   A) A current will be induced in the coil.
   B) No current will be induced in the coil.
   C) An emf and current both will be induced in the coil.
   D) Only an emf will be induced in the coil.

   Ans: B) No current will be induced in the coil.

7. Current in a coil changes from 1.6 A to 0.2 A in 2 second inducing an emf of 2.8 V. the value of self-inductance of the coil is
   A) 40 H B) 28 H C) 4 H D) 56 H

   Ans: C) 4 H

8. The resonance phenomenon is exhibited by a circuit only if following components are present
   A) L and R B) R and C C) L and C D) None of the above

   Ans: C) L and C

9. According to generalised Ampere-Maxwell law $\oint B.dl$ is equal to

   A) $\mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$ B) $\mu_0 i_c$ C) $\varepsilon_0 \frac{d\phi_E}{dt}$ D) $\mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$

   Ans: A) $\mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$

10. Modern telescopes called reflecting telescopes use a concave mirror rather than a lens for the objective because
    I. No chromatic aberration in a mirror.
    II. Giving mechanical support to a mirror is easier.
    A) I is true, II is false B) I is false, II is true
    C) Both I and II are true D) Both I and II are false

    Ans: C) Both I and II are true

11. According to Huygen's principle, the speed of the secondary wavelets is
    A) Twice that of the wave B) Zero
    C) Same as the wave D) Infinite

    Ans: C) Same as the wave.

12. Macroscopic particles in our daily like do not show wave-like properties because
    A) They are not associated with waves.
    B) Their wavelength is extremely high
    C) Their wavelength is zero
    D) Their wavelength is negligibly small

    Ans: D) Their wavelength is negligibly small

13. At the distance of closest approach of an α-particle with gold nucleus,
    A) Both kinetic energy and potential energy are equal.
    B) Entire kinetic energy is converted into potential energy
    C) Entire potential energy is converted inti kinetic energy.
    D) Both kinetic energy and potential energy are zero.

    Ans: B) Entire kinetic energy is converted into potential energy

14. The nuclear force is
    A) Attractive for distance r = 0.5 fm
    B) Attractive for distance r < 0.8 fm
    C) Repulsive for distance r > 0.8 fm
    D) Repulsive for distance r < 0.8 fm

    Ans: D) Repulsive for distance r < 0.8 fm

15. p-type semiconductor is electrically
    A) Positive
    B) Negative
    C) Neutral
    D) As temperature increases it becomes negative

    Ans: C) Neutral

II. Fill in the blanks by appropriate answer given in the bracket for all the following question: **(5 ×1=5)**

(decreasing, interference, helium, greater, diffraction, increasing)

16. The torque on a rectangular current loop in a uniform magnetic field increases by ________ the rea of the loop.
    Ans: Increasing

17. The mutual inductance of a solenoid can be decreased by ______________ the number of turns pr unit length either in inner or outer solenoid.
    Ans: Decreasing

18. Fringes of unequal intensities are obtained in ____________ patter.
    Ans: Diffraction

19. Alpha particle is a _______________ nucleus.
    Ans: Helium

20. The value of energy band in insulators is ______ then 3 eV.
    Ans: Greater

PART-B

III. Answer any Five of the following questions: **(5×2=10)**

21. State and explain Gauss's law in electrostatics.

Ans: It states that, the total electric flux passing through any closed surface $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface.

$$\phi_E = \frac{q}{\varepsilon_0}$$

Where,

q = charge enclosed

ε_0 = permittivity of free space.

22. Two-point charges $5\times10^{-8}C\ and\ -3\times10^{-8}C$ **are located 10 cm apart. Find the point between the two charges where potential is zero.**

Ans:

$V_A = 0$

$$\Rightarrow \frac{1}{4\pi\varepsilon_0}\times\frac{5\times10^{-8}}{x\times10^{-2}} = \frac{1}{4\pi\varepsilon_0}\times\frac{3\times10^{-8}}{(10-x)10^{-2}} = 0$$

$$\Rightarrow \frac{1}{4\pi\varepsilon_0}\times\frac{5\times10^{-8}}{x\times10^{-8}} = \frac{1}{4\pi\varepsilon_0}\times\frac{3\times10^{-8}}{(10-x)10^{-2}}$$

$$\Rightarrow 5(10-x) = 3x$$

$$50-5x = 3x$$

$$50 = 8x$$

$$\therefore x = \frac{50}{8}cm\ \ from\ 5\times10^{-8}C \text{ charge}$$

23. When the force experienced by a moving charge in magnetic field becomes

a) Maximum

Ans: 90^0

b) Minimum?

Ans: 0^0 or 180^0

24. Define susceptibility and magnetization for a magnetic material.

Ans:

It is the ratio of intensity of magnetization developed in the material to the applied magnetizing force (H).

Magnetization of the material is defined as net magnetic dipole moment per unit volume of the material. It is also known as Intensity of magnetization.

25. Write the principle of AC generator. Mention the expression for induced emf in it.

Ans:

Principle: The working of AC generator is based on the principle of EMI. When a closed coil is rotated in a uniform magnetic field, with its axis. Perpendicular to the magnetic field, the magnetic flux linked with the coil changes and an induced emf and hence a current is set up in it.

Induced emf $\in = \in_0 \, sin\omega t$

Where, $\in_0$= NBAω = peak value of induced emf. Clearly induced emf varies simultaneously with time.

26. Give any two sources of energy loss in actual transformer.

Ans: (Any Two)

- Loss due to heating of coils
- Loss due to flux leakage
- Loss due to eddy currents
- Hysteresis loss

27. Mention any two applications of UV (Ultraviolet) rays.

Ans:

- Photographic film.
- Photocells.

28. What is power of a lens? Write its SI unit.

Ans:

Power of a lens is its ability to converge or to diverge a beam of light incident on it. And it is defined as the reciprocal of its focal length.

Unit of Power of a lens is dioptre (D).

29. Distinguish between intrinsic and extrinsic semiconductors.

Ans:

Intrinsic semiconductor	Extrinsic semiconductor
Semiconductor in its pure from are called intrinsic semiconductor.	When impurity atoms are added to the pure semiconductor is called extrinsic semiconductor.
Here number of holes is equal to number of electrons above zero kelvin.	Here number of holes and number of electrons are unequal.
The conductivity depends on temperature.	The conductivity depends on temperature and impurity.
Conductivity is due to both electrons and holes.	The conductivity is mainly due to majority charge carriers.

PART-C

IV. Answer any Five of the following questions: (5×3 =15)

30. Mention any three properties of the electric field lines.

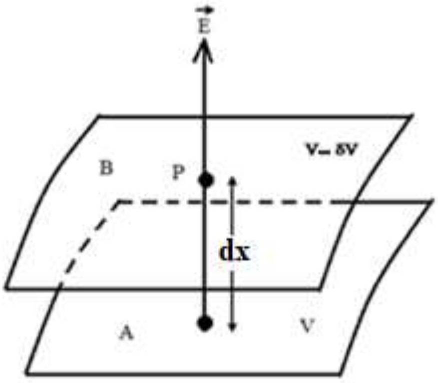
Ans: (Any three)

- Electric field lines are straight, when they represent the electric field due to an isolated charge, and are curved when they represent the field due to two or more charges placed nearby.
- The electric field lines are directed away from a positive charge and directed towards negative charge.
- The tangent drawn to an electric field line at any point gives the direction of electric field at that point.
- Two electric field lines cannot cross each other. [If two electric field lines cross each other than at the point of intersection there will be two tangents. It means that there are two values of the electric field at a point which is not possible].
- Electric field lines are closer (crowded) when the electric field is stronger and electric field lines spread out when the field is weaker.
- Electric field lines start form positive charge and end at negative charge. If there is a single charge, they may start or end at infinity.
- The number of electric filed lines leaving the positive charge or terminating at negative charge is proportional to the magnitude of the charge.
- The lines of force do not pass through a conductor as the electric field inside a conductor is always zero.
- Electric lines of force can pass through the non-conductor or dielectric.
- Electric lines of force cannot have sudden makes and breaks. They are continuous and not appear as closed loop.
- Electric lines of force are equidistant and parallel to one another in a uniform electric field.

31. Deduce $E = -\frac{dV}{dx}$ where, the terms have usual meaning.

Ans:

Consider two closely spaced equipotential surfaces A & B with potential V and $V - \delta V$ respectively. Where $\delta V$is the decrease in potential in the direction of the electric field $\vec{\boldsymbol{E}}$. Let P be a point on the surface B. Let δx be the perpendicular distance from P to the surface A. Let a unit positive charge +1C is moved along the perpendicular from the surface B to the surface A against the electric field.



Work done to move the unit positive charge from B to A is: W =$-F.\delta x$

For unit positive charge, $W = -\vec{E}.\vec{\delta x}$ --------(1)

By definition work done is equal to the potential difference between the surface A and B.

i.e. $W = V_A - V_B$

$W = V - (V - \delta V)$

$W = \delta V$ ------ (2)

Comparing equation (1) and (2)

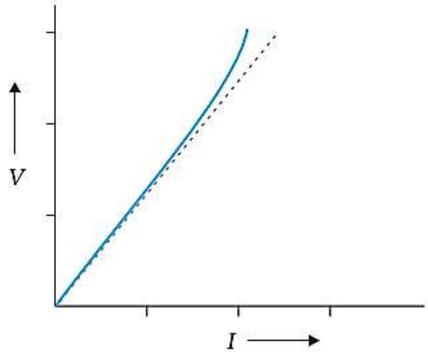
$$\vec{E} = -\frac{\delta V}{\delta x}$$

Negative sign shows that the direction of the electric field $\vec{E}$ is in the direction of decreasing potential.

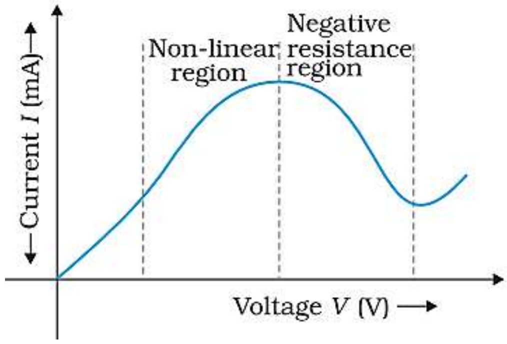
32. Give any three limitations of Ohm's law.

Ans: (Any two)

- Ohm's law is applicable only if all the physical conditions remain constant.
- Ohm's law is not applicable at very low and at very high temperature.
- Ohm's law holds good for metallic conductor for which V-I graph is linear.
- Ohm's law is not applicable for semiconductors, electrolyte, discharge tube etc. Because here V-I graph is non-linear.



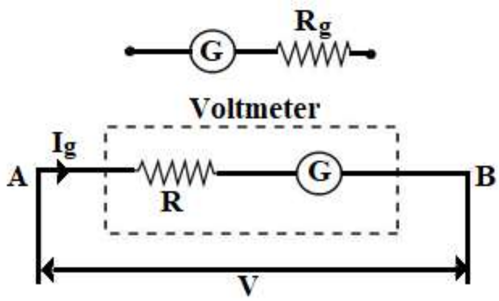
- The relation between V and I is not unique. i.e., there is more than one value of V for the same current I. A material exhibiting such behaviour is GaAs



33. Explain, how a galvanometer is converted into a voltmeter?

Ans:

A voltmeter is an instrument used to measure potential difference. It is always connected in parallel in a circuit. A galvanometer is very sensitive device and it can be used to measure very low currents.



A galvanometer can be converted into a voltmeter by connecting a high resistance in series with the coil of the galvanometer. Let R_g be the resistance of the galvanometer, I_g be the current required for full scale deflection and R be the high resistance to be connected in series with the galvanometer. If V is the maximum potential difference to be measured then

$$V = I_g\left(R_g + R\right)$$

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

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

Since R_g and R are constant so V is directly proportional to I_g

34. Mention any three properties of paramagnetic materials.

Ans: (Any Three)

- They get weakly attracted to a magnet.
- They have tendency to move from a region of weak magnetic field to strong magnetic field.
- When a paramagnetic substance is placed in a magnetic field, the magnetic lines of force prefer to pass through the substance rather than through air. Therefore, the resultant field B inside the substance is more than the external fieldB_0.
- When a rod of paramagnetic material is suspended freely in a uniform magnetic field, the rod comes to rest with its longest axis along the direction of the external magnetic field.
- When paramagnetic material is placed in a non-uniform magnetic field, it moves from weaker to the stronger parts of the field.
- The relative permeability $(\mu_r)$of the paramagnetic substance is always more than 1.
- The magnetic susceptibility of a paramagnetic substance has small positive value.
- The magnetic susceptibility of a paramagnetic substance varies inversely as the absolute temperature. i.e., $\chi \propto \frac{1}{T}$
- Paramagnetic substance loses magnetism with rise in temperature.

35. Lenz's law is the consequence of law of conservation of energy. Explain.

Ans:

Whenever a magnet is moved towards or away from a closed coil, the induced current always opposes the motion of the magnet, as predicted by Lenz's law.

When the north pole of the magnet is brought closer to a coil, its face towards the magnet develops north polarity and thus repels North Pole of the magnet. Work has to be done in moving the magnet closer to the coil against this force of repulsion. The mechanical energy spent to overcome the force of repulsion is converted into electrical energy, which appears in the coil. Thus, Lenz's law is in accordance with the law of conservation of energy.

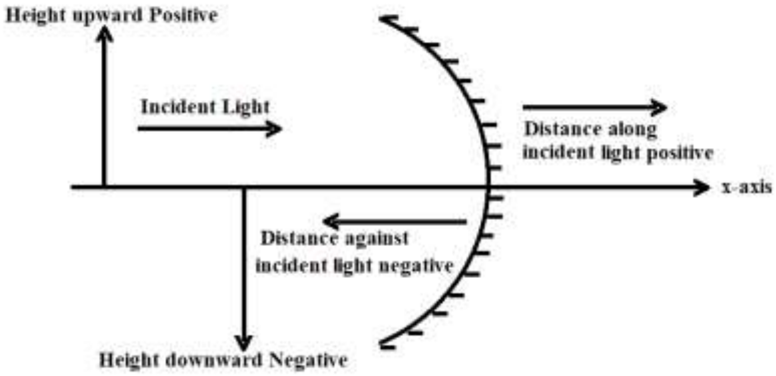
Similarly, when the north pole of the magnet is moved away from the coil, its face towards the magnet develops south polarity and thus attracts the north pole of the magnet. Here work has to be done in moving the magnet away from the coil against this force of attraction. The mechanical energy spent in overcoming this opposition is converted into electrical energy. Thus, Lenz's law is in accordance with the law of conservation of energy.

36. Write Cartesian sign conventions adopted for measuring distances in reflection of light at spherical mirrors.

Ans:

- All ray diagrams drawn with the incident ray travelling from left to right.
- All distance is measured from the pole of the mirror.
- All distance measured in the direction of incident light are taken to be positive.

- All distance measured in the opposite direction of incident light are taken to be negative.
- Height measured upwards & perpendicular to the principal axis are taken positive.
- Height measured downwards & perpendicular to the principal axis are taken negative.



37. Write three postulates of Bohr's atom model.

Ans:

Bohr's model is based on the following postulates.

- **Postulate 1:** Electrons revolve round the nucleus only in certain stable orbits (called stationary orbits) without the emission of radiant energy.
- **Postulate 2:** Electrons revolve around the nucleus only in those orbits for which the angular momentum of the electron is integral multiple of $\frac{h}{2\pi}$ where h is Planck's constant.

  i.e., Angular momentum, $mvr = n\frac{h}{2\pi}$ where $n = 1, 2, 3 \ldots \infty$ (Bohr's quantization rule) where n is called principal quantum number.
- **Postulate 3:** An electron might make a transition from one of its (specified non-radiating) orbits to another of lower energy. When it does so, a photon is emitted having energy equal to the energy difference between the inner and the outer orbits.

  i.e., $h\nu = E_o - E_i$ (Bohr's frequency condition)

  The frequency of the emitted photon is given by $\nu = \frac{E_o - E_i}{h}$ where E_i and E_o are the energies of the electron in inner and outer orbits.

38. Mass defect of $_7N^{14}$ *is* $0.11236\,u$. Calculate the binding energy and binding energy per nucleon in MeV.

Ans:

$$BE = \Delta mc^2$$

$$= 0.11236c^2\left(\frac{931.5MeV}{c^2}\right)$$

$$BE = 104.663MeV$$

$$\frac{BE}{A} = \frac{104.663MeV}{14} = 7.475MeV/Nucleon$$

PART-D

V. Answer any Three of the following questions: **(3×5=15)**

39. a) what are polar and non-polar molecules?

Ans:

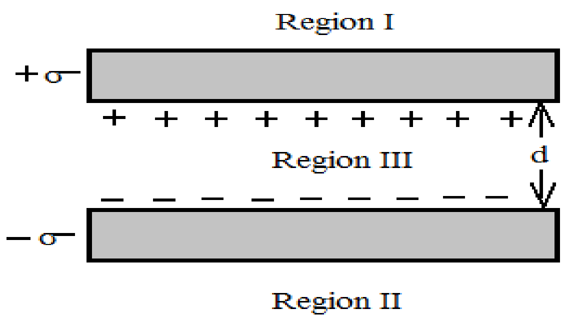
Polar Molecules: A molecule in which the centre of mass of positive charges (proton) does not coincide with the centre of mass of negative charges (electrons) is called polar molecule.

Non-Polar Molecule: A molecule in which the centers of mass of positive charges coincide with the centers of mass of negative charges is called a non-polar molecule.

b) Derive the expression for the capacitance of a parallel plate capacitor.

Ans:

A parallel plate capacitor consists of two large plane parallel conducting plates separated by a small distance d. Let A be the area of each plate and +Q and –Q be the total charges on each plate. Such that$Q = \pm\sigma A$; where $+\sigma$ and$-\sigma$ be the uniform surface charge densities on the two plates.



The electric field due to the two charged plates in the region I is:

$$\vec{E} = \frac{\sigma}{2\varepsilon_0} - \frac{\sigma}{2\varepsilon_0} = 0$$

Similarly Electric field due to the two charged plates in the region II is:

$$\vec{E} = \frac{\sigma}{2\varepsilon_0} - \frac{\sigma}{2\varepsilon_0} = 0$$

Electric field due to the two charged plates in the inner region III is added up.

$$\vec{E} = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0}$$

$$\vec{E} = \frac{\sigma}{\varepsilon_0}$$

The direction of electric field is from positive to the negative plate. For $d^2 << A$, the field is uniform.

For uniform electric field, the potential difference is, V= Ed

$$V = \frac{\sigma}{\varepsilon_0} d$$

∴The capacitance C of the parallel plate capacitor is: $C = \frac{Q}{V}$

$$C = \frac{\sigma A}{V}$$

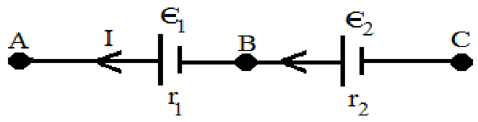
$$C = \frac{\sigma A}{\frac{\sigma d}{\varepsilon_0}}$$

$$C = \frac{\varepsilon_0 A}{d}$$

40. Arrive the expressions for equivalent emf and internal resistance of two cells connected in series.

Ans:

Consider two cells connected in series, with negative terminal of one cell connected to the positive terminal of the other.



Let ε_1 & ε_2 be the emf of the two cells r_1, r_2 be their internal resistance respectively. Let I be the total current.

Let V(A), V(B) & V(C) be the potentials at points A, B & C respectively.

Potential difference between A & B is; $V_{AB} = \varepsilon_1 - Ir_1$ ....(1)

Potential difference between B & C is; $V_{BC} = \varepsilon_2 - Ir_2$ ....(2)

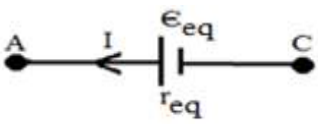
Hence the potential difference between the terminals A and C of the combination is,

$$V_{AC} = V_{AB} + V_{BC}$$

$$V_{AC} = (\varepsilon_1 - \mathrm{I}r_1) + (\varepsilon_2 - Ir_2)$$

$$V_{AC} = (\varepsilon_1 + \varepsilon_2) - I(r_1 + r_2) \quad ....(3)$$

If the series combination is replaced by a single cell between A and C of emf ε_{eq} and internal resistance r_{eq},



Then $V_{AC} = (\varepsilon_{eq} - Ir_{eq})$ ....(4)

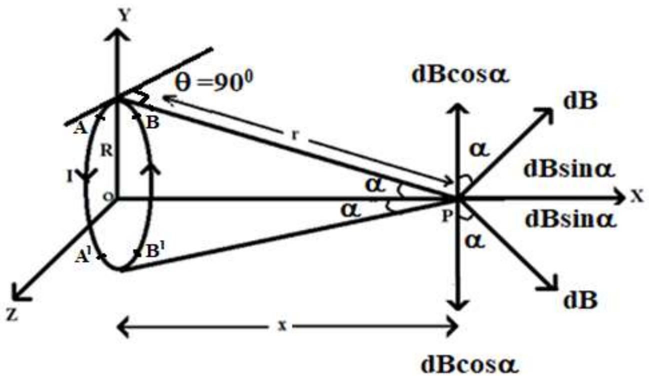
Comparing equation (3) and equation (4)

$$\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2 \quad And \quad r_{eq} = r_1 + r_2$$

41. Deduce the expression for the magnetic field on the axis of a circular current loop.

Ans:

Consider a circular loop of radius R carrying a current I. The loop is placed in Y-Z plane with its center at the origin O. Axis of the loop lies along positive X-direction. Let P be a point at a distance x from the center O of the loop



Consider a infinitesimally small element AB of length dl. Magnetic field due to dl at P is given by

$$dB = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}$$

Since any element of the loop will be perpendicular to the displacement vector (θ=90°)

Then,

$$dB = \frac{\mu_0}{4\pi}\frac{Idl}{r^2}$$

$$\therefore dB = \frac{\mu_0}{4\pi}\frac{Idl}{(x^2+R^2)}$$

The direction of magnetic field is perpendicular to the plane containing current element and displacement vector.

Similarly magnetic field at P due to diametrically opposite element $(A'B')$of length dl is

$$dB = \frac{\mu_0}{4\pi}\frac{Idl}{(x^2+R^2)}$$

To find net magnetic field at P, resolve $d\vec{B}$ into rectangular components as shown in the diagram. It is found that dB cosα cancels with each other, because it is equal and opposite. Then net magnetic field at P is dB = 2dB sin α.

The entire coil can be imagined to be made up of large number of such pairs of diametrically opposite current elements. Hence the resultant magnetic field at P due to entire coil is,

$$B = \sum 2dB\sin\alpha$$

$$B = 2\sum\frac{\mu_0}{4\pi}\frac{Idl}{(x^2+R^2)}\sin\alpha$$

But $\sum dl = \frac{\text{circumference}}{2} = \frac{2\pi R}{2} = \pi R$ [since summation being taken half way around the coil]

And $\sin\alpha = \frac{R}{(x^2+R^2)^{\frac{1}{2}}}$

$$\therefore B = \frac{\mu_0}{4\pi}\frac{2\pi RIR}{(x^2+R^2)(x^2+R^2)^{\frac{1}{2}}}$$

$$B = \frac{\mu_0}{4\pi}\frac{2\pi IR^2}{(x^2+R^2)^{\frac{3}{2}}}$$

For n-turns $B = \left(\frac{\mu_0}{4\pi}\right)\frac{2n\pi IR^2}{(R^2+x^2)^{\frac{3}{2}}}$

42. a) what is the interference of light?

Ans:

The modification in the distribution of light energy due to the superposition of two or more waves of light is called interference.

b) Give the conditions for constructive and destructive interference of light in terms of path difference.

Ans:

Condition for constructive interference:

Resultant intensity at a point is maximum when $cos\left(\frac{\varphi}{2}\right) = \pm 1$

$$\frac{\varphi}{2} = 0, \pi, 2\pi, 3\pi, \ldots.$$

$$\varphi = 0, 2\pi, 4\pi, 6\pi, \ldots.$$

In general phase difference, $\varphi = 2n\pi$ where, $n = 0, 1, 2$ ….

Path difference = $\frac{\lambda}{2\pi}$ (phase difference)

Also, path difference $\delta = \frac{\lambda}{2\pi}(2n\pi) = n\lambda$ for n = 0,1,2,3………

Condition for destructive interference:

Resultant intensity at a point is minimum when $cos\left(\frac{\varphi}{2}\right) = 0$

$$\frac{\varphi}{2} = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \ldots$$

$$\varphi = \pi, 3\pi, 5\pi \ldots$$

In general phase difference $\varphi = (2n+1)\pi$ where $n = 0, 1, 2$ …

Also, path difference $\delta = \frac{\lambda}{2\pi}(2n+1)\pi = (2n+1)\frac{\lambda}{2}$ or $\delta = \frac{\lambda}{2\pi}(2n-1)\pi$ where, n = 1,2,3……

c) Mention any two applications of Polaroids.

Ans: (Any two)

- Polarised are extensively used in polarising sunglasses.
- They are used to produce and detect plane polarised light in the laboratory.
- They are used to view 3-dimensional cinema and images
- To control the intensity of light entering automobiles, trains and airplanes.
- They are used in the digital display of calculators, wrist watches etc.

43. Write Einstein's photoelectric equation. Using this, explain the experimental observations of photo electric effect.

Ans:

Thus, Photon energy = Work function of the material +Maximum KE of the photoelectron

$$h\gamma = W + \frac{1}{2} mv^2_{max}$$

This equation is known as Einstein's Photoelectric Equation.

- According to Einstein, photoelectric emission is the result of the collision between a photon and an electron which are two micro particles. Since the collision lasts for a very short interval of time, photoelectric emission is instantaneous.
- From Einstein's photoelectric equation, $h\gamma = h\gamma_0 + \frac{1}{2} mv^2_{max}$

$$\text{i.e.., } \frac{1}{2} mv^2_{max} = h(\gamma - \gamma_0)$$

❖ If $\gamma < \gamma_0$, KE will be negative and the velocity will become imaginary, photoemission is not possible. Hence a minimum frequency is needed for the photoemission called threshold frequency.

❖ If $\gamma = \gamma_0$, KE is zero, electrons just emitted.

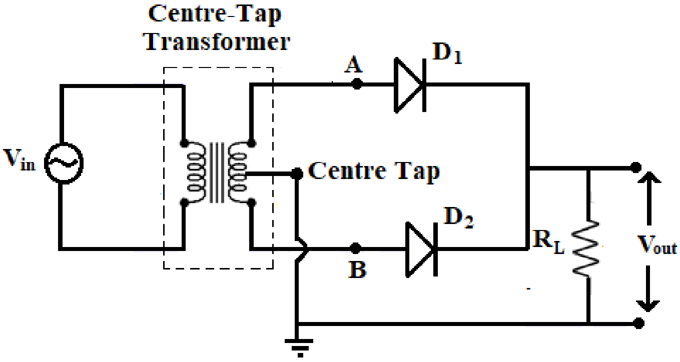
❖ If $\gamma > \gamma_0$, KE is positive. From the photoelectric equation it follows that maximum KE of emitted electrons is directly proportional to the frequency γ of the incident radiation and also it is independent of intensity of radiation.

- Photoelectric current is directly proportional to the intensity of incident radiation.

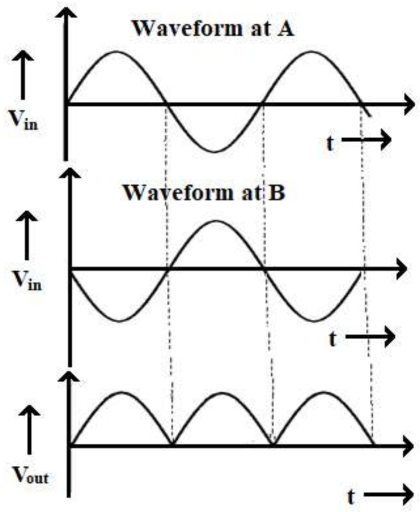
44. What is rectifier? Explain the working of p-n junction diode as a full wave rectifier with circuit and input- output waveforms.

Ans:

A rectifier in which current flows over a complete cycle of the input A.C is called a full wave rectifier.



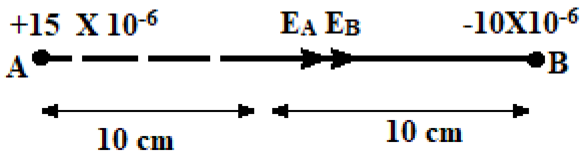
The circuit diagram is as shown in the figure. The diodes D_1 and D_2 with a load resistor R_L are connected across the secondary of the transformer. The R_L is connected to the center tap of the secondary transformer. The A.C voltage to be rectified is applied to the primary of the transformer.



During the positive half cycle of the input voltage i.e.., when potential at A is positive and at B is negative, the diode D_1 is forward biased and D_2 is reverse biased. So D_1 conducts & D_2 does not conduct. During the negative half cycles of the input voltage i.e.., when potential at A is negative and at B is positive the diode D_2 is forward biased and D_1 is reverse biased. So D_2 conducts and D_1 does not conduct. Thus, in each cycle the current flows through the load resistor R_L in the same direction. Hence output obtained is unidirectional (D.C.) and pulsatory.

45. Two-point charges $+15\mu C$ and $-10\mu C$ are separated by a distance of 20 cm, in air. Calculate the electric field at the midpoint of line joining two charges. If a point charge of 20 mC is placed at that mid-point. What is the magnitude of electric force experienced by it?

Ans:



$E_{mid} = E_A + E_B$

$= \frac{1}{4\pi\varepsilon_0} \times \left[\frac{15\times10^{-6}}{(10\times10^{-2})^2} + \frac{10\times10^{-6}}{(10\times10^{-2})^2} \right]$

$= 9\times10^9 \left[\frac{25\times10^{-6}}{100\times10^{-4}} \right]$

$= 9\times10^9 \times 25\times10^{-6} \times 10^{+2}$

$= 9\times25\times10^5$

$= 225\times10^5\, N/C$ *awayy from* $15\times10^{-6} C$

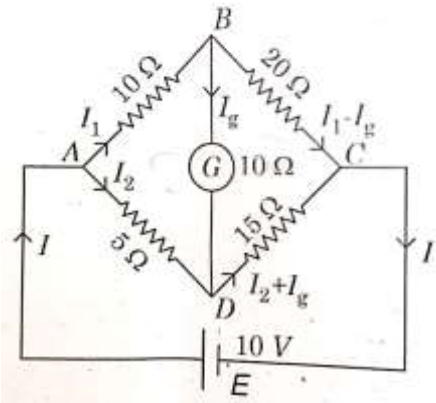
$Force = q(E_{mid})$

$= 20\times10^{-3} \times 225\times10^5$

$= 4500\times10^2$

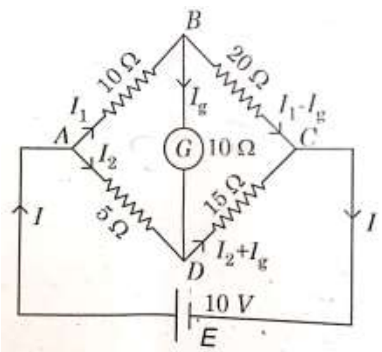
$Force = 4.5\times10^5 N$

46.



In the given Wheatstone's network, calculate the value of electric current flowing through the galvanometer.

Ans:



Loop ABDA

$$10I_1 + I_g 10 - 5I_2 = 0$$
$$2I_1 + 2I_g - I_2 = 0$$
$$2I_1 = I_2 - 2I_g$$
$$4I_1 = 2I_2 - 4I_g \quad ----(1)$$

Loop BCDB

$$\Rightarrow 20\left(I_1 - I_g\right) - 15\left(I_2 + I_g\right) - 10I_g = 0$$
$$\Rightarrow 20I_1 - 20I_g - 15I_2 - 15I_g - 10I_g = 0$$
$$\Rightarrow 20I_1 - 15I_2 - -45I_g = 0$$
$$\Rightarrow 4I_1 - 3I_2 - 9I_g = 0 \quad ----(2)$$

Loop EADCFE

$$\Rightarrow 5I_2 + 15\left(I_2 + I_g\right) - 10 = 0$$
$$5I_2 + 15I_2 + 15I_g - 10 = 0$$
$$20I_2 + 15I_g = 10$$
$$4I_2 + 3I_g = 2 \quad ----(3)$$

From equation (1) & (2)

$$2I_2 - 4I_g - 3I_2 - 9I_g = 0$$
$$-I_2 - 13I_g = 0$$
$$I_2 = -13I_g$$

From equation (3)

$$4\left(-13I_g\right) + 3I_g = 2$$
$$-52I_g + 3I_g = 2$$
$$-49I_g = 2$$
$$I_g = -\frac{2}{49}A = \frac{2}{49}A$$

Opposite direction from convention.

47. A sinusoidal voltage of 250 V and frequency of 50 Hz, is applied to a series LCR circuit. In which, $R = 6\Omega, L = 25\ mH\ \text{and}\ C = 796\ \mu F$. Calculate

a) The impedance of the circuit and
b) The power factor.

Ans:

$$R = 6\Omega, L = 25mH, C = 796\mu F$$

$$Z = \sqrt{R^2 + \left(X_L - X_C\right)^2}$$
$$= \sqrt{R^2 + \left(2\pi fL - \frac{1}{2\pi fC}\right)^2}$$
$$= \sqrt{6^2 + \left(2\times 3.14\times 50\times 25\times 10^{-3} - \frac{1}{2\times 3.14\times 50\times 796\times 10^{-6}}\right)}$$

$Z = 7.07\Omega$

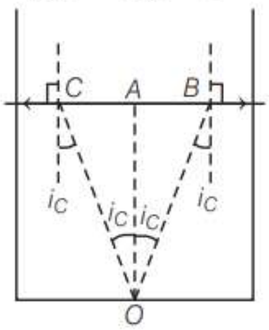
$\cos\phi = \frac{R}{Z} = \frac{6}{7.07} = 0.8486$

48. A small bulb (a point source) is placed at the bottom of a tank containing water to a depth of 80cm. what is the radius of the circular surface of water through which light emerge out? Refractive index of water is 1.33.

Ans:

Let the bulb is placed at point O,

$AB = AC = r$



If the light falls at an angle of incidence equal to critical angle i_C, then only a circular area is formed because if angle of incidence is less than the critical angle, it will refract into air and when angle of incidence is greater than critical angle, then it will be reflected back in water.

The source of light is 80 cm below the surface of water,

i e. . AO = 80 cm, $\mu_w = 1.33$

Using the formula for critical angle,

$\sin i_C = \frac{1}{\mu_w}$

$\sin i_C = \frac{1}{1.33} = 0.75$

$\Rightarrow i_C = 48.6^0$

$In\ \Delta OAB, \tan i_C = \frac{AB}{AO}$

$\Rightarrow \tan i_C = \frac{r}{l}$

$\Rightarrow r = l \tan i_C = 80 \tan 48.6$

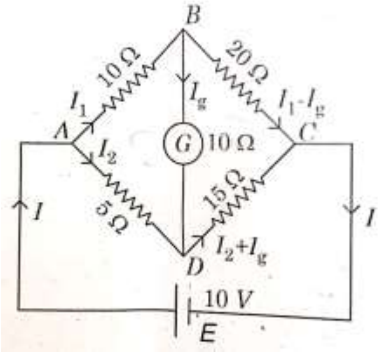
$r = 80 \times 1.1345 = 90.7cm$

PART – E

(For visually challenged students only)

46. In a Wheatstone's network ABCD, resistance AB = $10\,\Omega$, BC = $20\,\Omega$, CD = $15\,\Omega$ and DA = $50\,\Omega$ are connected in cycle order. A cell of emf 10 V is connected between A and C. A galvanometer of resistance $10\,\Omega$ is connected between B and D. Calculate the electric current flowing through the galvanometer.

Ans:



Loop ABDA

$$10I_1 + I_g 10 - 5I_2 = 0$$
$$2I_1 + 2I_g - I_2 = 0$$
$$2I_1 = I_2 - 2I_g$$
$$4I_1 = 2I_2 - 4I_g \quad ----(1)$$

Loop BCDB

$$\Rightarrow 20(I_1 - I_g) - 15(I_2 + I_g) - 10I_g = 0$$
$$\Rightarrow 20I_1 - 20I_g - 15I_2 - 15I_g - 10I_g = 0$$
$$\Rightarrow 20I_1 - 15I_2 - -45I_g = 0$$
$$\Rightarrow 4I_1 - 3I_2 - 9I_g = 0 \quad ----(2)$$

Loop EADCFE

$$\Rightarrow 5I_2 + 15(I_2 + I_g) - 10 = 0$$
$$5I_2 + 15I_2 + 15I_g - 10 = 0$$
$$20I_2 + 15I_g = 10$$
$$4I_2 + 3I_g = 2 \quad ----(3)$$

From equation (1) & (2)

$$2I_2 - 4I_g - 3I_2 - 9I_g = 0$$
$$-I_2 - 13I_g = 0$$
$$I_2 = -13I_g$$

From equation (3)

$$4(-13I_g) + 3I_g = 2$$
$$-52I_g + 3I_g = 2$$
$$-49I_g = 2$$
$$I_g = -\frac{2}{49}A = \frac{2}{49}A$$

Opposite direction from convention.

DEPARTMENT OF PHYSICS

CREATIVE EDUCATION FOUNDATION KARKALA

www.creativeedu.in

Phone No: 9019844492