CANARA VIKAAS PRE UNIVERSITY COLLEGE
PHYSICS ANSWER KEY - 2024

PART-A

I.

1. (d)
2. (a)
3. (c)
4. (b)
5. (a)
6. (b)
7. (c)
8. (c)
9. (a)
10. (c)
11. (c)
12. (d)
13. (b)
14. (d)
15. (c)

II.

16. increasing
17. decreasing
18. diffraction
19. helium
20. greater

PART- B

III.

21. The total electric flux through a closed surface is equal to $\frac{1}{\epsilon_0}$ times the net charge enclosed by the closed surface.

Explanation:

Let q be like total charge enclosed by the surface. Then from Gauss law, total electric flux, $\phi = \frac{q}{\epsilon_0}$

Where ϵ_0 = permittivity of free space.

22.

$$V_A + V_B = 0$$

$$\frac{5 \times 10^{-8}}{x} = \frac{3 \times 10^{-8}}{0.10 - x}$$

On solving

$$x = 0.0625m$$

23. a) When $\theta = 90°$
    b) When $\theta = 0°$

24. **Susceptibility**: It is the ratio of magnetization to magnetic intensity.

    $\chi = \frac{m}{H}$

    Magnetization: It is the net magnetic moment per unit volume of a material.

25. The principle of AC generator is **Electromagnetic induction.**

$$V = V_m sin\omega t$$

Where $V_m = NBA\omega$= peak value of emf

26. 1) Loss due to heating of coils.
    2) Loss due to flux leakage.
    3) Loss due to eddy currents.

27. a) in the treatment of bone and skin diseases.
    b) in sterilize surgical instruments.
    c) To activate rate of chemical reaction.
    d) in high resolving power of microscope.

28. It is the ability of lens to converge or diverge rays of light.

    OR

    It is the reciprocal of its focal length.

    SI unit : dioptre(D)

29.

Intrinsic semiconductor	**Extrinsic semiconductor**
1. It is a pure semiconductor.	1. It is doped semiconductor.
2. Number of electrons and holes are equal.	**2.** Number of electrons and holes are not equal.
3. Conductivity depends on temperature.	**3.** Conductivity depends upon temperature and impurities.
4. Conductivity is low.	**4.** Conductivity is high.

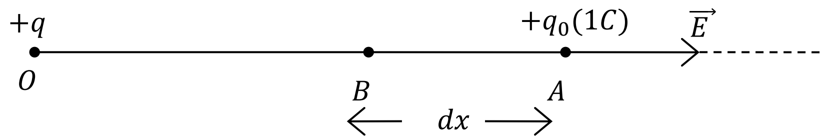
PART- C

IV

30. a) Electric field lines are purely imaginary lines along which unit positive charge tend to move.
    b) They never intersect each other.
    c) They do not form closed loop.
    d) They originate from a positive charge and terminate on a negative charge.
    e) Tangent drawn to electric field line at any point, gives the direction of electric field at that point.

f) They are perpendicular to the surface to the surface of the charged body.
g) They are absent within a charged body.

31.



Let $+q$ be the charge placed at point 'O'

* Consider two points A and B separated by a small distance dx from a point charge $+q$ at O.

If E is the electric field due to $+q$ then work done in moving a unit positive charge $+q_0$ from A to B is

$$dW = F \cdot S \cos\theta$$

$$dW = -E \cdot dx \quad \text{------(1)}$$

$(\because \quad F = E, \quad S = dx \text{ and } \theta = 180°)$

The negative sign indicates that force and displacement are in opposite direction

This work done is equal to the potential difference between A and B.

ie, $dW = dV$ ----(2)

From equation (1) and (2)

$$-E \cdot dx = dV$$

$$\boxed{E = \frac{-dV}{dx}}$$

Thus, electric field at a point is equal to the negative potential gradient at the point.

32. *It is not applicable for variable temperature.

* It is not applicable for complex circuits.

* It is applicable for conductors at constant temperature and if all physical conditions of conductor remain the same.

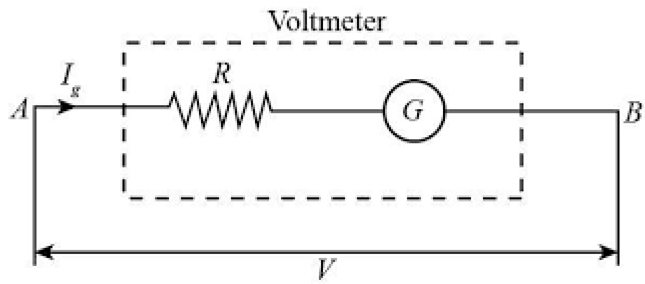
* It is not applicable for semiconductors (diode, transistor), thermistor, super conductors.

vacuum tubes (triode pentode), discharge tubes and electrolytes.

* Current – Voltage relationship varies with change of polarity of applied potential difference.

* The relation between V and I is not unique. ie, there is more than one value of V for the same current.

33. A galvanometer can be converted into voltmeter by connecting high resistance in series with it.



In the figure, R = high resistance

G = resistance of the galvanometer

V =maximum voltage to be measured

I_g = current for full scale deflection in the galvanometer

From Ohm's law, $V = I_g(G + R)$

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

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

34.

1. The substance which are weakly attracted by a magnet is called paramagnetic substance. Eg: Aluminium, chromium, alkali and alkaline, earth metals etc
2. The magnetic flux density (B) inside paramagnetic substance is larger than air.
3. They are weakly magnetized in the direction of external magnetic field.
4. Magnetization (M) has a small positive value.
5. Magnetic permeability μ_r is more than unity $\mu_r > 1$.
6. Magnetic susceptibility (χ) is more than unity .i.e, χ >1.

35. Lenz law states that the induced current always tends to oppose the cause which produces it. So in order to work against opposing forces, we have to put extra effort. This extra work leads to periodic changes in magnetic flux hence more current is induced. So the extra effort is just transformed into electrical energy.

36.

1. All the distances are measured from the pole of the mirror and along its principal

axis.

2. The distances measured in the direction of incident light are positive.
3. The distances measured opposite to the direction of incident light are negative.
4. Heights measured upwards and normal to the principal axis are positive.

37.

a) In an atom, electron revolves in certain stable orbits called stationary orbits, without the emission of radiant energy.

b) The electrons revolve around the nucleus only in those orbits in which the angular momentum or electron is integral multiple of $\frac{h}{2\pi}$, where n is an integer.

c) An electron might make a transition from one of its specific non- radiation orbits to another of lower energy. When it does so, a photon is emitted having energy equal energy difference between the initial and final states. The frequency ϑ of emitted photon is given by, $h\vartheta = E_i - E_f$

38.

Formula:

Binding energy = $\Delta m \times 931MeV$

= $0.11236 \times 931.5MeV$

=104.66334 MeV

Binding energy per nucleon= $\frac{BE}{A}$

= $\frac{104.3644}{14}$

=7.475952MeV

PART – D

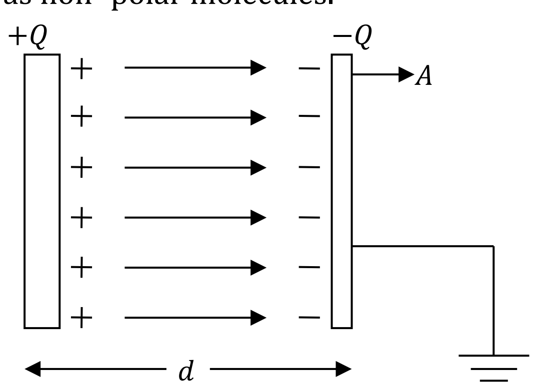
V

39. a)

Polar molecules: Center of positive and negative charges are don't coincide in the molecules are known as polar molecules.

Non- polar molecules: Center of positive and negative charges coincide in the molecules is known as non- polar molecules.

b)



Consider a parallel plate capacitor consisting of two identical parallel metal plates separates by a small distance with air as dielectric medium between them.

Let A be the area of each plate and 'd' be the separation between the plates.

If Q be the magnitude of charge density is $\sigma = \frac{Q}{A}$ ------(1)

The magnitude of the electric field between the plates of a parallel plate capacitor is

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

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

$$E = \frac{Q}{A\varepsilon_0} \text{ -----------(2)}$$

The direction of electric field is from positive to negative plate.

Potential difference between the plates is,

$$V = E \cdot d$$

$$V = \frac{Qd}{A\varepsilon_0} \text{ --------------(3)}$$

Where ε_0 = permittivity of free space

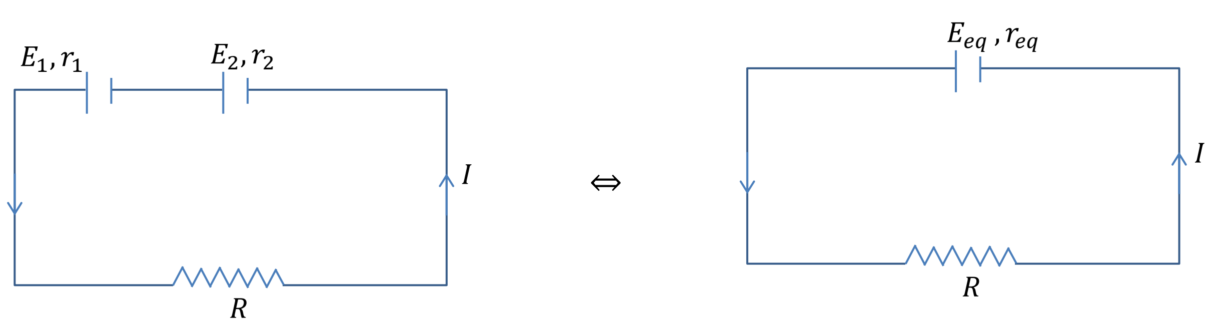
Capacity of parallel plate capacitor is,

$$C = \frac{Q}{V} \text{ -------------(4)}$$

From equations (3) and (4)

$$C = \frac{QA\varepsilon_0}{Qd} \qquad \boxed{= \frac{A\varepsilon_0}{d}}$$

40.



Consider two cells of emf's E_1 & E_2 internal resistances r_1 & r_2 respectively are connected in series

Let I be the current through the combination

Let V_1 & V_2 be the terminal potential differences across the cells respectively.

By definition of emf, $V = E - Ir$

The potential difference across E_1 is, $V_1 = E_1 - Ir_1$

The potential difference across the combination is,

$$V = V_1 + V_2$$

$$V = E_1 - Ir_1 + E_2 - Ir_2$$

$$V = (E_1 + E_2) - I(r_1 + r_2) \quad \text{------------(2)}$$

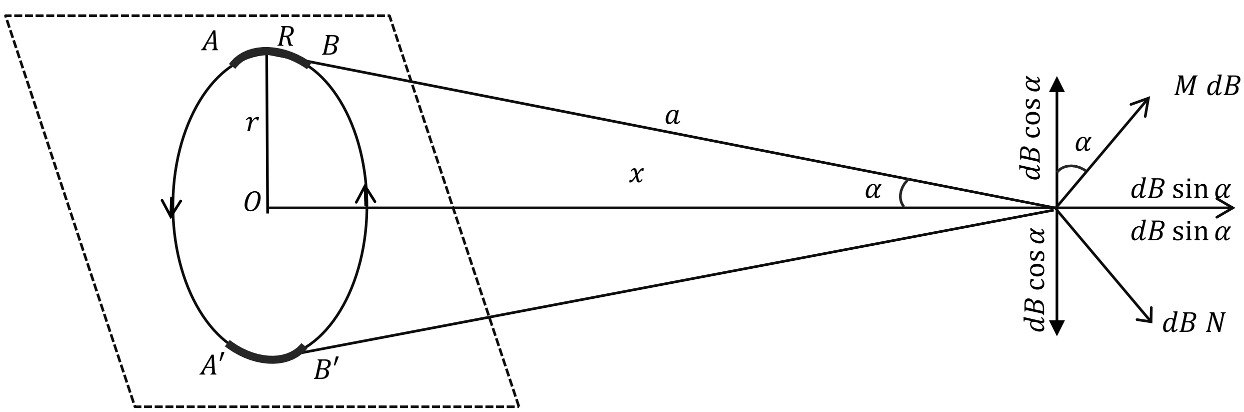
If the combination is replaced by single cell of emf E_{eq} and internal resistance r_{eq}, the potential difference is

$$V = E_{eq} - I_{r_{eq}} \quad \text{-------------(3)}$$

Comparing (1) and (2) we get

$$\boxed{E_{eq} = E_1 + E_2} \quad \text{and} \quad \boxed{r_{eq} = r_1 + r_2}$$

41.



Consider a circular coil of radius r carrying a current I ampere. Let P be a point on the axis of the coil at a distance x from its center. Let AB and A′B′ be the two current elements each of length dl. The magnetic field at P due to current AB is

$$dB = \left(\frac{\mu_0}{4\pi}\right)\frac{Id\ell \sin\theta}{a^2} \qquad \text{(along PM)}$$

Where θ = 90°, sinθ =1

$$dB = \left(\frac{\mu_0}{4\pi}\right)\frac{Id\ell}{a^2} \qquad \text{(along PM)}$$

Similarly, The magnetic field at P due to current A′B′ is,

$$dB = \left(\frac{\mu_0}{4\pi}\right)\frac{Id\ell\sin\theta}{a^2} \qquad \text{(along PN)}$$

Where θ = 90°, sinθ =1

$$dB = \left(\frac{\mu_0}{4\pi}\right)\frac{Id\ell}{a^2} \qquad \text{(along PN)}$$

The magnetic field dB at P can be resolved into horizontal $(dB\sin\alpha)$ and vertical $(dB\cos\alpha)$ components
The vertical component cancels each other and horizontal components added up.

Hence magnetic field at P due to two elements

$$= dB\sin\alpha + dB\sin\alpha$$
$$= 2dB\sin\alpha$$

The resultant magnetic field at P due to one turn of the coil is,

$$B = \sum 2\,\underline{dB}\sin\alpha$$

$$B = \sum 2\left(\frac{\mu_0}{4\pi}\frac{Id\ell}{a^2}\right)\sin\alpha$$

$$B = \frac{\mu_0}{4\pi}\frac{2I\sum d\ell}{a^2}\sin\alpha$$

From figure, $\therefore \sum d\ell = \frac{\text{circumference}}{2} = \frac{2\pi r}{2} = \pi r$

$$\sin\alpha = \frac{r}{a}$$

Then, $B = \left(\frac{\mu_0}{4\pi}\right)\frac{2I(\pi r)}{a^2}\left(\frac{r}{a}\right)$

$$B = \frac{\mu_0}{4\pi}\frac{2I\pi r^2}{a^3}$$

From figure, $a^2 = r^2 + x^2$

$$a = (r^2 + x^2)^{1/2}$$
$$a^3 = (r^2 + x^2)^{3/2}$$

Then ,

$$\boxed{B = \left(\frac{\mu_0}{4\pi}\right)\frac{2\pi I r^2}{(r^2 + x^2)^{3/2}}}$$

For n turns of the coil, $\boxed{B = \left(\frac{\mu_0}{4\pi}\right)\frac{2\pi n I r^2}{(r^2 + x^2)^{3/2}}}$

42.

a) The modification in the distribution of light energy due to superposition of two or more waves of light.

b) Constructive Interference: The path difference is an integral multiple of λ. i.e, $\delta = n\,\lambda$

Destructive Interference: The path difference is an odd multiple of $\frac{\lambda}{2}$. i.e, $\delta = (2n+1)\frac{\lambda}{2}$

c) 1. They are used in sun glasses.
2. They are used in window of vehicles.
3. They are used in headlights of vehicles.
4. They are used to view 3D movie cameras.

43.

According to Einstein, light consists of photon.

When light of suitable frequency is incident on the metal surface, photons of energy $E = h\vartheta$

Interacts with the free electrons present in the metal and electron absorbs this energy. The energy absorbed by the electron is used in two process,

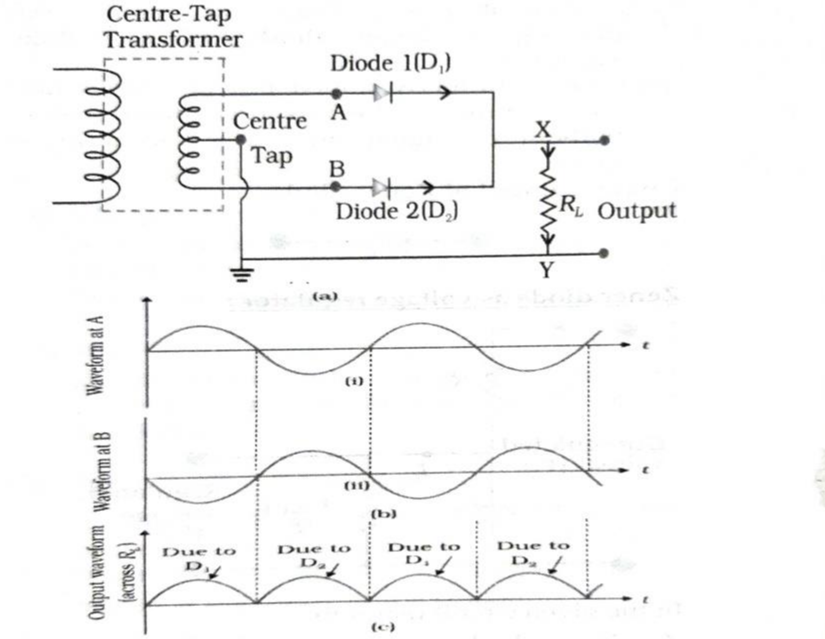
1. Part of energy is used to eject the electron from metal surface i.e, work function.
2. Remaining part of energy is used to provide kinetic energy for ejected electrons.
   According to law of conservation of energy,
   Total energy= work function + kinetic energy
   $E = \emptyset_0 + KE$
   $KE = h\vartheta - h\vartheta_0$
   Where $\vartheta_0 = Threshold\ frequency$
   $\vartheta = frequency\ of\ incident\ radiation$

Explanation:

1. Einstein treated as collision between photon and electron as collision between two micro particles. Therefore photoelectric effect is an instantaneous process.
2. If $\vartheta = \vartheta_0, KE = 0$. Photoelectric emission is possible, this proves of work function.
3. If $\vartheta < \vartheta_0, KE = -ve$. Photoelectric emission is not possible, this proves the existence of threshold frequency.
4. If $\vartheta > \vartheta_0, KE = +ve$. Photoelectric emission is possible, this proves the dependency of kinetic energy of photoelectrons with the frequency of incident radiation.
5. Photoelectric current is directly proportional to the intensity of incident radiation.

44. It is a process of converting AC into DC is called rectifier.

Solution:



In the above circuit diagram,

T- Step down transformer

D1 and D2- diodes

R_L −Load resistance

The AC voltage to be rectified is applied to the primary of the transformer.

Working:

1. During the positive half cycle of input AC, i.e, when A is positive with respect to B, Diode D1 is forward biased and diode D2 is reverse biased. Hence D1 conducts current and D2 does not conduct current. Thus the current flows through R_L.
2. During the negative half cycle of input AC, i.e, when A is negative with respect to B, Diode D1 is reverse biased and diode D2 is forward biased. Hence D2 conducts current and D1 does not conduct current. Thus the current flows through R_L.

VI

45. Given $q_1 = 15\mu c,\ q_2 = -10\mu c$, r= 0.2m

$$E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}$$

$$E_1 = \frac{9\times10^9\times15\times10^{-6}}{0.1^2} = 135 \times 10^5 NC^{-1}$$

$$E_2 = \frac{9\times10^9\times10\times10^{-6}}{0.1^2} = 90 \times 10^5 NC^{-1}$$

$$E + E_1 + E_2 = 225 \times 10^5 NC^{-1}$$

$$F = Eq = 225 \times 10^5 \times 20 \times 10^{-3} = 45 \times 10^4 N$$

46. Given R1= 10 Ω, R2= 20 Ω, R3= 5 Ω and R4= 15 Ω

Applying Kirchoff's loop rule to ABDA,

$$10I_1 + 10I_g - 5I_2 = 0$$

$$2I_1 + 2I_g - I_2 = 0 - - - - - - -(1)$$

Applying Kirchoff's loop rule to BCDB,

$$20(I_1 - I_g) - 15(I_2 + I_g) - 10I_g = 0$$

$$20I_1 - 20I_g - 15I_2 - 15I_g - 10I_g = 0$$

$$4I_1 - 9I_g - 3I_2 = 0 - - - - - - -(2)$$

Applying Kirchoff's loop rule to ADCA,

$$5I_2 + 15(I_2 + I_g) - 10 = 0$$

$$5I_2 + 15I_2 + 15I_g - 10 = 0$$

$$3I_g + 4I_2 = 2 - - - - - - (3)$$

Solving (1) and (2),

$$13I_g + I_2 = 0\text{--------------}(4)$$

Solving (3) and (4),

$$I_g = -0.048A$$

47. a) impedance, $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$$Z = \sqrt{R^2 + \left(2\pi fL - \frac{1}{2\pi fC}\right)^2}$$

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

$$z = 7.13\Omega$$

b) $\cos \phi = \frac{R}{Z}$

$$= \frac{6}{7.13}$$

$$= 0.8$$

48. Given :$d = 0.8m$, $\mu = 1.33$

$$\mu = \frac{\sin r}{\sin i}$$

$$1.33 = \frac{\sin 90°}{\sin i}$$

$$i = \sin^{-1}(\frac{1}{1.33})$$

$$i = 48.75°$$

$R = \tan(48.75°) \times 0.8$

R= 0.91m

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