(2)

(a) Sol^n ~~If E = 0~~

We have the relation betn electric field and potential as—

$$E = -\frac{dv}{dr}$$

$\Rightarrow dV = -E\,dr$

$\Rightarrow \int dV = -\int E\,dr$

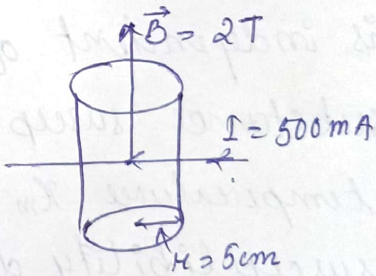
$\Rightarrow V = -\int 0.dr$

$\Rightarrow V = \int 0$

$\Rightarrow V = const^n$

∴ If $\vec{E} = 0$ in a region then the potential at that region is constant.

(b) Sol^n → $B = 2T$



$I = 500\ mA$

$= 500 \times 10^{-3} A$

$= 0.5\ A$

$l = 2 \times r$

$= 10cm = 0.1\ m$

$\theta = 90°$

∴ Force on the conductor is—

$F = I l B \sin\theta$

$= (0.5)(0.1)(2T)\sin 90°$

$= 0.10\ N$

(d) Sol^n → When the reflected and refracted ray are divergent, the image is virtual. These rays are converged by the eyelens to form a real image on the retina. The virtual image serves as a virtual object. Also the screen is not located at the position of virtual image.. So there is no contradiction.

(e) Ans → Given

$f_o = 1cm$, $f_e = 20m$, $L = 20\,cn$.

∴ Total magnification of the microscope.

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

[-ve sigh indicates that the final image is inverted]

$= \frac{20}{1}\left(1+\frac{25}{20}\right)$

$= 20\left(1+\frac{5}{4}\right)$

$= 20\left(\frac{9}{4}\right)$

$= 9\times 5$

$= 45$ //

$\frac{15}{2}\left(1+\frac{25}{6.25}\right)$

15

7.5 + 5

=

(f) Sol^n → The mathematical expression of the postulates that an electron has to follow in order to revolve around the nucleus is —

$mvr = n\left(\frac{h}{2\pi}\right)$

Bohr proposed it in 1913. It's called Bohr's quantum condition.

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(b) (8) Ans→ When Si is doped with B, we get a p-type semiconductor.
Yes it possess overall charge neutrality.

(9) Sol^n→

$BE = \{m_p Z + (A-Z) m_n\} - M$

For $^{14}_{7}N$

$Z = 7, \quad A = 14$

$\therefore BE = \{(7 \times 1.007825) + (14-7)(1.008665)u\} - 14.003$

$= (7.054775 + 7.060655) - 14.00307$

$= 14.11543 - 14.00307$

$= 0.112364$

As we have

$1u = 931 MeV$

$\Rightarrow 0.11236 u = (0.11236 \times 931) MeV$

$= 104.60716 MeV$

$\approx 104.6 MeV$

(10)(i) Ans→ Infrared waves sometimes referred to as heat waves. This is because water molecules present in most materials ~~absorb~~ radially absorb infrared waves and thus the thermal motion of the molecules increases, ~~and~~ hence they heat up and heat up their surroundings.

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(j) Sol^n We have

$$I_{max} = k(a_1+a_2)^2$$

and $$I_{min} = k(a_1-a_2)^2$$

$$\therefore \frac{I_{max}}{I_{min}} = \frac{k(a_1+a_2)^2}{k(a_1-a_2)^2}$$

$$\Rightarrow \frac{I_{max}}{I_{min}} = \frac{a_2\left(\frac{a_1}{a_2}+1\right)^2}{a_2\left(\frac{a_1}{a_2}-1\right)^2}$$

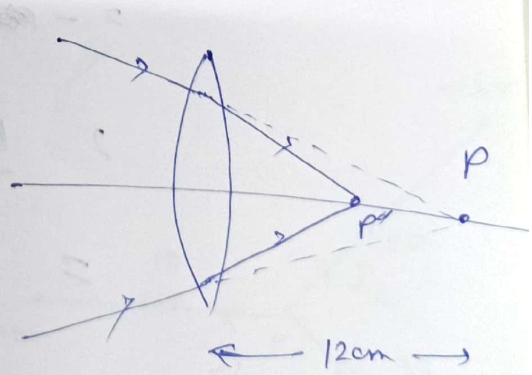
$$\Rightarrow \frac{I_{max}}{I_{min}} = \frac{(\mu+1)^2}{(\mu-1)^2}, \quad \mu = \frac{a_1}{a_2}$$

$$= \left(\frac{\mu+1}{\mu-1}\right)^2$$ //

(k) Sol^n → In this case as point p lies on the right side of the lense so it act as a virtual object for the lense - so

$u = +12$ cm

$f = +20$ cm



Now using the lense formula -

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$= \frac{1}{20} + \frac{1}{12}$$

$$= \frac{3+5}{60}$$

$$\Rightarrow \frac{1}{v} = \frac{8}{60} = \frac{4}{30}$$

$$\Rightarrow v = \frac{30}{4} = 7.5 \text{ cm}$$

① Sol^n → $\vec{E} = (20\hat{i} + 30\hat{j})$ N/C

$\Delta V = -(\vec{E}\,\Delta x)$

$= -(E_x \Delta x_x + E_y \Delta x_y)$

$= -(20 \times 2 + 30 \times 2)$

$= -(40 + 60)$

$= -100$ V

As the potential at the origine is zero.

∴ The pot. at the point (2, 2) is -100 V //

③ ⓔ Sol^n → Given –

$N = 100$

$A = 5 m^2$

$B = 10$ T

$\phi_i = 5 \times 10^3$ wb

$\phi_f = 0$

dt = change in time = 0.1 s.

$\phi = NBA$

$= 100 \times 5 \times 10$

$= 5 \times 10^3$

$\therefore \varepsilon_{ind} = -\frac{d\phi}{dt}$

$= -\left(\frac{0 - 5 \times 10^3}{0.1}\right)$

$= \frac{\times 5 \times 10^3}{0.1}$

$= 5 \times 10^4$ volt //

Ramanujan Senior Secondary School
Pre-Final - II
Subject : Physics (Theory)
H.S. 2nd Year

Time : 3 hours | Full Marks: 70

The figures in the margin indicate full marks for the questions

General Instructions:

(i) *Marks for each question are indicated against it.*
(ii) *Question Nos. **1(a)** to **1(j)** are very short-answer type questions and carry 1 marks each.*
(iii) *Question Nos. **2(a)** to **2(l)** are short-answer type questions and carry 2 marks each.*
(iv) *Question Nos. **3(a)** to **3(j)** are also short-answer type questions and carry 3 marks each.*
(v) *Question Nos. **4(a)** to **4(c)** are long-answer type questions and carry 5 marks each.*

1. Answer following questions very briefly (any eight) : $1\times8=8$

(a) de Broglie in 1924 reasoned that nature was symmetrical and that the two basic physical entities _____ and _____ must have symmetrical character. (Fill in the blanks)

(b) Choose the correct answer :
Accelerated electrons can show –
(i) Interference only (ii) Diffraction only
(iii) Both interference and diffraction

(c) Name the equipment which can transmit optical signal through it and are used as 'light pipe'.

(d) A plane electromagnetic wave is prapagating in space along x-axis. If the magnetic field component of the wave is as given below, write an expression for its electric field.

$$B_y = 2\times10^{-7}\sin(kx - wt)$$

(e) How eddy current can be minimised in transformer.

(f) What is the phase difference between voltage and current in LCR circuit at resonance.

(g) If R and L represent resistance and inductance respectively then what is the dimension of $\frac{L}{R}$.

(h) Of two metals A and B, if is found that $x_A >> 1$ and $-1 \le x_B < 0$. Name the types of materials to which the metals A and B do belong.

(i) What determines the intensity of light in photon picture of light.

(j) Show that weber = volt × second.

2. Answer the following questions (any ten) : $2\times10=20$

(a) If electric field E=0 in a region do you think potential at the region should also be zero.

(b) A uniform magnetic field of 2T is produced in a cylindrical region of free space having radius 5 cm. A conductor carrying a current of 500 mA passes through the region intersecting the axis normally. What is the magnitude of the force acting on the conductor.

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(c) Write the use of each of the following:
(i) Microwaves (ii) U.V. rays

(d) A virtual image, we always say, cannot be caught on a screen. Yet when we 'see' a virtual image. We are obviously bringing it on to the 'screen' (i.e. the retina) of our eye. Is there a contradiction.

(e) If $f_o = 1$ cm, $f_e = 2$ cm and $L = 20$ cm respectively, calculate the total magnification of the microscope.

(f) Write the mathematical expression of the postulate that an electron has to strictly follow in order to revolve round that nucleus. Name the scientist who proposed it in 1913.

(g) Obtain the binding energy in MeV of a nitrogen nucleus.

Given $m\left({}^{14}_{7}N\right) = 14 \cdot 00307u$

$m_H = 1 \cdot 007825u$

$m_n = 1 \cdot 008665u$

$1u = 931 \cdot 5 MeV / C^2$

(h) When Si is doped with B, what will be the type of resulting semiconductor? Will it possess overall charge neutrality?

(i) Why infrared waves are sometimes referred to as 'heat waves'.

(j) Prove that ratio of the intensities at maxima and minima is

$\frac{I_{max}}{I_{min}} = \left(\frac{r+1}{r-1}\right)^2$; where $r = \frac{a_1}{a_2}$ is the ratio of amplitudes.

(k) A beam of light converges at a point P. Now a lens is placed in the path of the convergent beam 12 cm from P. At what point does the beam converges if the lens is a convex lens of focal length 20 cm.

(l) Imagine an electric field $\vec{E} = \left(20\hat{i} + 30\hat{j}\right) N/C$ in a space. The potential at the origin is zero. Find potential at point (2,2) m.

3. Answer the following questions: 3×9=27

(a) State one drawback of Rutherford's model of the atom. What modifications of Rutherford's model were suggested by Bohr? State two limitations of Bohr's model of the atom.

(b) The equations of light wave from two sources are $y_1 = a_1 \sin wt$ and $y_2 = a_2 \sin(wt + \phi)$ where the symbols have their usual meaning. The indivisual intensities are I_1 and I_2. Show that the minimum resultant intensity due to superposition is $I_{min} = I_1 + I_2 - 2\sqrt{I_1 I_2}$.

(c) For a simple microscope prove that magnification $m = 1 + \frac{D}{f}$.

(d) Show that the ratio of rms value of AC to its peak value is 0·707.

(e) When a coil of area 5 m^2 and number of turns 100 is placed perpendicular to a magnetic field of 10T, the flux passing through it is 5×10^3 Wb. If the coil is removed from the field in 0·1S. Claculate the induced emf. Define 1 H self inductance.

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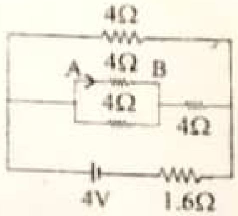
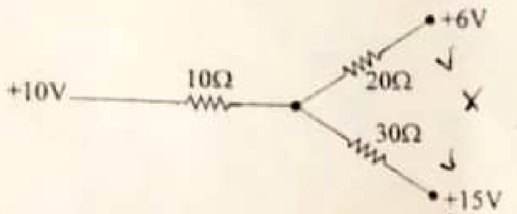
(g) What is a galvanometer? A galvanometer has a resistor of 50Ω. If across its terminals a resistance of 5Ω is connected, calculate the fraction of current that flows through the galvanometer.

(b)



Find the value of current I flowing from A to B in the given circuit.

(i) In the circuit given below, find the current through 10Ω.



(j) Three electric point charges q_o, q_1, q_2 are at distances $\vec{r}_0$, $\vec{r}_1$, $\vec{r}_2$ respectively with respect to same origin. What is the force on charge q_o in the field of charges q_1 and q_2 ?

4. Answer the following: $5\times3=15$

(a) Define electric dipole and dipole moment. Derive an expression for electric field intensity at a point on equitorial line of an electric dipole. $2+3=5$

(b) Derive an expression for motional electromotive force. In a rainy season you are running with your umbrella opened in a place where the horizontal component of earth's magnetic field is 0·26 G. If the length of your umbrella is 80 cm and your speed is 20 km/h. Calculate the motional emf developed across the shaft. $3+2=5$

(c) Establish the following lens makers formula

$$\frac{1}{f}=\left(\frac{n_2}{n_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

—x—

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