Class XII Physics

Sample Question Paper

(Marking Scheme)

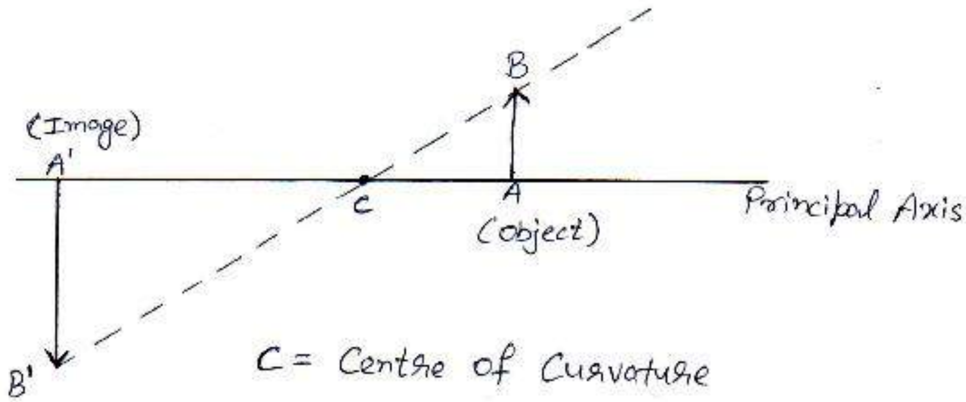
Time Allowed: 3 Hours *Maximum Marks: 70*

01. P.E. = $-\vec{p}.\vec{E}$ = $-$ p E Cos θ (½)
$\therefore$ P.E. is maximum when Cos θ = -1, i.e. $\theta = \pi$ (180^0) (½)

02. 4 → yellow (½)
7 → Violet (½)

03. The capacitor (1)

04.



(1)

05. C_m (t) is the frequency modulated wave. (1)

06. The current through the potentiometer wire = $\frac{3V}{(290+10)\Omega}$ = 10^{-2} A (½)

$\therefore$ Potential drop per unit length of the

potentiometer wire = $\emptyset$ = $\frac{10^{-2}\ A\ X 10\Omega}{400\ cm}$ = $\frac{1}{4}$ X 10^{-3} $V/_{cm}$ (1)

Balancing length (l) = 240 cm (given)

$\therefore$ V= $\emptyset\, l = \frac{1}{4} X\ 10^{-3}\ \ X\ 240\ V = 6\ X\ 10^{-2} V$

(= 60 mV) (½)

07. Polarization (1)

Two Uses:

Polaroids can be used in sunglasses, window panes, photographic cameras, 3D movie cameras (Any Two) (½+½)

OR

Diffraction; Condition: Size of the obstacle sharpness should be comparable to the wavelength of the light falling. (1+1/2)

Any application (1/2)

08. E = Energy of the photon = hυ $= \frac{hc}{\lambda}$ (½)

$\therefore\ \lambda = \frac{hc}{E}$

$\therefore$ Wave length of the moving electron = $\lambda = \frac{hc}{E}$ (½)

$\therefore$ Momentum of the electron = p

$= \frac{h}{\lambda} = \frac{hE}{hc} = \frac{E}{c}$ (½)

$= \frac{6\ X 10^{-17}}{3 X 10^{8}}$ kg ms^{-1}= 2 X 10^{-25} kg ms^{-1} (½)

09. Rydberg formula for the wavelengths of spectral lines in hydrogen spectrum is

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$ (½)

The short wavelength limit λ_L for the Lyman series would be

$$\frac{1}{\lambda_L} = R\left(\frac{1}{\infty^2} - \frac{1}{1^2}\right) = R$$

$\therefore\ R = \frac{1}{913.4\ \mathring{A}}$ (½)

∴ The short wavelength limit λ_B for the Balmer series, would be

$$\frac{1}{\lambda_B} = R\left(\frac{1}{\infty^2} - \frac{1}{2^2}\right) = \frac{R}{4}$$ (½)

$$\therefore \lambda_B = \frac{4}{R} = 4 \text{ X } 913.4 \text{ Å}$$

$$= 3653.6 \text{ Å}$$ (½)

10. a) LAN, WAN, Internet (1)

b) Three (1)

11. Let the radius of each drop be r. The capacitance C of each drop is kr, where k is a constant.

Also q = CV, V = 900 volt (½)

∴ charge on each drop = q = (kr X 900) C (½)

∴ Total charge on all the eight drops = Q = 8 q

=7200 kr (½)

Let R be the radius of the large drop. Then

$$\frac{4\pi}{3} R^3 = 8 \text{ X } \frac{4\pi}{3} r^3$$

$$\therefore R = (8)^{1/3} r = 2r$$ (½)

∴ Capacitance C' of the large drop = kR = 2kr (½)

∴ Potential of the large drop $= \frac{Q}{C'} = \frac{7200\ kr}{2\ kr}$ volt

= 3600V (½)

12. With key K_2 open, the current I in the galvanometer is given by

$$I = \frac{E}{R + R_G}$$

When K_2 is closed, the equivalent resistance, say R', of the parallel combination of S and R_G is given by

$$R' = \frac{SR_G}{S + R_G}$$ (½)

The total current, say I' drawn from the battery would now be

$I' = \frac{E}{R+R'}$

This current gets subdivided in the inverse ratio of S and R_G ; Hence the current I'' through G, would now be given by

$$I'' = \frac{S}{S+R_G} I' = \frac{S}{S+R_G} \frac{E}{(R+R')}$$ (½)

$$= \frac{S \;.\; E}{S+R_G} \quad \frac{1}{\left[R + \frac{S R_G}{S + R_G}\right]}$$

$$= \frac{S \; E}{RS + RR_G + SR_G}$$ (½)

But $I'' = \frac{I}{n} = \frac{1}{n} \frac{E}{R+R_G}$

$$\therefore \quad \frac{E}{n\,(R+R_G)} = \frac{SE}{RS + RR_G + SR_G}$$ (½)

Or n RS + n S R_G = RS + RR_G + SR_G

or (n-1) RS = R R_G - (n-1) SR_G

or (n-1) RS + R_G $[R-(n-1)S]$

$$\therefore R_G = \frac{(n-1)\,RS}{R-(n-1)S}$$ (½)

This is the required expression

When R $>>$S , we have

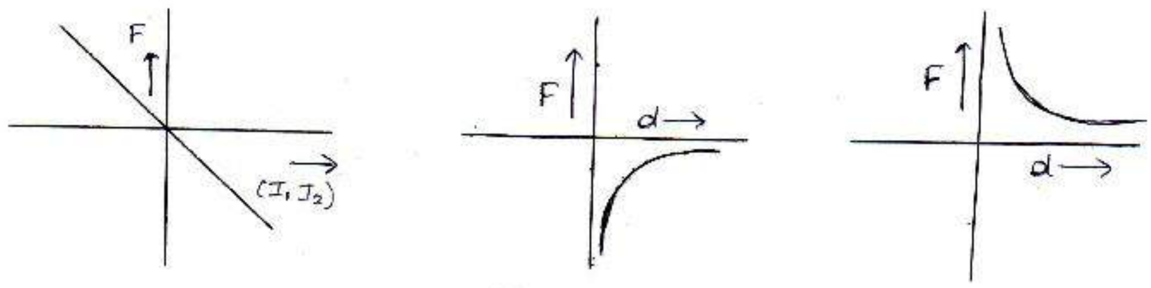
$$R_G \simeq \frac{(n-1)\,RS}{R} = (n-1)\,S$$ (½)

13. We know that F is an <u>attractive (-ve)</u> force when the currents I_1 and I_2 are 'like' currents i.e. when the product I_1I_2 is positive.

Similarly F is a <u>repulsive (+ve)</u> force when the currents I_1 and I_2 are 'unlike' currents, i.e. when the product I_1I_2 is negative. (1/2)

Now F $\propto$ (I_1 I_2), when d is kept constant and F $\propto \frac{1}{d}$ when I_1I_2 is kept constant. (1/2)

The required graphs, therefore, have the forms shown below.



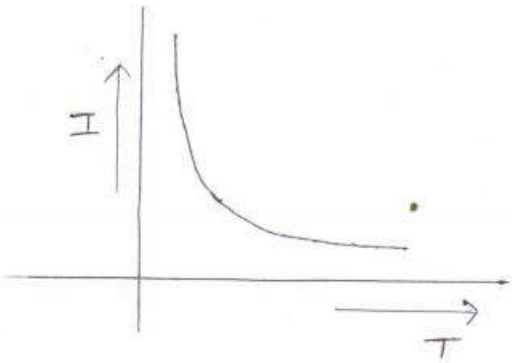
(i) (ii) (iii)

(1+1/2+1/2)

OR

(i) P- Paramagnetic (½)

Q-Ferromagnetic materials (½)



(ii) (1)

14.The current, I, leads the voltage, V, by an angle $\boldsymbol{\phi}$ where

$\tan \boldsymbol{\phi} = \frac{X_c - X_L}{R}$

Here $X_c = \frac{1}{\omega C} = 500\ \Omega$ (1/2)

and $X_L = \omega L = 100\ \Omega$, $R = 400\ \Omega$

$\therefore \tan \phi = 1$ (½)

$\therefore \boldsymbol{\phi} = 45^0$

The power factor becomes unity when $\phi = 0^0$. (1/2)
Hence we need to adjust C to a new value C' where

$X_c{'} = X_L = 100\Omega$ (½)

Thus, phase angle is 45^0 with the current LEADING the voltage.
To make power factor as unity we need to have Xc also equal to 100 ohms. For this C needs to have a value of 10 µF. (1/2)
We, therefore need to put an additional capacitor of (10-2), i.e, 8 µF in parallel with the given capacitor (1/2)

15. Discussion on the 'observed inconsistency' (1)

Discussion on 'Removing' the contradiction through the concept of an additional current, called the 'displacement current'. (1 +1)

(Pages 270 and 271 of NCERT Book, Part I)

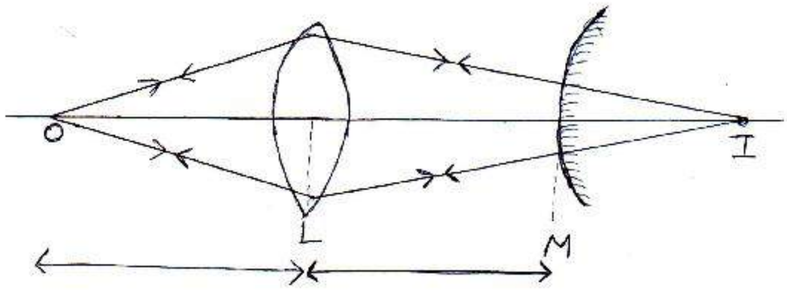
16. Focal length of the convex lens = $\frac{1}{P}$ m (1/2)
Let v be the position of the image, I, of the object formed by the convex lens alone. We then have

$$\frac{1}{v} - \frac{1}{(-u)} = \frac{1}{f} \qquad \therefore v = 150\text{cm}$$ (1/2)

Hence the distance of the image (formed by the convex lens alone) from the convex mirror would be (150-50) cm ,i.e.,100 cm. This distance equals the radius of curvature of the convex mirror. (1/2)

Hence focal length of the convex mirror equals100/2, i.e., 50 cm. (½)

∴ Radius of curvature of the convex mirror
R = LI – LM
(½)



(1/2)

17. Calculation of 'fringe width, β' the 'normal set up' (1½)
Calculation of fringe width, β' in the changed set up (1)
Observing that $\beta' = \beta$ (½)

(Reference : NCERT Book, Part II, pages 363, 364)

18. Initial number of radioactive atoms, per unit volume, in the blood streams of persons A and B are (N_0/V) and (N_0/V') respectively. (½)
After a time nT (T = Half life), these numbers would get reduced by a factor 2^n. (½)

Hence $N_1 = \left(\frac{N_o}{V}\right) \cdot \frac{1}{2^n}$

And $N_2 = \left(\frac{N_o}{V'}\right) \cdot \frac{1}{2^n}$ (½)

$\frac{N_1}{N_2} = \frac{V'}{V}$ (½)

or $V' = V \frac{N_1}{N_2}$ (½)

∴ Additional volume of blood needed by person B is

$V - V' = V - V\frac{N_1}{N_2} = \left(\frac{N_2 - N_1}{N_2}\right) V$ (½)

19. The equivalent gates in the two cases are the OR gate and the AND gate respectively.

(1/2 + ½)

(i) A combination of three NAND gates, connected in the manner shown, would be equivalent to an OR gate.

(Fig 14.46 (b) Page 511) (1)

(i) A combination of three NOR gates connected in the manner shown would be equivalent to an AND gate.

(Fig 14.48 (b) page 512) (1)

20. One can calculate the values of $\frac{1}{\lambda}$ and plot a graph between E (photon energy in eV) and $\frac{1}{\lambda}$ (in nm^{-1}). (1)

The resulting straight line graph can be used to

(i) read the value of E , corresponding to $\frac{1}{\lambda} = \frac{1}{100}$ nm^{-1} (1/2)

(ii) read the value of $\frac{1}{\lambda}$ (in nm^{-1}) corresponding to E = 1eV (1/2)

(iii) We have E $=\frac{hc}{\lambda}$

The slope of the graph (after appropriate adjustment of the units) would equal hc.

Since h is known, one can calculate c. (1)

21. The equation of the (amplitude) modulated signal is

$$C_m(t) = [\,(A_c + A_m \sin\omega_m t)\,] \sin\omega_c t \qquad (1)$$

This can be rewritten as

$$C_m(t) = [\,A_c(\,1 + \mu \sin\omega_m t)\,] \sin\omega_c t$$

Where $\mu = A_m/A_c$ = modulation index (1/2)

$$\therefore\ C_m(t) = A_c \sin\omega_c t + \frac{\mu A_c}{2}\, 2\sin\omega_m t\,.\sin\omega_c t \qquad (1/2)$$

$$= A_c \sin\omega_c t + \frac{\mu A_c}{2}\ [\cos\ (\omega_c - \omega_m)t - \cos\ (\omega_c + \omega_m)t]$$

(1/2)

These are the three sinusoidal waves present in the amplitude modulated signal.

The frequencies of these three waves are

$$f_1 = \frac{\omega_c}{2\pi}$$

$$f_2 = \frac{\omega_c - \omega_m}{2\pi}$$

$$\text{and } f_3 = \frac{\omega_c + \omega_m}{2\pi}$$

(1/2)

22. (i) Heavy doping makes the depletion region very thin. This makes the electric field of the junction very high, even for a small reverse bias voltage. This in turn helps the Zener diode to act as a 'voltage regulator'. (1)

(ii) When operated under reverse bias, the photodiode can detect changes in current with changes in light intensity more easily. (1)

(iii). The photon energy, of visible light photons varies from about 1.8 eV to 3 eV. Hence for visible LED's, the semiconductor must have a band gap of 1.8 eV. (1)

23. (i) – Expression for the force in vector form (1)

- Statement of Flemings' left hand rule (1)

(ii) – Adaptation to different situations and flexible and adjustable attitude (1)
- Sharing excitement in classroom learning with family members

(iii) – Avoiding unnecessary arguments in conflicting situations in everyday life (1)

24. (a) Statement of Gauss's law (1)

Simple 'Proof' (2)

(Pages 33 and 34 of NCERT Book I)

(b) Set ρ be the uniform density of negative charge. We then have

$$\frac{4\pi a^3 \rho}{3} = Ze$$

$$\therefore \rho = \frac{3\,Ze}{4\pi a^3}$$ (1/2)

Taking a sphere of radius r (centred at the nucleus) as the Gaussian surface, we have

$E(r)\ X\ 4\pi r^2 = \frac{Q}{\varepsilon_o}$ (1/2)

Where Q is the net charge enclosed by the Gaussian surface. Now

$$Q = (+Ze) + (- \rho.\frac{4\pi r^3}{3})$$

$$= Ze - Ze\ (\frac{r^3}{a^3}) = Ze\ (1 - \frac{r^3}{a^3}) \qquad (1/2)$$

Substituting this value of Q, we get

$$E(r) = \frac{Ze}{4\pi\varepsilon_0 r^2}(1 - \frac{r^3}{a^3})$$

$$= \frac{Ze}{4\pi\varepsilon_0}(\frac{1}{r^2} - \frac{r}{a^3}) \qquad (1/2)$$

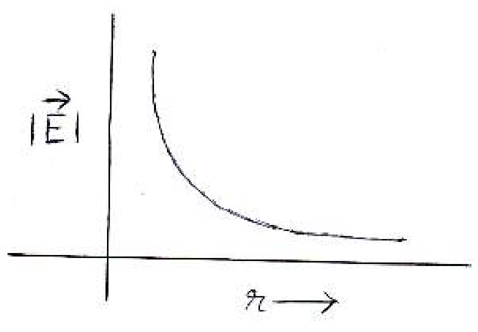
OR

Derivation of the expression for $\vec{E}$

$$[\ \vec{E} = \frac{2qa(-\hat{p})}{4\pi\epsilon_0(r^2+a^2)^{\frac{3}{2}}}] \qquad \text{(page 28 NCERT Book I)}$$

For r >> a, $|\vec{E}| = \frac{2qa}{4\pi\epsilon_0\, r^3}$ (3)

Thus, the graph has the form shown. (1)



Derivation of the expression for torque (Page 31, NCERT Book I) (1)

25. Statement of Faraday's law of e-m induction (1)

Derivation of the expression for induced emf (2)

'Justification' on the basis of the concept of Lorentz's force (2)

(Page 212 + page 213 NCERT Part I)

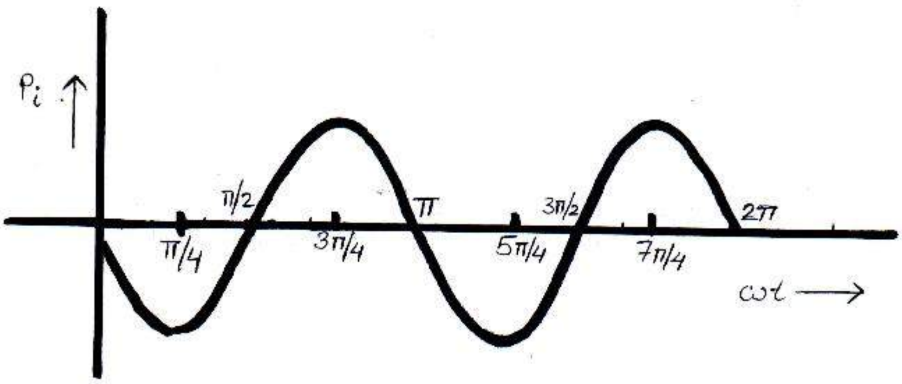
OR

Applying Kirchoff's loop rule to obtain expressions for

(i) Current flowing in the circuit ($2\frac{1}{2}$)

(ii) Inductive reactance of L (1/2)

Finding expression for instantaneous power, P_i, the graph has the form shown. (1)



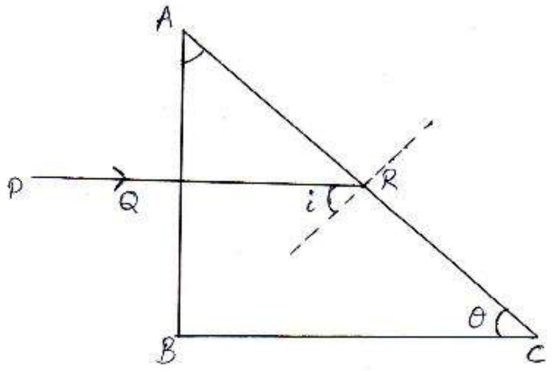
(1)

26. (a) Explaining the use of the phenomenon of total internal reflection in

(i) an optical fibre (NCERT Page 322 fig 9.16 + Explanation) (1/2 +1)

(ii) a prism that inverts an image without changing its size. (NCERT Page 322 fig 9.15 9(c) + Explanation) (1/2 +1)

(b)



(1/2)

The angle of incidence at the face AC = i

But i = A

(Angle between two lines is the same as the angle between their perpendiculars)

Also Θ = Π/2 – A = Π/2 – i (1/2)

The minimum value of I, so that there is total internal reflection at the face AC, equals i_c where $i_c = \sin^{-1}(\frac{1}{\mu})$ (1/2)

The maximum value of Θ corresponding to the minimum value of i (= i_c) is therefore,

$\Theta_{max} = \Pi/2 - i_c = \Pi/2 - \sin^{-1}(\frac{1}{\mu})$ (1/2)

OR

Statement of Huygen's principle (1)

Absence of 'back wave' (Page 354 NCERT book part II) (1)

Drawing the refracted wave front $(1\frac{1}{2})$

Obtaining Snell's law of refraction (Fig 10.5 Page 357 NCERT book part II) $(1\frac{1}{2})$