15.02.2024

MODEL EXAM

+2 PHYSICS

ANSWER KEY

SCIENCENTRE — CENTRE FOR CAREER EXCELLENCE — TOUCH THE INVISIBLE SKY

RAYS — THE SKY IS THE LIMIT

Powered by aegon LEARNING

Questions 1 – 7 – 1 score each

1) Electric flux density [or Intensity of electric field]

2) Polarisation or Intensity of magnetisation

3) paramagnet

4) visible light

5) Heinrich Hertz

6) $\frac{h}{2\pi}$

7) an insulator.

Questions 8 – 14 – 2 scores each

(8) → Linear charge density is the charge per unit length

ie, $\lambda = \frac{q}{l}$

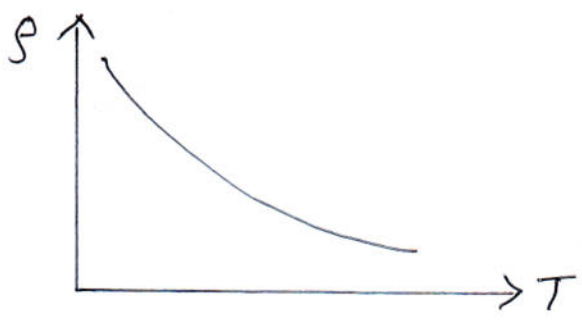
→ Its unit is $C\,m^{-1}$

⇒ Surface charge density is the charge per unit area

ie, $\sigma = \frac{q}{A}$

⇒ Its unit is $C\,m^{-2}$

(9)



(10) I law : Whenever the magnetic flux linked with a coil changes, an emf is induced in the coil.

II law : The magnitude of the induced emf is equal to the rate of change of magnetic flux.

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

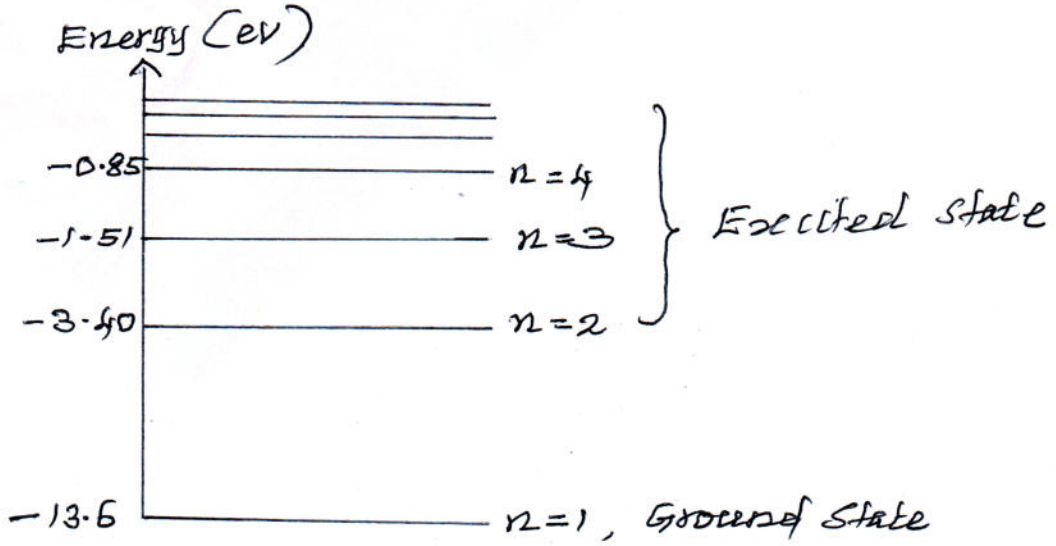
(11) $R = \frac{V^2}{P} = \frac{220 \times 220}{100} = 484\ \Omega$

(12) They are the sources of light which emit light of same frequency, same amplitude and same phase or constant phase difference.

(13) photon energy = work function + Maximum K.E of photoelectron

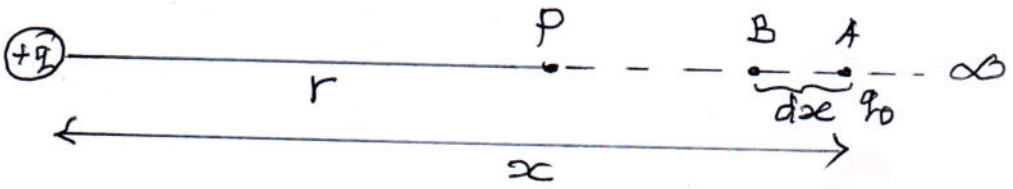
ie; $h\nu = \phi_0 + KE_{max}$

(14)



Questions 15–21 – 3 scores

15(a) potential due to a point charge.



Force b/w q and q_0 at a distance of 'x' is

$$F = \frac{KqQ_0}{x^2}$$

Small W.D to move from A to B

$$dW = -F\,dx$$

∴ Total W.D to move from ∞ to P is

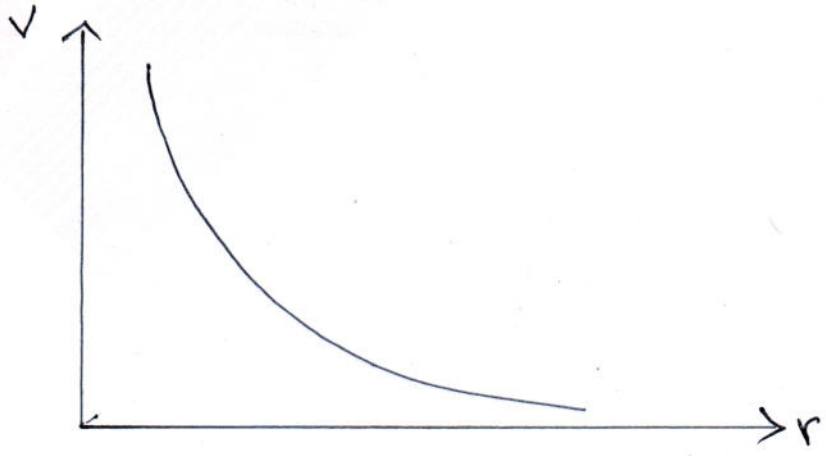
$$W = \int_{\infty}^{r} -F\,dx = \int_{\infty}^{r} -\frac{KqQ_0}{x^2}\,dx$$

on integration; $W = \frac{KqQ_0}{r}$

∴ potential at 'P' is, $V = \frac{W}{Q_0}$

$$\therefore V = \frac{Kq}{r} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$$

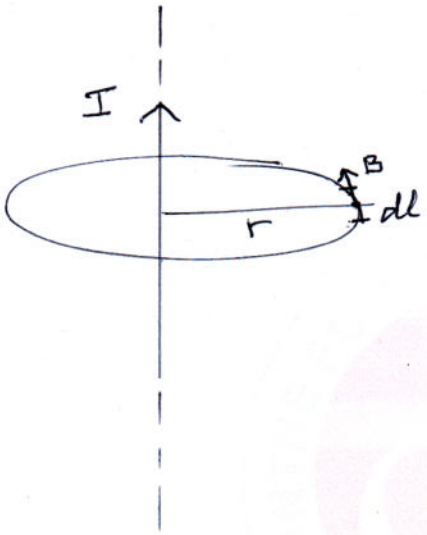
(b)



(16) a) Amper's circuital law: The line integral of magnetic field over a closed loop is equal to the μ_0 times ~~the~~ total current enclosed by the loop.

ie, $\oint \vec{B} \cdot \vec{dl} = \mu_0 I$

b)



According to Amper's circuital law;

$\oint B \cdot dl = \mu_0 I$

$B \oint dl = \mu_0 I$

$B \cdot 2\pi r = \mu_0 I$

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

(17) Energy stored in an inductor (solenoid) is given by;

$U = \frac{1}{2} L I^2$

Here $L = \mu_0 n^2 Al$ and from $B = \mu_0 n I$

$I = \frac{B}{\mu_0 n}$

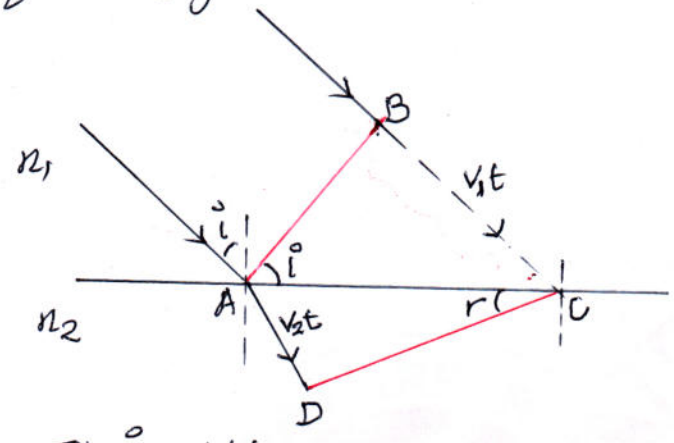
$\therefore U = \frac{1}{2} (\mu_0 n^2 Al) \cdot \frac{B^2}{\mu_0^2 n^2}$

$U = \frac{B^2 Al}{2\mu_0}$

(18) a) electromagnetic waves are produced by accelerating charges (or oscillating charges)

b) It is the part of the e.m. waves which causes heating effect. They raise the temperature of the object on which they fall.

(19)



$$\sin i = \frac{v_1 t}{AC}$$

$$\sin r = \frac{v_2 t}{AC}$$

$$\therefore \frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$$; which is the Snell's Law.

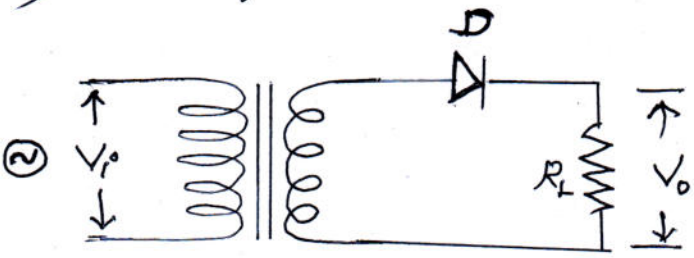
(20) a) It is the spontaneous disintegration of a heavy nucleus by the emission of some radiations like alpha, beta and gamma.

b) The energy releases from stars is due to nuclear fusion.

$$4\,{}^{1}_{1}H + 2\bar{e} \longrightarrow {}^{4}_{2}He + 2\nu + 6\gamma + 26.7\ MeV.$$

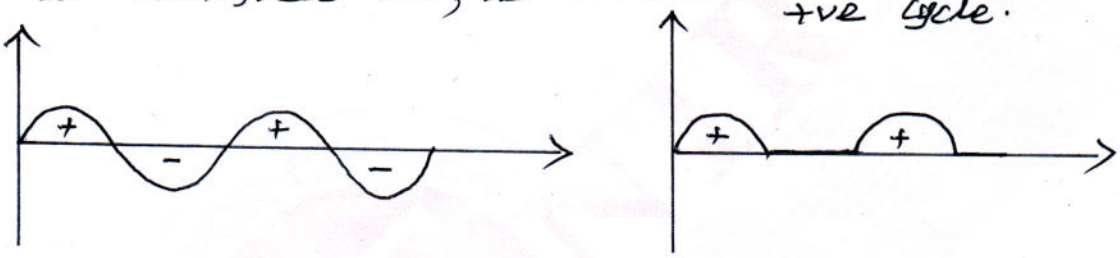
Thus four Hydrogen atoms combine to form ${}^{4}_{2}He$ atom with a release of 26.7 MeV of Energy.

(21) (a) A half wave rectifier converts AC to DC.



For the first +ve cycle of AC diode D is forward biased and for the first -ve half cycle diode D is Reverse biased. Hence we get a rectified DC; as diode conducts only for +ve cycle.

(b)



Questions 22 - 25 - 4 Scores

(22) (a) Energy stored in a capacitor

W.D to increase the charge by an amount dq is

$$dW = V\,dq = \frac{q}{C}\,dq.$$

∴ Total W.D to charge from 0 to Q is given by;

$$W = \int_0^Q \frac{q}{C}\,dq.$$

on integration; $W = \frac{1}{2}\frac{Q^2}{C}$

This work is stored as energy in a capacitor

$$\therefore U = \frac{1}{2}\frac{Q^2}{C} \quad \text{OR} \quad U = \frac{1}{2}CV^2 = \frac{1}{2}QV$$

(b) $C_1 = C_2 = 900\ pF$

$V_1 = 100V$

$V_2 = 0V$

Common potential $V_{common} = \dfrac{C_1V_1 + C_2V_2}{C_1 + C_2}$

$= \dfrac{V_1 + V_2}{2}$ (since $C_1 = C_2$)

$= \dfrac{0+100}{2} = 50V$

∴ Energy Stored $U = \frac{1}{2} C_{eff} \cdot V_{common}^2$

$= \frac{1}{2}(C_1 + C_2) V^2$

$= \frac{1}{2} \times (900 + 900) \times 10^{-12} \times (50)^2$

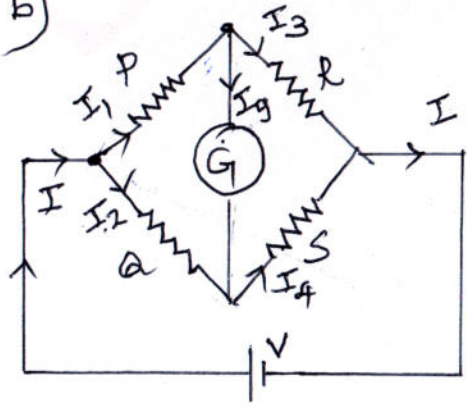
$= \underline{2.25 \times 10^{-6} J}$

(23) a) Loop rule (KVL)

It states that the algebraic sum of product of current and resistance in a closed loop is equal to the total emf present in that loop.

ie, $\Sigma IR = E$

b)



According to KCL,

$I_1 = I_3 + I_g$

$I_4 = I_2 + I_g$

According to KVL

$I_1P + I_gG - I_2Q = 0$

$I_3R + I_4S - I_gG = 0$

In balancing condition $I_g = 0$

$\therefore I_1 = I_3$ and $I_4 = I_2$

ie; $I_1 P = I_2 Q$

$I_3 R = I_4 S$

$$\therefore \boxed{\frac{P}{R} = \frac{Q}{S}}$$

(24) a) The surface integral of magnetic field over a closed area is equal to zero.

OR

The magnetic fluxe through any closed surface is equal to zero.

ie; $\oint \vec{B} \cdot d\vec{s} = 0$

b) If monopoles excisted;

$$\oint \vec{B} \cdot d\vec{s} = \mu_0 q_m$$

where q_m is the magnetic charge enclosed by the surface.

(25) a) I law :- Incident ray, refracted and the normal all lie in the same plane.

II law (Snell's law)

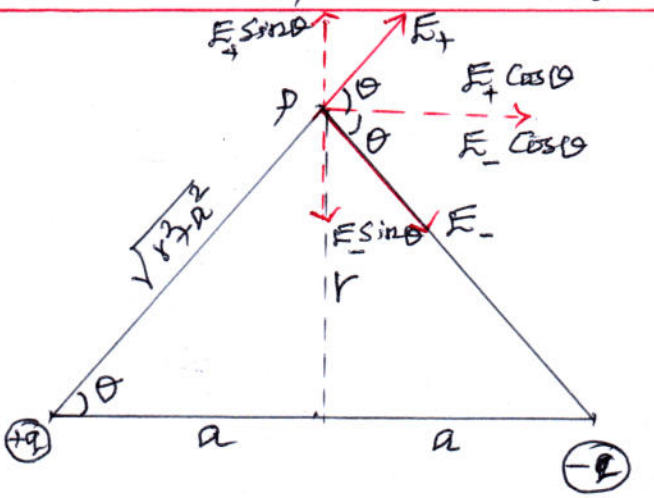
The ratio of sine of angle of incidence to the sine of angle of refraction is a constant for a given pair of media and given colour of light. ie; $\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$

b) Total internal reflection

The angle of incidence in the denser medium for which the angle of refraction in rarer medium is 90° is called Critical angle. If the angle of incidence is further increased, the ray of light is not refracted. It is Completely reflected into the denser medium. This phenomenon is called Total internal reflection.

Questions 26 – 29 – 5 Scores.

(26) a)



Electric field at P is;

$$E = 2E_+ \cos\theta$$

$$= 2 \cdot k \frac{q}{(r^2+a^2)} \cdot \frac{a}{\sqrt{r^2+a^2}}$$

$$= k \cdot \frac{q \cdot 2a}{(r^2+a^2)^{3/2}}$$

$$E = \frac{1}{4\pi\varepsilon_0} \frac{p}{(r^2+a^2)^{3/2}}$$

For a short dipole $r >> a$; $(r^2+a^2)^{3/2} \approx r^3$

$$\therefore \boxed{E = \frac{1}{4\pi\varepsilon_0} \frac{p}{r^3}}$$

(b) Total charge $= 0$

dipole moment $p = q \cdot 2a$

$= 2.5 \times 10^{-7} \times 30 \times 10^{-2}$

$= 7.5 \times 10^{-8}$ Cm

(27) a) Current sensitivity is the deflection produced per unit current.

ie; $I_s = \frac{\theta}{I} = \frac{NAB}{C}$

b) A Galvanometer can be converted in to voltmeter by connecting a high resistance 'R' in series with the galvanometer.

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

c) $I = \frac{V}{R} \Rightarrow I = \frac{3}{3+60} = \frac{3}{63}$

$$I = \frac{1}{21} A$$

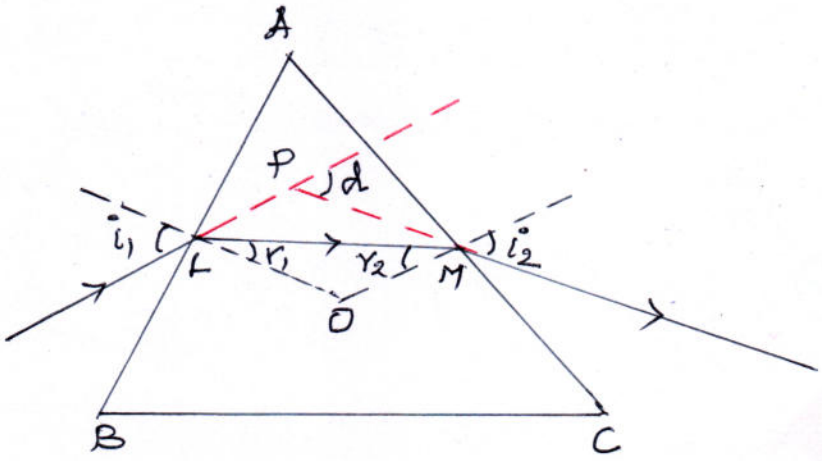
(28) a) Mutual Induction

b) → A step-up transformer increases the voltage where as a step-down transformer decreases the voltage.

→ number of turns in primary is less than number of turns in secondary for a step-up transformer: where as number of turns in primary is more than number of turns in secondary for a step-down transformer.

c) (i) Copper loss (ii) Eddy current loss
(iii) Magnetic flux leakage (iv) Hysterisis loss.

29) a)



In $\triangle PLM$, $d = (i_1 - r_1) + (i_2 - r_2)$

$$d = (i_1 + i_2) - (r_1 + r_2) \longrightarrow (1)$$

In $\triangle OLM$; $LO + r_1 + r_2 = 180$

$$r_1 + r_2 = 180 - LO$$

But $A + LO = 180$

$$\therefore r_1 + r_2 = A \longrightarrow (2)$$

In the minimum deviation position; $d = D$

$i_1 = i_2 = i$ and $r_1 = r_2 = r$

$$\therefore r = \frac{A}{2} \text{ and } i = \frac{A+D}{2}$$

$\therefore n = \frac{\sin i}{\sin r}$ becomes;

$$\boxed{n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)}}$$

b) From Snell's Law:

$$n_1 \sin i_1 = n_2 \sin r_1$$

when angles are small;

$$n_1 i_1 = n_2 r_1$$

∴ for the first face;

$$i_1 = n r_1$$

for the second face;

$$i_2 = n r_2.$$

$$\therefore \quad d = (i_1 + i_2) - A$$

$$= (n r_1 + n r_2) - A$$

$$= nA - A$$

$$\boxed{d = (n-1)A}$$