FIITJEE INTERNAL TEST
CBSE MOCK TEST – 1
PHYSICS

Class – XII
HINTS & SOLUTIONS

SECTION-A

1. as $\lambda = \frac{h}{P} = \frac{h}{\sqrt{2mk}} \Rightarrow K_p < K_e$

2. High coercivity ensures that the magnetization is not destroyed by stray magnetic fields or temperature variations.

3. F.M. transmission gives higher fidelity reception than A.M. transmission due to the presence of a large number of sidebands.

4. $P = \frac{1}{f} = \frac{1}{\infty} = 0$

5. The direction of electron parallel to the magnetic field.

SECTION-B

6. Average value of a.c is that value of a direct current which sends the same charge in a circuit in the same time as is sent by the given alternating current in its halftime period.

$I_{av} = \frac{2}{\pi} I_0$

rms value of a.c is that value of a direct current which produces the same heating effect in a given resistor as is produced by the given alternating current when passed for the same time.

$I_{rms} = \frac{1}{\sqrt{2}} I_0$

Given I = 5 sin(314 t) ampere

$\therefore$ Peak value of current, I_0 = 5A

$I_{aw} = 0.637\ I_0 = 0.637 \times 5 = 3.185$ A

$I_{rms} = 0.707\ I_0 = 0.707 \times 5 = 3.535$ A

7. Net emf = $E_2 - E_1 = 9 - 5 = 4V$

Total resistance = 0.3 + 1.2 + 4.5 + $\frac{6 \times 3}{6+3}$ = 8Ω.

Current through the circuit, I = $\frac{4}{8} = 0.5$ A

Current through the 3Ω resistance = $\frac{6 \times 0.5}{6+3} = \frac{1}{3}$ A.

8. $\Delta E = -0.85 - (-3.4)$

$= 2.55\text{ev} = \dfrac{1245}{\lambda}\text{eV}$

$= \lambda = \dfrac{1245}{2.55} = 488\text{nm} = 4880\text{A}^\circ$

It belongs to visible spectrum.

9. Resistance increases by 16 times.

10. $2\pi f = \omega = \dfrac{qB}{m}$

$B = \dfrac{2\pi fm}{q} = 0.66\ \text{T}$

$R = \dfrac{\sqrt{2mk}}{qB} \Rightarrow k = \dfrac{(qBR)^2}{2m}$

k = 7.4 MeV

SECTION-C

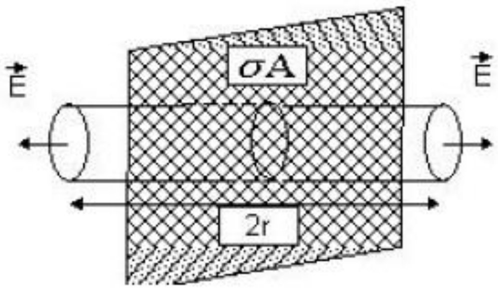
11. The electric flux through a given surface area is the total number of electric lines of force passing normally this area. It is given by

$$\Delta\Phi = \vec{E}.\overrightarrow{\Delta S}$$

The SI unit of electric flux = Vm.

According to Gauss's theorem, the total flux through a closed surface is $\dfrac{1}{\varepsilon_0}$ times the total charge enclosed by the enclosed by the closed surface.

Derivation: Consider a non - conducting sheet of charge with surface charge density σ. Consider a cylinder of length 2r and cross - sectional area A as Gaussian surface.



From symmetry electric field $\vec{E}$ points at right angle to the end caps and away from the sheet. There is no contribution from the curved surface because angle between $\vec{E}$ and $\overrightarrow{ds}$ is 90°.

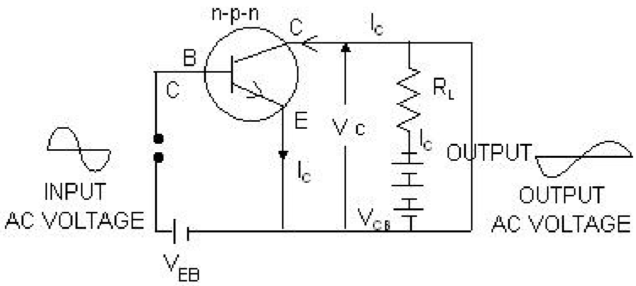
At the end faces, angle between $\vec{E}$ and $\overrightarrow{ds}$ is zero.

From Gauss's law, $\int \vec{E}.\overrightarrow{ds} = \dfrac{q}{\varepsilon_0}$

$EA + EA = \dfrac{\sigma A}{\varepsilon_0}$

$E = \dfrac{\sigma}{2\varepsilon_0}$.

12. The circuit details for using an NPN transistor as common emitter amplifier are shown in the Fig.



The input (base – emitter) circuit is forward biased and the output (collector – emitter) circuit is reverse biased.

When no a. c. signal is applied, the potential difference Vc between the collector and the emitter, is given by

$V_c = V_{ce} - I_c \times R_L$

Where V_{ce} is the voltage of battery V_{CE}

when an a.c. signal is fed to the input circuit, the forward bias increases during the positive half cycle of the input. This results in an increase in I_c and a consequent decrease in Vc, as is clear from (1) Thus during positive half cycle of the input, the collector becomes less positive.

During the negative half cycle of the input, the forward bias is decreased resulting in a decrease in I_E and hence I_c. Therefore, form (1) V_C would increase, making the collector more positive. Hence in a common –emitter amplifier, the output voltage is 180° out of phase with the input voltage.

Numerical: Given $R_{in} = 1000\ \Omega$, $\Delta I_B == 10\mu A = 10^{-5}$ A,

$\Delta I_c = 2mA = 2 \times 10^{-13}$ A, $R_{out} = 5k\Omega = 5 \times 10^3\ \Omega$

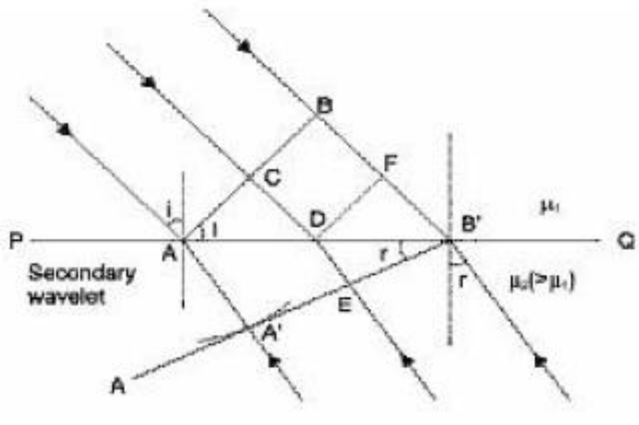
(i) Current gain,

$$\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{2\times10^{-3}}{10^{-5}} = 200.$$

(i) Voltage gain,

$$A_v = \beta\frac{R_{out}}{R_{in}} = \frac{200\times5\times10^3}{1000} = 1000$$

13. Wavefront: - It is defined as the locus of points having the same phase of oscillation.



Let a plane Wavefront AB be incident on a refracting plane surface PQ separating a rarer medium of refractive index μ_1 from a denser medium of refractive index $\mu_2(\mu_2 > \mu_1)$. During the time the disturbance from B reaches B′, the disturbance from A must have travelled a distance AA′ as radius, draw a sphere. Draw a sphere. Draw a tangent, to the sphere, from point B′. B′A′ will be the refracted Wavefront. Let us now confirm the validity of the refracted Wavefront.

For A′EB′ to be the true refracted Wavefront, the following should be satisfied.

$$\frac{CD}{c_1}+\frac{DE}{c_2}=\frac{AA'}{c_2}=\frac{BB'}{c_1} \qquad \ldots(1)$$

From D, draw DF parallel to ACB.

Now, $BF+FB'=BB'$

or $$\frac{BF}{c_1}+\frac{FB'}{c_1}=\frac{BB'}{c_1} \qquad \ldots(2)$$

From (1) *and* (2), $$\frac{CD}{c_1}+\frac{DE}{c_2}=\frac{BF}{c_1}+\frac{FB'}{c_1}$$

or $$\frac{BF}{c_1}+\frac{DE}{c_2}=\frac{BF}{c_1}+\frac{FB'}{c_1} \qquad [\because CD=BF]$$

or $$\frac{DE}{c_2}=\frac{FB'}{c_1}$$

∆s ABB′ and DFB′ are similar.

Therefore, $$\frac{B'D}{B'A}=\frac{FB'}{B'B} \qquad \ldots(3)$$

∆s AA′B′ and DEB′ are similar.

Therefore, $$\frac{B'D}{B'A}=\frac{DE}{AA'} \qquad \ldots(4)$$

From (4) *and* (3), $\frac{DE}{AA'}=\frac{FB'}{B'B}$ *or* $\frac{DE}{c_2t}=\frac{FB'}{c_1t}$ *or* $\frac{DE}{c_2}=\frac{FB'}{c_1}$

Let us now deduce the laws of refraction.

$$\sin i=\frac{BB'}{AB'} \quad and \quad \sin r=\frac{AA'}{AB'}$$

$$\therefore \quad \frac{\sin i}{\sin r}=\frac{BB'}{AB'}\times\frac{AB'}{AA'}=\frac{BB'}{AA'}=\frac{c_1t}{c_2t}=\frac{c_1}{c_2}=\text{constant}$$

This proves Snell's law of refraction.

14. (i) A slide wire bridge is known as metre bridge. It is constructed on the principle of balanced Wheatstone bridge, when a Wheatstone bridge is balanced then $\frac{P}{Q}=\frac{\ell}{100-\ell}$

(ii) When resistance R and S are connected: Since balance point is found at a distance ℓ_1 from the zero and

$$\therefore \quad \frac{R}{S}=\frac{\ell_1}{100-\ell_1} \qquad \ldots(i)$$

When unknown resistance X is connected in parallel to S.

$\therefore$ Total resistance in the right hand gap is $S_1=\frac{SX}{S+X}$

$$\left[\because \frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2} \Rightarrow R=\frac{R_1R_2}{R_1+R_2}\right]$$

Since balance point is obtained at a distance ℓ_2 from the zero and

$\therefore \quad \frac{R}{S_1} = \frac{\ell_2}{100 - \ell_2}$

Putting the value of S_1, we get $\frac{R}{\frac{SX}{S+X}} = \frac{\ell_2}{100 - \ell_2}$

$\frac{R(S+X)}{SX} = \frac{\ell_2}{100 - \ell_2}$ …(ii)

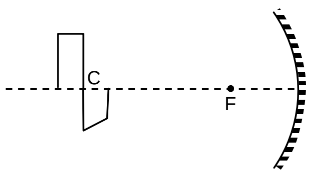
Hence, $X = \frac{\ell_1(100 - \ell_2)}{100(\ell_2 - \ell_1)} \cdot S$

15. (i) Saturation current is same for incident radiations of different frequencies but of same intensity. It does not change with increase in anode potential.
(ii) Stopping potential is same for incident radiation of different intensities but same frequency. This is because stopping potential depends on frequency and not on the intensity of incident radiation.
(iii) Photoelectric current increases linearly with the intensity of incident radiation of same frequency.

16. (a) X-rays are sometimes used for the treatment of certain forms of cancer.
Various types of em waves one used depending on the type, stage and location of the cancer and the condition of the patient.

Wavelength range – 10^{-8} M to 10^{-13} M
Frequency range – 10^{16} to 10^{20}
Gamma rays are used in medicine to destroy cancer cells
Wavelength range – 10^{-10} M to 10^{-14} M
Frequency range – 10^{19} to 10^{23}
(b) Ozone layer absorbs 97 – 99% of the sun's medium frequency ultraviolet light which otherwise would potentially damage exposed life forms near the earth surface.
(c) Momentum associated with em wave is equal to $\frac{h}{\lambda}$. h is of the order of 10^{-34}, so momentum transferred with em waves is very small and hence momentum transferred by em waves incident on the surface is very small.

17. (a)



As, $m = \frac{V}{u}$
V and u are different.

(b) Intensity of image will reduce because only upper half portion of mirror reflects the rays. But its magnification and image type are unaffected.

18. (a) dw = vdQ

$dw = \frac{Q}{C} dQ$

$\int dw = U = \frac{1}{C}\frac{Q^2}{2}$

$U = \frac{Q^2}{2C}$

(b) $W = qV_{ab} + qV_{bc} + qV_{cd} + qV_{da}$
As, $V_{ab} = 0$, $V_{dc} = 0$
and $V_{ad} = -V_{bc}$
W = 0

OR

(a) $V_B - V_A = -\int E d\ell$

$$= -\int \frac{\sigma}{\varepsilon_o} d\ell$$

$$V_B - V_A = \frac{\sigma}{\varepsilon_o} d$$

$$C = \frac{Q}{V_A - V_B} = \frac{\sigma A}{\frac{\sigma d}{\varepsilon_o}}$$

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

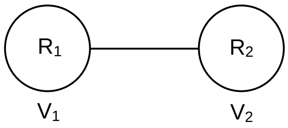
(b) $V_1 = V_2$

$$\frac{Q_1}{4\pi\varepsilon_o R_1} = \frac{Q_2}{4\pi\varepsilon_o R_2}$$

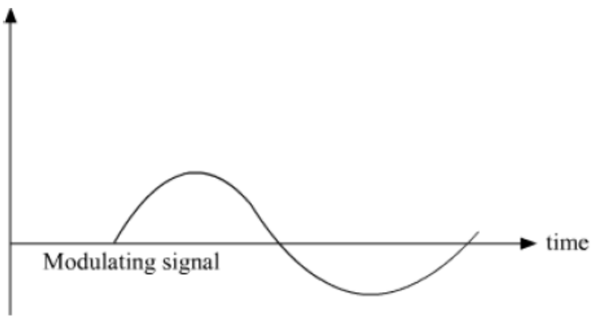
$$\frac{R_1 Q_1}{4\pi R_1^2 \varepsilon_o} = \frac{R_2 Q_2}{4\pi R_2^2 \varepsilon_o}$$

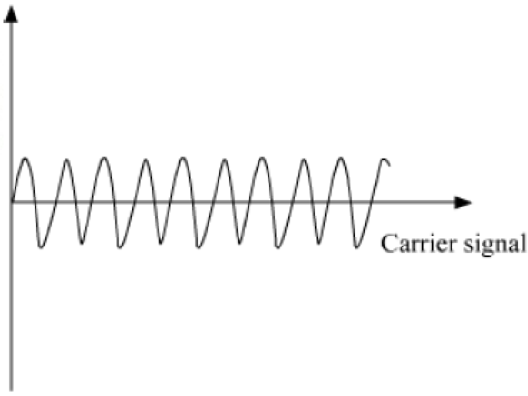
$$R_1\sigma_1 = R_2\sigma_2$$

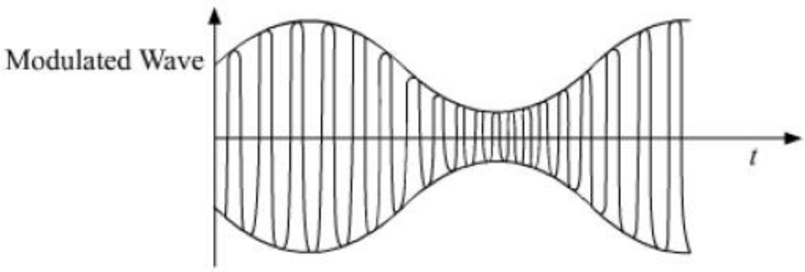
$$\frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1}$$



19. (i) To send the signal over large distances for communication.
(ii) To avoid the fluctuation and reduce noise of signal.







20. Resistance offered by a conductor of unit length and unit area of cross section is known as resistivity.
Derivation - $I = neAv_d$

$$= neA\frac{eE}{m}\tau$$

$$= \frac{ne^2A}{ml}V\tau \qquad ...(1)$$

$$\frac{V}{I} = R = \frac{ml}{ne^2A\tau}$$

$$\rho = \frac{m}{ne^2\tau} \quad ...(2)$$

21. (i) Capacitance of a capacitor: The capacitance of a capacitor is the amount of charge required to raise its potential by unity

(ii) Dielectric strength of a dielectric: The maximum electric field that a dielectric medium can with stand without breaking down of its insulating property is called its dielectric strength

When a dielectric is inserted between the plates of a charged parallel plate capacitor, the field causes a uniform polarization of the dielectric and the total field in the dielectric is reduced

The capacitor C_0 is given by

$$C_0 = \frac{\varepsilon_0 A}{d}$$

The capacitance C, with dielectric between the plates is

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

The product $\varepsilon_0 K$ is called the permittivity of the medium and is denoted by ε.

$$\therefore \varepsilon = \varepsilon_0 K \Rightarrow K = \frac{\varepsilon}{\varepsilon_0}$$

Where K is called the dielectric constant of the substance
Dividing (2) by (1), we get

$$\frac{C}{C_0} = \frac{\varepsilon_0 KA}{d} \times \frac{d}{\varepsilon_0 A}$$

$$\frac{C}{C_0} = K \therefore C = KC_0$$

Thus the dielectric constant of a substance of a substance is the factor >1 by which the capacitance increases from its vacuum value, when the dielectric is inserted fully between the plates of a capacitor.

22. (a) According to Bohr's second postulate of quantization, the electron can revolve round the nucleus only in those circular orbits in which the angular momentum of the electron is integral multiple of $\frac{h}{2\pi}$ where *h* is Planck's constant (= 6.62×10^{-34} Js).

So, if *m* is the mass of electron an *v* is the velocity of electron in permitted quantized orbit with radius *r* than

$$mvr = n\frac{h}{2\pi} \quad \ldots(i)$$

Where *n* is the principle quantum number and can take integral values like *n* = 1, 2, 3…

This is the Bohr's quantization condition.

Now, de-Broglie wavelength is given as

$$\lambda = \frac{h}{mv}$$

Where $\mu \rightarrow$ is wavelength associated with electron.

v is the velocity of electron.

h – is the velocity of electron.

m – mass of electron

$\nu = \frac{h}{mv}$ …(ii)

Putting value of *v* from (ii) in (i)

$$m \times \frac{h}{m\lambda} \times r = n\frac{h}{2\pi}$$

$$\frac{rh}{\lambda} = \frac{nh}{2\pi}$$

$2\pi r = \lambda n$

Now circumference of the electron in the n^{th} orbital state of Hydrogen atom with radius *r* is $2\pi r$.

(b) In *n* is the quantum number of the highest energy level involved in the transitions, then the total number of possible spectral lines emitted is

$$N = \frac{n(n-1)}{2}$$

Third excited state means fourth energy level i.e. n=4. Here, electron makes transition from $n = 4$ to $n = 1$ so highest *n* is $n = 4$.

Thus, possible spectral lines

$$N = \frac{4(4-1)}{2} = \frac{4 \times 3}{2} = 6$$

6 is the maximum possible number of spectral lines.

SECTION-D

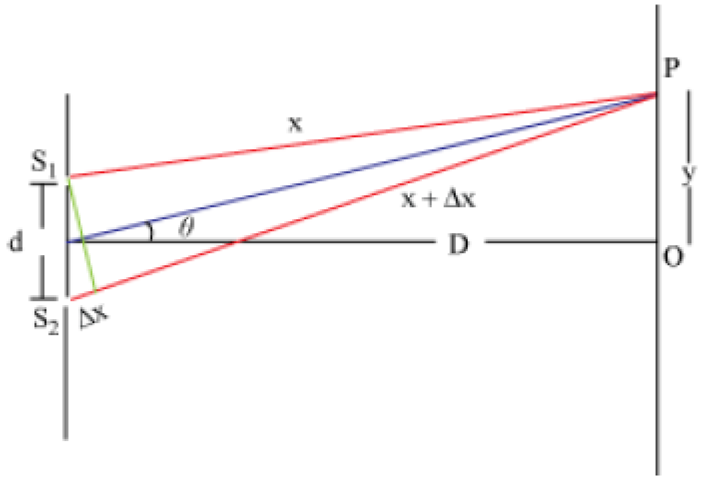
23. (i) Careless attitude towards life.
(ii) Capacitor
(iii) $V = V_m \text{ Sin } \omega t$

$i = i_m \text{ Sin } (\omega t + \frac{\pi}{2})$, $i_m = \frac{V_m}{x_C}$

$X_C = \frac{1}{wC}$ called capacitor reactance.

SECTION-E

24. Two sources are called coherent sources, if the phase difference between them is either zero or constant. And this is essential for interference of light.
For any other incoherent source of light a steady interference pattern can never be obtained, even if the sources emit waves of equal wavelengths and equal amplitudes. This is because the waves emitted by a source undergo rapid and irregular changes of phase, so that the intensity at any point is never constant. Naturally the phase difference between the waves emitted by the two sources cannot remain constant.



The two waves interfering at P have different distances S_1P and $S_2P = x + \Delta x$.
So, for the two sources S1 and S2we can respectively write,
$I_1 = I_{01}\sin(kx - wt)$
$I_1 = I_{02}\sin(k(x + \Delta x) - wt) = I_{02}\sin(kx - wt + \delta)$
$\delta = k\Delta x = (2\pi/\lambda) \times \Delta x$
The resultant can be written as,
$I = I_0\sin(kx - wt + \varepsilon)$
Where $I_0^2 = I_{01}^2 + 2I_{01}I_{02}\cos\delta$
and $\tan\varepsilon = I_{02}\sin\delta/(I_{01} + I_{02}\cos\delta)$
The condition for constructive (bright fringe) and destructive (dark fringe) interference are as follows;
$\delta = 2\pi r$ for bright fringes.
Where n is an integer.
$\delta = (2n + 1)\pi$ for dark fringes.
Now to find the fringe width,
The path difference is $\Delta x = S_2P - S_1P$,
Nearly equal to d sin θ = d an θ = $\frac{dy}{D}$
Hence we can write, y = $\frac{\nu\lambda D}{d}$, n is an integer.
Fringe width is the distance between two consecutive dark or bright fringes,
so we have fringe width = $\frac{\lambda D}{d}$.
If the whole apparatus is immersed in water and refractive index of water is *n* then,
$\frac{\nu}{c} = \frac{1}{n}$ Where ν is velocity of light in water.
$\Rightarrow \quad n = \frac{\nu\lambda}{\nu\lambda_\omega}$ λ = wavelength of light in air.
$\Rightarrow \quad n = \frac{\nu\lambda}{\lambda_\omega}$ λ_ω = wavelength of light in water
Hence,
$$\beta_\omega = \frac{\lambda_\omega d}{D} = \frac{\lambda d}{nD}$$
$\beta_\omega = \frac{1}{n}\beta$ This shows fringe width will be reduced by the factor of the refractive index of water.

OR

. (a) The surface which has same potential through out is called an equipotential surface.

Since $dw = \vec{F}.d\vec{x}$

$dw = (q_o E)\cdot d\vec{x}$

(force on the test charge $q_o \vec{F} = q_o \vec{E}$)

Since work done is moving a test charge along an equipotential surface is always zero.

$\Rightarrow \; q_o \vec{E}.\overrightarrow{dx} = 0$

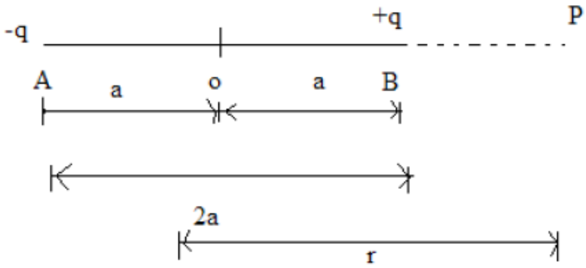
or

$\vec{E}.\overrightarrow{dx} = 0$

$\Rightarrow \; E \perp d\vec{x}$

(b) Consider an electric dipole of dipole length 2a and point P on the axial line such that OP = r where O is the centre of the dipole.

Electric Potential at point P due to the dipole



$V = V_{PA} + V_{PB}$

$V = \frac{K(-q)}{(r+a)} + \frac{K(+q)}{(r-a)}$

$V = Kq\left[\frac{1}{r-a} - \frac{1}{r+a}\right]$

$V = Kq\left[\frac{(r+a)-(r-a)}{(r-a)(r+a)}\right]$

$V = Kq\left[\frac{r+a-r+a}{r^2-a^2}\right]$

$V = Kq\frac{(2a)}{r^2-a^2} \quad (\because \vec{P} = 2aq)$

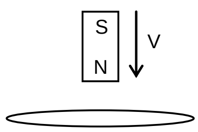
$V = \frac{KP}{r^2-a^2}$

For a short electric dipole (a) can be neglected

$\Rightarrow \; V = \frac{KP}{r^2}$.

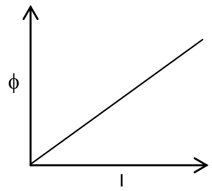
25 (a) Consider a bar magnet falling freely. It will increase the number magnetic field lines through the coil in downward direction, As $e = -\frac{d\phi}{dt}$.

Hence, the upper face of the coil will become north pole, which will oppose the motion of magnet. Similarly lower will become south pole.

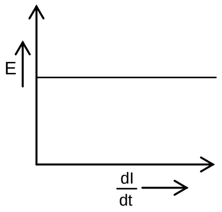


(b) $\phi = LI$

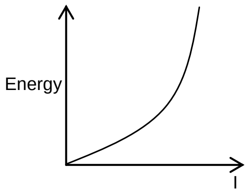
(i)



(ii) $e = \left|\frac{LdI}{dt}\right| \Rightarrow$

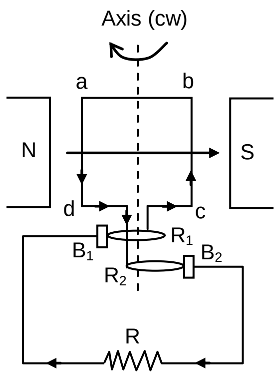


(iii) Energy = $\frac{1}{2}LI^2 \Rightarrow$



OR

(a)

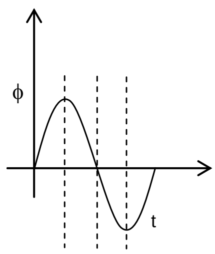


Abcd $\rightarrow$ Armature
N, S $\rightarrow$ Field magnet
R_1, R_2 $\rightarrow$ Slip rings
Brushes or sliding contact $\rightarrow$ B_1, B_2

Principle: Whenever in a closed ckt, the magnetic flux changes, an induced e.m.f. is produced.

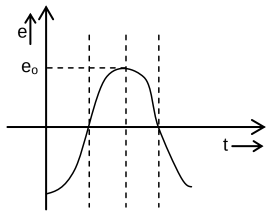
$$E = -\frac{d\phi}{dt}$$

(i) Magnetic flux:
$\phi = \phi_o \sin \omega t$



(ii) Alternating e.m.f.

$$e = \frac{-d\phi}{dt} = -\phi_o w \cos \omega t$$



(b) We have to reduce the value of current in ac circuit by introducing chock coil because chock coil has high impedance.

26 According to Bohr, energy is radiated in the form of a photon when the electron of an excited hydrogen atom returns from higher energy state to the lower energy state. In other words, energy is radiated in the form of a photon when electron in hydrogen atom jumps from higher energy orbit ($n = n_i$) where $n_i > n_f$. The energy of the emitted radiation or photon is given by

$$hv = E_{n_i} - E_{n_f}$$

We know $$E_n = \frac{-me^4}{8h^2 \epsilon_0^2 n^2}$$

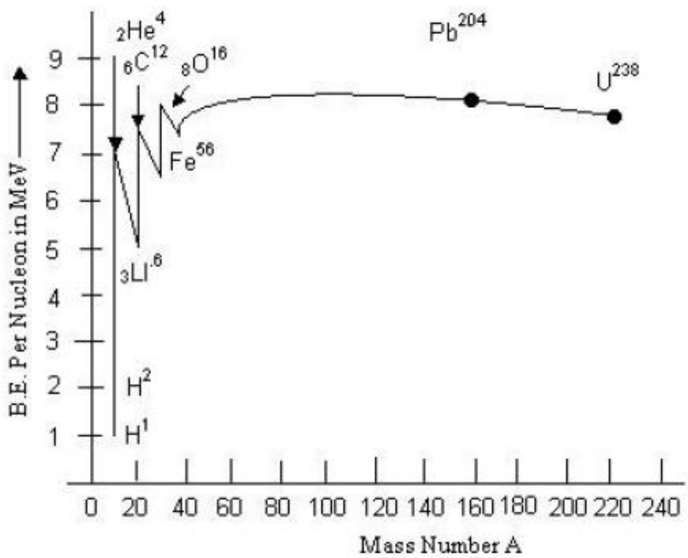
$\therefore$ $$hv = \frac{me^4}{8\epsilon_0^2 n_1^2 h^2} - \frac{me^4}{8\epsilon_0^2 n_1^2 h^2} \text{ i.e, } hv = \frac{me^4}{8\epsilon_0^2 h^2}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

or $$v = \frac{me^4}{8\epsilon_0^2 h^2}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

	Name of series
n = 4 to n = 3	Paschan
n = 4 to n = 2	Balmer
n = 4 to n = 1	Lyman

OR

(a) The graph showing the variation of binding energy per nucleon with mass number is shown below.



Conclusions:

(i) The intermediate nuclei have large value of BE/A so they are more stable.

(ii) BE/A has low value for both of light and heavy nuclei so they are unstable nuclei.

(b) In nuclear fission, unstable heavy nuclei splits into two stable intermediate nuclei and in Nuclear fission, unstable heavy nuclei splits into two stable intermediate nuclei and in Nuclear fusion, 2 unstable light nuclei combines to form stable intermediate nuclei so in both processes energy liberates as stability increases.

(c) $n \rightarrow P^{+} \; {}_{-1}\beta^{0} + \overline{V}$

Neutrinos are difficult to detect as they go through all object by penetrating them.