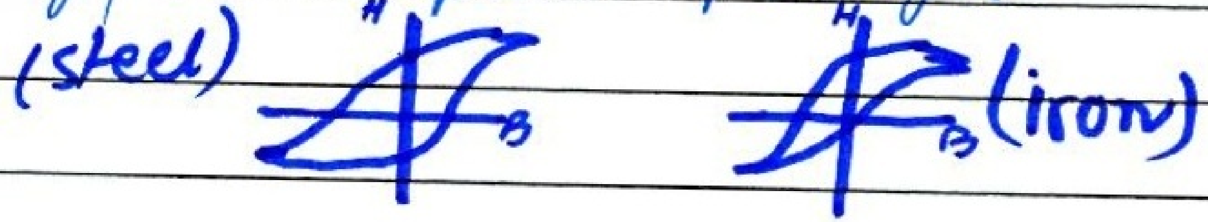
Q. No. 2 Part (i) **Energy Dissipation for Steel and Iron:**

Iron is a soft magnetic material so it is easy to magnetize and demagnetize it as its retentivity and coercivity is small. Once magnetized, it easily loses it magnetization on removal of current. Therefore, less energy is dissipated per cycle. due to small hysterisi loop

However, steel has a thicker hysterisis loop comparitively, so it is difficult to magnetized and demagnetize it. It has greater retentivity. and it is comparitively harder so more energy is dissipated per cycle.

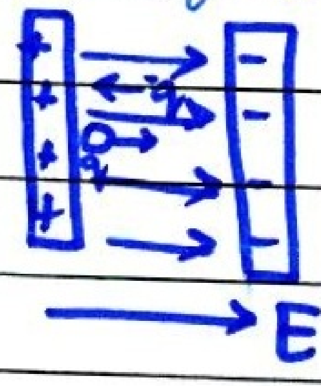


Q. No. 2 Part (ii) **Potential Gradient :** Electric field intensity is equal to rate of change of potential.

$W = Fd\cos\theta$ ($\theta = 180°$) as work is done against field.

$W = -Fd \rightarrow (1)$

$U = W = q_0 V \rightarrow (2)$



From (1) and (2)

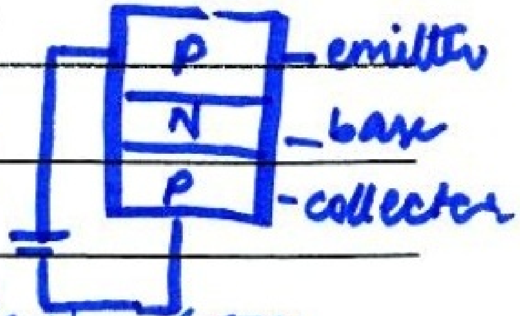
$-Fd = q\Delta V$ $(\because F = qE)$

$-qE\Delta r = q\Delta V$ $(\because d = \Delta r)$

$$E = -\frac{\Delta V}{\Delta r}$$

Negative sign shows work is done against field or field decreases as distance increases.

Q. No. 2 Part (iii) **Base Region**



Base region is made thin and lightly doped because if this is lightly doped so most of the charge carrier will flow from emitter to collecter and only a few will recombine with base particles. This constitutes large current in collector such that

$$I_E \approx I_C$$

$$\boxed{I_E = I_B + I_C}$$

When collector current is significantly high, base current will be much low.

....

Q. No. 2 Part (iv) lyman series $p = 1$, $R_H = 1.0974 \times 10^7 m^{-1}$

for longest wavelength $\Rightarrow n = 2$

Sol:-

$$\frac{1}{\lambda} = R_H \left(\frac{1}{p^2} - \frac{1}{n^2} \right)$$

$$= 1.0974 \times 10^7 \left(\frac{1}{1^2} - \frac{1}{2^2} \right) = 1.0974 \times 10^7 \left(\frac{3}{4} \right)$$

$$\frac{1}{\lambda} = 8230500 \ m^{-1}$$

$$= 1.214 \times 10^{-7} m$$

$$= 121.4 \times 10^{-9} m$$

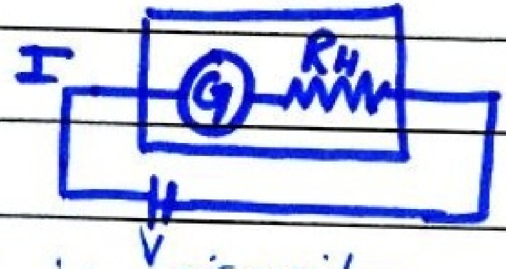
$$\boxed{\lambda_{max} = 121.4 \ nm}$$

Result : longest λ is 121.4 nm.

Q. No. 2 Part (v)

Curie Temperature	Critical temperature
(i) The temperature at which ferromagnetic material become paramagnetic	Temperature at which or below which materials become superconductive.
(ii) It's very high temperature	It's very low temperature
(iii) Heating a material causes loss in its magnetic properties and domains become slightly disordered.	Resistance becomes zero and there are no losses at high current.
(iv) Eg: Iron, nickel, cobalt can become paramagnetic.	Eg: At 125 K oxygen, barium, cadmium became superconductors

Q. No. 2 Part (vi) **Voltmeter:**



On connecting a high resistance to galvanometer is series we can for voltmeter. It is connected in parallel in circuit. Ideally its resistance is infinity.

$I_g = I_H = I$, $V = V_g + V_h = I_g R_g + I_h R_H$

$V = IR_g + IR_H$

$V = IR = I_g R_g + I_g R_H$

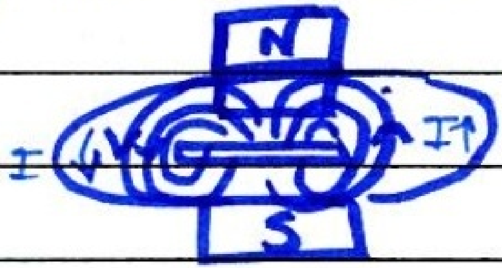
$$R_H = \frac{V}{I_g} - R_g$$

Q. No. 2 Part (vii) **Eddy Currents :**

These are the circular currents produced when a metallic object is placed in a changing magnetic field. When field changes, flux linking the coil changes and induced current is produced which is called Eddy Current. According to lenz's law this current opposes the cause that produced them and have opposite direction which causes heat due to friction.

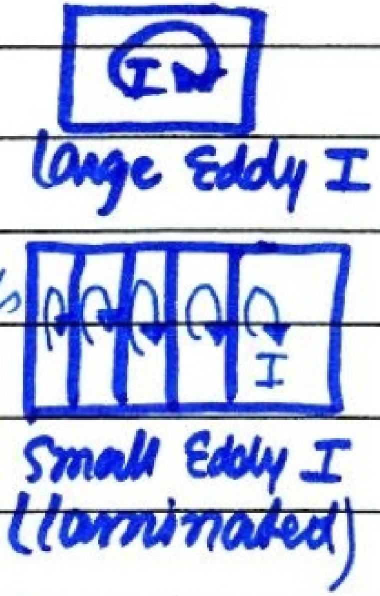
Uses

Cooktops, Metal detectors, Magnetic Brakes.



Q. No. 2 Part (viii) **Laminated Iron Core:**

In a transformer laminated soft iron core is used instead of solid one to reduce losses due to Eddy Currents

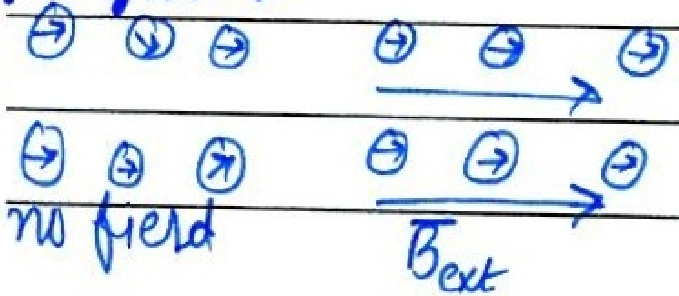


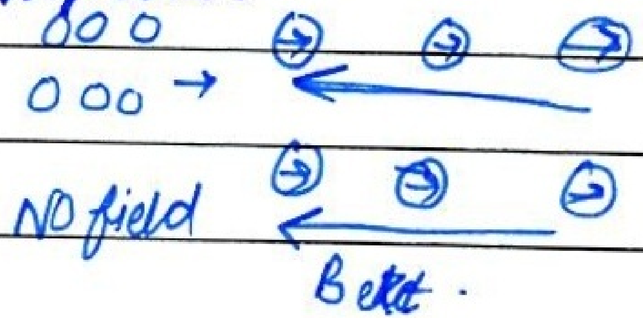
→ In a solid core there flow a large current so there will be much large losses. To prevent them laminated core with thin insulating layer between them is used to reduce losses by limiting current to a single small cores.

Q. No. 2 Part (ix)

Paramagnetic materials	Dimagnetic Materials.
① There domains are weakly arranged in magnetic field and they act as weak tiny magnet in absence of external field.	Their orbital and spin motion lead to cancellation of the magnetic fields hence they don't exhibit magnetic character.
② In external 'B' they are weakly attracted along direction of field.	In external 'B' they are weakly repelled.
③ Eg: Aluminium, Antimony	Eg: Copper, Zinc
Diagram:	Diagram.

④

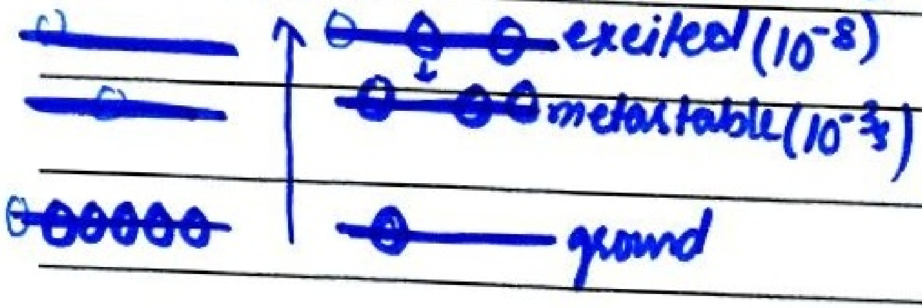




Q. No. 2 Part (x) **Laser Action:** It is the process of producing laser. Meta-Stable state and population inversion are its important concepts.

Meta Stable state: An intermediate state between ground and excited state where e^- stay longer than in excited state for about 10^{-3} s. LASER is only produced when e^- are in meta-stable state.

Population inversion: An artificial state in which applied potential causes more electrons in excited state than in ground state. Whereas under normal conditions e^- reside in ground state.



Q. No. 2 Part (xi) ~~$K.E = 1200\ keV = 1200 \times 10^3\ eV$~~

Hadrons	Leptons
1) Strongest particles They can experience all forces	They experience weak nuclear force, but sometimes electro-magnetic force two.
2) They are composed of quarks and antiquarks (up, down, charm, strange, top, bottom)	There are 4 basic leptons 2 new have been introduced. (electron, muons and there anti particles.)
3) They form mesons and baryons. They are elementary	They are not elementary

Q. No. 2 Part (xii) **Alpha Factor**: It is the amplification factor. Its value ranges from (0.95 - 0.99) usually. It is

$$\alpha = \frac{I_c}{I_E}$$

Beta Factor: It is the current gain or current amplification factor. ranges from (20 - 400 V). It is

$$\beta = \frac{I_C}{I_B}$$

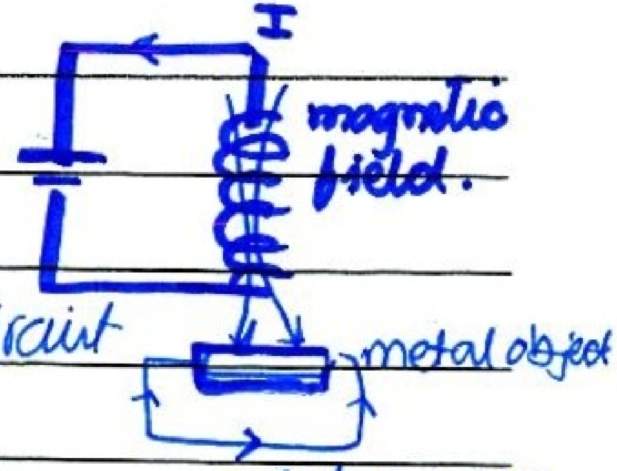
Relation b/w α and β $(I_E = I_B + I_C)$

$$\beta = \frac{I_C}{I_E - I_C} \quad \text{(divide by } I_C)$$

$$\beta = \frac{I_C/I_C}{I_E/I_C - I_C/I_C} = \frac{1}{\frac{1}{\alpha} - 1}$$

$$\boxed{\beta = \frac{\alpha}{1-\alpha}}$$

Q. No. 2 Part (xiii) **Metal Detector:**



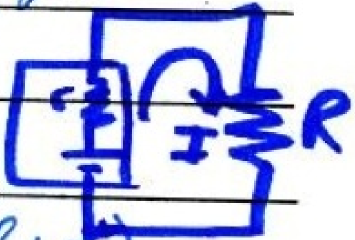
Metal detector can work on principle of
→ Eddy Currents and → RL circuits.
In RL circuits change in fR between circuit A and B produces a beat and object is detected.

However with Eddy currents; as current flow in circuit and magnetic field is produced. When metallic object is brought near the field induces a current in the object, these eddy currents induces flux and an alarm or other detection system connected in the circuit would produce sound / signal indicating presence of an object near to it. These currents are opposite to circuit current.

V = I R

....

Q. No. 2 Part (xiv) **Maximum power output:** Most often power is wasted, however we need to get maximum power to avoid losses.



$P = VI = V^2/R = I^2 R \qquad (V = \varepsilon = I(R+r))$

$P = \frac{I^2}{R} = \frac{\varepsilon^2 \cdot R}{(R+r)^2} = \frac{\varepsilon^2 R}{(R-r)^2 + 4rR}$

Condition $(r = R)$

$P = \frac{\varepsilon^2 R}{0 + 4R^2}$

$P = \frac{\varepsilon^2}{4R}$

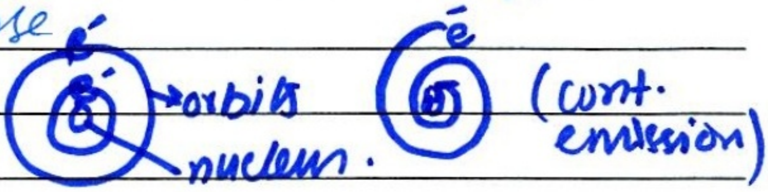
$$\boxed{P = \frac{\varepsilon^2}{4r}}$$

Hence when $r = R$ or $R = r$ the power delivered is maximum.

Q. No. 3 (Page 1)

Bohr's Atomic Model

It was a planetry model in which large mass is concentrated in centre surrounded by e^- at distance.
He provided quantization of momentum so that the structure would not collapse.
As, if atom continuosly exhibits energy, it decreases and collapse



Postulates :

① Electron revolves around nucleus continuosly this centripetal force is provided by electrostatic force.

$$\frac{mv^2}{r} = \frac{ke^2}{r}$$

② Electrons revolve around fixed orbits and not in any orbit. They revolve only in those orbits fore which angular momentum is integral multiple of $h/2\pi$

$$mvr = L = \frac{h}{2\pi} \Rightarrow L = \frac{nh}{2\pi}$$

③ Electrons do not continuously emit radiations Only when jumping to higher or lower orbit energy is absorbed or emitted.

$$\Delta E = E_2 - E_1$$

Q. No. 3 (Page 2)

Quantization of Energy:

Total energy is sum of K.E and PE on e^-

$$E = K.E + P.E$$

$$= \frac{1}{2}\frac{ke^2}{r} - \frac{ke^2}{r}$$ (from bohr's first postulate)

$$E = -\frac{1}{2}\frac{ke^2}{r} \rightarrow (A)$$

Put r in (A)

$$r = \frac{n^2h^2}{4\pi^2 ke^2 m}$$

$$E = \frac{-1}{2}\frac{ke^2}{\left(\frac{n^2h^2}{4\pi^2 mke^2}\right)}$$ (simplify)

$$E = -\frac{2\pi^2 mk^2e^4}{n^2h^2}$$

All these are constant. So,

$$E = \frac{-1}{n^2}\left(\frac{2(3.14)^2(9.11\times10^{-31})(9\times10^9)^2(1.6\times10^{-19})^4}{(6.626\times10^{-3})^2}\right)$$

$$E = -\frac{2.176\times10^{-8}}{n^2}$$

$$E = \frac{-13.6\ eV}{n^2}$$

for first orbit $n=1$

$$E_0 = -13.6\ ev$$

Therefore the quantized energy is

$$E_n = -\frac{E_0}{n^2}$$

This shows that as the ~~e~~ e' moves away from nucleus its energy decreases.

for further orbits:

$$E_1 = \frac{\varepsilon_0}{1} = -13.6\,eV$$

$$E_2 = \frac{-\varepsilon_0}{2^2} = -3.4\,eV$$

$$\varepsilon_3 = \frac{-\varepsilon_0}{3^2} = -1.51\,eV$$

$$\vdots$$

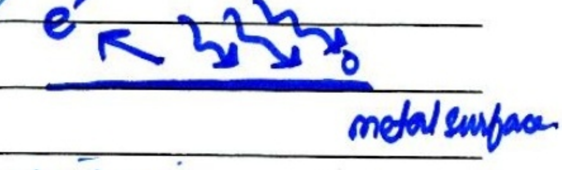
$$\varepsilon_n = \frac{-\varepsilon_0}{n^2}$$

Hence energy is quantized.

Q. No. 4 (Page 1)

Photo Electric Effect.

When high frequency rays (x-rays)/ photons hit the metal surface electrons are emitted. This is called photo-electric effect and electrons are called photoelectrons



* It has 2 basic experiments done by varying Potential (V) and frequency (f)

Drawbacks:

Classical physics fails to explain it because.

1. Classically, ~~emitted~~ waves are sinosuidally electro--magnetic waves which should ~~emit electrons~~ increase the intensity of wave when amplitude (photons) increase. However it does not happen.

2. Electrons should be emitted at a frequencies However, it does not occur and e´ are not emitted if frequency is below certain threshold frequency.

3. Classically emission should be simultaneos but electrons are emitted spontaneosly or suddenly.

Einstein Equation:

Using Planck's theory and his own, Einstein quantized energy and derived a relation for photoelectric effect. Electrons revolve in quantized orbits.

Work function ϕ is the minimum amount of energy required to eject electrons.

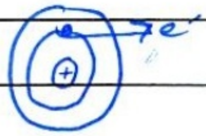
$$K.E = E - \phi$$

$$K.E = hf - \phi$$

Ideally K.E of e' is zero when the photon has only that amount of energy to eject e' and no work is done ~~agai~~ and carried as kinetic energy of electrons.

$$K.E = 0$$

$$0 = hf - \phi$$



$$hf = \phi$$

$$\boxed{f = \frac{\phi}{h}}$$

Cutoff wavelength can be:

$$c = f\lambda$$

$$f = \frac{c}{\lambda}$$

$$\frac{c}{\lambda} = \frac{\phi}{h}$$

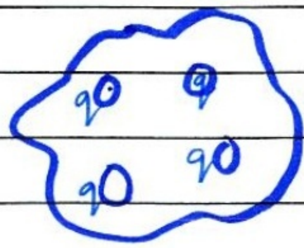
$$\boxed{\lambda = \frac{hc}{\phi}}$$

Q. No. 4 (Page 3)

Q. No. 5 (Page 1)

Gauss's Law

It is defined as the electric flux is $1/\varepsilon_0$ times the total charge enclosed in a body



$$\phi = \frac{q_1}{\varepsilon_0} + \frac{q_2}{\varepsilon_0} + \frac{q_3}{\varepsilon_0} \cdots \frac{q_n}{\varepsilon_0}$$

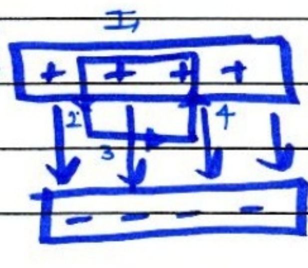
$$= \frac{1}{\varepsilon_0}(q_1 + q_2 + q_3 \cdots q_n)$$

$$= \frac{\left(\sum_{i=1}^{n} q_i\right)}{\varepsilon_0}$$

$$\boxed{\phi = \frac{Q}{\varepsilon_0}}$$

Electric fied intensity between oppositely charged parallel plates

Consider a cube place in magnetic field as gaussion surface.
On the side face of cube total flux that acts is



$\phi_1 = EA\cos\theta$ (out of field $\Rightarrow E = 0$)
$= 0$

$\phi_2 = EA\cos 90^\circ$
$= 0$

Net flux $= \phi = EA$ → ①

$\phi_3 = EA\cos 0^\circ$
$= EA$

$\phi_4 = EA\cos 90^\circ$
$= 0$

Q. No. 5 (Page 2)

Surface charge density is

$\frac{Q}{\varepsilon_0}$ $\quad \sigma = \frac{Q}{A}$

$$Q = \sigma A$$

$$\phi = \frac{\sigma A}{\varepsilon_0} \rightarrow (2)$$

$$EA = \frac{\sigma A}{\varepsilon_0}$$ Compare (1) and (2)

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

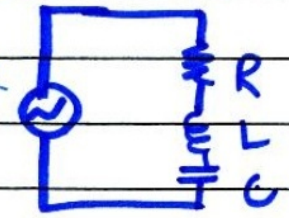
Thus ~~flux the~~ electric field intensity b/w 2 oppositely charged plates is $\frac{\sigma}{\varepsilon_0}$.

Q. No. 5 (Page 3)

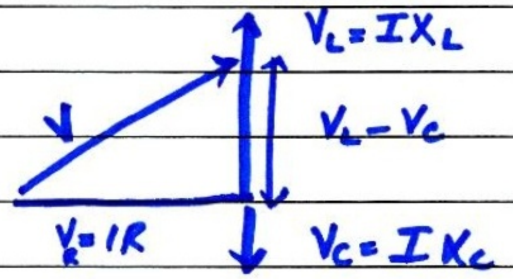
Q. No. 6 (Page 1)

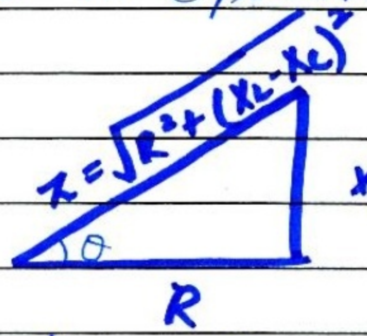
RLC Series resonance Circuit

In RLC series circuit Resistance, Inductor and capacitor are connected in series.



① V and I are in phase in resistive circuit
② Voltage leads currents by 90° in inductive circuit
③ Voltage lags current by 90° in capacitive mode.





Impedance Triangle.

$V = IR$

$V_L = IX_L$, $V_C = IX_C$

$V_{eq} = \sqrt{(IR)^2 + I^2(X_L - X_C)^2}$

$\frac{V}{I} = Z = \sqrt{R^2 + (X_L - X_C)^2}$

$$\boxed{Z = \sqrt{R^2 + (X_L - X_C)^2}}$$ its the impedance

The factor $(X_L - X_C)$ is called reactance.

angle θ can be measure as (b/w $0 < \theta < 90$)

$\tan\theta = \frac{X_L - X_C}{R}$

$$\boxed{\theta = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)}$$

* $V_m = V_m \sin(\omega t)$
* $I = I_m \sin(\omega t \pm \theta)$

Properties:

1. If $X_L > X_C$ then the circuit is inductive
2. If $X_C > X_L$ then circuit is capacitive.
3. If $X_L - X_R = 0$ ie $X_L = X_R$ then the circuit is purely resistive.

At Resonance:

$$X_L = X_C$$

$$f_R = \frac{1}{2\pi\sqrt{LC}}$$

Q. No. 6 (Page 3)

QE
= CVE

$K.E = q_0 V$

$\frac{1}{2} m v^2 = q_0 V$

$v = \sqrt{\frac{2 q_0 V}{m}}$

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

$\lambda = \frac{h}{m \sqrt{\frac{2 q_0 V}{m}}} = \frac{h}{\sqrt{2 q_0 V m}}$

$V = 2V$

$\lambda = \frac{h}{2mv}$