100% (60/60)

SR IPE PHYSICS

Revised Edition 23 - 24

CHAPTER WISE WEIGHTAGE AS PER BIE

VERY SHORT ANSWER QUESTIONS (2MARKS)		***SHORT ANSWER QUESTIONS (4MARKS)***	
1. RAY OPTICS	2 M	1. RAY OPTICS	4 M
2. MOVING CHARGES AND MAGNETISM	2 M	2. WAVE OPTICS	4 M
3. MAGNETISM AND MATTER	(2+2) M	3. ELECTIRIC FIELDS & CHARGES	4 M
4. ALTERNATING CURRENT	2 M	4. ELECTRIC POTENTIAL & CAPITANCE	4 M
5. ELECTROMAGNETIC WAVES	2 M	5. MOVING CHARGES AND MAGNETISM	4 M
6. DUAL NATURE OF RADIATION & MATTER	(2+2)M	6. ELECTRO MAGNETIC INDUCTION	4 M
7. SEMI CONDUCTORS	2 M	7. ATOMS	4 M
8. COMMUNICATION SYSTEM	2 M	8. SEMI CONDUCTORS	4 M
GRAND TOTAL	20 M	GRAND TOTAL	32 M

LONG ANSWERS QUESTIONS	
1. WAVES	8 M
2. CURRENT ELECTRICITY	8 M
3. NUCLEAR PHYSICS	8 M
GRAND TOTAL	24 M

Name:......................

Class:......................

College:.................

IPE – JUNE 2023 (TS)

I SECTION – A (10X2=20)

1. Mention the basic methods of modulation.
2. Define 'Power' of a convex lens. What is its units.
3. Draw the circuits symbols for p-n-p and n-p-n transistors.
4. Distinguish between ammeter and voltmeter.
5. What is 'Work function'?
6. Magnetic lines form continuous closed loops. Why?
7. Write down Einstein's photoelectric equation..
8. Define magnetic declination.
9. Define power factor. On which factors does power factor depend?
10. The charging current for a capacitor is 0.6 A. what is the displacement current is across its plates.

II SECTION – B (6X4=24)

11. State and explain Coulomb's inverse square law in electricity.
12. What are the limitations of Bohr's theory of hydrogen atom?
13. With a neat labeled diagram explain the formation of image in a simple microscope.
14. Derive an expression for the capacitance of a parallel plate capacitor.
15. Distinguish between half – wave and full – wave rectifier.
16. Derive an expression for the magnetic dipole moment of a revolving electron.
17. Explain Doppler Effect in light. Distinguish between red shift and blue shift..
18. Obtain an expression for the emf induced across a conductor which is moved in a uniform magnetic field which is perpendicular to the plane of motion.

III SECTION – C (2X8=16)

19. Explain the principle and working of a nuclear reactor with the help of a labelled diagram?
    Calculate the energy equivalent of 1 gr of substance.
20. Explain the formation of stationary waves in an air Column enclosed in open pipe. Derive the equation for the frequencies of the harmonics produced.
21. State Kirchhoff's law for an electrical network. Using these laws deduce the condition for balance in a Wheatstone bridge.

IPE – MARCH 2023 (TS)

I SECTION – A (10X2=20)

1. What is principle of moving coil galvanometer.?
2. Define magnetic inclination or angle of dip.
3. A small angled prism of 4^0 deviates a ray through 2.48^0. Find the refractive index of the mirror.
4. Classify the following materials with regard to magnetism: Manganese, Cobalt, Nickel, Bismuth, Oxygen, and Copper.
5. What is important fact did Millikan's experiment establish?
6. A transformer converts 200V ac into 2000V ac. Calculate the number of turns in the secondary if the primary has 10 turns.
7. If the wavelength of electromagnetic radiation is doubled, what happens to the energy of photon?
8. Give an example of photo sensitive substances. Why they are called so?
9. What is sky wave propagation?
10. Write the truth table of NAND gate. How does it differ from AND gate?

II SECTION – B (6X4=24)

11. Distinguish between half – wave and full – wave rectifier
12. Describe the ways in which Eddy currents are used to advantage.
13. Write a short note on De Broglie's explanation of Bohr's second postulate of quantization.
14. Derive an expression for the magnetic dipole moment of a revolving electron.
15. Define critical angle. Explain total internal reflection using a neat diagram.
16. Explain Doppler Effect in light. Distinguish between red shift and blue shift..
17. Derive an expression for the capacitance of a parallel plate capacitor.
18. State Gauss's law in electrostatics and explain its importance.

III SECTION – C (2X8=16)

19. How are stationary waves formed in closed pipes? Explain the various modes of vibrations and relations for their frequencies
    A closed organ pipe 70cm long is sounded. If the velocity of sound is 331m/s , what is the fundamental frequency of vibration of the air column ?
20. What is radioactivity? State the law of radioactive decay. Show that radioactive decay is exponential in nature.
    The half-life radium is 1600 years. How much time does 1g of radium take to reduce to 0.125g?
21. State Kirchhoff's law for an electrical network. Using these laws deduce the condition for balance in a Wheatstone bridge.

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2. RAY OPTICS

1. A small angled prism of 4^0 deviates a ray through 2.48^0. Find the refractive index of the mirror.

A. $D_m = A(\mu - 1)$ $\quad A = 4^0, \quad D_m = 2.48^0$

$$(\mu - 1) = \frac{D_m}{A} = \frac{2.48^0}{4} = 0.62$$

$$(\mu - 1) = 0.62 \Rightarrow \mu = 1 + 0.62 \Rightarrow \mu = 1.62$$

2. What is myopia? How can it be corrected?

A. Myopia (or) Nearsightedness: The defect of the eye lens to form the image **in front of the retina.**
It is corrected by using **concave lens.**

3. What is hypermetropia? How can it be corrected?

A. Hypermetropia (or) Farsightedness: The defect of the eye lens to form the image **behind the retina.**
It is corrected by using **convex lens.**

4. What is 'dispersion'? Which colour gets relatively more dispersed?

A. Dispersion: Splitting of white light into its seven colours, is called dispersion.
Violet colour is more dispersed.

5. Define 'power' of a convex lens. What is its units?

A. Power of a lens: Reciprocal of the focal length is called power of lens.
Units : Dioptre(D)

6. A concave mirror produces an image of a long vertical pin, placed 40cm from the mirror, at the position of the object. Find the focal length of the mirror.

A. u = - 40cm, $\quad$ v = - 40cm, $\quad \frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$$\frac{1}{f} = -\frac{1}{40} - \frac{1}{40} \quad \frac{1}{f} = -\frac{2}{40} = \frac{1}{20} \Rightarrow f = -20\text{cm.}$$

7. MOVING CHARGES & MAGNETISM

7. What is the importance of Oersted's experiment?

A. Every current carrying conductor produces a magnetic field around it and which is perpendicular to current carrying conductor.

8. What is the smallest value of current that can be measured with a moving coil galvanometer?

A. It is used to measure very small current upto 10^{-9}A

9. How do you convert a moving coil galvanometer into an ammeter?

A. A **low** resistance is connected in **Parallel** to it.

10. How do you convert a moving coil galvanometer into a voltmeter?

A. A **high** resistance is connected in **Series** to it.

11. Distinguish between ammeter and voltmeter.

Ammeter	Voltmeter
It used to measure current	It is used measure P.D Between two points.
Resistance of an ideal Ammeter is zero.	Resistance of an ideal Voltmeter is infinity
It is connected in series in the circuits.	It is connected in parallel in the circuit

12. A circular coil of radius 'r' having N turns carries a current 'i'. What is its magnetic moment?

A. Magnetic moment $(M) = N\,i\,A \qquad (A = \pi r^2)$
$(M) = N\,i\,(\pi r^2)$

13. What is principle of moving coil galvanometer.

A. Deflection produced in current carrying coil placed in uniform magnetic field is directly proportional to current.

$$(Deflection\ angle)\ \alpha\ (Current\ in\ the\ Coil)$$

8. MAGNETISM AND MATTER

14. What happens to compass needles at the Earth's pole?

A. At pole $\theta = 90^0$, $B_H = B\cos 90^0 = 0$
it may point out in any direction. **Dip Needle.**

15. What are the units of magnetic moment, magnetic induction and magnetic field?

A. 1) Magnetic moment : **Am^2**
2) Magnetic induction : **Tesla (or) Wb m^{-2}**
3) Magnetic field : **Tesla**

16. Define magnetic inclination or angle of dip.

A. The angle between the direction of earth's magnetic field(B_E) and direction of Horizontal magnetic field(B_H) is called magnetic inclination or angle of dip.

17. Classify the following materials with regard to magnetism: Manganese, Cobalt, Nickel, Bismuth, Oxygen, and Copper.

A. Dia magnetic: Bismuth, Copper
Para magnetic: Manganese, Oxygen
Ferro magnetic: Nickel, Cobalt

18. Magnetic lines form continuous closed loops. Why?

A. Since, isolated magnetic poles do not exists.

19. Define magnetic declination.

A. The angle between magnetic meridian and geographical meridian is called angle of declination

20. What is the magnetic moment associated with a solenoid?

A. **M = N i A** $\qquad$ M = (Total no.of turns)(current)(area)

21. What do you understand by the 'magnetization' of a sample?

A. The magnetic moment per unit volume is called magnetization. $\left[\textbf{Magnetization(I)} = \frac{\textbf{Magnetic moment}}{\textbf{Volume}}\right]$

S.I Units magnetization is A/m.

11. ELECTROMAGNETIC WAVES

22. If the wavelength of electromagnetic radiation is doubled, what happens to the energy of photon?

A. $E \propto \frac{1}{\lambda}, \frac{E_2}{E_1} = \frac{\lambda_1}{\lambda_2}, \frac{E_2}{E_1} = \frac{\lambda}{2\lambda}, \quad E_2 = \frac{E}{2}$

23. Give any two uses of infrared rays.

A. 1)Solar water heaters.2)To take Photo in fogconditions.

24. What are the applications of microwaves?

A. 1) Micro wave ovens 2) Aircraft navigation.

25. What is the principle of production of electromagnetic waves?

A. An accelerated charges produces an E.M. wave.

26. Microwaves are used in Radars, why?

A. Due to short wavelengths, it is easily penetrate the earth's atmosphere. for space vehicle communication

27. What is the average wavelength of X – rays?

A. Range 10nm to 10^{-4}nm.

$$Average = \frac{(10 + 10^{-4})}{2} nm = 5.00005 nm.$$

28. What is the ratio of speed of infrared rays and ultraviolet rays in vacuum?

A. The ratio of speed is **1:1,**
Speed of EM waves = **$3x10^8$m/s**

29. Define power factor. On which factors does power factor depend?

A. Average power lost over cycle is given by
$P = VICos\emptyset$,. $Cos\emptyset$ is called power factor.
It is depends on Voltage (V), current (i), & phase($\emptyset$) .

12. DUAL NATURE OF RADIATION & MATTER

30. What are "cathode rays"?

A. A stream of fast moving electrons are called cathode rays

31. What is "work function"

A. The minimum energy required to escape from the metal surface is called work function.

32. What is "photoelectric effect"?

A. Eemission of electrons from a metal surface when suitable frequency of light falls on it is called photo electric effect.

33. Write down Einstein's photoelectric equation.

A. $h\vartheta = W_{\emptyset} + KE_{max}$ $h\vartheta \rightarrow$ Energy of Photon

$W_{\emptyset} \rightarrow$ Work function, $KE_{max} \rightarrow$ Kinetic energy

34. Write down deBroglie's relation and explain the terms therein.

A. The debroglie wavelength associated with a material particle is given by $\boldsymbol{\lambda} = \frac{h}{p} = \frac{h}{mv}$ where 'h' is plank's constant. P : momentum, m : mass of electron, v: velocity

35. State Heisenberg' Uncertainty Principle.

A. It is impossible to measure the both the position and momentum of a particle simultaneously to any desire degree of accuracy. $\Delta p\, \Delta x \approx h$

36. Give an example of photo sensitive substances. Why they are called so?

A. **Example :-** Li, Na, K, Zn, Cd, Mg etc

Their work function is low, They emit the photo electrons

37. What is important fact did Millikan's experiment establish?

A. Charge Present on a body is equal to integral multiple of an electron $\mathbf{Q = \pm ne}$

16. COMMUNICATION SYSTEMS

38. What are the basic blocks of a communication system?

A. 1) Transmitter. 2) Receiver. 3) Channel.

39. What is "World Wide Web" (WWW)?

A. It is an encyclopedia of knowledge accessible to everyone round the clock through inter net.

40. Mention the Frequency range of speech signals.

A. Speech signals frequency range is 300Hz to 3100Hz.

41. What is sky wave propagation?

A. The propagation in which the waves of range a few 1MHz to 30MHz are received due to total internal reflection takes place at ionosphere is called sky wave propagation.

42. Mention various parts of the ionosphere?

A. D layer (Part of stratosphere),E layer (Part of stratosphere) F_1layer (Part of mesosphere),F_2layer (Part of thermosphere

43. Define modulation. Why is it necessary?

A. **Modulation:** The process of combining low frequency audio signal with high frequency audio signals is called modulation

Necessary of Modulation:

1) To reduce size of the antenna.

2) To avoid mixing signal from different transmitter's.

44. Mention Basic methods of modulation.

A. **1)** Amplitude modulation (AM)

2) Frequency modulation (FM), **3)** Phase modulation (PM).

45. Which type of communication is employed in mobile phones?

A. Wireless communication (Space wave)

46. What is meant by wattles component of current?

A. The component of current which does not useful work in an A.C circuit is called wattles current

10. ALTERNATING CURRENT

47. A transformer converts 200V ac into 2000V ac. Calculate the number of turns in the secondary if the primary has 10 turns.(IMP)

$$\frac{N_S}{N_P} = \frac{V_S}{V_P} \Rightarrow \frac{N_S}{10} = \frac{2000}{200} \Rightarrow N_S = 100$$

48. What type of transformer is used in a 6V bed lamp?

A. Step down transformer is used in 6V bed lamp.

49. What is the phenomenon involved in the working of a transformer?

A. Transformer works on the principle of mutual induction.

50. Write the expression for the reactance of i) an inductor and ii) a capacitor.

A. **1)** $(X_L) = \omega L$, **2)** $(X_C) = \frac{1}{\omega C}$

51. When does a LCR series circuit have minimum impedance?

A. At resonance $\mathbf{X_L}$=$\mathbf{X_C}$ and **Z** minimum.

15. SEMICONDUCTOR ELECTRONICS

52. What is a p-type semi conductor? What is the majority and minority charged carriers in it?

A. If a trivalent impurity is added to a tetravalent semiconductor is called p-type semiconductor.

majority charge carriers are **holes.**

minority charge carriers are **electrons.**

53. What is an n-type semi conductor? What is the majority and minority charged carriers in it?

A. If a pentavalent impurity is added to a tetravalent semiconductor is called n-type semiconductor.

majority charge carriers are **electrons.**

minority charge carriers are **holes.**

54. What are intrinsic and extrinsic semiconductors?

A. Pure form of semiconductors is called intrinsic semiconductors.

When impure atoms are added to increase their conductivity, they are called extrinsic semiconductors.

55. What is a p-n junction diode? Define depletion layer.

A. The junction formed with two electrodes when **P-type** and **N-type** semiconductor are joined is called p-n junction diode.

Depletion layer: The narrow region on either side of the junction, due to immobile charge carries is called depletion layer.

56. Which gates are called universal gates?

A. NAND gates and NOR gates are called universal gates.

57. What is Zener voltage (V_Z) and how will a Zener diode be connected in circuits generally?

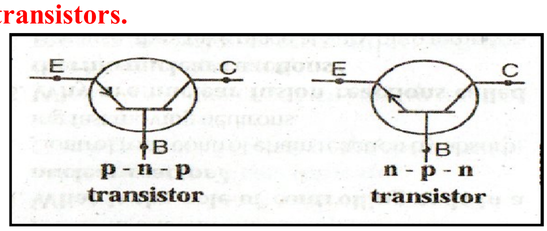
A. Reverse bias voltage at which resistance becomes zero and current increases suddenly is called Zener Voltage. Zener diode always connected in reverse bias.

58. Define amplifier and amplification factor.

A. **Amplifier:-** The device used for raising the strength of a weak signal is known as amplifier.

Amplification factor: - The ratio of output power to input power is called amplification factor.

59. Draw the circuit symbols for p-n-p and n-p-n transistors.

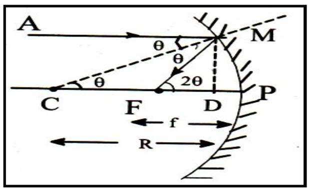


2. Ray Optics (4 Marks)

1. *Define focal length of a concave mirror. Prove that the radius of curvature of a concave mirror is double its focal length.*

A. **focal length*:*** The distance between the focus (F) and the pole(P) of the mirror is called the focal length.

Consider a ray parallel to the principal axis striking the mirror at M get reflected passing through the focus (F). The line CM is perpendicular to the mirror



Let ' θ ' be the angle of incidence, $\angle AMC = \angle MCP$

Draw MD⊥ CP

The right angled Δ^{le} MCD $\tan\theta = \dfrac{MD}{CD} --- (1)$

The right angled Δ^{le} MFD $\tan 2\theta = \dfrac{MD}{FD} --- (2)$

Dividing eq(2) by eq(1)

$$\frac{\tan 2\theta}{\tan\theta} = \frac{\left(\frac{\cancel{MD}}{FD}\right)}{\left(\frac{\cancel{MD}}{CD}\right)} = \frac{CD}{FD} ------ (3)$$

If is ' θ ' very small, $\tan\theta \approx \theta$ and $\tan 2\theta \approx 2\theta$

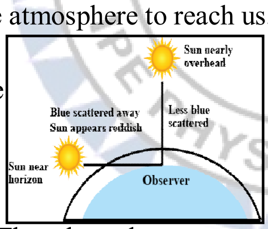
M lies very close to 'P' CD = CP and FD = FP

From eq^n $\dfrac{2\cancel{\theta}}{\cancel{\theta}} = \dfrac{CP}{FP} = \dfrac{R}{f} \Rightarrow 2 = \dfrac{R}{f} \Rightarrow \boxed{R = 2f}$

Radius of curvature is equal to double of its focal length.

2. *Why does the setting sun appear red?*

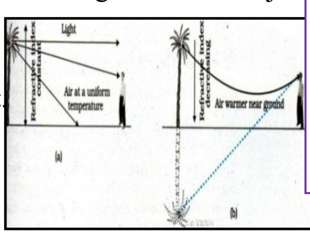
A. Sunlight passes through the atmosphere before it reaches us. Sun light is composed of seven colors (VIBGYOR) in the evenings, where the sun is near the horizon. The rays have to travel longer path in the atmosphere to reach us. The dust, smoke and water vapor present in the atmosphere deviate away these colors differently depending in their wavelengths. As red has longer wavelength, it is less deviated. Thus the red comes to straight while other colors get deviated into space. That's why setting sun appears red.



3. *Explain the formation of a mirage*

A. **Mirage:** Mirage is an optical phenomenon in which light rays are bent to produce a displaced image of distant object is called mirage.

1. Mirage are formed due to total internal reflection of light.
2. On hot summer days the density of air is less near the ground due to heat.



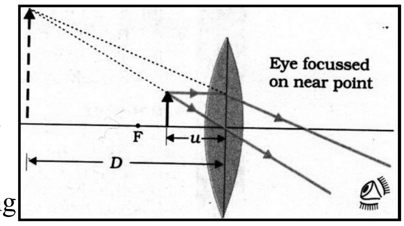
3. Hotter air is less dense and smaller refractive index than cooler air.
4. In the air is still, the optical density at different layers of air increases with height.
5. Hence the light rays coming from a tall body such as tree, bends away from normal and under goes total internal reflection.

4. *With a neat labeled diagram explain the formation of image in a simple microscope.*

A. **Simple Microscope:** A simple microscope consists of only one convex lens of small focal length.

It is also called as magnifying glass.

In this, the object is placed between the principal focus F and the optic center of the convex lens



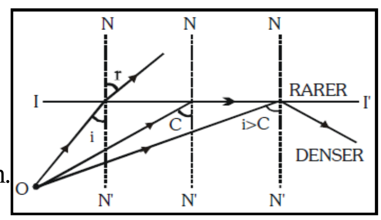
The light ray coming from the object parallel to principal axis refracts at lens and passes through second principal focus **F$^{|}$**. Another light ray from the object passes through the optic of the lens undeviated. These two rays meet on the back side of the object to form the image. Hence, the image formed is virtual. Erect and magnified.

5. *Define critical angle. Explain total internal reflection using a neat diagram.*

A. **Critical angle*:*** when light ray travels from denser medium to rarer medium, the angle of incidence, for which angle of refraction is 90^0 is called critical angle.

Total internal reflection*:* when a light ray travels from denser to rarer medium, the angle of incidence is greater than the critical angle, then it reflects into the same medium is called total internal reflection.

Explanation*:* Consider an object in the denser medium. A ray incident on **II^1** surface bends away from the perpendicular. As the angle of incidence is increased, the angle of refraction goes on increasing. For certain angle of incidence, the refracted ray parallel to **II^1** surface (90^0) When the angle of incidence is further increased, the ray is not refracted but is totally reflected back into the same medium. This phenomenon is called total internal reflection.



6. *Explain the formation of rainbow.*

A. **Rainbow*:*** The multicolored arc that appears in the sky, opposite to sun on a rainy day is called rainbow. Rainbow is the combined effect of Dispersion, Refraction and total internal reflection of sunlight by spherical water droplets of rain in atmosphere. The water drops in atmosphere act as small prisms and cause of dispersion and total internal reflection of sunlight to form rainbow.

The primary rainbow is a 3 step process.

1) The sunlight is first refracted as it enters a rain drop, which causes different colors.

2) These refracted rays strike the inner surface of the drop and get internally reflected

3) These internally reflected rays again get refracted at the opposite surface and come out. As red is less deviated, it comes straight to observer and appears at top. As violet is more deviated, it comes from lower level drops and appears at bottom.

The secondary rainbow is also formed due to double internal reflection of sunlight in the rain drops.

7. *Explain Doppler Effect in light. Distinguish between red shift and blue shift.*

A. **Doppler Effect in light*:*** the change in the apparent frequency of light, due to relative motion between source of light and observer. This phenomenon is called Doppler shift in light.

Red shift*:* When source and observer away from each other apparent frequency decreases or apparent wave length increases this is called red shift.

Blue shift*:*, When source and observer approach each other apparent frequency increases or apparent wave length decreases this is called blue shift.

8. *How do you determine the resolving power of your eye?*

A. **Resolving Power of Eye*:*** The power of instrument to produce separate images of two objects lying closer to each other is called resolving power.

1) Let us take a pattern of black strips of equal width separated by white stripes of increasing width from the left to right on a wall at a height of eye.

2) By moving away or closer to the wall, find the position where we can just see some two black strips as separate strips with one eye.

3) All the black strips would merge into one another and would not be distinguishable.

4) If 'd' is the width of the white stripe which is separates to the two regions and 'D' is the distance between the eye and the wall, the resolving power of the eye is given by d/D.

9. *Does the principle of conservation of energy hold for interference and diffraction phenomena? Explain briefly*

A. **1) Yes,** law of conservation of energy is obeyed.

2) Pattern of bright and dark fringes are formed in interference and diffraction.

3) These patterns obey the principle of conservation of energy

4) In interference and diffraction, light energy is redistributed.

5) If it decreases in one region producing a dark fringe. It increases in another region producing bright fringe.

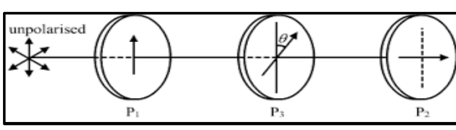
6) Thus there is no gain or loss of energy.

10. *Discuss the intensity of transmitted light when a Polaroid sheet is rotated between two crossed Polaroid's.*

A. Let I_0 be the intensity of polarized light after passing through the first polarizer P_1. Then the intensity of light after passing through second polarizer P_2 will be

$I = I_0 \cos^2\theta$

Where θ is the Where θ is the angle between



passing axes P_1 and P_2 since P_1 and P_2 are crossed the angle between the pass axes of P_2 and P_3 will be $\left[\frac{\pi}{2} - \theta\right]$

Hence the intensity of light emerging from P_3 will be

$$I = I_0 \cos^2\theta \,.\cos^2\left[\frac{\pi}{2} - \theta\right]$$

$$I = I_0 \cos^2\theta \,.\sin^2\theta$$

$$I = \frac{I_0}{4}\sin^2 2\theta$$

The transmitted intensity will be maximum when $\theta = \frac{\pi}{4}$

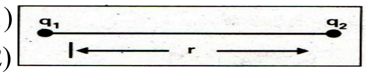
11. *State and explain Coulomb's inverse square law in electricity.*

A. **Coulomb's law :** The force of attraction between two electric charges is directly proportional to product of their charges and is inversely proportional to the square of distance between them and acts along the line joining the charges.

Explanation: The force between two charges q_1 and q_2 are separated by a distance 'r' is given by

$F \propto q_1\, q_2$ .... (1)

$F \propto \frac{1}{r^2}$ .... (2)



From (1) and (2) we get $F \propto \frac{q_1\, q_2}{r^2}$

$$F = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{q_1\, q_2}{r^2}$$

Where ε_0 is the permittivity of free space and

$\left(\frac{1}{4\pi\varepsilon_0}\right) = 9X10^9 Nm^2C^{-2}$

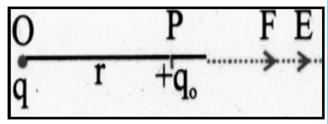
$$F = (9X10^9)\,\frac{q_1\, q_2}{r^2}$$

12. *Define intensity of electric field at a point. Derive an expression for the intensity due to a point charge.*

A. **Intensity of Electric field (E):** The force acting per unit positive charge is called intensity of electric field.

Derivation: Let 'P' be a point at a distance '**r**' from Point charge '**q**' at a point '**O**'.

The force $F = \dfrac{1}{4\pi\varepsilon_0}\dfrac{qq_0}{r^2}$



The force acting on a unit positive at 'P' due to 'q' is

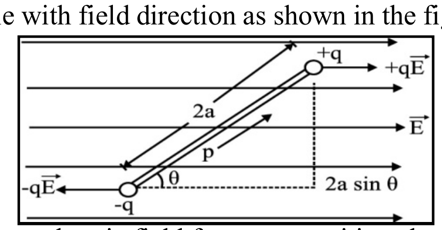
From the definition $E = \dfrac{F}{q_0} = \dfrac{1}{q_0}\left(\dfrac{1}{4\pi\varepsilon_0}\dfrac{qq_0}{r^2}\right)$

$$E = \left(\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\right)$$

13. *Derive the equation for the couple acting on a electric dipole in a uniform electric field.*

A. **Dipole*:*** A pair of equal and opposite charges separated by a distance (2a) is called dipole.

It is placed in a uniform electric field E. making an angle with field direction as shown in the figure.



Due to electric field forces on positive charge (+q) is F = +qE and force on negative charge F = -qE.

These two equal and opposite charges constitute torque (or) moment of couple.

Torque = Force X Perpendicular distance

$$\tau = (qE)(2a\sin\theta)$$

$$\tau = 2aq.E\sin\theta$$

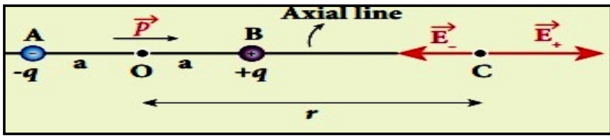
Dipole moment P = q X 2a = 2aq

$$\tau = PE\sin\theta$$

In vector form $\tau = P\,X\,E$

14. *Derive an expression for the intensity of the electric field at a point on the axial line of an electric dipole.*

A. **Electric** field at an axial point of an electric dipole. As shown in figure. Consider an electric dipole consisting of charge –q and +q separated by distance 2a and placed in vacuum. Let P be a point on the axial line at distance r from the center O



Electric field due to charge –q at a point P is

$$E_{-q} = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{-q}{(r+a)^2}$$

Electric field due to charge +q at a point P is

$$E_{+q} = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{+q}{(r-a)^2}$$

Hence the resultant electric field at a point P is

$$E_{axial} = E_{+q} + E_{-q}$$

$$= \left(\frac{q}{4\pi\varepsilon_0}\right)\left[\frac{1}{(r-a)^2} - \frac{1}{(r+a)^2}\right]$$

$$= \left(\frac{q}{4\pi\varepsilon_0}\right)\left[\frac{(r+a)^2-(r-a)^2}{(r^2-a^2)^2}\right] = \left(\frac{q}{4\pi\varepsilon_0}\right)\left[\frac{4ra}{(r^2-a^2)^2}\right]$$

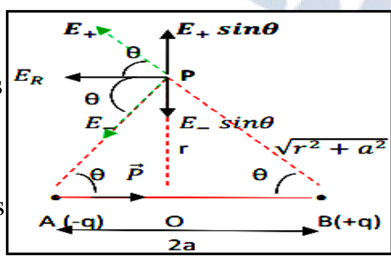
$$= \left(\frac{1}{4\pi\varepsilon_0}\right)\left[\frac{2pr}{(r^2-a^2)^2}\right] \text{ Here } (P = q \times 2a)$$

If r >> a, a^2 can be neglected compared to r^2

$$\boxed{E_{axial} = \left(\frac{1}{4\pi\varepsilon_0}\right)\left[\frac{2p}{r^3}\right]}$$

15. *Derive an expression for the intensity of the electric field at a point on the equatorial line of an electric dipole.*

A. Electric field at an equatorial point of an electric dipole. As shown in figure. Consider an electric dipole consisting of charge –q and +q separated by distance 2a and placed in vacuum. Let P be a point on the equatorial line at distance r from the center O



Electric field due to charge –q at a point P is

$$E_{-q} = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{-q}{r^2+a^2}$$

Electric field due to charge +q at a point P is

$$E_{+q} = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{+q}{r^2+a^2}$$

Clearly the magnitude ofE_{+q} and E_{-q} perpendicular to the dipole axis will cancel out. The components parallel to the dipole axis will add up. The total electric field is opposite to $E_{equs} = -(E_{+q}\cos\theta + E_{+q}\cos\theta)$

$$= -2E_{+q}\cos\theta$$

$$= -2.\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{+q}{r^2+a^2}.\frac{a}{\sqrt{r^2+a^2}} \quad \text{Here } (P = q \times 2a)$$

$$= -\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{P}{(r^2+a^2)^{3/2}}$$

If r >> a, a^2 can be neglected compared to r^2

$$\boxed{E_{equa} = -\left(\frac{1}{4\pi\varepsilon_0}\right)\left[\frac{p}{r^3}\right]}$$

16. *State Gauss's law in electrostatics and explain its importance.*

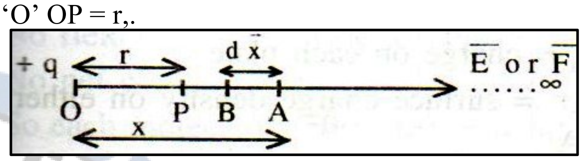
Gauss' law*:* The total electric flux through any closed surface is equal to $\frac{1}{\epsilon_0}$times the net charge enclosed by The surface $\boxed{\text{Total electric flux } \oint_s E.ds = \frac{q}{\varepsilon_0}}$

Importance of Gauss' Law*:*

1) Valid for closed surface any shape and size.
2) Gives the relation for between the electric field and the charge.
3) Applicable to any distribution of charge with in the closed surface.

17. *Derive an expression for the electric potential due to a point charge.*

A. Consider a point charge +Q at point on 'O' in free space. Let us find electric potential at point 'P' due to charge +q. let 'r' be the position vector of 'P' from 'O' OP = r,.



Consider point A having distance '*x*' with respect to the point 'O'. the electric field intensity at that point

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{x^2}$$

Total amount of work done (W) in bringing unit positive charge from infinite ∞ to r.

$$W = \int_\infty^r dw = -\int_\infty^r E.dx = -\int_\infty^r \frac{1}{4\pi\varepsilon_0}\frac{Q}{x^2}.dx$$

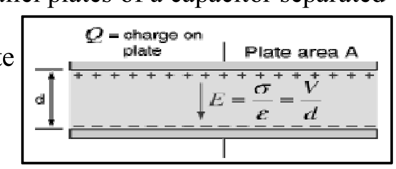
$$= -\frac{Q}{4\pi\varepsilon_0}\int_\infty^r \frac{1}{x^2}.dx = -\frac{Q}{4\pi\varepsilon_0}\left[-\frac{1}{x}\right]_\infty^r$$

$$W = -\frac{Q}{4\pi\varepsilon_0}\left[-\frac{1}{x}\right]_\infty^r = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{r}-\frac{1}{\infty}\right]$$

$$= \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{r}-\frac{1}{\infty}\right] \Rightarrow \boxed{V = \left(\frac{1}{4\pi\varepsilon_0}\right)\left(\frac{Q}{r}\right)}$$

18. *Derive an expression for the capacitance of a parallel plate capacitor.*

A. P and Q are two parallel plates of a capacitor separated by a distance of d. The area of each plate is A. The plate P is charged and Q is earth connected.



The charge on P is +q and surface charge density

$$\sigma = \frac{q}{A} \text{..........(1)}$$

The electric field due to charge +q is $= \frac{\sigma}{2\epsilon_0}$

The electric field due to charge - q is $=-\frac{\sigma}{2\epsilon_0}$

Resultant field.

$$E = \frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0} = 2.\frac{\sigma}{2\epsilon_0} = \frac{\sigma}{\epsilon_0} \text{.......... (2)}$$

Relation between 'V' and 'E'

V = Ed.........(3)

$V = \frac{\sigma}{\epsilon_0}.d = \frac{q}{\epsilon_0 A}.d$ But captaincy $C = \frac{q}{V}$

Captaincy of the parallel plate capacitor is given by

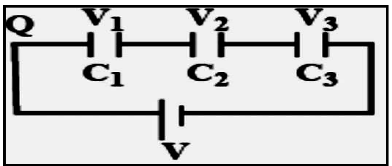
$$C = \frac{\epsilon_0 A}{d}$$

19. *Explain series combination of capacitors. Derive the formula for equivalent capacitance in each combination.*

A. **Series combination:** In series combination first capacitor second plate is connected to second capacitor first plate and second capacitor second plate is connected to third capacitor first plate and so on first capacitor first plate and last capacitor second plate is connected to opposite terminals of a battery

1) In series combination the **charge** on each capacitor will be **same** but **potential** is **different**.

$V = V_1 + V_2 + V_3$



But $V = \frac{q}{C}$, $V_1 = \frac{q}{C_1}$, $V_2 = \frac{q}{C_2}$, and $V_3 = \frac{q}{C_3}$,

$$V = \frac{q}{C_1} + \frac{q}{C_2} + \frac{q}{C_3} = q\left[\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right]$$

$$\frac{\cancel{q}}{C} = \cancel{q}\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

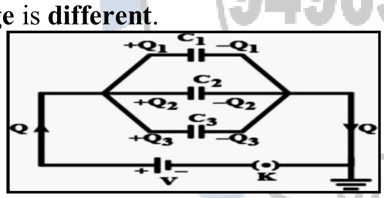
$$\boxed{\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

20. *Explain parallel combination of capacitors. Derive the formula for equivalent capacitance in each combination.*

Parallel combination: If the first plates of all the capacitors connected to common terminal and second plates of all the capacitors connected to common terminal and these terminals are connected to opposite terminals of the battery.

1) In parallel combination the **potential** on each capacitor will be **same** but **charge** is **different**.

$q = q_1 + q_2 + q_3$



But $q = CV$, $q_1 = C_1V$, $q_2 = C_2V$, and $q_3 = C_3V$

$$q = C_1V + C_2V + C_3V$$

$$q = V(C_1 + C_2 + C_3)$$

$$C\cancel{V} = \cancel{V}(C_1 + C_2 + C_3)$$

$$\boxed{C = C_1 + C_2 + C_3}$$

21. *State and explain Ampere's law.* (7. CHAPTER)

A. **Ampere's law:** The line integral of the intensity of magnet field around closed path is equal to μ_0 times the net current enclosed by the path. $\oint \vec{B}\,\vec{dl} = \mu_0 i$

Proof: Consider a long straight conductor carrying current 'i'. Magnetic field at a distance 'r' from the conductor is given by. $dB = \frac{\mu_0}{2\pi}\frac{(i)}{r}$

The value 'B' is parallel to 'dl' $\theta = 0^0 \Rightarrow \cos 0^0 = 1$

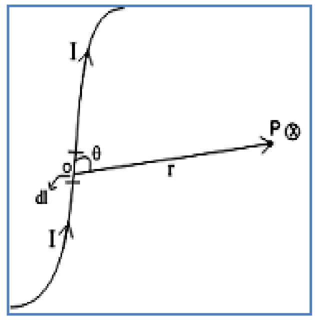
$$\oint \vec{B}.dl = \oint \vec{B}.dl \cos 0^0 = \oint \vec{B}.dl$$

$$\vec{B}\int dl = B(2\pi r) \qquad \left(\int dl = 2\pi r\right)$$

$$\int B.dl = \frac{\mu_0}{2\pi}\frac{(i)}{r}x(2\pi r) \Rightarrow \boxed{\int B.dl = \mu_0 i}$$

22. *State and explain Biot-Savart law.*

A. Consider a very small element of length dl of a conductor carrying current (i). Magnetic induction due to small element at a point P distance r form the element.



Magnetic induction dB is directly proportional to current (i).

dB $\propto$ (i)………… (1)

Magnetic induction dB is directly proportional to Length of the element (dl).

dB $\propto$ dl………… (2)

Magnetic induction dB is directly proportional to sine angle between r and dl and.

dB $\propto$ sin θ…….. (3)

Magnetic induction dB is inversely proportional to the square of the distance from small element to point P

dB $\propto \frac{1}{r^2}$………… (4)

From (1), (2), (3) and (4) $\quad dB \propto \frac{(i)(dl)(\sin\theta)}{r^2}$

$dB = \frac{\mu_0}{4\pi}\frac{(i)(dl)(\sin\theta)}{r^2}$ $\quad$ **μ_0 :** Permeability in free space.

$\frac{\mu_0}{4\pi} = 10^{-7}$ Wb m^{-1} A^{-1}

$$\boxed{\text{In Vector form } dB = \frac{\mu_0}{4\pi}\frac{i.dl\left(d\vec{l} \times \vec{r}\right)}{r^3}}$$

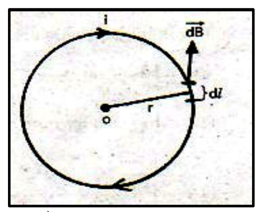
23. *Derive an expression for the magnetic field at the center of a current carrying circular coil using Biot-Savart law.*

A. Consider a circular coil of radius 'r' and carry a current 'i'. Consider a small element 'dl'. Let 'O' is the center of the coil. By using Biot-Savart Law.

From Biot-savart law $dB = \frac{\mu_0}{4\pi}\frac{i.dl.\sin\theta}{r^2}$

As dl is perpendicular to 'r' $\theta = 90^0 \Rightarrow \sin 90^0 = 1$

$$dB = \frac{\mu_0}{4\pi}\frac{i.dl}{r^2}$$



$$\text{Now } \int dB = \int \frac{\mu_0}{4\pi}\frac{i.dl}{r^2}$$

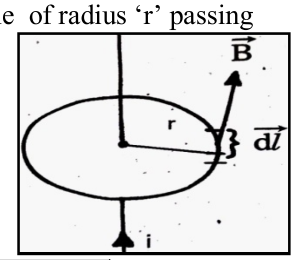
$$B = \frac{\mu_0}{4\pi}\frac{i}{r^2}\int dl$$

$$B = \frac{\mu_0}{\cancel{4\pi}}\frac{i}{\cancel{r^2}}\left(\cancel{2\pi}\cancel{r}\right) \qquad \left(\therefore \int dl = 2\pi r\right)$$

$\boxed{B = \frac{\mu_0}{2}\frac{i}{r}}$ If the circular coil has 'N' turn $\boxed{B = \frac{\mu_0}{2}\frac{Ni}{r}}$

24. *Find the magnetic induction due to a long current carrying a conductor.*

Let 'P' be a point at a distance 'r' from the long straight conductor carrying a current 'i' magnetic induction is same at all points on the circle of radius 'r' passing through a point 'P'



$$\int B.dl = \mu_0 i$$

$$\int \vec{B}.dl \cos 0^0 = \mu_0 i$$

$$\vec{B}\int dl = \mu_0 i$$

$$B(2\pi r) = \mu_0 i$$

$$\boxed{B = \frac{\mu_0}{2\pi}\frac{i}{r}}$$

25. *What is impact parameter and angle of scattering? How are they related to each other?*

A. **Impact parameter (b):** The perpendicular distance of the initial velocity of the alpha-particle from the centre of the nucleus is called "impact parameter"

Angle of Scattering (θ): The angle between the direction of approach and the direction of the scattering of alpha particle is called angle of scattering.

The relation between impact parameter and scattering angle

$$\boxed{b = \frac{1}{4\pi\varepsilon_0} \times \frac{Ze^2}{\left(\frac{1}{2}mv^2\right)} \cot\frac{\theta}{2}}$$

26. *What are the limitations of Bohr's theory of hydrogen atom?*

A. **1.** It could not explain the **fine structure of spectral lines** in hydrogen atom.

2. It could not explain the **wave properties** of electron.

3. It could not explain the **elliptical orbits** because Bohr assumed the circular orbits.

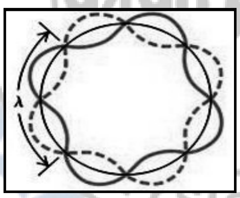
4. It fails in the case of atoms of the elements for Which $Z > 1$.

27. *Write a short note on Debroglie's explanation of Bohr's second postulate of quantization.*

A. Bohr proposed his second postulate as the angular momentum of electron in a stationary orbit is quantized.

$$\boxed{mv_r r_n = \frac{nh}{2\pi}}$$

De Broglie argued that the electron in the stationary orbit acts like a particle wave. As a result it forms stationary waves in the orbit.



The distance travelled by the particle wave along circumference should be equal to integral multiples of wavelength to form stationary waves.

Therefore $2\pi r_n = n\lambda$ for $n = 1, 2, 3\ldots\ldots$

Applying De Broglie hypothesis, we have

$$\lambda = \frac{h}{p} = \frac{h}{mv_n} (P = mv), \quad n\lambda = n\frac{h}{mv_n} (\text{Here } n\lambda = 2\pi r_n)$$

$$2\pi r_n = n\frac{h}{mv_n} \Rightarrow \boxed{\mathbf{mv_r r_n = \frac{nh}{2\pi}}}$$

28. *Describe Rutherford atom model. What are the draw back of this model ?*

A. **Rutherford model of Atom:**

1) Atoms is hollow sphere of radius **10^{-10}m.**

2) Total +Ve charge and mass of the atom is concentrated in a nucleus of radius in the order of **$10^{13}$to 10^{-15}m.**

3) Electrons revolves around the nucleus like planets aroun the sun.

4) Total +Ve charge inside the nucleus is equal to total –Ve charge of revolving electrons around it.

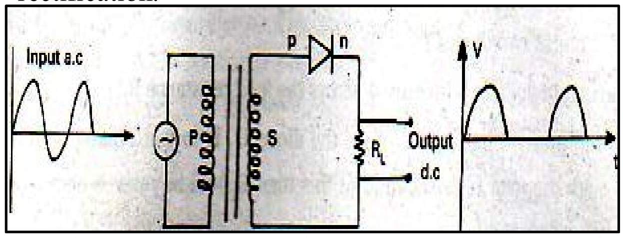
Drawbacks of Rutherford's Model of Atom:

1) As the revolving electron loses energy continuously, it must spiral inwards and finally merge into the nucleus. So atom has to collapse. According to electromagnetic theory it is impossible.

2) It could not explain the line spectra of atoms.

29. *What is rectification? Explain the working of a half wave rectifier.*

A. **Rectification*:*** The process of converting on alternating current into a direct current is called rectification.



1) A half wave rectifier can be constructed with a single diode. The AC input signal is connected to the primary coil of a transformer. The output signal is taken across the load resistance R_L.

2) During **positive** half cycle, the diode is **forward** biased and current flows through the diode.

3) During **negative** half cycle, the diode is **reverse** biased and **no** current flows through the diode.

4) This means current flows through the diode only during positive half cycles and negative half cycles are blocked. Hence in the output we get only half cycles.

5) Rectifier efficiency is defined as the ratio of output dc power to the input ac power.

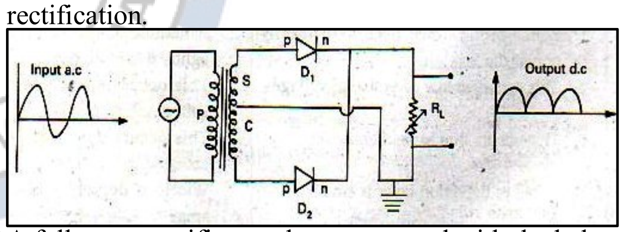
$$\eta = \frac{\text{output D.C power}}{\text{input A.C power}} = \frac{0.406R_L}{r_f + R_L}$$

R_L : Load Resistance. r_f: Forward resistance of diode.

Maximum efficiency of half wave rectifier is 40.6%

30. *What is rectification? Explain the working of a full wave rectifier*

A. **Rectification*:*** The process of converting on alternating current into a direct current is called rectification.



1) A full wave rectifier can be constructed with the help of two diodes $D_1$and D_2.

2) The secondary transformer is centre tapped at C and its ends are connected to the P regions of two diodes D_1 and D_2.

3) The output voltage measured across the load Resistance R_L

4) During positive half cycles of AC, the diode D_1 is forward biased and current flows through the load resistance R_L . At this time D_2 will be reverse biased and will be in switch off position.

5) During Negative half cycles of AC, the diode D_2 is forward biased and current flows through the load resistance R_L . At this time D_1 will be reverse biased and will be in switch off position.

6) Rectifier efficiency is defined as the ratio of output dc power to the input ac power.

$$\eta = \frac{\text{output D.C power}}{\text{input A.C power}} = \frac{0.812R_L}{r_f + R_L}$$

R_L : Load Resistance. r_f: Forward resistance of diode.

Maximum efficiency of full wave rectifier is 81.2%

31. ***Distinguish between half – wave and full – wave rectifier.*** **(SEMI CONDUCTORS)**

Half –Wave rectifier	Full – Wave rectifier
1. Only **one** diode is used	**1. Two** diodes are used
2. The output is **discontinuous**	**2.** The output is **continuous**
3. Efficiency is 40.6%	**3.** Efficiency is 81.2%
4. Efficiency is **Low.**	**4.** Efficiency is **High.**
5. Only one half of the AC input wave is converted as DC output	**5. Both** half of the AC input wave is converted as DC output

32. ***Desscribe the ways in which Eddy currents are used.*** **EMI**

A. **Eddy current:-** The currents produced in large pieces when they are oscillated in magnetic fields are called eddy currents.

ADVANTAGES:-

1.**Magnetic Brakes in trains:** When strong electromagnets are activated, the eddy currents induced in the rails oppose the motion of train. As a result, **smooth breaking effect** comes into play.

2. **Electromagnetic damping:** In galvanometer electromagnetic damping brings the coil to rest quickly. This happens due to eddy currents produced in the core.

3. **Induction Furnace:** A high frequency alternating current is passed through a coil which surrounds the metals to be melted. Then the eddy currents generated in the metals produce high temperatures.

4. **Electric power meter:** The shiny **metal disc** in the electric power meter **rotates due** to eddy currents.

33. ***Derive an expression for the magnetic dipole moment of a revolving electron.*** **7. MOVING CHARGES**

A. Consider an electron revolving in a circular orbit of radius 'r' with speed 'v'.

The time taken by the electron to complete one revolution

$$T = \frac{2\pi r}{V}$$

$$\text{Electric current } (i) = \frac{e}{t} = \frac{eV}{2\pi r}$$

$$\text{Magnetic dipole moment } (M) = \text{NiA}$$

$$M = (1)\left(\frac{eV}{2\pi r}\right)\left(\pi r^2\right)$$

$$M = \frac{evr}{2}$$

34. ***What are the basic components of a cyclotron? Mention its uses?*** **7. MOVING CHARGES**

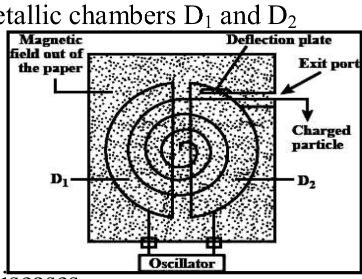
A. **Cyclotron:** Cyclotron is device used to accelerate positively charged particles like protons, deuterons etc.

Two hollow D- shaped metallic chambers D_1 and D_2

High frequency oscillator.

Strong electromagnet.

Vacuum chamber.



Uses:

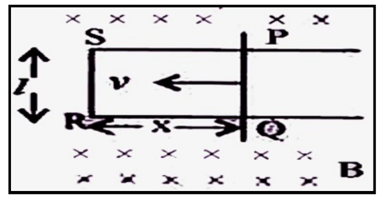
For treatment of chronic diseases.

In detection and construction of nuclei.

35. ***Obtain an expression for the emf induced across a conductor which is moved in a uniform magnetic field which is perpendicular to the plane of motion.***

A. Let conductor PQ is moving with velocity 'v' towards left through a distance 'x' on a rectangular conductor PQRS placed in uniform magnetic field 'B' perpendicularly

The magnetic flux enclosed by the loop PQRS is



$$\varphi_B = Blx$$

From Faraday's law

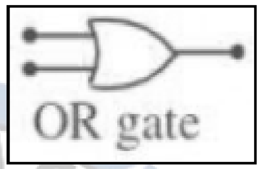
$$\text{emf } (\varepsilon) = -\frac{d}{dt}(Blx)$$

$$\text{emf } (\varepsilon) = -\frac{d}{dt}(Blv)$$

$$\text{Induced emf } (\varepsilon) = -Blv \qquad \left(\frac{dx}{dt} = v\right)$$

36. ***OR, AND, NOT, NAND, and NOR gates.***

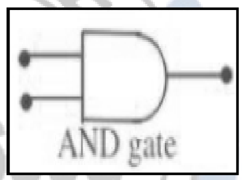
OR GATE



Truth Table for OR gate:

Input A	Input B	Output Y
0	0	0
1	0	1
0	1	1
1	1	1

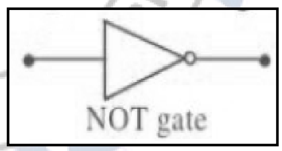
AND GATE



Truth Table for AND gate:

Input A	Input B	Output Y
0	0	0
1	0	0
0	1	0
1	1	1

OR GATE

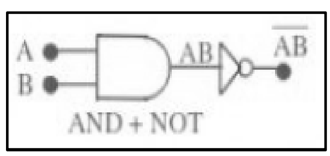


Truth Table for NOT gate:

Input A	Output Q
0	1
1	0

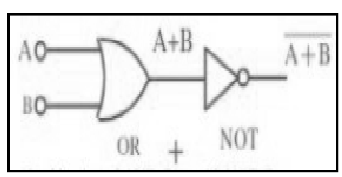
37.Define NAND and NOR gates. Give their truth tables.

NAND gate: When the output of an AND gate is connected to the in put of a NOT gate, the resultanting gate is called NAND gate.



Input A	Input B	Output $Y=\overline{A.B}$
0	0	1
1	0	1
0	1	1
1	1	0

NOR gate: When the output of an OR gate is connected to the input of a NOT gate, the resultanting gate is called NAND gate.

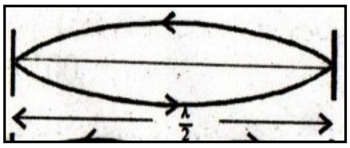


Input A	Input B	Output $Y=\overline{A+B}$
0	0	1
1	0	0
0	1	0
1	1	0

1. *Explain the formation of stationary waves in stretched strings and hence deduce the laws of transverse waves in stretched string?*

A. Consider a string of length l' and linear density μ' be fixed between two supports under a tension T. a stationary wave is formed in the string due to the superposition of the waves. At the points where the string was fixed rigidly nodes are formed. The velocity of transverse vibration in a stretched string is given by $V = \sqrt{\frac{T}{\mu}}$

1St loop*:* It will have two nodes and one antinodes then the vibrating length $l = \frac{\lambda}{2}$



$\boxed{\lambda = 2l} \rightarrow (1)$

$\boxed{V = \sqrt{\frac{T}{\mu}}} \rightarrow (2)$

Relation between V, ϑ, and λ

$$V = \vartheta\lambda \qquad \vartheta = \frac{V}{\lambda} \rightarrow (3)$$

Substitute eq^n (1) and (2) values in eq^n (3) we get

$$\vartheta = \frac{1}{\lambda}\sqrt{\frac{T}{\mu}}$$

$$\boxed{\vartheta_0 = \frac{1}{2l}\sqrt{\frac{T}{\mu}}}$$

This is known as fundamental frequency

2nd loop*:* It will have three nodes and two antinodes then the vibrating length $l = \frac{2\lambda}{2}$

$\boxed{\lambda = \frac{2l}{2}} \rightarrow (1)$

$\boxed{V = \sqrt{\frac{T}{\mu}}} \rightarrow (2)$

Relation between V, ϑ, and λ

$$V = \vartheta\lambda \qquad \vartheta = \frac{V}{\lambda} \rightarrow (3)$$

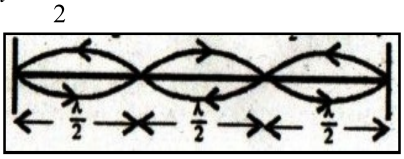
Substitute eq^n (1) and (2) values in eq^n (3) we get

$$\vartheta = \frac{1}{\left(\frac{2l}{2}\right)}\sqrt{\frac{T}{\mu}}$$

$$\boxed{\vartheta_1 = \frac{2}{2l}\sqrt{\frac{T}{\mu}}} \quad (or) \quad \boxed{\vartheta_1 = 2\vartheta_0}$$

This is known as 1st over tone (or) 2nd harmonic

3rdloop *:*It will have four nodes and three antinodes then the vibrating length $l = \frac{3\lambda}{2}$



$\boxed{\lambda = \frac{2l}{3}} \rightarrow (1)$

$\boxed{V = \sqrt{\frac{T}{\mu}}} \rightarrow (2)$

Relation between V,ϑ, and λ

$$V = \vartheta\lambda \qquad \vartheta = \frac{V}{\lambda} \rightarrow (3)$$

Substitute eq^n (1) and (2) values in eq^n (3) we get

$$\vartheta = \frac{1}{\left(\frac{2l}{3}\right)}\sqrt{\frac{T}{\mu}}$$

$$\boxed{\vartheta_2 = \frac{3}{2l}\sqrt{\frac{T}{\mu}}} \quad (or) \quad \boxed{\vartheta_2 = 3\vartheta_0}$$

This is known as 2st over tone (or) 3rd harmonic

Laws of transverse vibrations*:*

First law: (when T and μ are constants)

The fundamental frequency of stretched string is inversely proportional to length of the string.

$$\boxed{\vartheta \;\alpha\; \frac{1}{l} \qquad \vartheta_1 l_1 = \vartheta_2 l_2}$$

Second law: (when l and μ are constants)

The fundamental frequency of stretched string is directly proportional to square root of the tension.

$$\boxed{\vartheta \;\alpha\; \sqrt{T} \qquad \frac{\vartheta_1}{\vartheta_2} = \sqrt{\frac{T_1}{T_2}}}$$

Third law: (when l and T are constants)

The fundamental frequency of stretched string is inversely proportional to square root of the linear density

$$\boxed{\vartheta \;\alpha\; \frac{1}{\sqrt{\mu}} \qquad \frac{\vartheta_1}{\vartheta_2} = \sqrt{\frac{\mu_2}{\mu_1}}}$$

1. **Current in a circuit falls from 5.0A to 0.0A in 0.1sec. if an average emf of 200V is induced, give an estimate of the self-inductance of the circuit.**

A. di = 5.0 – 0.0 = 5A, dt = 0.1sec, emf e = 200V L = ?

$$e = L\frac{di}{dt} \Rightarrow L = e\frac{dt}{di} \Rightarrow L = \cancel{200}\left(\frac{0.1}{\cancel{5}}\right) = 4H$$

2. **What is the de-Broglie wavelength associated with an electron, accelerated through a potential difference of 100volt?**

A. Applied potential (V) = 100V,

$$\text{Wavelength}(\lambda) = \frac{h}{p} = \frac{12.27}{\sqrt{100}} = \frac{12.27}{10} = 1.227nm$$

4. **What is the de-Broglie's wavelength of a ball of mass 0.12Kg moving with a speed of 20m/s?**

A. Mass (m) = 0.12Kg. Speed (v) = 20m/s, h = 6.63x 10^{-34}J.

$$\text{de-Broglie Wavelength}(\lambda) = \frac{h}{p} = \frac{h}{mv}$$

$$(\lambda) = \frac{6.63\times10^{-34}}{0.12\times20} = \frac{6.63\times10^{-34}}{2.4} = 2.762\times10^{-34}\,met$$

5. *A current of 10A passes through two very long wires held parallel to each other and separated by a distance of 1m. What is the force per unit length between them?*

$$I_1 = I_2 = 10A,\; d = 1m,\quad \mu_0 = 4\pi\times10^{-7}H/m$$

$$F = \frac{\mu_0 I_1 I_2}{2\pi d} \Rightarrow F = \frac{4\pi\times10^{-7}\times10\times10}{2\pi} = 2\times15^{-5}$$

6. *A long straight wire carries current of 35A. What is the magnitude of the field B at a point 20cm from the wire?*

A. I = 35A and r = 20cm = 0.2m,

$$B = \frac{\mu_0}{4\pi}.\frac{2i}{r} = \frac{4\pi\times10^{-7}}{4\pi}.\frac{2(35)}{0.2} = 3.5\times10^{-5}T.$$

7. **The horizontal component of the earth's magnetic field at a certain place is 2.6x10^{-5}T and the angle of dip 60^0. What is the magnetic field of the earth at this location?**

A. **H_E** = 2.6x10^{-5}T, $\theta = 60^0$ **B_E = ?**

$$H_E = B_E\cos\theta, B_E = \frac{H_E}{\cos\theta}$$

$$B_E = \frac{2.6\times10^{-5}}{\left(\frac{1}{2}\right)} = 2\left(2.6\times10^{-5}\right) = 5.2\times10^{-5}T$$

2. *How are stationary waves formed in closed pipes? Explain the various modes of vibrations and relations for their frequencies*

A. **<u>Closed Pipe</u>:-**If one end of the organ pipe is closed and the other end is open is Known as closed organ pipe

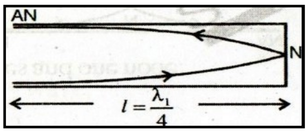
<u>Formation of stationary wave</u>:-When a sound wave is sent to a closed pipe. The wave reflects back at the closed end of the pipe. The incident wave and reflected wave travelling in opposite direction super impose each other.

<u>First harmonic (or) fundamental:</u>

It will have one node and one antinodes

The vibrating length $l = \frac{\lambda_1}{4}$

$\lambda_1 = 4l$



Relation between V, ϑ, and λ

$$V = \vartheta\lambda \Rightarrow \vartheta_0 = \frac{V}{\lambda_1} \rightarrow (1)$$

$$\boxed{\vartheta_0 = \frac{V}{4l}}$$

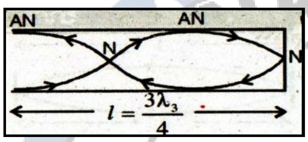
This is known as first harmonic (or) fundamental

<u>Third harmonic (or) first overtone:</u>

It will have two node and two antinodes

The vibrating length $l = \frac{3\lambda_3}{4}$

$\lambda_3 = \frac{4l}{3}$



Relation between V, ϑ, and λ

$$V = \vartheta\lambda \Rightarrow \vartheta_1 = \frac{V}{\lambda_3} \Rightarrow \vartheta_1 = \frac{V}{\left(\frac{4l}{3}\right)}$$

$$\boxed{\vartheta_1 = \frac{3V}{4l}} \qquad \boxed{\vartheta_1 = 3\vartheta_0}$$

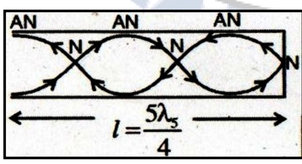
This is known as 1st over tone (or) 3rd harmonic

<u>Fifth harmonic (or) Second overtone:</u>

It will have three node and three antinodes

The vibrating length $l = \frac{5\lambda_5}{4}$

$\lambda_5 = \frac{4l}{5}$



Relation between V, ϑ, and λ

$$V = \vartheta\lambda \Rightarrow \vartheta_2 = \frac{V}{\lambda_5} \Rightarrow \vartheta_2 = \frac{V}{\left(\frac{4l}{5}\right)}$$

$$\boxed{\vartheta_2 = \frac{5V}{4l}} \qquad \boxed{\vartheta_2 = 5\vartheta_0}$$

This is known as 2nd over tone (or) 5th harmonic

The frequency ratio of the closed pipe is given by

$$\boxed{\vartheta_0 : \vartheta_1 : \vartheta_2 = 1\left(\cancel{\frac{V}{4l}}\right) : 3\left(\cancel{\frac{V}{4l}}\right) : 5\left(\cancel{\frac{V}{4l}}\right) = 1 : 3 : 5}$$

A steel wire 0.72m long has a mass of 5.0 X 10⁻³ kg. If the wire is under a tension of 60 N, what is the speed of transverse waves on the wire?

$M = 5.0X10^{-3}$ kg $L = 0.72$m $T = 60$ N

$$\mu = \frac{M}{l} = \frac{5.0X10^{-3}}{0.72} = 6.9X10^{-3}\ \text{kg/m}$$

The speed of the wave on the wire is given by

$$V = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{60}{6.9X10^{-3}}} = 93\,m/s$$

3. *Explain the formation of stationary waves in an air Column enclosed in open pipe. Derive the equation for the frequencies of the harmonics produced.*

A. **<u>Open pipe</u>:-** If both ends of the organ pipe is open is known as open organ Pipe

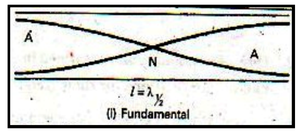
<u>Formation of stationary wave</u>:-When a sound wave is sent to a closed pipe. The wave reflects back at the closed end of the pipe. The incident wave and reflected wave travelling in opposite direction super impose each other is called stationary wave.

<u>First harmonic (or) fundamental:</u>

It will have one node and two antinodes

The vibrating length $l = \frac{\lambda_1}{2}$

$\lambda_1 = 2l$



Relation between V, ϑ, and λ

$$V = \vartheta\lambda \Rightarrow \vartheta_0 = \frac{V}{\lambda_1}$$

$$\boxed{\vartheta_0 = \frac{V}{2l}}$$

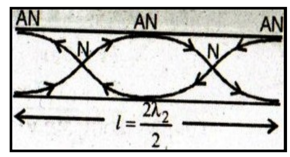
This is known as first harmonic (or) fundamental frequency.

<u>Second harmonic (or) first overtone:</u>

It will have two node and three antinodes

The vibrating length $l = \frac{2\lambda_2}{2}$

$\lambda_2 = \frac{2l}{2}$



Relation between V, ϑ, and λ

$$V = \vartheta\lambda \Rightarrow \vartheta_1 = \frac{V}{\lambda_2} \Rightarrow \vartheta_1 = \frac{V}{\left(\frac{2l}{2}\right)}$$

$$\boxed{\vartheta_1 = \frac{2V}{2l}} \qquad \boxed{\vartheta_1 = 2\vartheta_0}$$

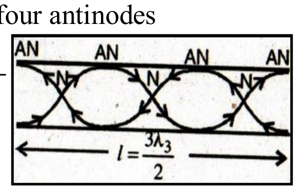
This is known as 1st over tone (or) 2nd harmonic

<u>Third harmonic (or) second overtone:</u>

It will have three node and four antinodes

The vibrating length $l = \frac{3\lambda_3}{2}$

$\lambda_3 = \frac{2l}{3}$



Relation between V, ϑ, and λ

$$V = \vartheta\lambda \Rightarrow \vartheta_2 = \frac{V}{\lambda_3} \Rightarrow \vartheta_2 = \frac{V}{\left(\frac{2l}{3}\right)}$$

$$\boxed{\vartheta_2 = \frac{3V}{2l}} \qquad \boxed{\vartheta_2 = 3\vartheta_0}$$

This is known as 2nd over tone (or) 3rd harmonic

The frequency ratio of the open pipe is given by

$$\boxed{\vartheta_0 : \vartheta_1 : \vartheta_2 = 1\left(\cancel{\frac{V}{2l}}\right) : 2\left(\cancel{\frac{V}{2l}}\right) : 3\left(\cancel{\frac{V}{2l}}\right) = 1 : 2 : 3}$$

A closed organ pipe 70cm long is sounded. If the velocity of sound is 331m/s , what is the fundamental frequency of vibration of the air column ?

A. $l = 70$cm $= 70 \times 10^{-2}$ m $v = 331$m/s

$$\vartheta = \frac{V}{4l} = \frac{331}{4\left(70X10^{-2}\right)} = 118.2\,Hz$$

4. What is Doppler Effect? Derive an expression for the apparent frequency heard when the source is in motion and the observer is at rest

A. The phenomenon of apparent change in frequency due to relative motion between the source and observer is called Doppler effect

Expression for the apparent frequency heard when the Source is in motion and the Observer is at rest

Let us consider a source **S** producing a sound note the frequency let the velocity of sound in air be' **V'**

$$V = \vartheta\lambda$$

Let the source S is moving with a velocity V_S towards observer at rest .Then the distance travelled by the source in time T is equal to $V_S T$ the wave is compressed and hence wavelength of the wave is decrease The apparent wavelength is $\lambda^1 = \lambda - V_S T$

The apparent frequency $= \frac{V}{\lambda^1}$

$$\vartheta^1 = \frac{V}{(\lambda - V_S T)} \quad \left(\therefore \lambda = \frac{V}{\vartheta}, \quad T = \frac{1}{\vartheta}\right)$$

$$\vartheta^1 = \frac{V}{\left(\frac{V}{\vartheta} - \frac{V_S}{\vartheta}\right)}$$

$$\boxed{\vartheta^1 = \left(\frac{V}{V - V_S}\right)\vartheta}$$

Then the apparent frequency $\vartheta^{|}$ is greater than the actual frequency

Similarly when the source is moving away from the observer The wavelength of the wave increases.

The apparent wavelength is $\lambda^{11} = \lambda + V_S T$

The apparent frequency $= \frac{V}{\lambda^1}$

$$\vartheta^{11} = \frac{V}{(\lambda + V_S T)} \quad \left(\therefore \lambda = \frac{V}{\vartheta}, \quad T = \frac{1}{\vartheta}\right)$$

$$\vartheta^{11} = \frac{V}{\left(\frac{V}{\vartheta} + \frac{V_S}{\vartheta}\right)}$$

$$\boxed{\vartheta^{11} = \left(\frac{V}{V + V_S}\right)\vartheta}$$

Then the apparent frequency $\vartheta^{||}$ is less then the actual frequency ϑ

A rocket is moving at speed of 200m/s towards a stationary target. While moving, it emits a wave of frequency 1000Hz. Some of the sound reaching the target gets reflected back to the rocket as an echo. Calculate the frequency of the sound as detected by the target (330m/s)

$V_S = 200m/s$, $\vartheta = 1000\text{Hz}$, $\vartheta^1 = ?$

$$\vartheta^1 = \left(\frac{V}{V - V_S}\right)\vartheta = \left(\frac{330}{330-200}\right)(1000) = \left(\frac{33\cancel{0}}{13\cancel{0}}\right)(1000) = 2540Hz$$

Two organ pipes of length 65 cm and 70cm respectively are sounded simultaneously. How many beats per second will be produced between fundamental frequencies of the two pipes? (velocity of sound = 330 m/s)

$$\Delta n = n_1 - n_2 = \frac{V}{2l_1} - \frac{V}{2l_2}$$

$$\Delta n = 330\left(\frac{1}{2\times 65\times 10^{-2}} - \frac{1}{2\times 70\times 10^{-2}}\right)$$

$$= \frac{(330)(140-130)}{(130\times 140)} = \frac{3300\times 100}{18200} = 18Hz$$

5. What is Doppler Effect? Derive an expression for the apparent frequency heard when the observer is in motion and the source is at rest

A. The phenomenon of apparent change in frequency due to relative motion between the source and observer is called Doppler effect

Expression for the apparent frequency heard when the Observer is in motion and the Source is at rest

Let us consider a source **S** producing a sound note the frequency let the velocity of sound in air be' **V'**

$$V = \vartheta\lambda$$

Let the observer O is moving with velocity V_o towards the source at rest .He will receive more number of waves each second. The distance travelled by him in one second is V_o the extra waves received by him due to his motion are equal to $\frac{V_o}{\lambda}$ in second.

The apparent frequency is given by

$$\vartheta^{|} = \vartheta + \frac{V_o}{\lambda}$$

$$\vartheta^{|} = \vartheta + \frac{V_o}{\left(\frac{V}{\vartheta}\right)}$$

$$= \vartheta + \frac{V_o}{V}\vartheta$$

$$\vartheta^{|} = \left[1 + \frac{V_o}{V}\right]\vartheta$$

$$\vartheta^{|} = \left[\frac{V + V_o}{V}\right]\vartheta$$

Then the apparent frequency $\vartheta^{|}$ is greater than the actual frequency ϑ

Similarly when the observer is moving away from the source at rest with velocity V_o he receive $\frac{V_o}{\lambda}$ number of waves less in every second

The apparent frequency is given by

$$\vartheta^{||} = \vartheta - \frac{V_o}{\lambda}$$

$$\vartheta^{||} = \vartheta - \frac{V_o}{\left(\frac{V}{\vartheta}\right)} = \vartheta - \frac{V_o}{V}\vartheta$$

$$\vartheta^{||} = \left[1 - \frac{V_o}{V}\right]\vartheta$$

$$\vartheta^{||} = \left[\frac{V - V_o}{V}\right]\vartheta$$

Then the apparent frequency $\vartheta^{||}$ is less then the actual frequency ϑ

A string has a length of 0.4m and a mass of 0.16g. if the tension in the string is 70N, what are the three lowest frequencies it produces when plucked ?

A) L= 0.4m; M= 0.16g = $0.16X10^{-3}$ kg

$$\mu = \frac{M}{l} = \frac{0.16X10^{-3}}{0.4} = 0.4X10^{-3}kg/m$$

T = 70N; $\vartheta_n = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

$$\vartheta_1 = \frac{1}{2l}\sqrt{\frac{T}{\mu}} = \frac{1}{2X\,0.4}\sqrt{\frac{70}{0.4X\,10^{-3}}} = 523\text{ Hz}$$

$$\vartheta_2 = 2\vartheta_1 = 2\,X\,523 = 1046\,Hz$$

$$\vartheta_3 = 3\vartheta_1 = 3\,X\,523 = 1569\,Hz$$

A stretched wire of length 0.6m is observed to vibrate with a frequency of 30Hz in the fundamentals mode. If the string has a linear mass of 0.05kg/m Find (1) the velocity of propagation of transverse waves in the string (2) the tension in the string.

(1) V = $2lV$ =(2)(0.6)(30) =36Hz.

(2) $T = V^2\mu = (36)(36)(0.05) = 64.8N$

6. *What is radioactivity? State the law of radioactive decay. Show that radioactive decay is exponential in nature.*

A. **<u>Radio activity</u>*:*** The nuclei of certain elements disintegrate spontaneously by emitting alpha, beta and gamma rays. This phenomenon is called Radioactivity or Natural radioactivity.

<u>Law of Radioactivity</u>*:* The rate of radioactive decay $\left(\frac{dN}{dt}\right)$ the number of nuclei decaying per unit time at any instant, is directly proportional to the number of nuclei N present at that instant is called law of radioactivity decay.

<u>Radioactive decay is exponential in nature</u>*:* Let 'N' be the number of radioactive atoms present at a time 't'. Let dN atoms disintegrate in time 'dt'. According to law of radioactive decay

$$\left(\frac{dN}{dt}\right) \propto N$$

$\left(\frac{dN}{dt}\right) = -\lambda N \ldots\ldots\ldots (1)$

λ is called decay constant. The negative sign indicates the decrease in the number of nuclei.

From equation (1) $\frac{dN}{N} = -\lambda\, dt \ldots\ldots\ldots\ldots (2)$

Integrating on both sides

$$\int \frac{dN}{N} = -\lambda \int dt$$

$\log_e N = -\lambda t + C \ldots\ldots.. (3)$

Where C is called integration constant.

At t = 0, N = N_0 Substituting in equation (3)

We get $\log_e N_0 = C$

$$\log_e N = -\lambda t + \log_e N_0$$

$$\log_e N - \log_e N_0 = -\lambda t$$

$$\log_e \left[\frac{N}{N_0}\right] = -\lambda t$$

$$N = N_0 e^{-\lambda t}$$

The equation is known as law of radioactive decay.

The half-life radium is 1600 years. How much time does 1g of radium take to reduce to 0.125g?

Half-life of radium = 1600 years,   Initial mass = 1g.

Final mass = 0.125 g.

The quantity remaining after 'n' half lifes is $\frac{1}{2^n}$ of the initial quantity

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n \Rightarrow \frac{0.125}{1} = \left(\frac{1}{2}\right)^n$$

$$\frac{125}{1000} = \left(\frac{1}{2}\right)^n \Rightarrow \frac{1}{8} = \frac{1}{2^n}$$

$$\frac{1}{2^3} = \frac{1}{2^n} \Rightarrow n = 3$$

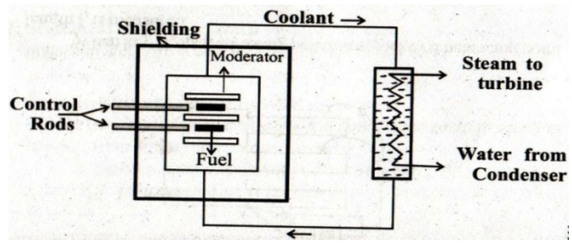
Time taken = (n)(half-lifes)

= (3) (1600) = 4800 years.

7. *Explain the principle and working of a nuclear reactor with the help of a labelled diagram?*

A. **<u>Principle</u>*:*** A nuclear reactor works on the principle of achieving controlled chain reaction in natural Uranium U^{238} enriched U^{235}, consequently generating large amounts of heat.

The nuclear reactor consists of **1)** Fuel **2)** Moderator. **3)** Control rods. **4)** Radiation shielding. **5)** Coolant.



1)<u>Fuel</u>*:* The fissionable material used in the reactor is called fuel.

Ex: Natural uranium, enriched uranium, plutonium and uranium are used as nuclear fuels.

2)<u>Moderators</u>*:* The function of the moderator is to slow down the fast moving neutrons produced as a result of nuclear fission.

Ex: Heavy water, Ordinary water, pure graphite, etc.

3)<u>Control Rods</u>*:* The function of a control rod is to absorb the neutrons and control the nuclear chain reaction.

Ex: Cadmium and Boron rods.

4)<u>Radiation Shielding</u>*:* The construction with cement and lead around the reactor to protect from harmful radiations is called radiationshielding.

5) <u>Coolant</u>*:* heat generated in fuel elements is removed by using a suitable coolant to flow around them.

<u>Ex</u>: water at high pressure (or) liquid sodium.

<u>Working</u>*:*

1. Uranium fuel rods are placed in the aluminum cylinders.

2. The graphite moderator is placed in between the fuel cylinder.

3. When a few U^{235}nuclei undergo fission, fast neutrons are released.

4. These neutrons pass through the surrounding.

5. The heat generated here is used to produce steam.

Uses of nuclear reactors:

To generate electric power.

To prepare the radio isotopes.

Pr: ***If one microgram of $^{235}_{92}U$ is completely destroyed in an atom bomb, how much energy will be released?***

A. m = 1μg = 1X 10^{-6} X 10^{-3} = 10^{-9} Kg.   c = 3X 10^8m/s

E = mc^2

E = (1X 10^{-9}) X (3X 10^8) X (3X 10^8)

E = 9X10^7J.

Calculate the energy equivalent of 1g of substance.

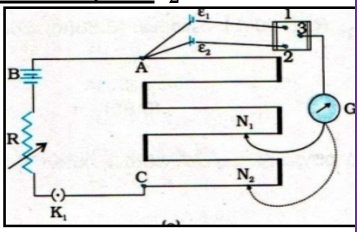
E = mc^2 = (1x10^{-3}) (3x10^8) (3x10^8) = 9 x10^3J

8. *State the working principle of potentiometer explains with the help of circuit diagram how the emf of two primary cells are compared by using the potentiometer.*

A. <u>Working principle of potentiometer</u>: The potential difference across a length of the potentiometer wire is directly proportional to its length (or) when a steady current is passed through a uniform wire, potential drop per unit length per potential gradient is constant.

$\varepsilon \propto l \Rightarrow \varepsilon = \emptyset\, l$

<u>Comparing the emf of two cells ε_1 and ε_2</u>:



1) The points marked 1, 2, 3 form a two way key.

2) 1[St] position of the key where 1 and 3 are connected so that the galvanometer is connected to ε_1

3) The jockey is moved along the wire till at a point N_1 at a distance l_1 from A, there is no deflection in the galvanometer. Then $\varepsilon_1 \propto l_1 \Rightarrow \varepsilon_1 = \emptyset\, l_1$

4) Similarly, if another emf ε_2 is balanced against l_2 (AN_2) then $\varepsilon_2 \propto l_2$ (1) $\Rightarrow \varepsilon_2 = \emptyset\, l_2$ (2)

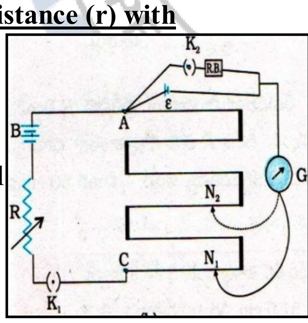
$$\frac{(1)}{(2)} = \frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$$

9. *State the working principle of potentiometer explains with the help of circuit diagram how the potentiometer is used to determine the internal resistance of the given primary cell.*

A. <u>Working principle of potentiometer</u>: The potential difference across a length of the potentiometer wire is directly proportional to its length (or) when a steady current is passed through a uniform wire, potential drop per unit length per potential gradient is constant.

$\varepsilon \propto l \Rightarrow \varepsilon = \emptyset\, l$

<u>Measurement of internal resistance (r) with potentiometer</u>:



1) Potentiometer to measure internal resistance (r) of a cell (ε) is shown in diagram.

2) The cell emf whose internal resistance (r) is to be determined is connected across a resistance box (R.B) through a key K_2

3) With key K_2 open, the jockey is moved along the wire till at a point N_1 at a distance l_1 from A, there is no deflection in the galvanometer.

Then $\varepsilon \propto l_1 \Rightarrow \varepsilon = \emptyset\, l_1$ (1)

4) When key K_2 is closed, the cell sends a current (i) through the resistance box (R.B).

5) If V is the terminal potential difference of the cell and balance is obtained at length l_2 (AN_2).

Then $V = \emptyset l_2$ …..(2)

$$\frac{(1)}{(2)} = \frac{\varepsilon}{V} = \frac{l_1}{l_2}$$

6) But $\varepsilon = I\,(r + R)$ and $V = iR$, this gives

7) $\frac{(r+R)}{R} = \frac{l_1}{l_2} \Rightarrow \frac{l_1}{l_2} = \left(\frac{r}{R} + 1\right)$

8) $\frac{r}{R} = \left(\frac{l_1}{l_2} - 1\right)$ $\quad r = R\left(\frac{l_1}{l_2} - 1\right)$

10. *State Kirchhoff's law for an electrical network. Using these laws deduce the condition for balance in a Wheatstone bridge.*

A. <u>Kirchhoff's first law (Junction rule or KCL)</u>: The sum of the currents flowing towards a junction is equal to the sum of current away from the junction.

$$i_1 + i_2 + i_4 = i_3 + i_5$$

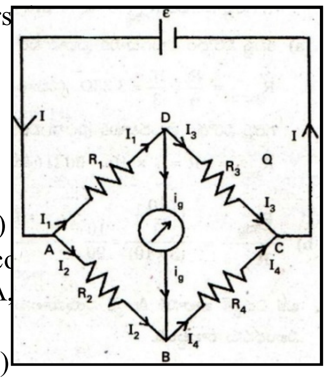
(or)

The algebraic sum of the currents at any junction is zero

<u>Kirchhoff's second law (Loop rule or KVL)</u>: The algebraic sum of potential around any closed is zero.

$\sum V = 0$

<u>Wheatstone bridge</u>: Wheat stone's bridge circuit consists of four resistances R_1, R_2, R_3 and R_4 are connected to form a closed path. A cell of emf ε is connected between the point A and C a galvanometer is connected between the points B and D as shown in fig. the current through the various branches are indicated in the figure. The current through the galvanometer is I_g and the resistance of the galvanometer is G.



Applying Kirchhoff's firs

At the junction D,

$i_1 - i_g - i_3 = 0$

$i_1 = i_g + i_3$ ……….. (1)

At the junction B,

$i_2 + i_g - i_4 = 0$

$i_2 + i_g = i_4$ ……….. (2)

Applying Kirchhoff's secc to the closed path ADBA,

$i_1R_1 + i_gG - i_2R_2 = 0$

$i_1R_1 + i_gG = i_2R_2$...... (3)

Applying Kirchhoff's second law to the closed path DCBD,

$i_3R_3 - i_4R_4 - i_gG = 0$

$i_3R_3 = i_4R_4 + i_gG$ …. (4)

When the galvanometer shows zero deflection the points D and B are at the same potential. So $i_g = 0$

Substituting this value (1), (2), (3) and (4).

$i_1 = i_3$ …………… (5)

$i_2 = i_4$ ……………. (6)

$i_1R_1 = i_2R_2$ ……….. (7)

$i_3R_3 = i_4R_4$………… (8)

Dividing (7) by (8)

$$\frac{i_1R_1}{i_3R_3} = \frac{i_2R_2}{i_4R_4}$$

$(i_1 = i_3,$ and $i_2 = i_4)$

$$\frac{R_1}{R_3} = \frac{R_2}{R_4}$$

Wheat stone's bridge principle: $R_4 = R_3 X \frac{R_2}{R_1}$

A wire of resistance 4R is bent in the form of a circle. What is the effective resistance between the ends of the diameter?

If a wire of resistance 4R is bent in the form a circle 'AB' is diameter. The resistance of upper and lower part's becomes 2R,2R respectively they are in parallel

$$R_1 = 2R, \quad R_2 = 2R$$

$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2},$ $\quad \frac{1}{R_P} = \frac{1}{2R} + \frac{1}{2R}$

$\frac{1}{R_P} = \frac{2}{2R} = \frac{1}{R},$

$$R_P = R\,\Omega$$