To Physics Teachers…

Physics is the most important subject in basic sciences. To provide sufficient background to meet the challenges of academic and professional streams, some important concepts are provided in this module.

To understand the lessons easily, it is divided into four stages. After giving sufficient practice to the pupil in subsequent stages, one can proceed from easier portions to slightly harder portions. By this technique, it is believed by us that, we can enable not only to make all the students pass but also to make the students to score high marks.

After following the numerous practices suggested in this module to the students, one can find it very easy to score full marks if given importance to the portions which are very important for the examinations and multiple choice one mark questions.

PHYSICS QUESTION PAPER - BLUE PRINT

UNIT	1Mark	3Marks	5Marks	10Marks	Total Marks
1. Electrostatics	4	2	1	1	25
2. Current Electricity	1	3	2	-	20
3. Effects of Electric Current	2	1	1	1	20
4. Electromagnetic Induction and Alternating Current	4	2	1	1	25
5. Electromagnetic Waves and Wave Optics	4	2	1	1	25
6. Atomic Physics	4	2	1	1	25
7. Dual Nature of Radiation and Matter and Relativity	2	1	2	-	15
8. Nuclear Physics	4	2	1	1	25
9. Semiconductor Devices and their Applications	3	4	1	1	30
10. Communication Systems	2	1	1	1	20
TOTAL	30	20	12	8	230

1. **There is a possibility of getting 65 marks if the pupil study the question and answers for the units 1,7 and 8 completely. The distribution of marks for these units are given in the following table.**

UNIT	1 MARK	3 MARKS	5 MARKS	10 MARKS	TOTAL MARKS
1	4	2	1	1	**25**
7	2	1	2	-	**15**
8	4	2	1	1	**25**
TOTAL MARKS					**65**

UNIT	Areas of importance for 3 mark questions	Areas of importance for 5 and 10 mark questions
1	Coulomb's law , Dipole, Electric field lines, Electric potential, Electric flux, Gauss's theorem, Capacitors, Action of Points.	Electric field lines, Electric potential due to point charge, Electric field-Axial line, Equatorial line, Electric potential due to dipole, Applications of Gauss's theorem, Capacitors – principle, Capacitance, Capacitors in series and in parallel, Van de Graff generator.
7	Photoelectric effect-Stopping potential, threshold frequency, Photo Electric cells, Electron microscope – uses and limitations, relativity.	Laws of Photo electric effects, Einstein's photo electric equation, Photo Electric cells, De-Broglie wave length, Length contraction , Time dilation mass-energy equivalency education (according to blue print there is no 10 marks questions from this unit)
8	Types of nuclei, Atomic mass unit , Nuclear forces, Radioactivity, Curie-definition, Breeder reactor, properties of neutron Cosmic rays, Pair production and annihilation of matter, Elementary particles.	Bainbridge mass spectrometer, Nuclear forces, α,β,γ rays-properties, Radioactive displacement laws, Half life period, Mean life time, Neutron discovery and properties, Geiger Muller counter, Atom bomb, Hydrogen bomb, Nuclear reactor, Stellar energy, p-p cycle, C-N cycle, Cosmic rays.

2. **After taking practice in the above units, if they learn very well in the units 2 and 4, the pupil may get high marks.**

UNIT	1 MARK	3 MARKS	5 MARKS	10 MARKS	TOTAL MARKS
2	1	3	2	-	20
4	4	2	1	1	25
TOTAL MARKS					45

UNIT	Areas of importance for 3 mark questions	Areas of importance for 5 and 10 mark questions
2	Drift velocity, Mobility, Current density, Ohm's law, Resistivity, Superconductors, Temperature Coefficient of resistance, Kirchhoff's laws, Comparison of emf and potential difference, Difference between electric energy and power, Faraday's laws of electrolysis , Secondary cells.	The relation between current and drift velocity, Application of superconductors, Combination of resistors – series and parallel, Kirchhoff's laws, Wheatstone's bridge, Potentiometer –Principle, E_1/E_2, Verifications of Faraday's laws of electrolysis, Daniel cell, Leclanche cell, Lead acid accumulator(*according to blue print there is no 10 marks questions from this unit.*)
4	Electromagnetic induction , Faraday's laws of electromagnetism, Lenz's law, Fleming's righthand rule, Methods of producing induced emf, Eddy currents, Effective (rms) value of alternating current, Q- factor	Self inductance of a long solenoid, Energy associated with an inductor, Mutual inductance of two long solenoids, Inducing emf by changing area enclosed by the coil, AC generator, Eddy currents, Transformers –Power losses, RLC series circuit, Power in AC circuit.

3. After learning the above 5 units, if the students learn the units 3 and 5 the students may get a minimum of 110/150 marks in physics.

UNIT	1 MARK	3 MARKS	5 MARKS	10 MARKS	TOTAL MARKS
3	2	1	1	1	20
5	4	2	1	1	25
TOTAL MARKS					45

UNIT	Areas of importance for 3 mark questions	Areas of importance for of 5 and 10 mark questions
3	Joule's law,Electric heating devices, Peltier coefficient, Thomson coefficient, Biot-Savart law, Tangent law, Definition. Ampere, Ampere's circuital law), Current sensitivity of Galvanometer Magnetic moment of a current loop .	Verification of Joule's law, Thermopile, Magnetic induction due to infinitely long straight conductor carrying current, Magnetic induction along the axis of a circular coil carrying current. Magnetic Lorentz force, Motion of charged Particle in uniform electric field, Cyclotron, Force on a current carrying conductor placed in a magnetic field, Conversion of galvanometer into an ammeter and voltmeter.
5	Electromagnetic waves, Applications of Infrared and ultra-violet rays, Fraunhofer lines, Difference between corpuscles and photons, Tyndall effect, Rayleigh Scattering, Huygen's Principle, Reason for darkness in the centre of Newton's Rings, Difference between Fresnel and Fraunhofer diffraction, Difference between interference and diffraction, Optic axis, Optical activity Specific rotation .	Electromagnetic waves and their characteristics , Emission and Absorption spectrum , Raman effect, Total internal reflection and refraction, Young's double slit experiment - Bandwidth, Newton's rings-Radius of n^{th} dark ring, Brewster's Law, Pile of plates, Double refraction, Nicol prism, Uses of polarids.

4.After completing 7 lessons, the pupil are asked to learn the lesson 6,9 and 10 if they learn all these lessons thoroughly, students may get full mark.

UNIT	1 MARK	3 MARKS	5 MARKS	10 MARKS	TOTAL MARKS
6	4	2	1	1	25
9	3	4	1	1	30
10	2	1	1	1	20
TOTAL MARKS					75

UNIT	Areas of importance for 3 mark questions	Areas of importance for 5 and 10 mark question
6	Principle of Millikan's experiment, Drawbacks of Rutherford atom model,Bohr's Postulates, Ionization energy, Ionizing potential, Difference between Hard X-rays-soft X-rays , Laue experiment – important facts, Moseley's Law , Characteristics of laser,	Cathode rays, Canal rays, X-rays-properties, J.J. Thomson experiment, Millikan's oil drop experiment, Radius of the n^{th} orbit, Spectral series of hydrogen atom, Bragg's law, Bragg's X-ray spectrometer, Ruby laser, He-Ne laser.
9	Forbidden energy gap, Intrinsic and Extrinsic semiconductors, Doping, Rectification, Zener breakdown, LED,users Transistor Configurations,Band width of amplifier, Negative feedback amplifier, Barkhausen conditions, Advantages of integrated circuits, Universal gates, OP-amp-Characteristics, Uses of CRO .	Half wave rectifier, Bridge rectifier, α and β relation – Current amplification, Single stage CE amplifier, Principle of feedback, feed back amplifier Colpitt's oscillator, De-Morgan's Theorem, Inverting amplifier, Non-inverting amplifier, summing amplifier, Difference amplifier, Logic gates.
10	Propagation of radio waves, Skip distance, Skip zone, Modulation-necessity Modulation, Modulation factor, Limitations of A.M, Scanning Digital communication, Scanning, Fibre optical communication - advantages and disadvantages.	Analysis of A.M, Radio transmission and reception – AM and FM, Radar- Principle-phase diagram action and applications, Satellite communication- merits and demerits.

1 MARK QUESTIONS AND ANSWERS

UNIT – 1 ELECTROSTATISTICS

1. A glass rod rubbed with silk acquires a charge of $+8x10^{-12}$C. The number of electrons it has gained or lost (**5x10^7(lost)**)
2. The electrostatic force between two point charges kept at a distance apart, in a medium ε_r=6, is 0.3 N, the force between them at the same separation in vacuum is (**1.8 N)**
3. Electric field intensity is 400 Vm^{-1} at a distance of 2 m from a point charge. What distance it will be 100 Vm^{-1}? **(4 m)**
4. Two point charges +4q and +q are placed 30 cm apart. At what point on line joining them the electric field is zero? **(20 cm from the charge +4q)**
5. A dipole is placed in a uniform electric field with its axis parallel to the field it experiences **(neither a net force nor a torque)**
6. If a point lies at a distance x from the midpoint of the dipole, the electric potential at this point is proportional to **($1/x^2$)**
7. Four charges +q, +q, -q and –q respectively are placed at the corners A,B, C and D of a square of side a. The electric potential at the centre O of the square is **(zero)**
8. Electric potential energy (U) of two point charges is **($q_1q_2/4\pi\varepsilon_0 r$)**
9. The work done in moving 500 μC charge between two points on equipotential surface is **(zero)**
10. Which of the following quantities is scalar? (**electric potential)**
11. The unit of permittivity is **($C^2N^{-1}m^{-2}$)**
12. The number of electric lines of force originating from a charge of 1 C is **(1.129 x 10^{11})**
13. The electric field outside the plates of two oppositely charged plane sheets of charge density σ is **(zero)**
14. The capacitance of a parallel plate capacitor increases from 5 μF to 60 μF when a dielectric is filled between the plates. The dielectric constant of the dielectric is **(12)**
15. A hollow metal ball carrying an electric charge produces no electric field at points **(inside the sphere)**

UNIT – 2 CURRENT ELECTRICITY

1. A charge of 60C passes through an electric lamp for 2 minutes. The current in the lamp is **(0.5 A)**
2. The material through which electric charge can flow easily is **(copper)**
3. The current flowing in a conductor is proportional to **(drift velocity)**
4. A toaster operating at 240 V has a resistance of 120 Ω. The power is **(480 W)**
5. If the length of a copper wire has a certain resistance R, then on doubling the length its specific resistance **(will remain the same)**
6. When two 2 Ω resistances are in parallel, the effective resistance is **(1 Ω)**
7. In the case of insulators, as the temperature decreases, resistivity **(increases)**
8. If the resistance of a coil is 2 Ω at 0^0C and α = 0.004 / ^{0}C, then its resistance at 100^0 C is **(2.8 Ω)**
9. According to Faraday's law of electrolysis, when a current is passed, the mass of ions deposited at the cathode is independent of **(resistance)**
10. When n resistors of equal resistances (R) are connected in series, the effective resistance is **(nR)**

UNIT – 3 EFFECTS OF ELECTRIC CURRENT

1. Joule's law of heating is **(H = VIt)**
2. Nichrome wire is used as the heating – element because it has **(high specific resistance)**
3. Peltier coefficient at a junction of a thermocouple depends on **(the temperature of the junction)**
4. In a thermocouple, the temperature of the cold junction is 20^0C, the neutral temperature is 270^0C. The temperature of inversion is **(520^0C)**
5. Which of the following equation represents Biot-Savart law?($\overrightarrow{dB} = \frac{\mu_o}{4\pi}\frac{I\overrightarrow{dl} \times \vec{r}}{r^3}$)
6. In a tangent galvanometer, for a constant current, the deflection is 30^0. The plane of the coil is rotated through 90^0. Now, for the same current, the deflection will be **(0^0)**
7. The period of revolution of a charged particle inside a cyclotron does not depend on **(the velocity of the particle)**
8. The torque on a rectangular coil placed in a uniform magnetic field is large, when **(the number of turns is large)**
9. Magnetic induction due to an infinitely long straight conductor placed in a medium of permeability μ is **(μI/2πa)**
10. Phosphor – bronze wire is used for suspension in a moving coil galvanometer, because it has **(small couple per unit twist)**
11. Of the following devices, which has small resistance?(**ammeter of range 0 – 10 A)**
12. A galvanometer of resistance G Ωis shunted with S Ω . The effective resistance of the combination is R_a. Then, which of the following statement is true? **(R_a is less than both G and S)**
13. An ideal voltmeter has **(infinite resistance)**

UNIT – 4 ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENT

1. Electromagnetic induction is not used in **(room heater)**
2. A coil of area of cross section 0.5 m^2 with 10 turns is in a plane which is perpendicular to an uniform magnetic field of 0.2 Wb / m^2. The flux through the coil is **(1 Wb)**
3. Lenz's law is in accordance with the law of **(conservation of energy)**
4. The self – inductance of a straight conductor is **(zero)**
5. The unit henry can also be written as a) VsA^{-1} b) WbA^{-1} c) **Ω** s d) all **Ans: (all)**
6. An emf of 12 V is induced when the current in the coil changes at the rate of $40As^{-1}$. The coefficient of self induction of the coil is (**0.3 H)**
7. A DC of 5A produces the same heating effect as an AC of **(5A rms current)**
8. Transformer works on (**AC only)**
9. The part of the AC generator that passes the current from the coil to the external circuit is (**brushes)**
10. In an AC circuit the applied emf $e = E_0 \sin(\omega t + \pi/2)$ leads the current $I = I_0 \sin(\omega t - \pi/2)$ by **(π)**
11. Which of the following devices does not allow d.c. to pass through? **(capacitor)**
12. Which of the following cannot be stepped up in a transformer? **(input power)**

13. In an ac circuit (**the average value of current is zero)**
14. The power loss is less in transmission lines when **(voltage is more but current is less)**

UNIT – 5 ELECTROMAGNETIC WAVES AND WAVE OPTICS

1. In an electro magnetic wave **(power is transmitted in a direction perpendicular to both the fields)**
2. Electromagnetic waves are (**transverse)**
3. In an electromagnetic wave the phase difference between electric field $\vec{E}$ and magnetic field $\vec{B}$ is **(zero)**
4. Atomic spectrum should be **(pure line spectrum)**
5. When a drop of water is introduced between the glass plate and plano convex lens in Newton's rings system, the ring system **(contracts)**
6. A beam of monochromatic light enters from vacuum into a medium of refractive index μ. The ratio of the wavelengths of the incident and refracted waves is **(μ : 1)**
7. If the wavelength of the light is reduced to one fourth, then the amount of scattering is **(increased by 256 times)**
8. In Newton's ring experiment the radii of the m^{th} and $(m+4)^{th}$ dark rings are respectively $\sqrt{5}$ mm and $\sqrt{7}$ mm. What is the value of m? **(10)**
9. The path difference between two monochromatic light waves of wavelength 4000 A^0 is 2×10^{-7} m. The phase difference between them is **(π)**
10. Refractive index of glass is 1.5. Time taken for light to pass through a glass plate of thickness 10 cm is **(5×10^{-10} s)**
11. In young's experiment, the third bright band for wavelength of light 6000 A^0 coincides with the fourth bright band for another source in the same arrangement. The wave length of the another source is **(4500A^0)**
12. A light of wavelength 6000A^0 is incident normally on a grating 0.005m wide with 2500 lines. Then the maximum order is **(3)**
13. A diffraction pattern is obtained using a beam of red light. What happens if the red light is replaced by blue light?
    (diffraction pattern becomes narrower and crowded together)
14. The refractive index of the medium, for the polarizing angle 60^0 is **(1.732)**

UNIT – 6 ATOMIC PHYSICS

1. The cathode rays are **(a stream of electrons)**
2. A narrow electron beam passes undeviated through and electric field $E = 3 \times 10^4$ V/m and an over lapping magnetic field $B = 2 \times 10^{-3}$ Wb/m^2, The electron motion, electric field and magnetic field are mutually perpendicular. The speed of the electron is **(1.5×10^7 ms^{-1})**
3. According to Bohr's postulates, which of the following quantities take discrete values? **(angular momentum)**
4. The ratio of the radii of the first three Bohr orbit is, **(1 : 4 : 9)**

5. The first excitation potential energy or the minimum energy required to excite the atom from ground state of hydrogen atom is, **(10.2eV)**
6. According to Rutherford atom model, the spectral lines emitted by an atom is, **(continuous spectrum)**
7. Energy levels A, B, C of a certain atom correspond to increasing values of energy (i.e.,)$E_A<E_B<E_C$. If λ_1, λ_2, λ_3 are the wavelengths of radiations corresponding to the transitions C to B, B to A and C to A respectively, which of the following statements is correct. $(\boldsymbol{\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}})$
8. The elliptical orbits of electron in the atom were proposed by **(Sommerfeld)**
9. X- ray is **(phenomenon of conversion of kinetic energy into radiation)**
10. In an X – ray tube, the intensity of the emitted X – ray beam is increased by **(increasing the filament current)**
11. The energy of a photon of characteristic X – ray from a Coolidge tube comes from **(an atomic transition in the target)**
12. A Coolidge tube operates at 24800 V. The maximum frequency of X – rays emitted from Coolidge tube is **(6×10^{18} Hz)**
13. In hydrogen atom, which of the following transitions produce a spectral line of maximum wavelength **($6 \rightarrow 5$)**
14. In hydrogen atom, which of the following transitions produce a spectral line of maximum frequency **($2 \rightarrow 1$)**
15. After pumping process in laser, **(the number of atoms in the excited state is greater than the number of atoms in the ground state)**
16. The chromium ions doped in the ruby rod **(absorbs green light)**

UNIT – 7 DUAL NATURE OF RADIATION AND MATTER AND RELATIVITY

1. A photon of frequency υ is incident on a metal surface of threshold frequency v_0. The kinetic energy of the emitted photoelectron is **($h(\upsilon-\upsilon_0)$)**
2. The work function of a photoelectric material is 3.3 eV. The threshold frequency will be equal to **(8×10^{14} Hz)**
3. The stopping potential of a metal surface is independent of **(intensity of incident radiation)**
4. At the threshold frequency, the velocity of the electron is **(zero)**
5. The photoelectric effect can be explained on the basis of **(quantum theory of light)**
6. The wavelength of the matter wave is independent of **(charge)**
7. If the kinetic energy of the moving particle is E, then the de Broglie wavelength is, $(\boldsymbol{\lambda = \frac{h}{\sqrt{2mE}}})$
8. The momentum of the electron having wavelength $2A^0$ is **(3.3×10^{-24} kg ms^{-1})**
9. According to relativity, the length of a rod in motion **(is less than its rest length)**
10. If 1 kg of a substance is fully converted into energy, then the energy produced is **(9×10^{16} J)**

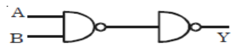
UNIT – 8 NUCLEAR PHYSICS

1. The nuclear radius of $_4Be^8$ nucleus is **(1.3×10^{-13} m)**
2. The nuclei $_{13}Al^{27}$ and $_{14}Si^{28}$ are example of **(isotones)**
3. The mass defect of a certain nucleus is found to be 0.03 amu. Its binding energy is **(27.93 MeV)**
4. Nuclear fission can be explained by **(liquid drop model)**
5. The nucleons in a nucleus are attracted by **(nuclear force)**
6. The ionization power is maximum for **(α – particles)**
7. The half life period of a certain radioactive element with disintegration constant 0.0693 per day is **(10 days)**
8. The radio-isotope used in agriculture is **($_{15}P^{32}$)**
9. The average energy released per fission is **(200 MeV)**
10. The explosion of atom bomb is based on the principle of **(uncontrolled fission reaction)**
11. Anaemia can be diagnosed by **($_{26}Fe^{59}$)**
12. In the nuclear reaction $_{80}Hg^{198} + X \rightarrow {}_{79}Au^{198} + {}_1H^1$, X – stands for **(neutron)**
13. In β – decay **(neutron number decreases by one)**
14. Isotopes have **(same proton number but different neutron number)**
15. The time taken by the radioactive element to reduce to 1 / e time is **(mean life)**
16. The half life period of N^{13} is 10.1 minute. Its life time is **(infinity)**
17. Positive rays of the same element produce two different traces in a Bainbridge mass spectrometer. The positive ions have **(different mass with same velocity)**
18. The binding energy of **($_{26}Fe^{56}$)** nucleus is **(493 MeV)**
19. The ratio of nuclear density to the density of the mercury is about **(1.3×10^{13})**

UNIT – 9 SEMICONDUCTOR DEVICES AND THEIR APPLICATIONS

1. The electrons in the atom of an element which determine its chemical and electrical properties are called **(valance electrons)**
2. In an N – type semiconductor, there are **(immobile positive ions)**
3. The reverse saturation current in a PN junction diode is only due to **(minority carriers)**
4. In the forward bias characteristic curve, a diode appears as **(ON switch)**
5. Avalanche breakdown is primarily dependent on the phenomenon of **(collision)**
6. The colour of light emitted by a LED depends on **(type of semi conductor material)**
7. The emitter base junction of a given transistor is forward biased and its collector – base junction is reverse biased. If the base current is increased, then its **(I_C will increase)**
8. Improper biasing of a transistor circuit produces **(distortion in the output signal)**
9. An oscillator is **(an amplifier with feedback)**
10. In a Colpitt's oscillator circuit **(capacitive feedback is used)**
11. Since the input impedance of an ideal operational amplifier is infinite, **(its input current is zero)**

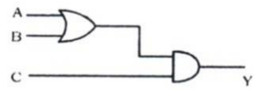
12. The following arrangement performs the logic function of ____ gate



(AND)

13. If the output (Y) of the following circuit is 1, the inputs A B C must be

(1 0 1)



14. According to the laws of Boolean algebra, the expression (A+AB) is equal to **(A)**

15. The Boolean expression ABC can be simplified as **$\bar{A} + \bar{B} + \bar{C}$**

UNIT – 10 COMMUNICATION SYSTEMS

1. High frequency waves follow **(the line of sight direction)**
2. The main purpose of modulation is to **(transmit low frequency information over long distances efficiently)**
3. In amplitude modulation **(the amplitude of the carrier wave varies in accordance with the amplitude of the modulating signal)**
4. In amplitude modulation, the band width is **(twice the signal frequency)**
5. In phase modulation **(both the phase and the frequency of the carrier wave varies)**
6. The RF channel in a radio transmitter produces **(high frequency carrier waves)**
7. The purpose of dividing each frame into two fields so as to transmit 50 views of the picture per second is **(to avoid flicker in the picture)**
8. Printed document to be transmitted by fax are converted into electrical signals by the process of **(scan)**

UNIT – I ELECTROSTATICS

3 Mark Questions And Answers

1. **What is meant by quantization of charges ?**

   i) The electric charge of any system is an integral multiple of a least amount of charge (e).

   ii) q=ne here n is an integer , e=1.602 x 10^{-19} C

2. **State the law of conservation of electric charges.**

   i) The total charge in an isolated system always remains constant.

   ii) Electric charges can neither be created nor destroyed. The total charge always remains conserved.

3. **What is meant by additive nature of charge . Give an example.**

   The total electric charge of a system is equal to the algebraic sum of electric charges located in the system. For example , if two charged bodies of charges +2q , -5q are brought in contact, the total charge of a system is -3q.

4. **State Coulomb's law in electrostatics**.

   The force of attraction or repulsion between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them.

   Vector notation:$F_{12} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2{}_{21}}\hat{r}_{21}$

5. Define 1 Coulomb .

One Coulomb is defined as the quantity of charge which when placed at a distance of 1 metre in air or vacuum from an equal and similar charge , experiences a repulsive force of $9x10^9$ N.

6. What is relative permittivity?

It is the ratio of permittivity of the medium to the permittivity in free space or air.

$$\varepsilon_r = \frac{\varepsilon}{\varepsilon_o}$$

7. State the super position principle in electrostatics.

The total force on a given charge is the vector sum of the forces exerted on it due to all other charges.

$$\vec{F}_1 = \vec{F}_{12} + \vec{F}_{13} + \vec{F}_{14} + \ldots + \vec{F}_{1n}$$

8. Define electric field intensity. Give its unit

Electric field intensity at any point is defined as the force experienced by a unit positive charge kept at that point. Unit : NC^{-1}

9. What is electric dipole? Define electric dipole moment.

Two equal and opposite charges separated by a very small distance constitute an electric dipole.

The magnitude of the dipole moment is given by the product of the magnitude of any one of the charges and the distance between them.$p = q \times 2d$ Unit: Cm.

10. Explain the working of microwave oven.

i) The device which is used to cook the food in a short time produces non-uniform oscillating electric field when it is operated.

ii) The water molecules in the food act as dipoles and are excited by an oscillating torque.

iii) A few bonds of water molecules are broken and the heat energy produced is used to cook food

11. Define electric potential.

The electric potential in an electric field is defined as the amount of work done in moving a unit positive charge from infinity to that point against the electric field. Unit : Volt (V)

12. Define electric potential difference.

The electric potential difference in an electric field is defined as the amount of work done in moving a unit positive charge from one point to another point against the electric field. Unit : Volt (V)

13. Define 1 Volt.

The potential difference between two points is 1 volt if 1 joule of work is done in moving 1 Coulomb of charge from one point to another point against the electric field.

14. What is electric potential energy of two point charges system?

The electric potential energy of two point charges is equal to the work done to assemble the charges. Unit : Joule (J)

15. What is meant by equipotential surface ?

If all the points of the surface are at the same electric potential, then the surface is called an equipotential surface.

16. Define electric flux. Give it Units.

The total number of electric lines of force, crossing through the given area is called the electric flux. Unit : N m^2 C^{-1}

17. State Gauss's law in electrostatics

The total flux of the electric field over any closed surface is equal to $\frac{1}{\varepsilon_0}$ times the net charge enclosed by the surface ie. $\Phi = \frac{q}{\varepsilon_0}$.

18. What is electrostatic shielding ?

i) The process of isolating a certain region of space from external field is called electrostatic shielding.

ii) The electric field inside the conductor is zero.

19. Why is it safer to sit inside a car (bus) rather than standing under a tree during lightning?

i) The electric field inside the car (bus) becomes zero.

ii) The metal body of the car (bus) provides electrostatic shielding.

iii) During lightning the electric discharge passes through the body of the car (bus)

20. What is electrostatic induction ?

The process of obtaining charges in a conductor without any contact with another charge is known as electrostatic induction.

21. What is a capacitor? Define capacitance of a capacitor.

Capacitor is a device to store charges.

Capacitance of a capacitor is defined as the ratio of charge given to the conductor to the potential developed in the conductor. Unit : farad(F)

22. Define 1 farad.

A conductor has a capacitance of 1 farad if a charge of 1 coulomb given to it raises its potential by 1 volt.

23. What are non polar molecules ? Give examples.

A non polar molecule is one in which the centre of gravity of the positive charges coincide with the centre of gravity of the negative charges. They do nont permanent dipole moments. Eg : O_2 , N_2 , H_2 etc.

24. What are polar molecules? Give examples.

A polar molecule is one in which the centre of gravity of the positive charges are separated from the centre of gravity of the negative charges. They have permanent dipole moments. Eg : N_2O , H_2O , HCl, NH_3 etc.

25. What is electric polarization ?

The alignment of the dipole moments of the permanent or induced dipoles in the direction of applied electric field is called polarisation or electric polarisation.

26. What are dielectrics? What is the effect of introducing a dielectric slab between the plates of a parallel plate capacitor?

i) A dielectric is an insulating material in which all the electrons are tightly bound to the nucleus of the atom.

ii) The capacitance of the capacitor increases if a dielectric is introduced.

27. Give the applications of the capacitors?

i) They are used in the ignition system of automobile engines to eliminate sparking.

ii) They are used to reduce voltage fluctuations in power supplies .

iii) They are used to increase the efficiency of power transmission.

28. What is corona discharge or action of points? Give its uses?

The leakage of electric charges from the sharp points on the charged conductor is known as corona discharge or action of points.

It is used in electrostatic machines for collecting charges and in lightning conductors.

29. A sample of HCl gas is placed in an electric field of 2.5 x 10^4 N C^{-1}. The dipole moment of each HCl molecule is 3.4 x 10^{-30} C m. Find the maximum torque that can act on a molecule.

Solution : :- Torque τ = pE $\sin\theta$

Maximum Torque τ_{max} = pE [$\because \theta = 90°$, $\sin\theta = 1$]

$\tau_{max} = 3.4\times10^{-30}\times2.5\times10^{4}$

$\boldsymbol{\tau_{max}=8.5\times10^{-26}}$ **Nm**

30. Calculate the potential at a point due a charge of 4 x 10^{-7} C located at 0.09 m away.

Solution : $V = \frac{1}{4\pi\varepsilon o}\frac{q}{r}$

$$= 9 \text{ x } 10^9 \text{ x } \frac{4 \text{ x } 10^{-7}}{0.09}$$

$$V = \frac{9 \text{ x } 10^9 \text{ x } 4 \text{ x } 10^{-7}}{9 \text{ x } 10^{-2}} \Rightarrow \mathbf{V = 4 \text{ x } 10^4 V}$$

31. An infinite line charge produces a field of 9 x 10^4 N C^{-1} at a distance of 2 cm. Calculate the linear charge density.

Solution :

$$E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

$$\lambda = E \times 2\pi\varepsilon_0 r$$

$$= 9\times10^4 \times \frac{1}{18} \times10^{-9}\times2\times10^{-2}$$

$$\left(\frac{1}{4\pi\varepsilon_0} = 9\times10^9 \qquad \frac{1}{2X2\pi\varepsilon_0} = 9\times10^9 \right)$$

$\boldsymbol{\lambda=10^{-7}}$ **Cm^{-1}**

32. Three capacitors each of capacitances 9 pF are connected in series. What is the total capacitance of the capacitor?

Solution :

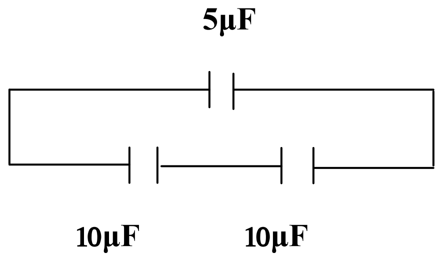
$$\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$\frac{1}{C_S} = \frac{1}{9} + \frac{1}{9} + \frac{1}{9}$$

$$\frac{1}{C_S} = \frac{3}{9}; \quad \frac{1}{C_S} = \frac{1}{3}$$

$$\mathbf{C_s = 3pF}$$

33. Calculate the effective capacitance of the combination.



Solution : $C_1 = 5\mu F$; $C_2 = 10\ \mu F$;

$C_3 = 10\ \mu F$

C_2 and C_3 are in series.

$$\frac{1}{C_S} = \frac{1}{C_2} + \frac{1}{C_3}\ ; \qquad \frac{1}{C_S} = \frac{1}{10} + \frac{1}{10}$$

$$\frac{1}{C_S} = \frac{2}{10} \Rightarrow \frac{1}{C_S} = \frac{1}{5} \Rightarrow C_s = 5\mu F$$

Now C_1 and C_s are in parallel.

$$C_p = C_1 + C_s$$

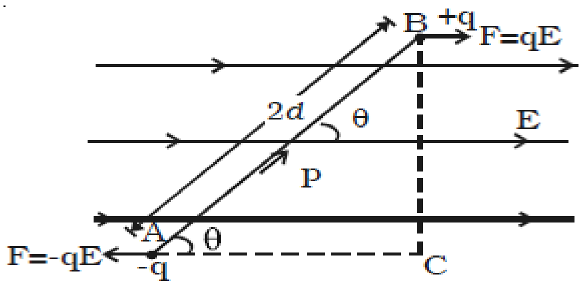
$$C_p = (5+5)\ \mu F \Rightarrow C_p = 10\mu F$$

5 Mark Questions And Answers

1.List the properties of electric lines of forces.

(i) Lines of force start from positive charge and terminate at negative charge.
(ii) Lines of force never intersect.
(iii) The tangent to a line of force at any point gives the direction of the electric field (E) at that point.
(iv) The number of lines per unit area, through a plane at right angles to the lines, is proportional to the magnitude of E. The lines of force are close together if, E is large an E is small where they are far apart,
(v) The number lines of force emerging out from q charge $N = \frac{q}{\varepsilon_0}$

2. Torque acting on an electric dipole



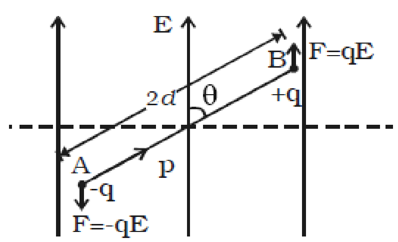
- The dipole AB is at an angle θ with the electric field.
- The force acting on q is q E., The force on –q is -qE
- The net force acting on the dipole is zero
- A torque acts on the dipole which tends the dipole in the direction of the field.
- Torque $\tau = F \times 2d \sin\theta$
- $\tau = qE \times 2d \sin\theta$ ($\because p = q \times 2d$)

  $\tau = pE \sin\theta$

In vector notation, $\vec{\tau} = \vec{p} \times \vec{E}$

3.Electric potential energy of an electric dipole in uniform electric field.

It is the work done in rotating the dipole to the desired position in the electric field.

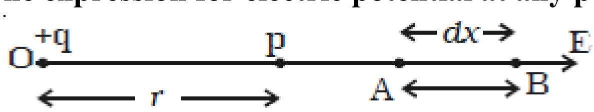


- Torque on the dipole $\tau = pE \sin\theta$
- The work done to rotate the dipole through an angle $d\theta$, $dW = \tau d\theta$

  $dW = pE\sin\theta \, d\theta$
- The work done to rotate dipole through an angle θ, $W = \int pE \sin\theta d\theta$

  $W = -pE \cos\theta$
- Electric potential energy of an electric dipole $U = -pE\cos\theta$

4. The expression for electric potential at any point due to a point charge.



- The potential difference between A and B , $dV = -E\, dx$
- Electric field at A , $E = \frac{1}{4\pi\varepsilon_0} \frac{q}{x^2}$

$$dV = -\frac{1}{4\pi\varepsilon_0} \frac{q}{x^2} dx$$

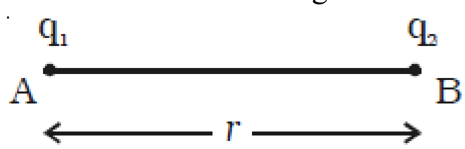
- The electric potential at P is the work done in moving a unit positive charge from infinity to that point

$$V = \int_{\infty}^{r} \frac{-q}{4\pi\varepsilon_0 x^2}\, dx$$

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

5. The expression for electric potential energy of two point charge system.

The electric potential energy of a two point charge system is equal to the work done to assemble the charges.



- The potential at B due to $q_1$charge , $V = \frac{q_1}{4\pi\varepsilon_0 r}$
- The work done to bring q_2 charge to B , $W = Vq_2$

  The electric potential energy $U = \frac{q_1 q_2}{4\pi\varepsilon_0 r}$

- The work done is stored as electric potential energy in the system

6. The energy stored in a capacitor.

- The capacitor is a charge storage device. This work done to store the charges is stored as electrostatic potential energy in the capacitor.
- If dq is the additional charge given to the plate,

  work done is, $dw = V dq$
- $\left[dW = \frac{q}{C} \quad dq \qquad \left[\because V = \frac{q}{C}\right]\right]$
- Total work done $W = \int_0^q \frac{q}{C} \quad dq, \; W = \frac{q^2}{2C}$
- This work done is stored as electric potential energy
- $U = \frac{q^2}{2C}$

  $U = \frac{1}{2}CV^2 \qquad [\because q = CV]$

10 Marks Questions And Answers

1. The expression for electric field intensity at any point due to an electric dipole along the axial line.

The charges –q and +q at A and B constitute an electric dipole. P is a point at a distance, r from the centre of the dipole along the axial line

The electric field at the point P due to +q placed at B is,

$$E_1 = \frac{1}{4\pi\varepsilon_o}\frac{q}{(r-d)^2} \quad \text{(along BP)}$$

E_1 and E_2 act in opposite directions.

Therefore, the magnitude of resultant electric field (E) acts in the direction of the vector with a greater magnitude. The resultant electric field at P is,

$$E = E_1 + (-E_2)$$

$$E = \left[\frac{1}{4\pi\varepsilon_o}\frac{q}{(r-d)^2} - \frac{1}{4\pi\varepsilon_o}\frac{q}{(r+d)^2}\right] \text{along BP.}$$

$$E = \frac{q}{4\pi\varepsilon_o}\left[\frac{1}{(r-d)^2} - \frac{1}{(r+d)^2}\right] \text{ along BP}$$

$$E = \frac{q}{4\pi\varepsilon_o}\left[\frac{4rd}{(r^2-d^2)^2}\right] \text{along BP.}$$

If the point P is far away from the dipole, then d <<r

$$\therefore \quad E = \frac{q}{4\pi\varepsilon_o}\frac{4rd}{r^4} = \frac{q}{4\pi\varepsilon_o}\frac{4d}{r^3}$$

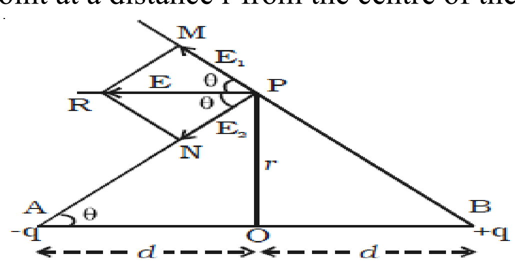
$$E = \frac{1}{4\pi\varepsilon_o}\frac{2p}{r^3} \text{ along BP.}$$

[$\because$ Electric dipole moment p = q x 2d]

E acts in the direction of dipole moment.

2. The expression for electric field at any point due to electric dipole along the equatorial line

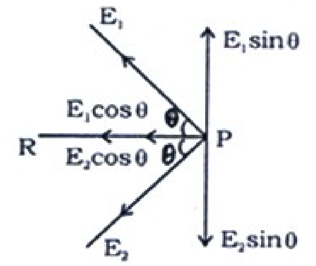
- -q and +q charges at A and B Constitute an electric dipole.
- P is a point at a distance r from the centre of the dipole O along the equatorial line



Electric field at P due to +q

$$E_1 = \frac{1}{4\pi\varepsilon_o}\frac{q}{BP^2} \text{ along BP.}$$

$$= \frac{1}{4\pi\varepsilon_o}\frac{q}{(r^2+d^2)} \text{ along BP } (\because BP^2 = OP^2 + OB^2)$$



Electic field at P due to -q

$$E_2 = \frac{1}{4\pi\varepsilon_o}\frac{q}{AP^2} \text{ along PA}$$

$$E_2 = \frac{1}{4\pi\varepsilon_o}\frac{q}{(r^2+d^2)} \text{ along PA}$$

$E_1 = E_2$, Resolving E_1 and E_2 in two perpendicular components

E_1 Sin θ , E_2 Sin θcancel each otherE_1 cosθ and E_2 cos$\theta$are added in the same direction along PR

$E = E_1 \cos\theta + E_2 \cos\theta$ (along PR)

$E = 2 E_1 \cos\theta$ ($\because E_1 = E_2$)

$$E = 2 \times \frac{1}{4\pi\varepsilon_o}\frac{q}{(r^2+d^2)} \times \cos\theta$$

- But,$\cos\theta = \frac{d}{\sqrt{r^2+d^2}}$

$$E = \frac{1}{4\pi\varepsilon_o}\frac{q}{(r^2+d^2)} \times \frac{2d}{(r^2+d^2)^{1/2}} = \frac{1}{4\pi\varepsilon_o}\frac{q2d}{(r^2+d^2)^{3/2}}$$

$$= \frac{1}{4\pi\varepsilon_o}\frac{p}{(r^2+d^2)^{3/2}} \quad (\because p = q2d)$$

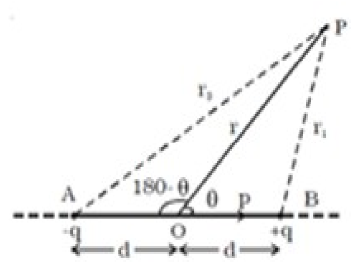
$\because$ **d << r,** $\mathbf{E = \frac{p}{4\pi\varepsilon_o r^3}}$

The direction of E is along the axis of the dipole and opposite to that of the dipole moment.

3. Expression for potential at any point due to an electric dipole.

-q and +q charges at A and B form an electric dipole . Its dipole moment is p. P is a point at a distance r from O. OP makes an angle θ with the axis of the dipole

Electric potential at P due to +q charge $= \frac{1}{4\pi\varepsilon_0}\frac{q}{r_1}$



Electric potential at P due to -q charge $= -\frac{q}{4\pi\varepsilon_0 r_2}$

Potential at Pdue to dipole $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r_1} - \frac{1}{4\pi\varepsilon_0}\frac{q}{r_2}$

$$V = \frac{q}{4\pi\varepsilon_o}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

Using cosine law, $r_1^2 = r^2 + d^2 - 2 r d \cos\theta$

$\because d << r$, $r_1^2 = r^2 \left(1 - \frac{2d\cos\theta}{r}\right)$,

$$\frac{1}{r_1} = \frac{1}{r}\left(1 + \frac{d\cos\theta}{r}\right), \quad \frac{1}{r_2} = \frac{1}{r}\left(1 - \frac{d}{r}\cos\theta\right)$$

$$V = \frac{q}{4\pi\varepsilon_o}\left[\frac{1}{r}\left(1+\frac{d\cos\theta}{r}\right) - \frac{1}{r}\left(1-\frac{d\cos\theta}{r}\right)\right]$$

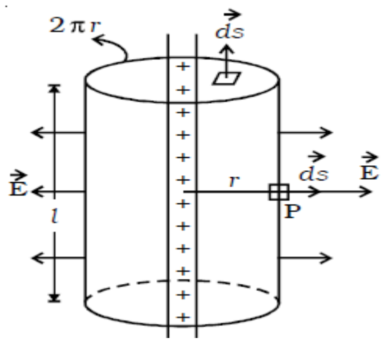
$$\therefore V = \frac{1}{4\pi\varepsilon_o}\frac{q\times 2d\cos\theta}{r^2} \quad (\because p = q \times 2d)$$

$$V = \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$$

- **Special cases**

1. If $\theta=0^0$, $V=\frac{p}{4\pi\varepsilon_0 r^2}$
2. If $\theta=180^0$, $V=\frac{-p}{4\pi\varepsilon_0 r^2}$
3. If $\theta=90^0$, $V = 0$

4. **Expression for electric field due to an infinite long straight charged wire.**



Consider an uniform the charged wire of infinite length having +q charge. Its linear charge density is $\lambda = \frac{q}{l}$. Let P be a point at a distance r from the wire. Consider a cylindrical Gaussian surface of length ℓ and radius r , closed at each end by plane caps normal to the axis.

Electric flux through the curved surface $(\phi) = \oint E\, dS \cos\theta$

$\phi = \oint E\, dS$ [$\because \theta=0$, $\cos\theta=1$] $\qquad \phi = E\,(2\pi r\ell)$

E and **d** are perpendicular to each other , the flux through the plane caps is equal to zero

By Gauss's law, $\phi = \frac{q}{\varepsilon_o}$

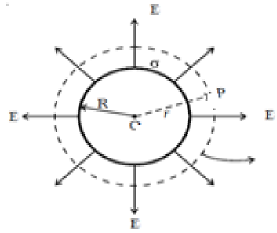
$$E\,(2\pi r\ell) = \frac{\lambda}{\varepsilon_o} \quad (\because q = \lambda)$$

$$\mathbf{E} = \frac{\lambda}{2\pi\varepsilon_0 r}$$

The direction of **E** is radially outward for positive charge. The direction of **E** is radially inward for negative charge.

5.The expression for electric field due to uniformly charged spherical shell

i) At a point outside the shell



Consider a charged shell of radius R . Let P be a point at a distance r from the centre. The sphere with radius r is the Gaussian surface. Electric field acts perpendicular to the surface.

Electric flux crossing normally to the surface,

$$\phi = \int_s \vec{E} \cdot \vec{ds} = \int_s E\, ds$$

[∵ θ=0]

$$\phi = E\ (4\pi r^2)$$

By Gauss's law $\phi = \frac{q}{\varepsilon_0}$

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

$$\mathbf{E} = \frac{q}{4\pi\varepsilon_0 r^2}$$

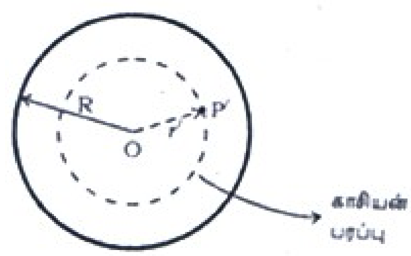
ii) At a point on the surface

At a point on the surface $\mathbf{E} = \frac{q}{4\pi\varepsilon_0 R^2}$ [∵ $r = R$]

iii) At a point inside the shell

Let r' be the distance of the point P from the centre outside the shell . The sphere with radius r' is the Gaussian surface

The flux crossing normally to the surface



$$\phi = \int_s \vec{E} \cdot \vec{ds} = \int_s E ds = E \times (4\pi r'^2)$$

[∵ θ=0]

By Gauss's law $\phi = \frac{q}{\varepsilon_0}$

Here q = 0, (The total charge inside the surface is zero)

$$E \times 4\pi r'^2 = \frac{q}{\varepsilon_0} = 0 \qquad \therefore E = 0$$

6.Principle of a capacitor , capacitance of a parallel plate capacitor.

Principle of a capacitor:-Capacitor is a device for storing electric charges.

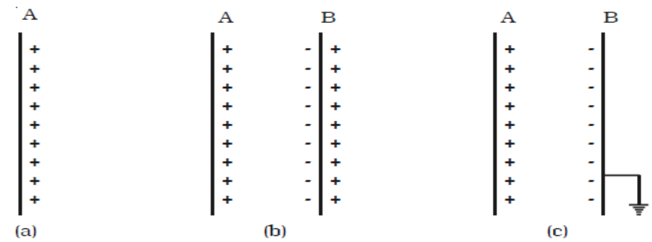
- Consider an insulated conductor (Plate A) with a positive charge

  'q'having potential lV . The capacitance of A is C=q/V.

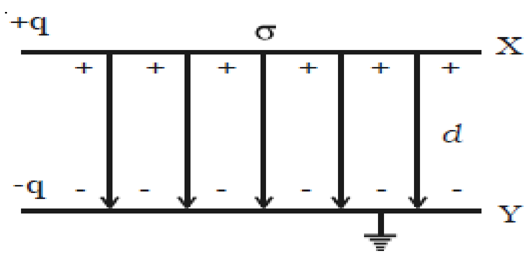
- When another insulated metal plate B is brought near A, negative charges are induced on the side of B near A. An equal amount of positive charge is induced on the other side of B. The negative charge in B decreases the potential of A, and the capacitance of A is increased.
- If the plate B is earthed, positive charges get neutralized Then the potential of A

decreases further, and capacitance of A is considerably increased.

The capacitance depends on the geometry of the conductors and nature of the medium.



Capacitance of a parallel plate capacitor



A parallel plate capacitor consists of two σ parallel metal plates X and Y each of area A, separated by a distance$d$, having a surface charge density σ . A charge$+q$ is given to the plate X. It induces a charge $-q$ on the upper surface of earthed plate Y.

Charge $q = \sigma A$

By the application of Gauss's law, electric field at a point between the two platesis,

$$E = \frac{\sigma}{\varepsilon_o}$$

The potential difference between X and Y

$$V = \int_d^0 -E\,dr$$

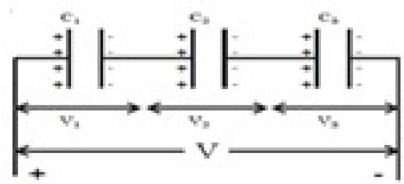
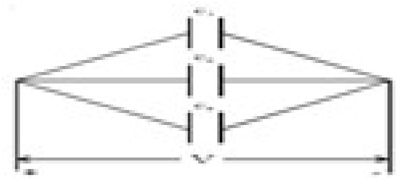
$$= \int_d^0 -\frac{\sigma}{\varepsilon_o}\,dr = \frac{\sigma d}{\varepsilon_o}$$

Capacitance of the parallel plate capacitor $C = \frac{q}{V}$

$$= \frac{\sigma A}{\sigma d/\varepsilon_o}$$

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

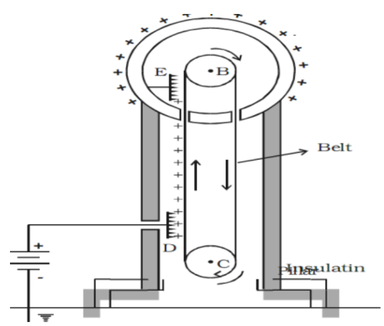
7. Capacitances of capacitors connected in series and parallel.

Capacitors in series	Capacitors in parallel
C_1, C_2, C_3 capacitors are connected in series. C_s is the effective capacitance 	C_1, C_2, C_3 capacitors are connected in parallel . C_p is the effective capacitance 
Charge in each capacitors are equal	Potential in each capacitors are equal
$V_1 = \frac{q}{C_1}$; $V_2 = \frac{q}{C_2}$; $V_3 = \frac{q}{C_3}$ $V = V_1 + V_2 + V_3$	$q_1 = C_1V$; $q_2 = C_2V$; $q_3 = C_3V$ $q = q_1 + q_2 + q_3$
$V = \frac{q}{C_s}$ $\frac{q}{C_s} = \frac{q}{C_1} + \frac{q}{C_2} + \frac{q}{C_3}$	$q = C_pV$ $C_PV = V(C_1+C_2+C_3)$
$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$	$\mathbf{C_P = C_1 + C_2 + C_3}$

8. The principle , construction and working of Van de Graaff Generator.

It is used to produce electrostatic potential difference of the order of 10^7 V.

Principle : Electrostatic induction , action of points



Construction :

- A hollow metallic sphere A is mounted on insulating pillars
- A pulley B is mounted at the centre of the sphere and another pulley C is mounted near the bottom. A belt made of silk moves over the pulleys.
- The pulley C is driven by an electric motor.
- Two comb shaped conductors D and E having number of needles are mounted near the pulleys.
- 10^4 volt is given to the comb D by a power supply.
- The comb E is connected to the inner side of the sphere

Working :

- Because of the high electric field near the comb D, the air gets ionised due to action of points, the negative charges in air move towards the needles and positive charges are repelled on towards the belt. These positive charges stick to the belt, moves up and reaches near the comb E.
- As a result of electrostatic induction, the comb E acquires negative charge and the sphere acquires positive charge. The high electric field at the comb E ionizes the air. Hence, negative charges are repelled to the belt, neutralizes the positive charge on the belt before the belt passes over the pulley. Hence the descending belt will be left uncharged.
- The machine, continuously transfers the positive charge to the sphere. After this stage no more charge can be placed on the sphere, it starts leaking to the surrounding due to ionization of the air.
- The leakage of charge from the sphere can be reduced by enclosing it in a gas filled steel chamber at a very high pressure.
- The high voltage produced in this generator can be used to accelerate positive ions (protons, deuterons) for the purpose of nuclear disintegration.

UNIT – 7 DUAL NATURE OF RADIATION AND MATTER AND RELATIVITY

3 Mark Questions And Answers

1. **What is photo electric effect?**

   Photo electric effect is the phenomena by which a good number of substances, chiefly metals , emit radiations under the influence of radiation such as γ rays , X-rays, ultraviolet and even visible light

2. **Define stopping potential?**

   The minimum negative potential given to the anode for which the photo electric current becomes zero is called stopping potential.

3. **Define threshold (cut-off) frequency.**

   Threshold frequency is defined as the minimum frequency of incident radiation below which the photoelectric emission is not possible completely, however high the intensity of incident radiation may be.

4. **Define work function.**

   The work function of a photo metal is defined as the minimum amount of energy required to liberate an electron from the metal surface. $W = h\vartheta_0$

5. **State Planck's quantum theory.**

   Light is emitted in the form of discrete packets of energy called 'quanta' orphoton.The energy of each photon is $E=h\vartheta$,

6. What are photo electric cells? Give their types.

It is a device which converts light energy into electrical energy.

Their types are

i) Photo emissive cell

ii) Photo voltaic cell

iii) Photo conductive cell

7. What are the uses of electron microscope?

(i)It is used in the industry, to study the structure of textile fibres, surface of metals, composition of paintsetc.

(ii) In medicine and biology, it is used to study virus, and bacteria.

(iii) In physics, it has been used in the investigation of atomic structur eand structure of crystals in detail.

8. What are the limitations of electron microscope?

An electron microscope is operated only in high vacuum. This prohibits the use of the microscope to study living organisms which would evaporate and disintegrates under such conditions.

9. What are De Broglie waves?

The waves associated with matter (particle) are called matter waves or De Broglie waves.

10. Give the wave mechanical concept of an atom.

i) The electron in various orbits behaves as a wave .

ii) The stationary orbits are those in which the orbital circumference ($2\pi r$) is an integral multiple of De Broglie wave length λ

iii) Stationary orbits for an electron are those which contain the complete waves of electron ($2\pi r = n\lambda$)

11. State Einstein's relativity theory.

i) There is no absolutespace

ii) All motions are relative.

iii) The time, mass, length and space are interdependent and are not absolute

12. What is meant by frame of reference? Give examples.

A system of co-ordinate axes which defines the position of a particle in two or three dimensional space is called a frame of reference.

Eg : i) Cartesian co-ordinate system ii) Our earth

13. What are inertial and non-inertial frames of references?

(i)Inertial(or)unaccelerated frames.

A frame of reference is said to be inertial, when the bodies in this frame obey Newton's law of intertia and other laws of Newtonian mechanics. In this frame, a body remains at rest or in continuous motion unless acted upon by a external force.

(ii)Non-inertial(or)accelerated frames

A frame of reference is said to be a non-intertial frame, when a body not acted upon by an external force, is accelerated. In this frame, Newton's laws are not valid.

14. Give the concept of space in classical mechanics.

(i)Fixed frame of reference by which the position or motion of any object in the universe could be measured.

(ii) The geometrical form of an object remains the same irrespective of changes in position or state of motion of the object or observer.

15. Give the concept of time in classical mechanics.

(i) The time interval between two events has the same value for all observers irrespective of their motion.

(ii) If two events are simultaneous for an observer, they are simultaneous for all observers, irrespective of their position or motion. This means simultaneity is absolute.

16. Give the concept of mass in classical mechanics.

In classical mechanics, the mass of the body is absolute and constant and independent of the motion of the body.

17. State the variation of mass with respect to the velocity.

i) The mass of the body changes with velocity.

ii) Einstein established the relation between the mass of a body at rest (m_o)and the mass of the same body moving with velocity v is

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

18. State the postulates of special theory of relativity .

i) The laws of physics are same in all inertial frames of references .

ii) The velocity of light in free space is constant in all the frames of reference.

19. If a moves with the velocity of light , what will be its mass? Comment on your result.

i.If v=c,$= \frac{m}{0} = \infty$

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

ii. No particle can attain the velocity of light.

20. The work function of a metal is 1.8 eV. Calculate its threshold wave length.

Solution:

W = 1. 8eV = 1. 8 x 1. 6 x 10^{-19}J

$$h\upsilon_0 = W$$

$$h\frac{c}{\lambda_0} = W$$

$$\lambda_0 = \frac{hc}{W}$$

$$\lambda_0 = \frac{6.626 \text{ X } 10^{-34} \text{ X}3 \text{ X } 10^{8}}{1.8 \text{ X } 1.6 \text{ X } 10^{-19}}$$

$$\lambda_0 = \frac{19.878 \text{ X } 10^{-26}}{2.88 \text{ X } 10^{-19}} ,$$

λ_0 = 6. 902 x 10^{-7}m or $\boldsymbol{\lambda_0 = 6902\ \mathring{A}}$

21. What is the de Broglie wave length of an electron of kinetic energy120*eV*?

Solution : $\lambda = \frac{h}{\sqrt{2mE}}$

$$= \frac{6.626 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 120 \times 1.6 \times 10^{-19}}}$$

$\lambda = 1.121 \times 10^{-10}$m (or)

$\boldsymbol{\lambda = 1.121\ \text{A}^\circ}$

22. Calculate the De Broglie wave length of an electron in the 4th orbit of hydrogen atom .

Solution : $r_4 = 4^2 r_1 = 16 \times 0.53\text{A}^\circ$ $[\because r_1 = 0.53\text{A}^\circ]$

$2\pi\, r_4 = n\lambda,$

$\lambda = \frac{2\pi r_4}{n}$

$= \frac{2 \times 3.14 \times 0.53 \times 10^{-10} \times 16}{4}$

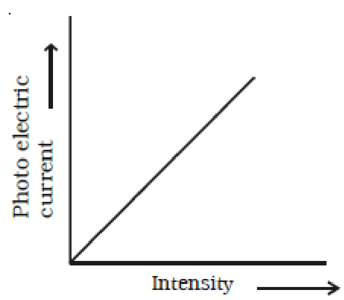
$= 3.14 \times 0.53 \times 10^{-10} \times 8$

$= \mathbf{13.313 \times 10^{-10} m}$

5MarksQuestionsAndAnswers

1.The effect of intensity of incident radiation on photo electric current.

- The intensity of incident radiation is varied and the corresponding photo electric current is measured (anode potential and frequency constant).



- The photo electric current increases linearly with a intensity of the incident radiation.
- The photo electric current is directly propotional to number of photo electrons.
- The number of photo electrons emitted per second is propotional to intensity of the incident radiation.

2. Photo electric effect , The laws of photo electric effect

Photo electric effect is the phenomena by which a good number of substances, chiefly metals , emit radiations under the influence of radiation such as γ rays , X-rays, ultraviolet and even visible light

The laws of photo electric effect :

(i) For a given photo sensitive material, there is aminimum frequency called the thres hold frequency, below which emission of photo electrons stops completely, how ever great the intensity may be.

(ii) The photo electric current is directly proportional to the intensity of the incident radiation, provided the frequency is greater than the threshold frequency.

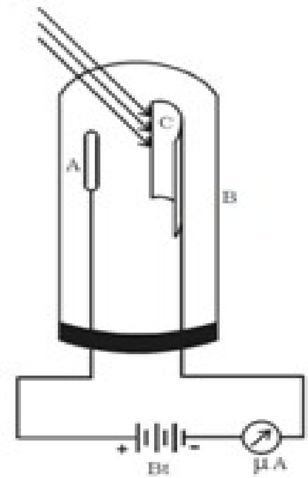
(iii)The photo electric emission is an instantaneous process.

(iv) The maximum kinetic energy of the photo electrons is directly proportional to the frequency of incident radiation, but is independent of its intensity.

3.The construction and working of photo electric cells

It is a device to convert light energy into electrical energy

Construction :



- It consists of a highly evacuated bulb B made of glass or quartz. A semi cylindrical metal plate C is the cathode.
- coated with a low work function material such as caesium oxide.
- A thin platinum wire A and serves as the anode.

Working :

- When a light of suitable wave length falls on the cathode, photo electrons are emitted, which are attracted by the anode A.
- The resulting current is measured by a micro ammeter.
- The current produced is proportional to the intensity of the incident light for a given frequency.

4. Applications of photo electric cells :

i) They are used for controlling the temperature of furnaces.

(ii)They are used for automatic switching on and off the street lights.

(iii)They are used in obtaining electrical energy from sunlight during space travel.

(iv) They are used in opening and closing of door automatically.

(v)They are used in instruments measuring light illumination.

5. De Broglie wave length of matter waves

- Planck's equation : $E = h\upsilon$
- Einstein's equation: $E = mc^2$
- $h\upsilon = mc^2$

$$h\frac{c}{\lambda} = mc^2 \qquad (\because \upsilon = \frac{c}{\lambda})$$

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

- If $c = v$
- $\lambda = \frac{h}{mv}$ or $\lambda = \frac{h}{p}$

6. De Broglie wave length of an electron

Kinetic energy of an electron $\frac{1}{2}m\text{v}^2 = eV$

$$\text{v} = \sqrt{\frac{2eV}{m}} \qquad (\lambda = \frac{h}{m\text{v}})$$

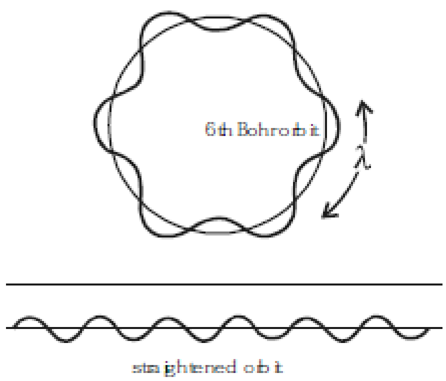
$$\lambda = \frac{h}{m\sqrt{\frac{2eV}{m}}} = \frac{h}{\sqrt{2meV}}$$

$$\lambda = \frac{12.27}{\sqrt{V}} A^0$$

Since E=eV, $\lambda = \frac{h}{\sqrt{2mE}}$

7.The wave mechanical concept of atom

- De Broglie wave length $\lambda = \frac{h}{mv}$
- The electron in various orbits behaves as a wave .
- The stationary orbits are those in which the orbital circumference (2πr) is an integral multiple of De Broglie wave length λ ($2\pi r = n\lambda$)



(n=1, 2, 3, . . .) $\boldsymbol{2\pi r = n(\frac{h}{m\text{v}})}$

$$m\text{v}r = \frac{nh}{2\pi}$$

- De Broglie's concept confirms the Bohr's postulate.

8.Einstein's photo electric equation

- Photo electric equation is explained by quantum theory
- Photo electric emission is the result of interaction between a single photon and an electron in the metal.
- The energy of the photon is used i) to liberate an electron from the metal surface (work function) ii) to impart kinetic energy to the electron

$$h\upsilon = W + \frac{1}{2}m\text{v}^2$$

- If there is no loss of energy , v = v $_{max}$

$$h\upsilon = W + \frac{1}{2}m\mathrm{v}^2{}_{max}$$

- If the frequency (υ) , is equal to the threshold frequency,

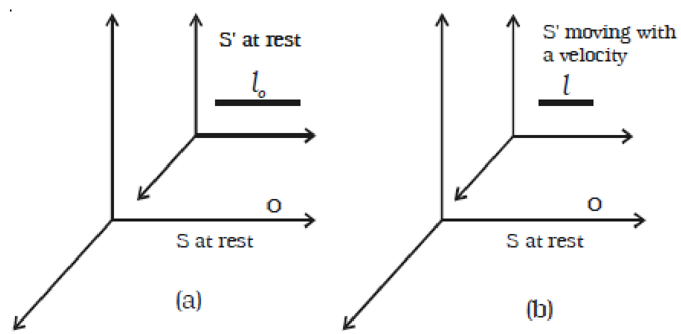
$$W = h\upsilon_0$$

$$h\upsilon = h\upsilon_0 + \frac{1}{2}m\mathrm{v}^2{}_{max}$$

$$h(\upsilon - \upsilon_0) = \frac{1}{2}m\mathrm{v}^2{}_{max}$$

9.Lorentz-Fitzgerald contraction (length contraction)

- Consider two frames of references S and S' . The length of the rod as measured by an observer in S frame of reference is ℓ_0Consider the frame of reference S' moves with the velocity v. Now the length measured by the observer is ℓ.



- $\ell = \ell_0\sqrt{1-\frac{\mathrm{v}^2}{c^2}}$
- $\ell < \ell_0$
- The length contracts by a factor $\sqrt{1-\frac{\mathrm{v}^2}{c^2}}$
- Eg : A circular object will appear as an ellipse for a moving observer.

11.Time dilation

- The clock in the frame of reference S' gives out signals in $t_0$seconds
- The time measured by the observer is t in the frame of reference S
- $t = \frac{t_0}{\sqrt{1-\frac{\mathrm{v}^2}{c^2}}}$
- $t > t_0$
- The time interval is lengthened by a factor $\frac{1}{\sqrt{1-\frac{\mathrm{v}^2}{c^2}}}$
- Eg: The clock in the moving ships will appear to go slower than the clocks in the earth.

12.Einstein's mass – energy equivalence

- Let mo be the rest mass and m be the mass of the body moving with velocity v
- According to Newton's second law, $F = \frac{d}{dt}(m\text{v}) \quad \rightarrow (1)$
- According to relativity theory

$$F = m\frac{d\text{v}}{dt} + \text{v}\frac{dm}{dt} \rightarrow (2)$$

- The increase in kinetic energy

$$dE_k = F\,dx$$

$$dE_k = m\,\text{v} \quad d\,\text{v} \;+ \text{v}^2 dm \rightarrow (3)$$

- According to Einstein's relativity theory

$$m = \frac{m_0}{\sqrt{1 - \frac{\text{v}^2}{c^2}}}$$

Differentiating, $c^2dm = mv\,dv + v^2dm \quad \rightarrow (4)$

- From equations (3) and (4)
- $dE_k = c^2\,dm \quad \rightarrow (5)$

$$\int_0^{E_k} dE_k = c^2 \int_{m_0}^{m} dm$$

Kinetic energy $E_k = mc^2 - m_0c^2$

- Total energy = Kinetic energy + Rest mass energy

$$E = E_k + m_0c^2$$

$$E = mc^2 - m_oc^2 + m_oc^2$$

$$\mathbf{E = mc^2}$$

UNIT–8 NUCLEARPHYSICS

3 Marks Questions And Answers

1. **What are isotopes? Give an Example.**
   Isotopes are atoms of the same element having the same atomic number Z but different mass number A. Eg.${}_1H^1$, ${}_1H^2$ and ${}_1H^3$
2. **What are meant by Isobars? Give an Example.**
   Isobars are atoms of different elements having the same mass number A, but different atomic number Z. Eg. i ${}_8O^{16}$ and ${}_7N^{16}$
3. **What is meant by isotones? Give an Example.**
   Isotones are atoms of different elements having the same number of neutrons. Eg: ${}_6C^{14}$ and${}_8O^{16}$ are some examples of isotones.
4. **What is the value of Nuclear density? What does it show?**
   i) Nuclear density = 1.816×10^{17} kgm^{-3}
   ii) The high value of the nuclear density shows that the nuclear matter is in an extremely compressed state.

5. Define atomic mass unit(1 amu)

One atomic mass unit is considered as one twelfth of the mass of carbon atom $_6C^{12}$.

$1\ amu = \frac{1}{12} \times$ Mass of $_6C^{12}$ atom

$1 amu = 1.66\times10^{-27}$ kg

6. Calculate the energy equivalent of 1amu.

$1 amu = 1.66\times10^{-27}$ kg

According to Einstein's mass energy relation, $E=mc^2$

$E = 1.66\times10^{-27} \times 9\times10^{-16} J$

$E = \frac{1.66\times10^{-27}\times9\times10^{16}}{1.6\times10^{-19}}$ eV $= 931 \times 10^6$ eV

Energy equivalent of 1amu= 931MeV

7. Define mass defect.

The difference in the total mass of the nucleons and the actual mass of the nucleus is known as the mass defect.

$Zm_p + Nm_n - m = \Delta m$

8. Define Binding energy.

When the protons and neutrons combine to form a nucleus, the mass that disappears (mass defect, Δm) is converted into an equivalent amount of energy (Δmc^2). This energy is called the binding energy of the nucleus.

∴ Binding energy $= [Zm_p + Nm_n - m]c^2 = \Delta mc^2$

9. What is meant by radioactivity? (natural radioactivity)

The phenomenon of spontaneous emission of highly penetrating radiations such as α, β and γ – rays by heavy elements having atomic number greater than 82 is called radioactivity.

10. Write the Radioactive law of disintegration.

The rate of disintegration at any instant is directly proportional to the number of atoms of the element present at that instant. i.e. $\frac{-dN}{dt} \propto N$

11. Define Curie.

Curie is defined as the quantity of a radio active substance which gives 3.7×10^{10}disintegrations per second 3.7×10^{10}becquerel = 1 curie

12. Define artificial radio activity.

The phenomenon by which even light elements are made radioactive by artificial are induced methods is called artificial radio activity.

13. Define roentgen.

One roentgen is defined as the quantity of radiation which produces 1.6×10^{12}pairs of ions in 1gram of air.

14. What are the methods of producing artificial radio – isotopes?

(i) Artificial radio-is isotopes are produced by placing the target element in the nuclear reactor, where plenty of neutrons are available.

E.g.:- (1)$_{15}P^{31} + _{0}n^{1} \rightarrow _{15}P^{32*} + \gamma$,

(ii) Another method of production of artificial radio-isotope is to bombard the target element with particles from particle accelerators like cyclotron

E.g.:- $_{11}Na^{23} + _{1}H^{2} \rightarrow _{11}Na^{24*} + _{1}H^{1}$

15. What is meant by radio – carbon dating?

(i) The half life of C^{14} is 5570 years. The ratio of C^{14} and C^{12} in the atmosphere is $1:10^{6}$.

(ii) Living things take C^{14} from food and air. However with death, the intake of C^{14} stops and the C^{14} that is already present begins to decay.

The amount of C^{14} in the sample will enable the calculation of time of death i.e, the age of the specimen could be estimated. This is called radio-carbon dating

16. What is artificial transmutation? Give example.

Artificial transmutation is the conversion of one element into another by artificial methods.

$_{7}N^{14} + _{2}He^{4} \longrightarrow _{8}O^{17} + _{1}H^{1}$

17. What are the precautions are to be taken for those, who are working in radiation laboratories?

(i) Radio active materials are kept in thick – walled lead container.

(ii) Lead aprons and lead gloves are used while working in hazardous area.

(iii)All radioactive samples are handled by a remote control process.

(iv)A small micro–film badge is always worn by the person andit is checked periodically for the safety limit of radiation.

18. What is meant by nuclear fission?

The process of breaking up of the nucleus of a heavier atom into two fragments with the release of large amount of energy is called nuclear fission.

19. What is meant by chain reaction?

i) A chain reaction is a self propagating process nuclear fission

ii) The number of neutrons goes on multiplying rapidly almost in a geometrical progression

20. Distinguish between electro static and cyclic particle accelerators

Sl.No.	Electro static accelerators	Cyclic accelerators
1	Particles are accelerated by applying a constant potential difference.	Particles are accelerated in multiple steps imparting a small energy in each successive step.
2	They can accelerate the particles up to a few million electron- volt energy..	They can accelerate the particles up to energy of the order of 10^{9}eV.
3	E.g. VandeGraff, Generator, Cockcroft-Walton generators	E.g. Cyclotron, Syncrotran, and betatron

21. Define critical size and critical mass?

Critical size of a system containing a fissile material is defined as the minimum size in which atleast one neutron is available for further fission reaction. The mass of the fissile material at the critical size is called critical mass.

22. What are moderators? Give examples.

Moderator is to slow down fast neutrons produced in the fission process having an average energy of about 2MeV to thermal neutrons with an average energy of about 0.025eV, which are in thermal equilibrium with the moderator. E.g. Ordinary water and heavy water and graphite

23. What are uses of Control rods? Give example.

The control rods are used to control the chain reaction by absorbing neutrons. E.g. Cadmium and Boron.

24. What is meant by Breeder reactor?

i) There actors which produce fissile material during the operation by the absorption of neutrons are called breeder reactors.

ii) $_{92}U^{238}$ and $_{90}Th^{232}$ are not fissile materials but area bundant in nature . In there actor, these can be converted in to a fissile material $_{94}Pu^{239}$ and $_{92}U^{233}$ respectively by absorption of neutrons.

25. What is Nuclear fusion or Thermo nuclear reaction?

Nuclearfusion is a process in which two or more lighter nuclei combine to form a heavier nucleus. This reaction can be carried out only at high temperature. So it is otherwise called thermo nuclear reaction.

26. What is meant by Cosmic Rays?

The ionising radiation many times stronger than γ- rays entering the earth from all the directions from cosmic orinterstellar space is known as cosmic rays. They are of two types primary cosmic rays and secondary cosmic rays.

27. What is meant by Pair production and annihilation of matter?

- The conversion of a photon into an electron–positron pair on its interaction with the strong electric field surrounding a nucleus is called pair production.
- The converse of pair production in which an electron and positron combine to produce a photon is known as annihilation of matter.

28. Write a note on Lepton.

(i) Leptons are lighter particles having mass equal to or less than about 207 times the mass of an electron

(ii) This group contains particles such as electron, positron, neutrino, antineutrino, positive and negative mesons.

(iii) The neutrinos and antineutrinos are massless and chargeless particles, but carrier of energy and spin.

29. Write a note on Mesons.

i. Mesons are fundamental particle possessing mass intermediate between electron and proton (m_e and m_p).

ii. The three types of mesons are (1) π-meson (pion) (2) K–meson (kaon) and (3) η - meson.

iii. The mesons are the interaction agents between nucleons.

30. Write a note on Baryons.

(i) Baryons form the heavier particle group.

(ii) Baryons are classified as nucleons and hyperons.

(iii)Protons and neutrons are nucleons.

(iv) There are four types of hyperons which are lambda, sigma, xi and omega hyperons.

31. Choose the pairs of isotopes, isobars and isotones from the following isotopes.

$_{11}Na^{22}$, $_{12}Mg^{24}$, $_{11}Na^{24,}$ $_{10}Ne^{23}$

Solution :-

(i) Isotopes : $_{11}Na^{22}$, $_{11}Na^{24}$

(ii) Isobars : $_{12}Mg^{24}$,$_{11}Na^{24}$

(iii)Isotones : $_{11}Na^{24}$,$_{10}Ne^{23}$

32. Find the number of atoms in one gram of $_3Li^6$? (Avagadro No. =$6.023x10^{23}$)

Solution :-

No. of atoms in 6 gm of Li = $6.023x10^{23}$

No. of atoms in 1 gm of Li=$\frac{(6.023x10^{23})}{6}$

$=1.0038x10^{23}$

The radioactive isotope $_{84}Po^{214}$ undergoes a successive disintegration of two α–decays and two β-decays. Find the atomic number and mass number of there sulting isotope.

Solution :-

$_{84}Po^{214} \longrightarrow {_Z}X^A + {_2}He^4 + {_2}He^4 + {_{-1}}e^0 + {_{-1}}e^0$

A + 4 + 4 = 214

A = 214 -8 = 206

Z + 2 + 2 – 1 – 1 = 84

Z + 2 = 84 ⇒ Z = 84 – 2 ⇒ Z = 82

Hence A = 206 and Z = 82

33. The isotope $_{92}U^{238}$ successively under goes three α- decays and twoβ-decays. What is the resulting isotope?

$_{92}U^{238} \longrightarrow {_Z}X^A + {_2}He^4 + {_2}He^4 + {_2}He^4 + {_{-1}}e^o + {_{-1}}e^o$

A+4+4+4= 238

A= 238 – 12 = 226

Z + 2 + 2 + 2 – 1 -1= 92

Z= 92-6+2

Z=88

Hence the Isotope is$_{88}$**Ra**^{226}

34. The half life of radon is 3.8 days. Calculate its mean life.

$\tau = \frac{1}{0.6931} T_{½}$ (or)

$\tau = 1.443 T_{½}$

$\tau = 1.443 x 3. 8$

$\tau = 5. 4834$ days

τ= 5. 5 days

35. What percentage of given radioactive substance will be left after 5 half life periods

Half life Period	Remaining Percentage	Decayed Percentage
I	50%	50%
II	25%	(50 + 25)% = 75%
III	12.5%	(75 + 12.5)% = 87.5%
IV	6.25%	(87.5 + 6.25)% = 93.75%
V	3.125%	(93.75+3.125)% = 96.875%

After 5 half life periods **3.125%** will be left

36. The half-life of $_{84}Po^{218}$ is 3 minute. What percentage of the sample has decayed in 15 minutes?

Half life Period	Remaining Percentage	Decayed Percentage
I (3 minute)	50%	50%
II (6 minute	25%	(50 + 25)% = 75%
III (9 minute)	12.5%	(75 + 12.5)% = 87.5%
IV (12 minute)	6.25%	(87.5 + 6.25)% = 93.75%
V (15 minute)	3.125%	(93.75+3.125)% = 96.875%

In 15 min 96.875% has decayed.

37. Tritium has a half life of 12.5 years. What fraction of the sample of will be left over after 25 years?

Half life Period	Remaining Fraction	Decayed fraction
I (12. 5 Years)	$\frac{1}{2}$	1/2
II (25 Years)	$\frac{1}{4}$	3/4

No. of half lives = $\frac{\text{Total life time}}{\text{Half life}}$

=25/12.5 = 2

Sample left after 25 years = ¼

5 Marks Questions And Answers

1. Explanation of binding energy curve.

- BE/A sharply with mass number A upto20. It increases slowly after A=20.ForA<20, there exists recurrence of peaks corresponding to those nuclei, whose mass numbers are multiples of four and they contain not only equal but also even number of protons and neutrons.

becomes almost flat for mass number between 40 and 120.

- The BE/A8.8MeVatA=56,($_{26}Fe^{56}$). Hence, iron nucleus is the most stable.
- The average B.E./A valueis about 8.5 MeV for nuclei having mass number ranging between 40 and 120. These elements are comparatively more stable and nonradio active.
- For higher mass numbers the curve drops slowly and the BE/A is about 7.6 MeV for uranium. Hence, they are unstable and radioactive.
- The lesser amount of binding energy for lighter and heavier nuclei explains nuclear fusion and fission respectively.

2. Nuclear force and properties of nuclear force.

- There is some other force in the nucleus which overcomes the electrostatic repulsion between positively charged protons and binds the protons and neutrons inside the nucleus called nuclear force.
- Nuclear force is charge independent. It is the same for all the three types of pairs of nucleons (n–n), (p–p) and (n–p).It force is not electrostatic in nature.
- Nuclear force is the strongest known force in nature.
- Nuclear force is not a gravitational force. Nuclear force is about 10^{40} times stronger than the gravitational force.
- Nuclear force is a short range force. It is very strong between two nucleons which are less than 10^{-15}m apart.

3. Properties of α-rays

- They move along straightlines with high velocities.
- They are deflected by electric and magnetic fields.
- They produce intense ionization in the gas through which they pass. (The ionizing power is 100 times greater than that of β-rays and 10,000 times greater than that of γ−rays.)
- They affect photographic plates.
- They produce fluorescence.
- Their penetrating power is less .

4. Properties of β–rays

(i)They move withover therangeof0.3cto0.99c,where c is the velocity of light.
(ii)They are deflected by electric and magnetic fields.
(iii)The ionization power is comparatively low. (less than alpha particles)
(iv) They affect photographic plates.
(v) They produce fluorescence.
(vi)Their penetrating power is greater than that of α−rays.

5. Properties of γ–rays

(i) They travel with the velocity of light.
(ii)They are not deflected by electric and magnetic fields.
(iii)They produce very less ionisation.
(iv)They affect photographic plates.
(v)They have a very high penetrating power.
(vi)They produce fluorescence.

6. Explain the Soddy-Fajan's radio active displacement law.

- **α-decay**

When a radioactive nucleus disintegrates by emitting an α-particle, the atomic number decreases by two and mass number decreases by four.

$$_{88}Ra^{226} \rightarrow _{86}Rn^{222} + _{2}He^{4}$$

- **β-decay**

When a radioactive nucleus disintegrates by emitting a β⁻ particle, the atomic number increases by one and the mass number remains the same.

$$_{90}Th^{234} \rightarrow _{91}Pa^{234} + _{-1}e^{0}$$

- **γ-decay**

When a radio active nucleus emits γ-rays, only the energy level of the nucleus changes and the atomic number and mass number remain the same.

Eg: During the radioactive disintegration of radium ($_{88}Ra^{226}$) in to radon($_{86}Rn^{222}$), gamma ray of energy 0.187MeVisemitted,whenradon returns from the excited state to the ground state.

7. Properties of neutrons

- Neutrons are the constituent particles of all nuclei, except hydrogen.
- Neutrons are neutral particles with no charge and mass slightly greater than that of protons.
- Neutrons are stable inside the nucleus. But outside the nucleustheyareunstable.The half life of neutron is 13minutes.

$$_{0}n^{1} \rightarrow _{1}H^{1} + _{-1}e^{0} + \bar{\vartheta}$$

- As neutrons are neutral, they can easily penetrate any nucleus.
- Neutrons are classified according to their kinetic energy as (a) slow neutrons(0 to 1000eV) and (b) fast neutrons(0.5MeV to 10MeV), (c) Thermal neutrons (0.025eV)

8. Medical applications of radio isotopes.

- Radiocobalt(Co^{60})used in the treatment of cancer.
- Radio-sodium (Na^{24}) - used to detect the presence of blocks in blood vessels, to check the effective functioning of heart Radio-iodine (I^{131}) -used in the detection of the nature of thyroid gland and to locate brain tumours.
- Radio-iron (Fe^{59}) -used to diagnose anaemia.
- Radio-phosphorous(P^{32})–used in the treatment of skin diseases.

9. Biologicalhazardsofnuclearradiations

- The biological effects of nuclear radiation can be divided into three groups
  (i)Short term recoverable effects
  (ii)long term irrecoverable effect sand
  (iii)genetic effect.
- The extent to which the human organism is damaged depends upon(i)thedose and the rate at which the radiation is given and (ii)the part of the body exposed to it.
- **Short term recoverable effects :**
  Smaller doses of radiation exposure produce skin disorder and loss of hair.
- **Long term irrecoverable effects :-**
  If the exposure is 100 R*, it may cause diseases like leukemia (death of red

blood corpuscle in the blood) or cancer. When it U 600 R, ultimately it causes death. Safe limit isabout250milliroentgenperweek.

Genetic effect :-

The radiations cause injury to genes in the reproductive cells and gives rise to mutations which pass on from generation to generation.

10. State and explain the working of Hydrogen bomb.

It is an explosive device to release a very large amount of energy by the principle of fusion of light nuclei.

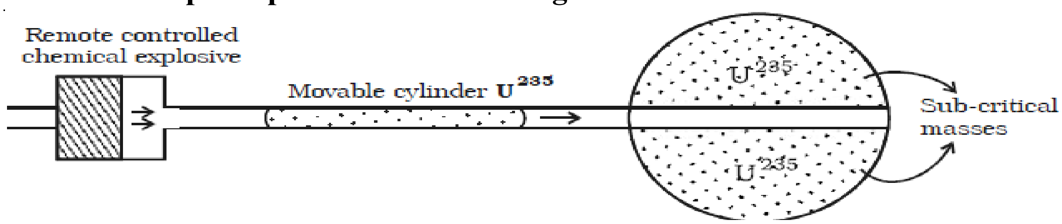
*The temperature required for the purpose of fusion is produced by the explosion of an atom bomb produces temperature (of the order of 50 million degree celcius.)

*A suitable assembly of deuteron and triton is arranged at the sight of the explosion of the atom bomb.

*Favourable temperature initiates the fusion of light nuclei in an uncontrolled manner, and releases enormous amount of heatenergy.

$_1H^3 + _1H^2 \rightarrow _2He^4 + _0n^1$ +energy

11. State the principle and working function of on atom bomb.



Principle :-

Uncontrolled fission chain reaction.

Fissile Material :-

U^{235} or Pu^{239}

Constructions :-

- An atom bomb consists of two hemispheres of U^{235} (or $_{94}Pu^{239}$), each smaller than the critical size and are kept apart by a separator aperture.

Working :-

- When the bomb has to be exploded, a third well fitting cylinder of U^{235} (or$_{94}Pu^{239}$)whose mass is also less than the critical mass, is propelled so that
    - it fuses together with the other two pieces.
    - The total quantity is greater than the critical mass and an uncontrolled chain reaction takes place resulting in a terrific explosion.

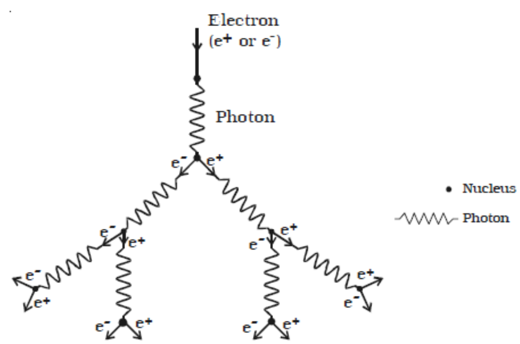
Effects :-

- The explosion releases tremendous amount of energy in the form of heat, light and radiation.
- Temperature of millions of degree celsius and pressure of millions of atmosphere are produced.

- Explosions produce shock waves.
- The release of radioactive γ–rays, neutrons and radioactive materials produce a health hazards.

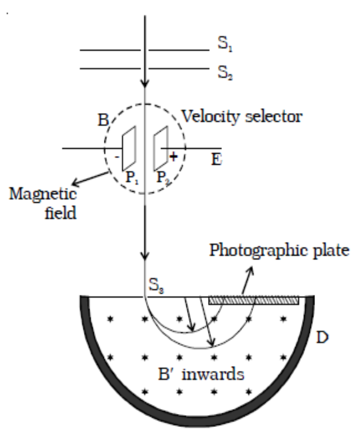
12. Cosmic ray showers

- The cascade theory shows that the shower production involves two processes. (i) radio active collision and (ii) pair production.
- An energetic electron (e^-) or positron (e^+)present in cosmic rays loses energy, when it collides with the nuclei of atoms in earth's atmosphere. This energy loss appears as high energy photon.
- This photon interacts with an atomic nucleus and produce an electron (e^-) positron (e^+) pair.
- The electron and positron, produce more photons on interaction with nuclei, which are further capable of bringing about pair production.
- The multiplication will continue until the initial energy becomes divided and the individual energy of the particles fall below the 'critical energy'.



10 Marks Questions And Answers

1. Bainbridge mass spectrometer – Determination of isotopic massesofnuclei



- Bainbridge mass spectro- meter is an instrument used for the accurate determination of atomic masses.

Construction :-

- A beam of positive ions produced in a discharge tube is collimated in toal fine beam by two narrowslits S_1 andS_2.

- This fine beam enters into a velocity selector.
- The velocity selector allows the ions of a particular velocity of to come out of it.

Working :-

The electric field (E) and magnetic field (B) are perpendicular to each other. They are adjusted that the deflection so that the ions do not suffer any deflection within the velocity selector.

$qE=Bqv$

$v=E/B$

- Ions having this velocity v,passout of the velocity selector and then through the slit S_3, to enter the evacuated chamber D.
- These positive ions are subjected to another strong uniform magneticfield of induction B' at right angles to the plane of the paper acting in wards.
- These ions are deflected along circular path of radius R and strike the photographic plate.
- The force due to magnetic field $B'qv$ provides the centripetal force.

$B'qv=mv^2/R$

$m=B'qR/v$

Substituting $v=E/B$

$m=BB'qR/E$

- Ions with different masses trace semi-circular paths of different radii and produce dark lines on the plate.
- The distance between the opening of the chamber and the position of the dark line gives the diameter 2 R.
- Since q, B, B′, E and R are known, the mass of the positive ions
- and hence isotopic masses can be calculated.

2. Obtain an expression to deduce the amount of the radioactive substance present at any moment.

Law of disintegration :-

- The rate of disintegration at any instant is directly proportional to the number of atoms of the element present at that instant.
- Let N_0 be the number of radio active atoms present initially and N, the number of atoms at a given instant t.
- $\frac{-dN}{dt} \propto N$
- $\frac{dN}{dt} = -\lambda N$ here λ - decay constant

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

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

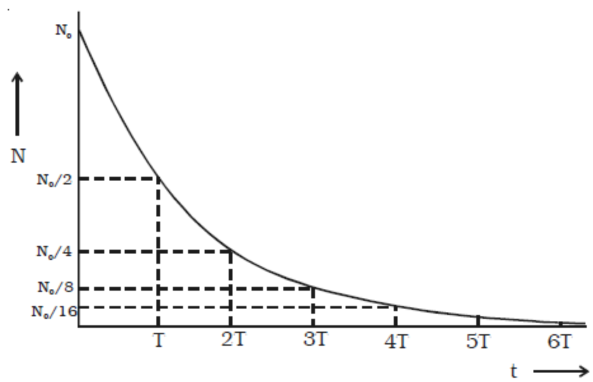
At t=0 $N=N_0$

- $\therefore C = \log_e N_0$

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

$\log_e(N/N_0) = -\lambda t, \qquad N/N_0 = e^{-\lambda t}$

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



The number of atoms of a radio active substance decreases exponentially with increase in time.

Half Life Period :-

The half life period of a radioactive element is defined as the time taken for one half of the radio active element to under god is integration.

From the law of disintegration

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

When $t = T_{1/2}$ $N = N_0/2$

$N_0/2 = N_0 e^{-\lambda T_{1/2}}$

$\log_e 2 = \lambda T_{1/2}$

$$T_{1/2} = \frac{\log_e 2}{\lambda},$$

$$T_{1/2} = \frac{\log_{10} 2}{\lambda} \times 2.3026$$

- $\mathbf{T_{1/2} = \frac{0.6931}{\lambda}}$

Half life period is inversely proportional to decay constant.

Relation between mean life and half life is given by

- $\mathbf{T_{1/2} = 0.6931\tau}$

3. The Discovery of neutrons and properties of neutrons.

Neutron-Discovery :-

- Bothe and Becker found that when beryllium was bombarded with α -particles, a highly penetrating radiation was emitted. Which were capable of traversing through at hick layer of lead and was unaffected by electric and magnetic fields.
- The radiation was thought to be γ−rays.
- In1932,Irene Curieand F. Joliot found that those radiations were able to knock out protons from paraffin and similar substances that are rich in hydrogen.
- Chadwick in the same year discovered that the emitted radiation consists of particles of mass nearly equal to proton and no charge.
- He called them as neutrons.
- $({}_0n^1)\,{}_4Be^9 + {}_2He^4 \rightarrow {}_6C^{12} + {}_0n^1$

Where ${}_0n^1$ represents neutron.

Properties of neutrons :-

(i) Neutrons are the constituent particles of all nuclei, except hydrogen.

(ii) Neutrons are neutral particles with no charge and mass slightly greater than that of protons.

(iii) Neutrons are stable inside the nucleus. But outside the nucleus they are unstable. The half life of neutron is 13 minutes.

$$_0n^1 \rightarrow {}_1H^1 + {}_{-1}e^0 + \bar{\nu}$$

(iv) As neutrons are neutral, they can easily penetrate any nucleus.

(v)Neutrons are classified according to their kinetic energy as (i) slow neutrons (0 to 1000eV)and (ii) fast neutrons (0.5MeV to 10MeV). (iii) Thermal neutrons (0.025eV)

4. Geiger–Muller counter

Principle :-

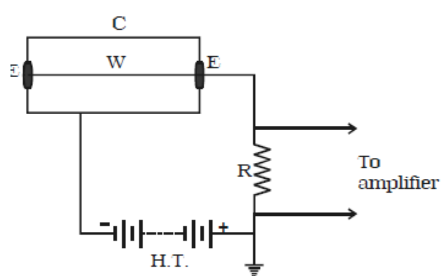
When nuclear radiations pass through gas, ionization is produced.

Construction:-

- A metal tube with glass envelope (C) acts as the cathode.
- A fine tungsten wire (W) along the axis of the tube acts as anode.
- The tube is filled with an inert gas like argon at a low pressure.
- One end is fitted with a thin mica sheet and this end acts as a window through which radiations enter the tube.
- A high potential difference of about 1000 V is applied between the electrodesthroughahighresistanceRofabout100megaohm.

Operation:-

- A ionizing radiation enters the counter.
- Primary ionisation takes place and a few ions are produced.
- Due to the high potential difference and they cause further ionisation
- These ions are multiplied by further collisions.
- An avalanche of electrons is produced and this avalanche of electrons on reaching the anode generates a current pulse.
- This current when passing through R develops a potential difference, amplified by electronic circuits and is used to operate an electronic counter.
- The counts in the counter is directly proportional to the intensity of the ionizing radiation.
- The ionisation of the gas is independent of the type of the incident radiation.
- Wilson cloud chamber detects the type of particle.



5. **Nuclearreactor.**

A nuclear reactor is a device in which the nuclear fission reaction takes place in a selfsustained and controlled manner. The essential parts of nuclear reactor are

i) Fissile material or fuel

(i) Fissile material or fuel
(ii) Moderator
(iii) Neutron source
(iv) Control rods
(v) The cooling system
(vi) Neutron Reflector
(vii) Shielding

- The fissile material or nuclear fuel generally use dis$_{92}U^{235}$. Pu^{239} and U^{233} are used as fissile material.
- In the pressurised heavy water reactors (PHWR), natural uranium oxide is used as fuel.
- In the pressurised light water reactors (PWR), low enriched uraniumisused as fuel
- In Kamini reactor U^{233} is used.

ii) Moderator

- A Moderator converts neutrons of a moderator is to slow down fast neutrons of energy about 2 *MeV*to thermal neutrons of energy about 0.025*eV*,)
- Moderators slow down the fast neutrons. E.g.Ordinary water and heavy water.

(iii)Neutronsource

- A source of neutron is required to initiate the fission chain reaction for the first time.
- E.g. A mixture of beryllium with plutonium or radium or polonium

(iv)Controlrods

- The control rods are used to control the chain reaction. They are very good absorbers of neutrons
- E.g.Boron,Cadmium,BoronCarbide.

(v)Thecoolingsystem

- The cooling system removes the heat generated in the reactor core.
- A good coolant must possess large specific heat capacity and high boiling point.
- E.g. Heavy water, ordinary water, liquid sodium.

(vi)Neutronreflectors

- Neutron reflectors prevent the leakage of neutrons to a large extent,by reflecting them back.
- E.g. Depleted Uranium (Uranium with less than 0.7% of $_{92}U^{235}$), Thorium.

(vii)Shielding

- There actor is surrounded by a concrete wall of thickness about 2 to 2.5m. as a protection against harmful radiations.

Usesofreactors :-

1) Power production
2) To produce radio – isotopes
3) Act as sources of neutrons

6. Stellar energy

Proton–Protoncycle

$_{1}H^{1} + _{1}H^{1} \rightarrow _{1}H^{2} + _{1}e^{0} + \nu$(emission of positron and neutrino)

$_{1}H^{1} + _{1}H^{2} \rightarrow _{2}He^{3} + \gamma$(emission of gamma rays)

$2_{2}He^{3} \rightarrow _{2}He^{4} + 2_{1}H^{1}$

There action cycle is written as

$4_{1}H^{1} \rightarrow _{2}He^{4} + 2_{1}e^{0} + 2\nu$+energy(26.7MeV)

Carbon–NitrogenCycle

The following cycle of reactions take place in carbon – nitrogen cycle in which carbon acts as a catalyst.

$_{1}H^{1} + _{6}C^{12} \rightarrow _{7}N^{13*} + \gamma$(emission of gamma rays)

$_{7}N^{13*} \rightarrow _{6}C^{13} + _{1}e^{0} + \nu$(emission of positron and neutrino)

$_{1}H^{1} + _{6}C^{13} \rightarrow _{7}N^{14} + \gamma$(emission of gamma rays)

$_{1}H^{1} + _{7}N^{14} \rightarrow _{8}0^{15*} + \gamma$(emission of gamma rays)

$_{8}0^{15*} \rightarrow _{7}N^{15} + _{1}e^{0} + \nu$(emission of positron and neutrino)

$_{1}H^{1} + _{7}N^{15} \rightarrow _{6}C^{12} + _{2}He^{4}$

The overall reaction of the above cycle is given as

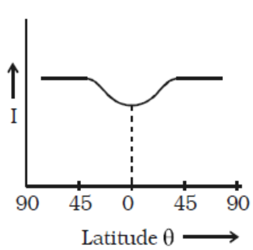
$4_{1}H^{1} \rightarrow _{2} He^{4} + 2_{1}e^{0} + 2\nu$+energy(26.7MeV)

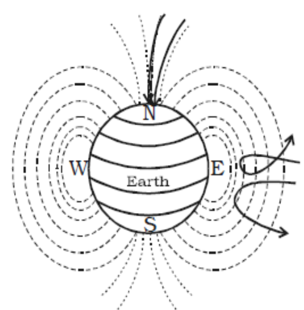
7. Cosmic Rays – Latitude effect , Altitude effect .

Cosmic Rays:

The ionising radiation many times stronger than γ-rays entering the earth from all the directions from cosmic orinter stellarspace is known as cosmic rays.

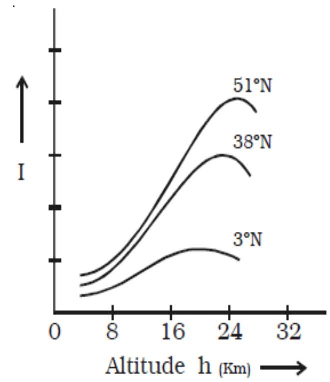
Latitude effect :





- The variation of cosmic ray intensity with geo magnetic latitude is known as latitude effect.
- Intensity is maximum at the poles ($\theta=90^{0}$), minimum at the equator($\theta=0$) and constant between latitudes of42^{0} and 90^{0}.
- The decrease in cosmic ray intensity at the earth's equator is be due to the earth's magnetic field.
- The charged particles approaching poles travel almost along the direction of the magnetic lines of force and hence maximum intensity at poles.
- The charged particles approaching equator have to travel in a perpendicular direction to the field and hence minimum intensity at the equator.

Altitude effect :



- The study of variation of cosmic ray intensity (I) with altitude (h) is known as altitude effect.
- The intensity increases with altitude and reaches a maximum at a height of about20km.
- Above this height there is a fall in intensity.

UNIT–2 CURRENT ELECTRICITY

3 Marks Questions And Answers

1. **Define Current.**
   The current is defined as the rate of flow of charges across any cross sectional area of a conductor.
   I = q/t. unit - ampere.(A)
2. **Define drift velocity.**
   Drift velocity is defined as the velocity with which free electrons get drifted towards the positive terminal, when an electric field is applied.
   Unit – ms^{-1}
3. **Define mobility.**
   Mobility is defined as the drift velocity acquired per unit electric field.
   Unit:$m^2V^{-1}s^{-1}$.
4. **Define current density.**
   Current density at a point is defined as the quantity of charge passing per unit time through unit area, taken perpendicular to the direction of flow of charge at that point. J=I/A
   Unit : A m^{-2}
5. **Define Ohm's law**
   At a constant temperature, the steady current flowing through a conductor is directly proportional to the potential difference between the two ends of the conductor. i.e$I \propto V$
   V = IR

6. Define the resistance of aconductor

Resistance of a conductor is defined as the ratio of potential difference across the conductor to the current flowing through it.

R= $\frac{V}{I}$ unit ohm(Ω)

7. Define electrical resistivity of a material.

The electrical resistivity of a material is defined as the resistance offered to current flow by a conductor of unit length having unit area of cross section.

unit: ohm-m(Ωm).

8. What is meant by superconductors?

The ability of certain metals, their compounds and alloys to conduct electricity with zero resistance at very low temperatures is called superconductivity. The materials which exhibit this property are called super conductors.

9. Define Transition temperature.

The temperature at which electrical resistivity of the material suddenly drops to zero and the material changes from normal conductor to super conductor is called the transition temperature or critical temperature.

10. What are the changes followed at the transition temperature?

(i) The electrical resistivity drops to zero.

(ii) The conductivity becomes infinity

(iii)The magnetic flux lines are excluded from the material.

11. Define temperature coefficient of resistance.

The temperature coefficient of resistance is defind as the ratio of increase in resistance per degree rise in temperature to its resistance at 0^0C. Its unit is per ^{0}C.

$$\propto = \frac{R_t - R_o}{R_o t} \; Unit\ /°C$$

12. State Kirchoff's i) current law ii) voltage law

1) Current law

The algebraic sum of the currents meeting at any junction in a circuit is zero. (law of conservation of charge)

2) Voltage law

The algebraic sum of the products of resistance and current in each part of any closed circuit is equal to the algebraic sum of the emf's in that closed circuit. (law of conservation of energy)

13. What is the principle of potentiometer?

The emf of the cell(E) is directly proportional to its balancing length.(l)This is the principle of a potentiometer. i.e.Eαl

14. Why is copperwire not suitable for a potentiometer?

Copperhas (i) Low electrical resistivity

(ii)High temperature coefficient of resistance

15. Distinguish between emf and potential difference

S.No.	emf	Potential difference
1	The difference of potentials between the two terminals of a cell in an open circuit is called the electromotive force (emf) of a cell.	The difference in potentials between any two points in a closed circuit is called potential difference.
2	Independent of external resistance of the circuit.	Proportional to the resistance between any two points.

16. Describe the function of a wattmeter.

- The instrument used to measure electrical power consists of a movable coil arranged between a pair of fixed coils in the form of a solenoid.
- A pointer is attached to the movable coil. The free end of the pointer moves over a circular scale.
- When current flows through the coils, the deflection of the pointer is directly proportional to the power.

17. Distinguish between electric power and electric energy

S.No.	Electric power	Electric energy
1	Electric power is defined as the rate of doing electric work.	Electric energy is defined as the capacity to do work.
2	Power P = VI	Energy E = VIt
3	Unit : watt (W)	Unit:Joule(J) Practical unit KWh

18. Define electrolysis

The passage of an electric current through a liquid causes chemical changes and this process is called electrolysis.

19. State Faraday's laws of electrolysis.

FirstLaw: The mass of a substance liberated at an electrode is directly proportional to the charge passing through the electrolyte.

$M \alpha q$ or$m = zIt$

SecondLaw: The mass of a substance liberated at an electrode by a given amount of charge is proportional to the chemical equivalent of the substance.

$m \alpha E$

20. Define electrochemical equivalent.

The electrochemical equivalent of a substance is defined as the mass of substance liberated in electrolysis when one coulomb charge is passed through the electrolyte. Unit - Kg C^{-1}

21. What are the applications of secondary cells?

(i) The secondary cells are rechargeable.

(ii) They have very low internal resistance. Hence they can deliver a high current if required.

(iii)They are used in all automobiles like cars, two wheelers, trucks etc

22. Distinguish between primary cells and secondary cells

S.No.	Primary cell	Secondary Cell
1	Electric energy is derived by irreversible chemical actions	Electrical energy is derived by reversible chemical reactions
2	Cannotbe recharged	Canbe recharged
3	High internal resistance	Low internal resistance
4	Cannot supply steady current for long time	Can supply steady current for longtime

23. If6.25×10^{18} electrons flow through a given crosssection in unittime, find the current.(Given:Charge of an electron is 1.6×10^{-19} C)

Solution:

$$I = \frac{q}{t} \Rightarrow I = \frac{ne}{t}$$

$$I = \frac{6.25 \text{ x } 10^{18} \text{ x } 1.6 \text{ x } 10^{-19}}{1} = \mathbf{1A}$$

24. An incandescent lamp is operated at 240V and the current is 0.5A. What is the resistance of the lamp?

Solution:

$$R = \frac{V}{I}$$

$$R = \frac{240}{0.5}$$

$$R = \frac{2400}{5}$$

R = 480Ω

25. A manganin wire of length 2m has a diameter of 0.4mm with a resistance of 70Ω. Find the resistivity of the material.

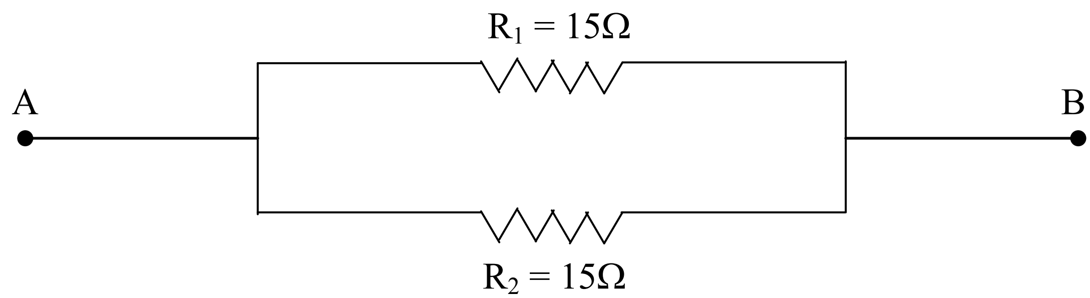
Solution: $\rho = \frac{R\pi r^2}{\ell}$

$$= \frac{70 \text{ x } 3.14 \text{ x } (2 \text{ x } 10^{-4})^{2}}{2}$$

$$= 1.57 \text{ x } 7 \text{ x } 4 \text{ x } 10^{-7}$$

$$\boldsymbol{\rho = 4.396\text{x}10^{-6}\ \Omega\ m}$$

26. In the given network, calculate the effective resistance between points A and B

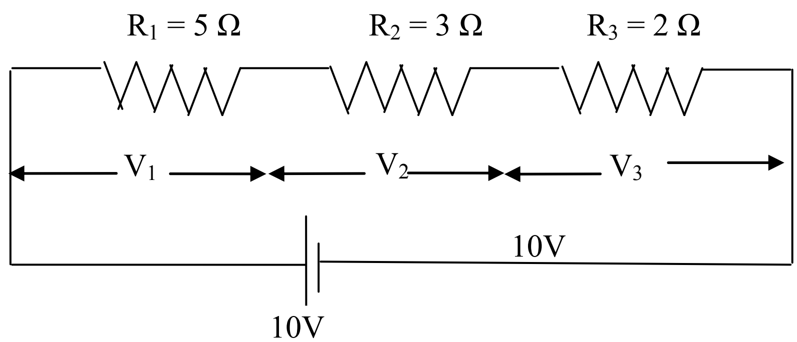


Solution:

R_1, R_2 are in Parallel combination

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{15} + \frac{1}{15}, \quad \frac{1}{R_p} = \frac{2}{15}, \qquad \mathbf{R_p = \frac{15}{2} = 7.5\ \Omega}$$

27. Three resistors are connected in series with 10V supply as shown in the figure. Find the voltage drop across each resistor.



Solution:

Effective resistance of series combination $Rs = R_1 + R_2 + R_3$

$Rs = 5 + 3 + 2 \Rightarrow \quad Rs = 10\ \Omega$

Current in circuit $I = \frac{V}{R_s} = \frac{10}{10} = 1$ A

According to Ohm's law $V = IR$

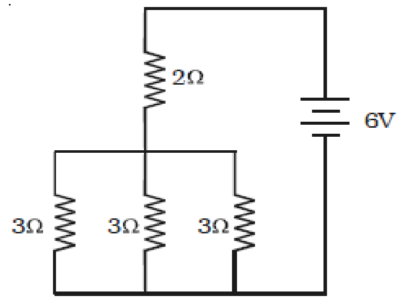
$V_1 = IR_1 = 1 \times 5 = 5V$

$V_2 = IR_2 = 1 \times 3 = 3V$

$V_3 = IR_3 = 1 \times 2 = 2V$

$\mathbf{V_1 = 5V;\ V_2 = 3V;\ V_3 = 2V}$

28. In the given circuit, what is the total resistance and current supplied bythebattery.



Solution:

3Ω, 3Ω, 3Ω are parallel combination.

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_p} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3}$$

$$\frac{1}{R_p} = \frac{3}{3} \quad R_p = 1\Omega$$

Now $R_p = 1\Omega$ and 2Ω are in series combination.

Hence effective resistance $= R_p + R_4$

$$R_s = (1+2)\Omega \Rightarrow R_s = 3\Omega$$

Current supplied by the battery $I = \frac{V}{R} = \frac{6}{3} = 2A$

I = 2A

29. Two wires of same material and length have resistances 5Ω and 10Ω respectively. Find the ratio of radii of the two wires.

Solution: Let $R_1 = 5\Omega$, $R_2 = 10\Omega$, $\ell_1 = \ell_2 = \ell$

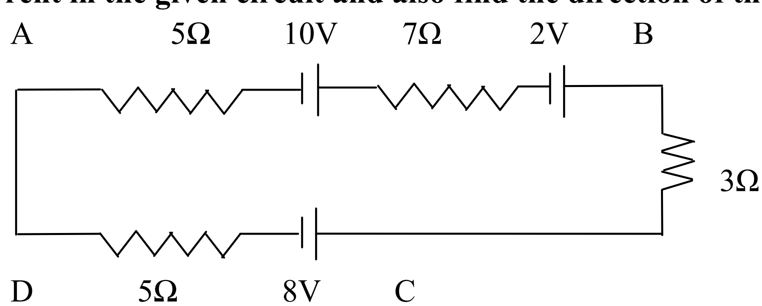
$$\frac{r_1}{r_2} = \sqrt{\frac{R_2}{R_1}}$$

$$= \sqrt{\frac{10}{5}}$$

$$\frac{r_1}{r_2} = \sqrt{\frac{2}{1}}$$

$r_1 : r_2 = \sqrt{2} : 1$

30. Calculate the current in the given circuit and also find the direction of the current.



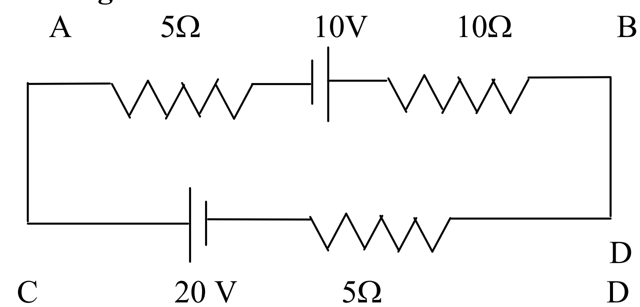
Solution:
Let the current flowing the circuit is I. Current flowing in the direction ABCDA(Clock wise direction)

$$5I + 7I + 3I + 5I = 10 + 2 - 8$$

$$20I = 4, \quad I = \frac{4}{20} \Rightarrow \mathbf{I = 0.2\ A}$$

Current is flowing in theClock wise direction

31. Calculate the current in the given circuit and also find the direction of the current.



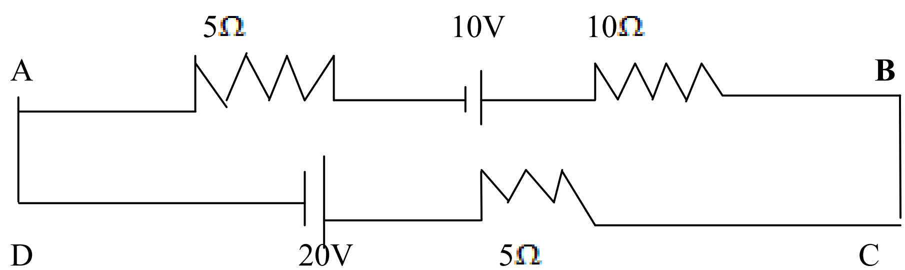
According to Kirchoff's second law

$5I + 10I + 5I = 10 + 20,$

$20I = 30 \Rightarrow I = \frac{30}{20} \Rightarrow \mathbf{I = 1.5\ A}$

Current flowing in the direction ABCDA(Clock wise direction)

32. Calculate the current in the given circuit and also find the direction of the current.



Solution:

According to Kirchoff's second law

$5I+10I+5I = 10-20$

$20I = -10$

$I= -\frac{10}{20}$

$I=-\frac{1}{2}$

$I=-0.5A$

Current I = 0.5A

Currents flows in the anti clock wise direction (ADCBA)

33. The resistance of a nichrome wire at 0^oC is 10Ω. If its temperature coefficient of resistance is $0.004/^oC$, find its resistance at boiling point of water. Comment on the result.

Solution:

$$R_t = Ro\,(1 + \alpha t)$$

$$R_{100} = Ro\,(1+100\alpha)$$

$$R_{100} = 10\,(1+ 100 \times 0.004)$$

$$=10\,(1 + 0.4)$$

$$= 10 \times 1.4$$

$$\mathbf{R_{100} = 14\Omega}$$

As the temperature increases the resistance also increases

34. The resistance of a platinum wire at 0°C is 4Ω. What will be the resistance of the wire at 100^o C if the temperature coefficient of resistance of platinum is 0.0038/°C.

Solution:

$$R_t = Ro\,(1 + \alpha\, t)$$

$$R_{100} = Ro\,(1 + 100\,\alpha)$$

$$R_{100}= 4\,(1 + 100 \times 0.0038)$$

$$= 4\,(1 + 0.38)$$

$$= 4 \times 1.38$$

$$\mathbf{R_{100} = 5.52\ \Omega}$$

$$= 4 \times 1.38$$

$$\mathbf{R_{100} = 5.52\ \Omega}$$

35. A 1.5 V carbon–zinc dry cell is connected across a load of 1000Ω.

Solution: Calculate the current and powers applied to it.

i) Current $I = \frac{V}{R}$

$= \frac{1.5}{1000}$

$\mathbf{I = 1.5 \times 10^{-3}\ A}$

ii) Power $P= VI$

$P=1.5 \times 1.5 \times 10^{-3}$

$\mathbf{P=2.25 \times 10^{-3}\ W}$

36. An iron box of 400 W power is used daily for 30minutes. If the cost per unit is 75 paise, find the weekly expense on using the iron box.

Solution: Energy Consumed

$E = P \times t$

$E = 400 \times \frac{1}{2} \times 7$

$E = 1400$ Wh

$E = 1.4$ Unit

Cost of 1 unit = Rs. 0.75

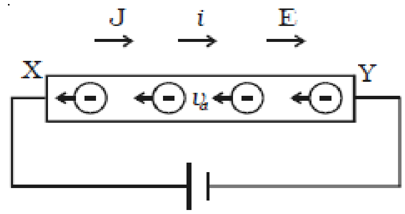
Cost of 1.4 Units = 1.4 x 0.75

Expense = **Rs 1.05**

5 MARKS QUESTIONS AND ANSWERS

1. Relation between current and drift velocity

- Consider a conductor XY of length L and area of cross section A . An electric field E is applied between its ends.
- Let n be the number of free electrons per unit volume.



- The total charge passing through the conductor $q=(nAL)e$
- The time in which the charges pass through the conductor, $t=L/v_d$
- The current flowing through the conductor, $I = \frac{q}{t} = \frac{(nAL)e}{\left(L/v_d\right)}$

$$I = nAe\ v_d$$

2. Applications of super conductors

(i) Super conductors form the basis of energy saving power systems,

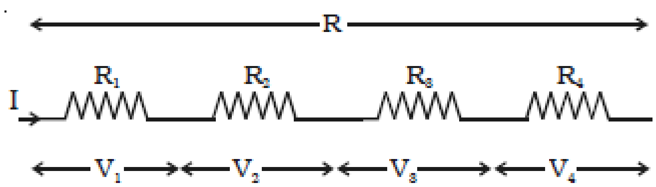
(ii) Super conducting magnets have been used to levitate trains above its rails.

(iii) Super conducting magnetic propulsion systems may be used to launch satellites into orbits directly from the earth without the use of rockets.

(iv) The current in a superconducting wire can flow with out any change in magnitude, it canbe used for transmission lines.

(v) Superconductors can be used as memory or storage elements in computers.

3. Effective resistance when number of resistors connected in series



- Let us consider the resistors of resistances R_1, R_2, R_3 and R_4 connected in series. Applied potential difference V.
- In Series connection current in each resistor the same.
- $V_1 = I R_1$; $V_2 = I R_2$, $V_3 = I R_3$, $V_4 = I R_4$
- Net potential $V = V_1+V_2+V_3+V_4$

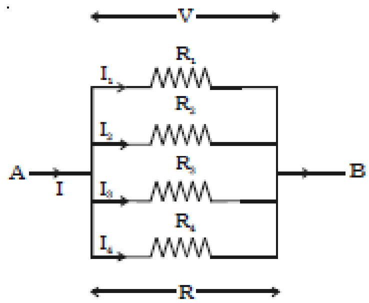
  $V = I[R_1+R_2+R_3+R_4]$ ⟶ (1)

  Let R_s be the effective resistance

  $V = I R_s$ ⟶ (2)

  From equations (1) and (2) , Effective resistance $R_s = R_1+R_2+R_3+R_4$

4. Resistors in parallel



Consider four resistors of resistances R_1, R_2, R_3 and R_4 are connected in parallel.A source of emf V is connected to the parallel combination in parallel connection the potential difference(V)across each resistor is the same.

$$I_1 = \frac{V}{R_1};\ \ I_2 = \frac{V}{R_2};\ \ I_3 = \frac{V}{R_3};\ \ I_4 = \frac{V}{R_4}$$

Net current$I=I_1 + I_2 + I_3 + I_4$.

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3} + \frac{V}{R_4}$$

$$I = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}\right) \quad \text{----}\!\!\rightarrow 1$$

- Let the effective Resistance be R_p

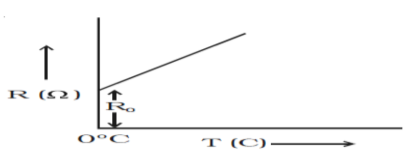
$$I = \frac{V}{R_p} \quad \text{------}\!\!\rightarrow 2$$

- From equations (1) and (2) $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$

5. Temperature dependence of resistance

- For conductors the resistance increases with increase in temperature.
- $R_t = R_o(1 + \alpha t)$

  α is called the temperature coefficient of resistance.

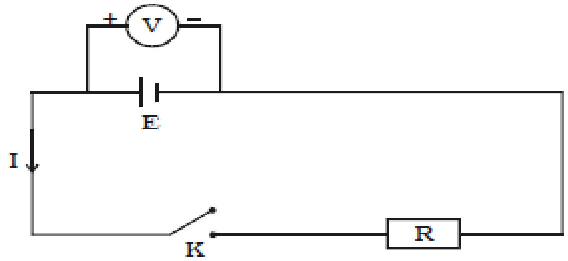


- The temperature coefficient of resistance is defined as the ratio of increase in resistance per degree rise in temperature to its resistance at 0^0C. Its unit is per ^{0}C. $\alpha = \frac{R_t - R_0}{R_0 t}$
- Metals have positive temperature coefficient of resistance,

Insulators and semiconductors(thermistors) have negative temperature coefficient of resistance in temperature.

- The temperature coefficient is low for alloys.

6. Determination of internal resistance of a cell using voltmeter



- With key K open the emf of cell E is found by connecting a high resistance voltmeter across it. A small value of resistance R is included in the external circuit and Key K is closed. The potential difference across R is equal to the potential difference across cell(V).

$$V = IR \longrightarrow 1$$

- Internal resistance of the cell (r) , V is less than E

$$V = E - Ir$$

$$Ir = E - V \longrightarrow 2$$

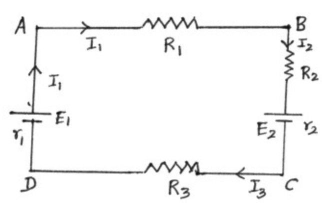
equations (1) / (2)

$$\frac{Ir}{IR} = \frac{E - V}{V}$$

$$r = \left(\frac{E - V}{V}\right) R$$

7. Kirchhoff's second law (Voltage law)

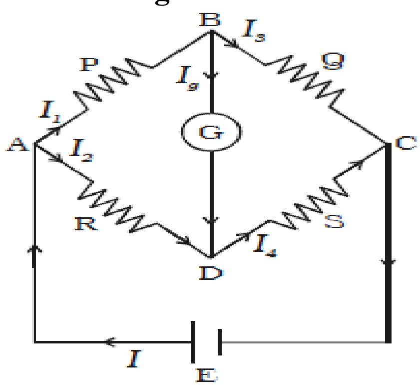
- Kirchhoff's voltage law states that the algebraic sum of the products of resistance and current in each part of any closed circuit is equal to the algebraic sum of the emf's in that closed circuit.
- It is based on the principle of law of conservation of energy
- The current in clockwise direction is taken as positive and the current in anti clock wise direction is taken as negative.



- For the circuit shown in fig;
- The closed loop ABCDA

$I_1 R_1 + I_2 R_2 + I_2 r_2 + I_3 R_3 + I_1 r_1 = E_1 - E_2$

8. **Wheatstone's bridge**



- Applying to Kirchhoff's first law at junction B : $I_1 - I_g - I_3 = 0 \rightarrow (1)$
  At junction D: $I_2 + I_g - I_4 = 0 \quad \rightarrow (2)$
- Applying to Kirchhoff's second law for the closed path ABDA
  $I_1P + I_gG - I_2R = 0 \quad \rightarrow (3)$
  According to Kirchhoff's second law for the closed path ABCDA
  $I_1 P + I_3 Q - I_4 S - I_2 R = 0 \quad \rightarrow (4)$
- For zero deflection $I_g = 0$
  $I_1 = I_3 \rightarrow (5)$
  $I_2 = I_4 \rightarrow (6)$
  $I_1P = I_2R \rightarrow (7)$
- Substituting the equation (5),(6),and (7) in equation 4
  $I_1(P+Q) = I_2(R+S) \quad \rightarrow (8)$

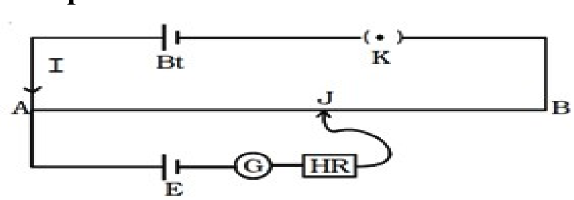
Dividing equation (8) and (7)

$$\frac{I_1(P+Q)}{I_1P} = \frac{R+S}{R}$$

$$1+\frac{Q}{P} = 1+\frac{S}{R}$$

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

9. **Principle of potentiometer**



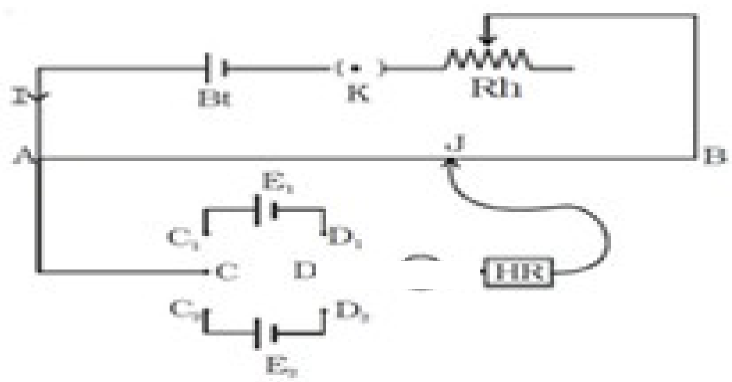
- The potentiometer wireB is connected in series with a battery (Bt), Key(K), rheostat(Rh) This forms the primary circuit.
- A primary cell is connected in series with the positive terminal A of the potentiometer, a galvanometer, high resistance and jockey.This forms the secondarycircuit.

- If the potential difference between A and J is equal to the emf of the cell, no current flows through the galvanometer. It shows zero deflection.
- If the balancing length is *l* the potential difference acrossAJ=Irl where *r* is the Resistance per unit length of the potentiometer wire

  ∴ E=Ir*l*,

  Eα*l*
- Emf of the cell(E) is directly proportional to its balancing length.

10. Comparison of emfs of to given primary cells using potentiometer



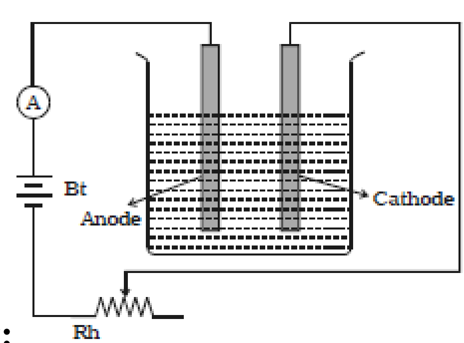
- The potentiometer wire AB is connected in series with the battery (Bt), key(K), Rheostat(Rh) .This forms the primary circuit
- The cells with emfs E_1, $E_2$are connected with the terminals $C_1D_1$and C_2D_2 of the DPDT switch.
- Current in the primary circuit is I. The resistance per unit length of the wire is r
- E_1 is connected to the secondary circuitl_1 is the balancing length

  $E_1 = Irl_1 \rightarrow (1)$
- $E_2$is connected to the secondary circuitl_2 is the balancing length

  $E_2=Irl_2 \rightarrow (2)$

  Dividing $1 \div 2 \Rightarrow \frac{E_1}{E_2} = \frac{\ell_1}{\ell_2}$

11. Verification of Faraday's first law of electrolysis



Law:

- The mass of a substance liberated at an electrode is directly proportional to the charge passing through the electrolyte. Abattery,a rheostat,a key and an ammeter are connected in series to an electrolytic cell

- A currentI_1 is passed for a time t. the mass m_1 of the substance deposited is obtained. $m_1 \propto I_1$
- A different current I_2 is passed for the same time *t*. The mass m_2 of

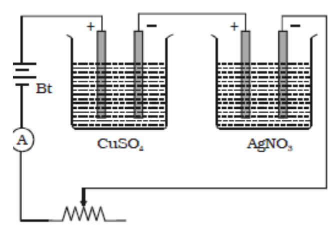
the substance deposite disobtained that$m_2 \propto I_2$

$$\frac{m_1}{m_2} = \frac{I_1}{I_2} \Rightarrow m \alpha I \qquad (1)$$

- The experiment is repeated for same current *I* for time mass of the substance deposited is$m_3 \propto t_1$
- The same current I is passed for time t_2, the mass of the substance deposited is m_4,$m_4 \propto t_2$
- $\frac{m_3}{m_4} = \frac{t_1}{t_2}$ m α t (2)

From equations(1)and(2)
MαIt

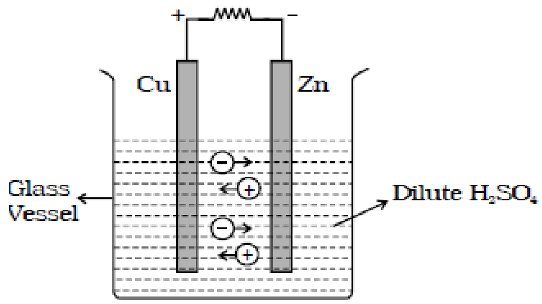
12. Verification of Faraday's second law of electrolysis



Rh

SecondLaw: The mass of a substance liberated at an electrode by a given amount of charge is proportional to the chemical equivalent of the substance.

- $m \alpha E$
  The circuits are connected as shown in the diagram
- The current is passed for time 't'.
- The mass of copper deposited is found as $m_1 m_1 \propto E_1$
  (E_1-chemical equivalent of copper)
- The mass of silver deposited is found as $m_2 m_2 \propto E_2$
  (E_2-chemical equivalent of silver)

* 

$$\frac{m_1}{m_2} = \frac{E_1}{E_2}$$

* $m \, \alpha \, E$

13. Voltaic cell:

Construction :

Anode→Copper

Cathode→Zinc

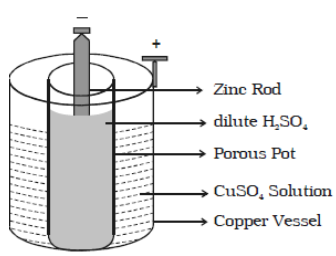
Electrolyte→Diluted sulphuric acid

Vessel→Glass

Action :

- Zinc rod reacts with H_2SO_4 and zinc rod becomes negative charge by removing Zn^{++}ions
- Copper neutralizes $2H^+$ ions and thus becomes positive.
- The current passes from copper to zinc in the external circuit.
- Emf produced by the cell → 1.08V

14. Daniel cell



It cannot supply steady current for a long time.

Construction :

Anode→Copper

Cathode→Zinc

Electrolyte→copper sulphate solution , Diluted sulphuric acid

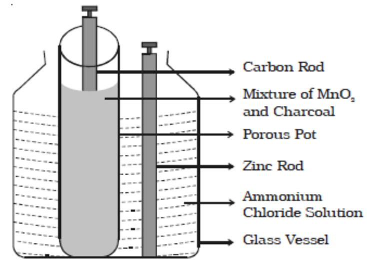
Vessel→Copper

Action :

- The zinc rod reacting with dilute sulphuric acid produces Zn^{++} ions and 2electrons and thus becomes negative.
- Zn^{++} ions pass through the pores of the porous potand reacts with copper sulphate solution, producing Cu^{++} ions the Cu^{++} ions deposit on the copper vessel and the

vessel becomes positive.

- When Daniel cell is connected in a circuit, the two electrons on the zinc rod pass through the external circuit and neutralizing the copper ions.
- Electric current passes from copper to zinc, in the external circuit
- Emf produced by the cell → 1.08V



15. Leclanche cell

Construction:

Anode→Carbon rod

Cathode→Zinc rod

Electrolyte→Ammonium Chloride solution

Vessel→Glass

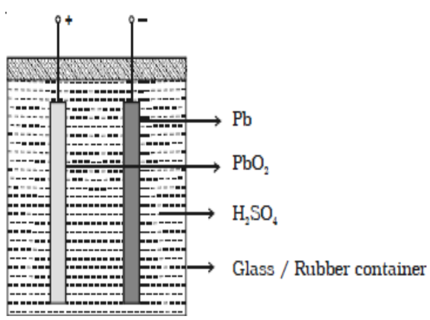
Action:

- At the zinc rod, due to oxidation reaction Zn atom is converted in toZn^{++} ions and 2electrons. Zn^{++}ions reacting with ammonium chloride produces zinc chloride and ammonia gas.

$$Zn^{++} + 2NH_4Cl \rightarrow 2NH_3 + ZnCl_2 + 2H^+ + 2e^-$$

- The positive charge of hydrogen ion is transferred to carbon rod and the two electrons from the zinc rod move towards carbon and neutralizes the positive charge.
- Thus current flows from carbon to zinc.
- Emf produced by the cell → 1.5V
- Current produced by the cell → 0.25

16. Lead – Acid accumulator



Construction :

Anode →Lead oxide

Cathode→Lead

Electrolyte→Diluted Sulphuric acid

Vessel→Rubber or Glass

Action:

- The spongy lead reacting with dilute sulphuric acid produces lead sulphate and two electrons due to oxidation.
- At the positive electrode due to reduction process lead oxide on reaction with

sulphuric acid produces lead sulphate and the two electrons are neutralized in this process.

- The cell has low internal resistance and hence can deliver high current.
- The emf of a freshly chargedcellis2.2Volt.
- The emf falls to about 2 volts during discharge .

UNIT 4 ELECTRO MAGNETIC INDUCTION AND ALTERNATIING CURRENT

3Mark Questions And Answers

1. Define magnetic flux. Give its unit.

The number of magnetic lines of force crossing a closed area is called magnetic flux

$\Phi = \vec{B} . \vec{A}$ unit : weber (Wb)

2. What is electromagnetic induction?

The phenomenon of producing an induced emf due to the changes in the magnetic flux associated with a closed circuit is known as electromagnetic induction.

3. State Faraday's laws of electromagnetic induction?

Firstlaw

Whenever the amount of magnetic flux linked with a closed circuit changes, an emf is induced in the circuit. The induced emf lasts so long as the change in magnetic flux continues.

Second law

The magnitude of emf(e) induced in a closed circuit is directly proportional to the rate of change of magnetic flux $\frac{d\Phi}{dt}$linked with the circuit.

$e \ \alpha \ \frac{d\Phi}{dt}$

4. State Lenz's law of electromagnetic induction?

The induced current produced in a circuit always flows in such a direction that it opposes the change or cause that produce sit.$e = -N\left(\frac{d\Phi}{dt}\right)$

5. State Fleming's Right hand rule.(Generator Rule)

The forefinger, the middle finger and the thumb of the right hand are held in the three mutually perpendicular directions. If the forefinger points along the direction of the magnetic field and the thumb is along the direction of motion of the conductor, then the middle finger points in the direction of the induced current.

6.What is self induction ?

The property of a coil which enables to produce an opposing induced emf in it when the current in the coil changes is called self induction.

7. Define coefficient of self induction

The coefficient of self induction of a coil is numericallyequal to the magnetic flux linked with a coil when unit current flows through it. Unit : Henry(H)

8. Define the unit of co-efficient of self induction

The unit of self inductance is henry(H).

One henry is defined as the self-inductance of a coil in which a change in current of one ampere per second produces an opposing emf ofonevolt.

9.What is mutual induction ?

The phenomenon of producing an induced emf in a coil due to the change in current in the other coil is known as mutual induction.

10.Define coefficient of mutual induction

The coefficient of mutual induction of two coils is numerically equal to the magnetic flux linked with one coil when unit current flows through the neighbouring coil.

Unit : Henry(H)

11. Define the unit of coefficient of mutual induction.

The unit of coefficient of mutual induction is henry.

One henry is defined as the coefficient of mutual induction between a pair of coils when a change of current of one ampere per second in one coil produces an induced emf of on evolt in the other coil.

12.What are the factors in which coefficient of mutual induction depends.

(i)Size and shape of the coils, number of turns and permeability of material on which the coils are wound.

(ii)proximity of the coils

13.What are the methods of producing induced emf?

The induced emf can be produced by changing

(i)the magnetic induction(B)

(ii)area enclosed by the coil(A)and

(iii)the orientation of the coil(θ) with respect to the magnetic field.

14. State the principle of A.C.generator (A.C. dynamo)

An emf is induced in a coil when it is rotated in a uniform magnetic field. (electromagnetic induction)

15.What are Eddy current (Foucault current) ?

When a mass of metal moves in a magnetic field or when the magnetic field through a stationary mass of metal is altered, induced current is produced in the metal. This induced current flows in the metal is called eddy current.

16. What is a transformer ? Give its principle.

Transformer is an electrical device used for converting low alternating voltage into high alternating voltage and vice versa.

Principle: electromagnetic induction (Mutual induction)

17. Distinguish between step-up transformer and step-down transformer

S.No	Step-up transformer	Step-down transformer
1.	Increases the voltage (Es > Ep)	Decreases the voltage (Es < Ep)
2.	Decreases the current(Is < Ip)	Increases the current (Is > Ip)
3.	The number of turns in the secondary coil is greater than the number of turns in the primary coil (Ns > Np).	The number of turns in the secondary coil is lesser than the number of turns in the primary coil (Ns < Np).
4.	Transformer ratio k >1	Transformer ratio k <1

18. Define the efficiency of a transformer

Efficiency of the transformer is defined as the ratio of output power to the input power.

$$\eta = \frac{output\ power}{INPUT\ POWER} = \frac{E_s I_s}{E_p I_p}$$

19. D. C. ammeter cannot read A.C.Why?

The average value of A.C over one complete cycle is zero. So when we connect a D.C ammeter it shows only zero deflection.

20. Define the rms value of A.C. (effective value of A.C)

The rms value of alternating current is defined as that value of the steady current, which when passed through a resistor for a given time, will generate the same amount of heat as generated by an alternating current when passed through the same resistor for the same time.

21.What is meant by inductive reactance ?

The resistance offered by a coil (inductor) is known as inductive reactance.

$X_L = L\omega$ → Unit : ohm (Ω) →

22.What is meant by capacitive reactance?

The resistance offered by a capacitor is known as capacitive reactance.

$X_c = \frac{1}{C\omega}$ Unit : ohm (Ω)

23. Acapacitorblocksd.cbutallowsa.c.w h y ?

- The capacitive reactance $X_c = \frac{1}{\omega C} = \frac{1}{2\pi\upsilon C}$
- The frequency of d.c $(\upsilon) = 0$
- So $X_c = \infty$ ie.capacitive reactance becomes infinity, It is does not allow d.c
- According to $X_c = \frac{1}{2\pi\upsilon C}$ it allows only a.c to pass through.

24. What happens in the current if the frequency of a.c voltage increases in R.L.C. series circuit?

If the frequency of the alternating voltage increases , the impedance decreases and the current increases . At the resonant frequency the current reaches its maximum value. If the frequency is greater than the resonant frequency, the current decreases slowly.

25.What is resonant frequency in R.L.C. series circuit?

The particular frequency at which the impedance of the circuit becomes minimum and therefore, the current becomes maximum is called resonant frequency of the circuit.

26.Define Q factor (Quality factor)

The Q factor of a series resonant circuit is defined as the ratio of the voltage across a coil or capacitor to the applied voltage.

$$Q = \frac{voltage across L or C}{applied voltage}$$

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

27. What is power factor of an a.c circuit?

Power factor = $\cos \Phi$

Here Φ is the phase difference between alternating current and voltage. It is the ratio of average power to its apparent power.

28.What is a choke coil?

A choke coil is an inductance coil of very small resistance used for controlling current in an a.c.circuit.

29. Distinguish between AF choke coil and RF choke coil

S.No	AF choke coil	RF choke coil
1.	Used in low frequency circuits.	Used in high frequency circuits.
2.	They have iron core.	They have air core.
3.	Self-inductance is high.	Self-inductance is low

30. A coil of area of cross section $0.5 m^2$ with 10 turns is in a plane which is perpendicular to an uniform magnetic field of $0.2 Wb/m^2$. What is the flux through the coil?

Solution: Magnetic flux $\Phi = NBA\cos\theta$

$\Phi = NBA\cos 0^o$ $(\because \theta = 0^o)$

$\Phi = 10 \times 0.2 \times 0.5$

$\mathbf{\Phi = 1\ Wb}$

31. An emf of 10 mv is induced when the current in the coil changes at the rate of 2A s^{-1}. What is the coefficient of self-induction of the coil?

Solution : $e = -L\frac{dI}{dt}$

Coefficient of self-induction $L = \frac{-e}{(\frac{dI}{dt})} = \frac{10\times10^{-3}}{2}$

$L = 5\times10^{-3}$ H (or) **L = 5mH**

32. An emf of 5V is induced when the current in the coil changes at the rate of 100A s^{-1}. What is the coefficient of self induction of the coil?

Solution : $e = -L\frac{dI}{dt}$

Coefficient of self-induction $L = \frac{-e}{(\frac{dI}{dt})} = \frac{-5}{100} \Rightarrow$ L = -0.05H

L= 0.05 H

33 . A solenoid of length1m and 0.05m diameter has 500 turns.If a current of 2A passes through the coil, calculate the coefficient of self induction of the coil.

Solution :

$$L = \frac{\mu_0 N^2 A}{l} \quad \frac{\mu_0 N^2(\pi r^2)}{l} = \quad =$$

$$= \frac{4\pi \times 10^{-7} \times (5\times10^{2})^2 \times 3.14 \times (25\times10^{-3})^2}{1}$$

$= 4 \times 3.14 \times 25 \times 3.14 \times 625 \times 10^{-7+4-6}$

$L = 6.16 \times 10^{-3}$ H (or) **L = 6.16mH**

34. Calculate the mutual inductance between two coils when a current of 4A changing to 8A in 0.5s in one coil,induces an emf of 50mv in the other coil.

Solution: $e_2 = -M(\frac{dI_1}{dt})$

Coefficient of mutual induction $M = \frac{-e_2}{(\frac{dI_1}{dt})}$

$M = \frac{-50\times10^{-3}}{(\frac{8-4}{0.5})} = \frac{-50\times10^{-3}}{(\frac{4}{0.5})} = \frac{-50}{8} \times 10^{-3} = -6.25$ mH

M = 6. 25 mH

35. Magnetic field through a coil having 200 turns and cross sectional area $0.04m^2$ changes from $0.1wbm^{-2}$ to0.04 wb m^{-2} in 0.02s.Find the induced emf.

Solution : $e = -\frac{d}{dt}(NBA)$

$= -NA\frac{dB}{dt}$

$= -200 \text{x } 0.04 \text{ x} \frac{(0.1 \sim 0.04)}{0.02}$

$= -200 \text{x} 0.04 \text{x} \frac{0.06}{0.02}$

$= -200 \text{x} 4 \text{x} 10^{-2} \text{ x} 3$

$= -2 \text{x} 4 \text{x} 3$

$e = -24\text{V}$

The magnitude of induced emf e =24V

36. An aircraft having a wing span of 20.48m flies due north at a speed of 40 ms^{-1}. If the vertical component of earth's magnetic fieldattheplaceis2×10^{-5}T,Calculate the emf induced between the ends of the wings.

Solution:-Induced emfe= - Bℓ v

$e = -2 \text{ x } 10^{-5} \text{ x } 20.48 \text{ x } 40$

$= -20.48 \text{ x } 80 \text{ x } 10^{-5}$

$= -1638.4 \text{ x} 10^{-5}$

e = -0.0164V

37. An aircraft having a wing span of 10m flies due north at a speed of 720 km/ hr . If the vertical component of earth's magnetic field at the place is 3×10^{-5}T,Calculate the emf induced between the ends of the wings.

Solution:-Induced emf e = -Bℓ v

$e = -3 \text{ x } 10^{-5} \text{ x } 10 \text{ x } 720 \text{ x} \frac{5}{18}$

$e = -3 \text{ x } 10 \text{ x } 200 \text{ x } 10^{-5}$

$e = -6000 \text{ x } 10^{-5} \Rightarrow$ **e = - 0.06 V**

38.Two rail so farailway track insulated from each other and the ground are connected to a millivolt meter.The train runs at a speed of 180 Km/hr. Vertical component of earth's magnetic field is 0.2×10^{-4} Wb/m^2 and the rails are separated by1m.Find the reading of the voltmeter.

Solution:-Induced emf e = -Bℓ v

$e = -0.2 \times 10^{-4} \times 1 \times 180 \times \frac{5}{18}$

$e = -0.2 \times 10^{-4} \times 1 \times 10 \times 5$

$e = -1 \times 10^{-3}\text{V}$

Reading of the voltmeter = 1mV

39. The transformer ratio of an ideal transformer is 1:20 .Its input power and voltages are 600mW, 6V respectively. Find the primary and the secondary current.

Solution : $\frac{N_s}{N_p} = \frac{1}{20}$, $E_p I_p = 600$ mW; $E_p = 6$V

$E_p I_p = 600$ mW

$I_p = \frac{600mW}{E_p} = \frac{600\times10^{-3}}{6} = 100\text{x}10^{-3} = 0.1$ A

But $\frac{N_s}{N_p} = \frac{I_p}{I_s}$

$I_s = \frac{Np}{Ns}$ x I_p $= \frac{20}{1}$ x 0.1 = **2A**

The current in the primary coil = 0.1A

The current in the secondary coil = 2A

40. 11 kW power is transmitted at a rate of 22,000V through a wire of resistance 2Ω. Find the power loss in the wire.

Solution :- Electric power P = VI

$I = \frac{P}{V}$

$I = \frac{11,000}{22,000}$

I = 0.5A

Power loss $= I^2R$

$= (0.5)^2$x 2

= 0.25 x 2

Power loss = 0.5 W

41. Write the equation of a 25 cycle currents in a wave having rms value of 30 A.

Solution : $\boldsymbol{i} = I_o \sin \omega t$

$\boldsymbol{i} = I_{rms}\sqrt{2}\sin 2\pi \upsilon t$

$= 30\text{x}\sqrt{2}\,\text{x}\sin 2\pi\,\text{x}\,25\text{t}$

$= 42.42\sin 50\pi t$

$\boldsymbol{i} = \mathbf{42.42\sin 157}\boldsymbol{t}$

42.A capacitor of capacitance 2µF is in an a.c.circuit of frequency 1000Hz. If the rms value of the applied emf is10V,find the effective current flowing in the circuit.

Solution : $X_c = \frac{1}{C\omega} = \frac{1}{C\,(2\pi v)}$

$X_c = \frac{1}{2\times10^{-6}\times2\pi\times10^3} \Rightarrow X_c = \frac{100}{4\pi} = \frac{\mathbf{250}}{\boldsymbol{\pi}}\mathbf{\Omega}$

Effective current $I_{rms} = \frac{E_{eff}}{X_c}$

$= \frac{10}{(\frac{250}{\pi})}$

$I_{rms} = \frac{10\times3.14}{250} = \frac{31.4}{25} =$ **0.126A**

5 Marks Questions And Answers

1.Self-inductance of a long solenoid

- Consider a long solenoid of length l and area of cross section A and number of turns N.and the current be I
- Magnetic flux per turn = B×Area of each turn

$$= \frac{\mu_0 NI}{\ell} \times A \quad \left[\because B = \frac{\mu_0 NI}{\ell}\right]$$

- Total magnetic flux of the solenoid

$$\phi = \frac{\mu_0 NIA}{\ell} \times N$$

$$\phi = \frac{\mu_0 N^2 IA}{\ell} \times N \qquad \rightarrow (1)$$

- Magnetic flux $\phi = LI$ $\rightarrow (2)$
- From equations 1 and 2

$$LI = \frac{\mu_0 N^2 AI}{\ell}$$

$$L = \frac{\mu_0 N^2 A}{\ell}$$

- In a medium of permeability μ $L = \frac{\mu N^2 A}{\ell}$

1. **Energy associated with an inducted**
   - Work has to be done by external agencies in establishing the current in an inductor
   - Induced emf $e = -L\frac{dI}{dt}$
   - The small amount of work done in an interval dt

$$dW = e\, I\, dt$$

$$dW = -L\frac{dI}{dt} \cdot I \; dt$$

$$dW = -L\, I\, dI$$

   - The total work done to increase the current from zero to maximum

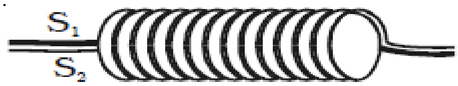
$$W = \int dW = \int_0^{I_0} -LIdI$$

$$W = -\frac{1}{2} L\, I_0^2$$

   - The energy stored in the inductor

$$U = \frac{1}{2} L\, I_0^2$$

3. Mutual induction of two long solenoid



- S_1 and S_2 are two long solenoids with length ℓ and area of cross section A. N_1 and N_2 are their number of turns
- The magnetic flux linked with S_2 due to I_1 current in $S_1 = B_1 A$

$$= \mu_0 \frac{N_1}{\ell} I_1 A \qquad \left[\because B_1 = \mu_0 \frac{N_1}{\ell} I_1\right]$$

- The total magnetic flux in S_2 $\phi_2 = \mu_0 \frac{N_1}{\ell} I_1 A \times N_2$

$$\phi_2 = \mu_0 \frac{N_1 N_2}{\ell} I_1 A \qquad \rightarrow (1)$$

- $\phi_2 = M I_1 \qquad \rightarrow (2)$
- From equations 1 and 2

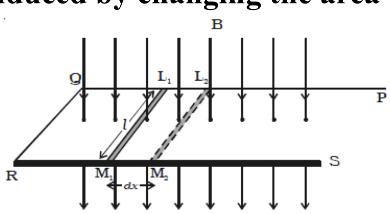
$$MI_1 = \frac{\mu_0 N_1 N_2 A I_1}{\ell}$$

$$M = \frac{\mu_0 N_1 N_2 A}{\ell}$$

- In a medium of permeability μ ,

$$M = \frac{\mu N_1 N_2 A}{\ell}$$

4. Emf induced by changing the area enclosed by the coil



- The conductor PQRS is in perpendicular to the magnetic field
- L_1M_1 – The sliding conductor , ℓ its length
- The initial area enclosd by the conductor L_1QRM_1
- The conductor is displaced by a distance of dx in dt seconds. The final area is L_2QRM_2
- Change in the area $\qquad dA = \ell\, dx$
- Change in magnetic flux $d\phi = B\, dA = B \ell\, dx$
- Induced emf $\qquad e = \frac{-d\phi}{dt}$

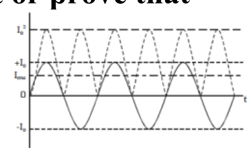
$$e = -B\ell \frac{dx}{dt}$$

$$e = -B\ell v$$

5. **Power losses in a transformer and the methods to reduce the losses**

S.No	Power loss	Causes	Method to reduce
1.	Hysteresis loss	The repeated magnetisation and demagnetization of the iron core	Using cores made of mumetal and silicon steel
2.	Eddy current loss (Iron loss)	The varying magnetic flux leads to eddy current and wastage of energy in the form of heat.	Using laminated core made of stelloy
3.	Flux loss	The flux produced in the primary is not linked with secondary	Using shell type core
4.	Copper loss	Current passing through the primary and secondary leads to Joule's heating effect	Using thick wires with low resistance

6. **Expression for RMS value of alternating current or prove that**



$$Irms = \frac{I_0}{\sqrt{2}}$$

- Alternating current $I = I_o \sin \omega t$

  I_0, is the peak value of the alternating current
- The amount of heat produced in the resistor of resistance R in a small time dt

  $$dH = I^2 R\, dt$$
- The amount of heat produced in one complete cycle

  $$H=\int_0^T i^2 R dt$$

  $$H =\int_0^T (I_0^2 \sin^2 \omega t) R \; dt$$

  $$H = \frac{I_0^2 RT}{2} \qquad \rightarrow (1)$$
- The heat produced by RMS value of the current (I_{rms})

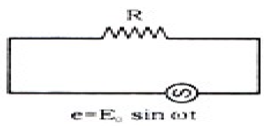
  $$H = I_{rms}^2 RT \qquad \rightarrow (2)$$
- From equations 1 and 2

  $$I_{rms}^2 = \frac{I_0^2}{2}$$

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

7.AC circuit with resistor only

An alternating source of emf is connected to a resistor with resistance R.



The instantaneous value of alternating emf

$$e = E_0 \sin \omega t \qquad \rightarrow \quad (1)$$

The potential drop across the resistore = iR

Potential drop must be equal to applied emf

$iR \;=\; E_0 \sin \omega t$

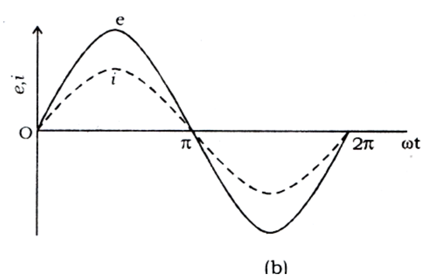
$i \;= E_0 \sin \omega t$

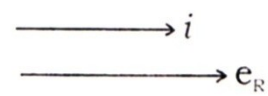
R ——

$i \;= I_o \sin \omega t \qquad \rightarrow \quad (2)$

The applied voltage and current are in phase with each other

Phase diagram **Phasor diagram**





8. Power in an AC circuit (True power or average power)

- The instantaneous power of an A.C circuit is the product of the instantaneous emf and the instantaneous current flowing through it.
- emf $\quad e = E_0 \sin \omega t$

  Current $i = I_0 \sin(\omega t + \phi)$
- Average power consumed in one complete cycle

$$P_{av} = \frac{\int_0^T ie\,dt}{\int_0^T dt}$$

$$= \frac{\int_0^T [I_0 \sin(\omega t + \phi) E_0 \; \sin \; \omega t] dt}{T}$$

$$P_{av} = \frac{E_0 I_0}{2} \cos \phi$$

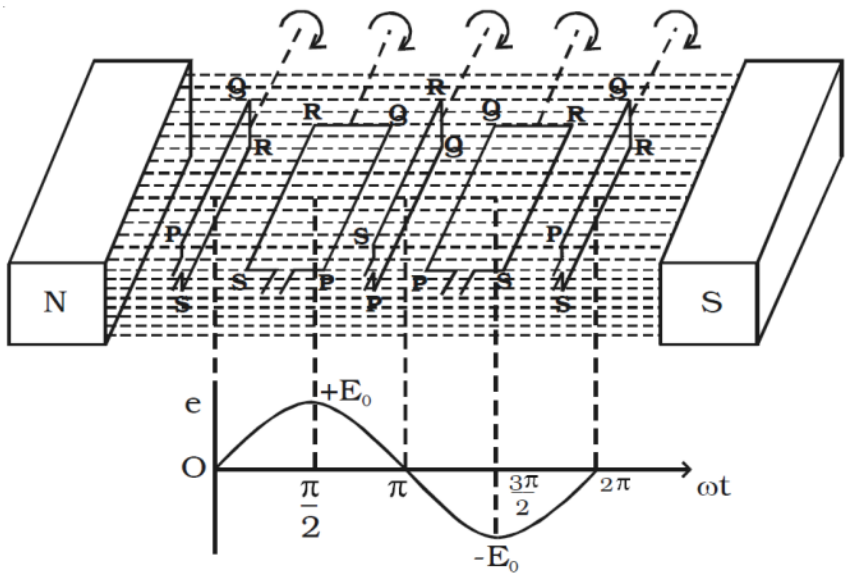
$P_{av} = \frac{E_0}{\sqrt{2}}\frac{I_0}{\sqrt{2}}\cos\phi$

$= E_{rms}\ I_{rms}\cos\phi$

P_{av} = Apparent power x Power factor

10 Mark Questions And Answers

1. Emf induced by changing the orientation of the coil.



- PQRS is a rectangular coil of N turns and area A is rotated with angular velocity ωabout an axis perpendicular to the direction of the magnetic field
- The magnetic flux ϕchanges.

The magnetic flux ϕ= NBA cosωt

The induced emf $e = -\frac{d\phi}{dt}$

$e = -\frac{d}{dt}(NBA\cos\omega t)$

$e = NBA\,\omega\sin\omega t$

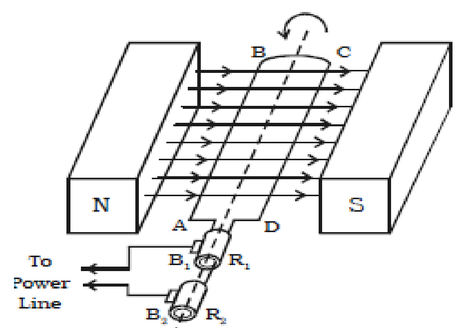
$e = E_o\sin\omega t$

Here $E_o = NBA\,\omega$

$\theta = \omega t$	**Plane of the coil with magnetic field**	**Induced emf**
0^o	Perpendicular	o
90^o	parallel	E_o
180^o	Perpendicular	0
270^o	parallel	$-E_o$
360^o	Perpendicular	0

2. Single phase A.C generator (A.C dynamo)

Principle: Electro magnetic induction



Construction :-

Essential parts

i) **Armature**;:- A large number of loops or turns of insulated copper wire wound over a laminated soft iron core.

ii) **Field magnets :**Permanent magnets in the case of low power dynamos and electro magnets in the case of high power dynamos.

iii) **Slip rings** :- The metal rings $\mathbf{R_1,R_2}$ are connected to the ends of the armature and they rotate along with armature.

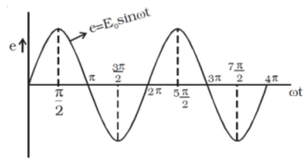
iv) **Brushes** :- $\mathbf{B_1,B_2}$ are the two flexible carbon brushes which pass on the current from armature to external power .

Working:-

- Armature rotates in anti clockwise direction in the magnetic field
- Emf is induced in the armature coil.
- The direction of induced emf is given by Fleming's right hand rule.

First half cycle	Second half cycle
1) **AB** moves downwards	**AB** moves upwards
2) **CD** moves upwards	**CD** moves downwards
3) The current flows in the armature along**DCBA**.	The current flows in the armature along**ABCD**
4) The current flows from $\mathbf{B_1}$ to$\mathbf{B_2}$ in the external circuit	The current flows from $\mathbf{B_2}$to$\mathbf{B_1}$in the external circuit

Wave form :



Induced emf $e = E_0 \sin\omega t$, Here, $E_0 = NBA\omega$

3. Eddy currents - methods to reduce , applications

When a mass of metal moves in a magnetic field or when the magnetic field through a stationary mass of metal is altered, induced current is produced in the metal. This induced current flows in the metal hence this current is called eddy current.

Methods to reduce;i) using thin laminated sheets instead of solid metal.

ii) holes drilled in the plates

Applications of Eddy current :

(i)***Dead beat galvanometer***

- When current is passed through a galvanometer the coil oscillates.
- Eddy currents are set up in the metallic frame, which opposes further oscillations of the coil.
- The oscillations of the coil die out instantaneously, the galvanometer is called dead beat galvanometer.

(ii)Inductionfurnace

- The material to be melted is placed in a varying magnetic field of highfrequency.
- A strong eddy current is developed inside the metal. Due to the heating effect of the current, the metal melts.

(iii) Inductionmotors

- Eddy currents are produced in a metallic cylinder called rotor, when it is placed in a rotating magnetic field.

- The eddy current initially tries to decrease the relative motion between the cylinder and the rotating magnetic field and metallic cylinder is set in to rotation.
- These motors are used in fans.

(iv)Electrom agneticbrakes

- The drum rotates along with the wheel when the train is in motion.
- When the brake is applied, a strong magnetic field is developed and eddy currents are produced in the drum .
- The eddy current oppose the motion of the drum and the train comes to rest.

(v)Speedometer

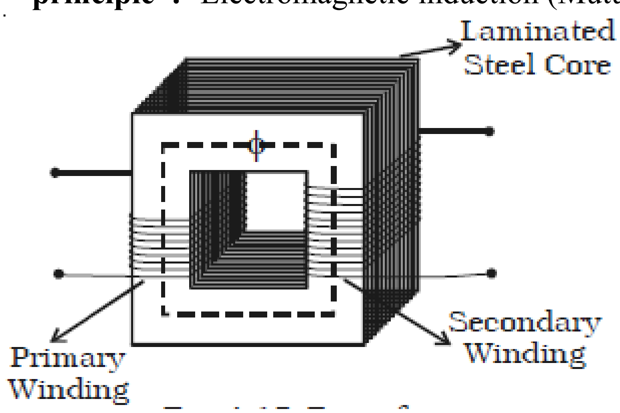
- A magnet rotates inside an aluminium cylinder (drum) according to the speed of the vehicle.
- Eddy currents produced in the drum makes it deflected through a certain angle .
- A pointer attached to the drum move so vera
  Calibrated scale which indicates the speed of the vehicle.

4. Transformer - principle , construction , working , efficiency , power losses

Transformer :

Transformer is an electrical device used for converting low alternating voltage into high alternating voltage and vice versa.

principle :- Electromagnetic induction (Mutual induction)



Construction :-

- It consists of insulated primary and secondary coils wound on a soft iron core .
- A laminated soft iron core is used.

Working:

- A varying alternating voltage is given to primary coils.
- The magnetic flux changes in the primary coils
- Magnetic flux in the secondary coil changes . An emf is induced in the secondary coils.

- E_p, E_s– the emfs N_p, N_s – the number of turns in the coils I_p, I_s – the currents
- Flux linked with primary and secondary are equal.

  $\frac{E_p}{N_p} = \frac{E_s}{N_s}$

- For an ideal transformer , the input power = output power

$$E_p I_p = E_s I_s$$

$$\text{ie. } \frac{E_s}{E_p} = \frac{I_p}{I_s}$$

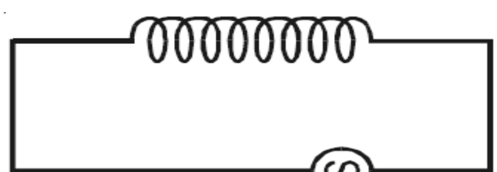
$\frac{E_s}{E_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$ = k ,the transformer ratio

Step up transformer	Step down transformer
$E_s > E_p$ $N_s > N_p$ $I_p > I_s$ $K > 1$	$E_p > E_s$ $N_p > N_s$ $I_s > I_p$ $K < 1$

- **Efficiency** $\eta = \frac{\text{output power}}{\text{Input power}} = \frac{E_s}{E_p}\frac{I_s}{I_p}$

- **Power losses**i) Hysteresis loss ii) copper loss
  iii) eddy current loss iv) flux loss

5. A.C circuit with inductor only



- An alternating source of emf is applied to pure inductor of negligible resistance with inductance L

  Applied emf $e = E_o \sin\omega t$ ⟶ (1)

  Induced emf $e = - L \frac{di}{dt}$

  But $e = - e'$

$$E_o \sin\omega t = L \frac{di}{dt}$$

$$i = \frac{Eo}{L}\sin \omega t \quad dt$$

Current; $i = \int di$

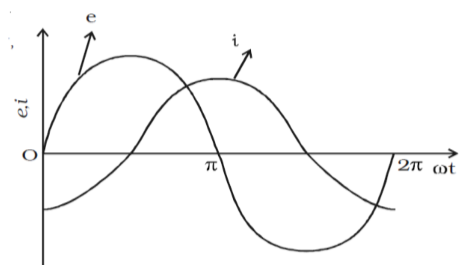
$$i = \int \frac{Eo}{L} \sin \omega t \quad dt$$

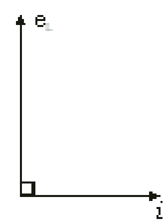
$$i = \frac{Eo}{\omega L} \sin (\omega t - \frac{\pi}{2})$$

$$\text{Current } i = I_o \sin (\omega t - \frac{\pi}{2}) \longrightarrow (2)$$

From equations (1) and (2) the current lags behind the voltage by a phase of $\frac{\pi}{2}$.

Phase diagramphasor diagram

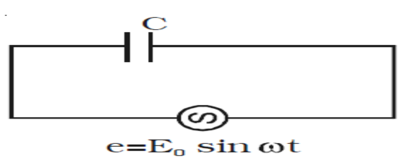




Reactance of the inductor

- $L\,\omega = X_L$
- For d.c. $\upsilon = 0$ $\therefore X_L = 0$ so a pure inductor offers zero resistance to d.c. . But the inductive reactance varies proportional to the frequency for a.c.

6. A.C circuit with capacitor only



- An alternating source of emf is connected to a capacitor of capacitance C

Applied emf $e = E_o \sin\omega t$ (1) $\longrightarrow$

- The potential drop across the capacitor = the applies emf

$$e = \frac{q}{C}$$

$$\text{Current } i = \frac{dq}{dt} = \frac{d}{dt}(Ce)$$

$$i = \frac{d}{dt}(CE_o \sin\omega t)$$

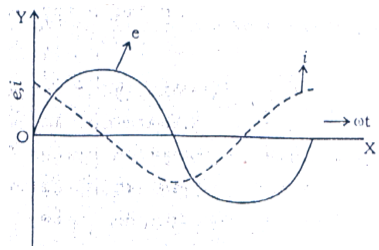
$$i = E_0\, C\omega \sin(\omega t + \frac{\pi}{2})$$

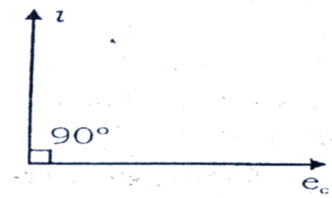
$$i = \frac{E_o}{(\frac{1}{C\omega})} \sin(\omega t + \frac{\pi}{2})$$

$$i = I_o \sin(\omega t + \frac{\pi}{2}) \longrightarrow (2)$$

From equations 1 and 2 current leads the voltage by a phase of $\frac{\pi}{2}$.

Phase diagram **Phasor diagram**





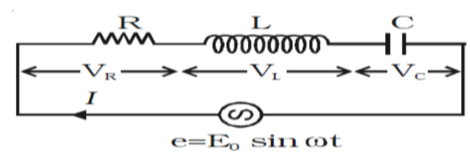
Reactance of the capacitor

- $X_C = \frac{1}{C\omega}$
- For d.c. $\upsilon = 0$, $X_C = \frac{1}{0} = \infty$

  So a capacitor does not allow a.c to pass through
- For a.c. $X_C \, \alpha \, \frac{1}{\upsilon}$

7. R, L, C series circuit

- A resistor R , an inductor L , a capacitor C are connected in series and the combination is connected across alternating source of emf

• $V_R = I\,R$ V_R, I are in phase • $V_L = I\,X_L$ V_L leads the current by a phase of $\frac{\pi}{2}$ • $V_c = I\,X_c$ V_c lags behind the current by a phase of $\frac{\pi}{2}$	

The circuit is considered as predominantly inductive

(i) **Effective voltage**

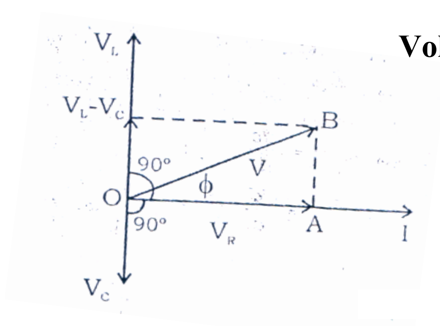
$$V^2 = V_R^2 + (V_L - V_C)^2$$

$$V = \sqrt{V_R^2 + (V_L - V_c)^2}$$

$$V = \sqrt{I^2R^2 + (IX_L - IX_C)^2}$$

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

Voltage phasor diagram



(ii) **Impedance**

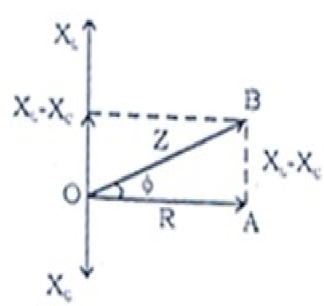
$$z = \sqrt{R^2 + (X_L - X_C)^2}$$

(iii) **Phase angle between V and I**

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

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

Current $I = I_o \sin(\omega t \pm \varphi)$



UNIT-3 EFFECTS OF ELECTRIC CURRENT

3 Mark Questions

1. State Joule's law of heating.
2. Define Peltier coefficient.
3. Define Thomson coefficient.
4. State Biot-Savart law.
5. State Ampere's circuital law.
6. Define Ampere.
7. Nichrome is used as heating element.Why?
8. What is Seebeck effect?
9. What is Peltier effect?
10. What is neutral temperature?
11. State Maxwell's right hand cork screw rule.
12. State right hand palm rule.
13. State end rule.
14. Give the limitations of cyclotron
15. State Fleming's left hand rule.
16. How will you increase the current sensitivity of a galvanometer?
17. Increasing the current sensitivity does not necessarily increase the voltage sensitivity. Why?
18. Define the magnetic moment of a current loop.

5 Mark Questions

1.Explain Biot-Savart law.
2.Derive an expression for magnetic induction due to a current carrying long solenoid.
3.Give the special features of magnetic Lorentz force.
4.Obtain an expression for force between two long parallel current carrying conductors.
5. How will you convert a galvanometer into an ammeter?
6. How will you convert a galvanometer into a voltmeter?

10 mark questions

1.Explain Joule heating effect with the calorimeter experiment

2.Derive an expression for magnetic induction at any point due to an infinitely long current carrying straight conductor .

3.Derive an expression for magnetic induction at any point along the axis of a current carrying circular coil.

4.Explain the principle, construction and working of a tangent galvanometer.

5.Discuss the motion of a charged particle in a uniform magnetic field.

6.Explain the principle, construction and working of Cyclotron

7.Derive an expression for the force acting on a current carrying conductor kept in a magnetic field.

UNIT – 5 ELECTROMAGNETIC WAVES AND WAVE OPTICS

3 Mark Questions

1) What is meant by electromagnetic waves?
2) What are the uses of infra red rays?
3) What are the uses of ultra violet rays?
4) What are Fraunhofer lines?
5) Define fluorescence and phosphorescence.
6) Distinguish between corpuscle and photon.
7) State Rayleigh scattering law.
8) What is meant by Tyndall scattering?
9) Why does the sky appear blue in color?
10) What are the applications of Raman spectrum?
11) State Huygen’s principle.
12) What are the conditions for sustained interference?
13) What is meant by Newton’s rings?
14) Why does the centre of the Newton’s ring appear in dark?
15) Define Diffraction.
16) Define grating element.
17) Distinguish plane of vibration and plane of polarisation.
18) Define optic axis.
19) What are the factors on which the optic rotation depend?
20) State specific rotation.

5 Mark questions

1) Explain Corpuscular theory.
2) Explain reflection of plane wave front at a plane surface.
3) Derive the expression for the radius of the n^{th} order dark ring in Newton’s rings experiment.
4) Explain pile of plates with diagram.
5) State and prove Brewster’s law.

6) Explain Nicol prism with diagram.
7) What are polaroids? Give the uses of polaroids.

10 Mark Questions

1) Explain emission spectra and absorption spectra.
2) Explain Raman effect.
3) Explain total internal reflection by wave theory
4) Derive the expression for bandwidth in Young's double slit experiment.
5) Discuss the theory of interference in thin transparent film due to reflected light and obtain condition for the intensity to be maximum and minimum.

UNIT – 6 ATOMIC PHYSICS

3 Mark Questions

1) What are cathode rays?
2) State principle of Millikan's oil drop experiment?
3) Define ionization energy.
4) Define ionization potential.
5) What are soft X-rays and hard X-rays.
6) Define excitation potential energy.
7) State Moseley's law
8) What are the applications of Moseley's law?
9) Distinguish spotaneous and simulated emission.
10) What is meant by normal population?
11) What is meant by inverted population?
12) What are the chatacteristics of laser?
13) Define holography.
14) What are the conditions to achieve laser action?
15) What are the important facts from law experiment?

5 Mark Questions

1) Write the properties of Cathode rays.
2) Write the properties of Canal rays.
3) Derive an expression for the distance of closest approach of α Particle.
4) What are the drawbacks of Somerfield's model?
5) Explain spectral series of hydrogen atom.
6) Write the properties of X- rays?
7) State and derive Bragg's law.
8) Explain the Laue experiment.
9) Explain the origin of Characteristic X- ray spectrum
10) Explain the scientific and industrial applications of Laser

10 Mark Questions

1) Describe the method of determining of the specific charge(e/m) of an electron by J.J.Thomson's method.
2) Describe the method of determining by the charge of an electron – Millikan's oil drop experiment.
3) State Bohrs postulates and derive an expression for the radius of the n^{th} orbit.
4) State Bragg's law and explain Bragg's X-ray spectrometer to determine the wave length of X-rays
5) Explain the working of Ruby laser with neat sketch.
6) With the help of energy level diagram, explain the working of He-Ne laser.

UNIT – 9 SEMICONDUCTOR DEVICES AND THEIR APPLICATIONS

3 Mark Questions

1) What is meant by forbidden energy gap?
2) What are intrinsic semiconductors?
3) What are extrinsic semiconductors?
4) What is meant by doping?
5) What are the methods of doping a semiconductor?
6) What is meant by rectification?
7) What are LED's? what are there uses.
8) What is meant by Zener breakdown voltage?
9) Define input characteristic of on transistor? Give it's unit.
10) Define bandwidth of on amplifier.
11) What is meant by feedback? What are the types of feedback?
12) What are the advantages of negative feedback?
13) Write the Barkhausen conditions for oscillation.
14) What are the advantages of Integrated Circuit?
15) Draw the block diagram of LC oscillator.
16) Draw the circuit diagram of OR gate using diodes.
17) Draw the circuit diagram of AND gate using diodes.
18) Draw the circuit diagram of NOT gate using transistor.
19) State De- Morgan's theorems.
20) What are Universal gate?why are they called so?
21) What are the important characteristics of operational amplifier?
22) What are the uses of cathode ray oscilloscope?
23) Prove (A+B)(A+C)=A+BC using Boolean identities.

5 Mark Questions

1) Explain the working of diode as a half wave rectifier.
2) Deduce the relation between α and β of a transistor.
3) Explain the working of a transistor as a switch .
4) Explain voltage divider bias with circuit diagram
5) State and prove De-Morgan's theorem.
6) Explain OR and AND gates by using electrical circuits.
7) Explain frequency response curve of a transistor amplifier.
8) How multimeter is used as ohm meter?

10 Mark Questions

1) Explain the working of bridge rectifier.
2) Describe the working of a transistor amplifier.
3) What is meant by feedback? Derive and expression for voltage gain of an amplifier with negative feedback?
4) Sketch the circuit of Colpitt's oscillator. Explain it's working.
5) Describe an operational amplifier. Explain its action as (i) inverting amplifier and (ii) noninverting amplifier.
6) Describe an operational amplifier. Explain its action as (i) summing amplifier and (ii) difference amplifier.
7) Explain the multimeter with the neat diagram.

UNIT – 10COMMUNICATION SYSTEMS

3 Mark Questions

1) Write the different ways of radio wave propagation?
2) Define skip distance.
3) Define skip zone.
4) Define modulation.
5) Define modulation factor.
6) What are the limitations of amplitude modulation?
7) What are the advantages of frequency modulation?
8) Define scanning
9) What are the advantages of digital communiation?
10) What are the advantages of fibre optics communication?

5 Mark Questions

1) Draw and explain the block diagram of AM radio transmitter.
2) Draw and explain the block diagram of superheterodyne FM receiver.
3) Write the applications of radar.
4) What are the advantage and disadvantages of digital communication.
5) Write the merits of satellite communication.
6) Explain AM radio receiver with block diagram.

10 Mark Questions

1) Explain the analysis of amplitute modulated wave.
2) Draw and explain the block diagram of superheterodyne AM receiver.
3) Explain the function of vidicon camera tube.
4) Explain Monochrome TV transmission with block diagram.
5) Explain monochrome TV receiver with block diagram.
6) Explain principle, transmission and reception of radar with block diagram.

PERSISTENCE AND PRACTICE LEAD TO SUCCESS