तत् त्वं पूषन् अपावृणु

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सत्र / SESSION

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Resource Material

(Competency Based Questions, FAQs, Mind maps)

$E = mc^2$

$V = IR$

PHYSICS (042)

CLASS XII & XI

PREPARED BY

TEAM OF ALL PGT (PHYSICS) OF JABALPUR REGION

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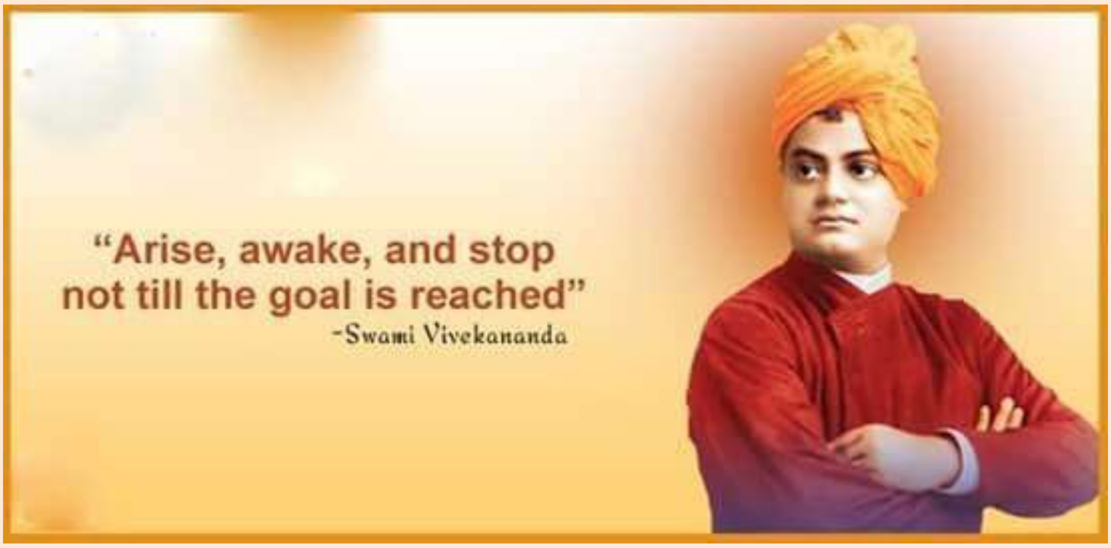
INDEX



"Arise, awake, and stop not till the goal is reached"
-Swami Vivekananda

Competency-Based Assessment

The Competency Based Education is mainly focussed on application of knowledge. It is learning outcome driven and is learning in context to real life.

The following two examples differentiate between Traditional vs Competency-Based Questions

Traditional question	Competency-Based Question	Skill required for Competency Based
1. Define Ohm's Law	1. A wire is replaced with double length. Predict the change in resistance. Justify	Analysing & problem solving
2. State Newton's Second Law.	2. Why do passengers fall forward when a bus stops suddenly? Explain using Newton's laws	Reasoning

Key Competencies required in Physics are :

- Conceptual Understanding
- Application of Concepts
- Analytical Thinking
- Experimental Skills
- Data Interpretation
- Problem Solving

Types of Competency-Based Questions

- Case Study Based
- Assertion-Reason
- Numerical based
- Experimental/Practical Based
- Higher Order Thinking Questions (HOTS)

For Designing Competency-Based Questions, following points are to be kept in mind:

- Align with learning outcomes
- Use real-life situations
- Include multi-step thinking
- Avoid rote memorization
- Integrate diagrams/data

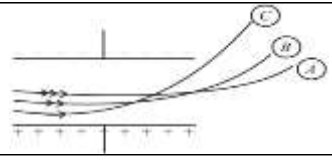
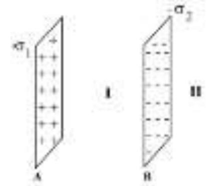
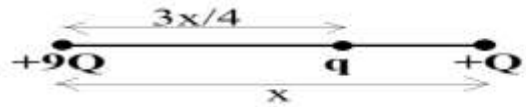
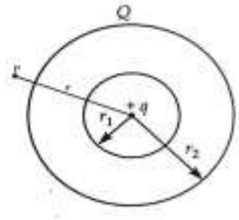
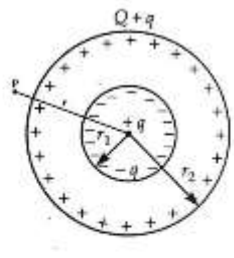
The significance of Assessment & Evaluation of competency based questions are:

- Focus on reasoning, not just answer
- Encourage multiple approaches
- Provide partial marking for steps

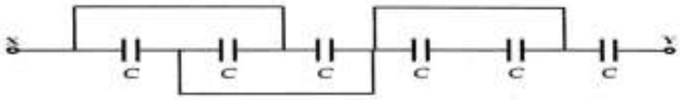
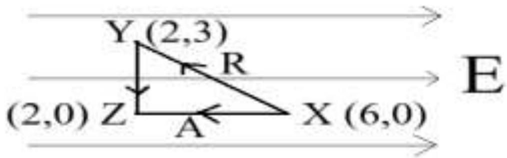
Hence, Competency-based learning enhances understanding, encourages critical thinking and makes Physics relevant to daily life. As a physics teacher, stress should be laid on making the learner competent to apply the concept, rule or law to real life situation or given problem to get the desired results.

COMPETENCY BASED QUESTIONS -CLASS XII

CHAPTER -1 ELECTRIC CHARGES AND FIELDS

Q. 1	Three particles are projected in uniform electric field with same velocity perpendicular to the electric field as shown in the figure. The particle having highest charge to mass ratio is-  (a). B (b) A (c) C (d) All have same
Q. 2	**Assertion(A):** A negative charge in an electric field moves along the direction of the electric field. **Reason(R):** On a negative charge a force acts in the direction of the electric field. a) If both Assertion and Reason are true and Reason is correct explanation of Assertion. b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion. c) If Assertion is true but Reason is false. d) If both Assertion and Reason are false.
Q.3	Two identical plates A and B having charge densities $+\sigma$ and $-\sigma$ are kept as shown in the figure. Obtain the value of electric field in- (i) region-I (ii) region-II 
Q.4	Two charges +9Q and +Q are kept fixed at a separation of x. An unknown charge q placed on the line joining two charges at a distance of 3x/4 from +9Q so that it may be in equilibrium.  What is your opinion about the stability of equilibrium related to the nature of the unknown charge and why?
Q.5	A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q. A charge +q is placed at the centre of the shell.  (a) What is the surface charge density on the inner surface and outer surface of the shell? (b) What is the electric field at point P at a distance r $(r > r_2)$ from the centre of the shell.
ANSWER	
A1	C Ray
A2	(d)
A3	In region-I, Total field $\vec{E} = \overrightarrow{E_A} + \overrightarrow{E_B} = \frac{\sigma}{2\epsilon_0}\hat{r} + \frac{\sigma}{2\epsilon_0}\hat{r} = \frac{\sigma}{\epsilon_0}\hat{r}$ (Since, they are in same direction) In region-II, Total field $\vec{E} = \overrightarrow{E_A} + \overrightarrow{E_B} = \frac{\sigma}{2\epsilon_0}\hat{r} + \frac{\sigma}{2\epsilon_0}(-\hat{r}) = 0$ (Since, they are in opposite direction)
A4	If unknown charge q is considered as negative and it is shifted slightly towards +Q, due to strong attraction from +Q it will never come back to its equilibrium position. Thus, the equilibrium will be unstable for negative charge. If unknown charge q is considered as positive and it is shifted slightly towards +Q, due to strong repulsion from +Q it will again come back to its equilibrium position. Thus, the equilibrium will be stable for positive charge.
A5	When the charge +q is placed at the centre, due to induction, -q charge is induced on the inner surface of the shell and +q charge is induced on the outer surface of the shell.  (a) Surface charge density on the inner surface $\sigma_{in} = \frac{q}{4\pi r_1^2}$ Surface charge density on the outer surface $\sigma_{out} = \frac{Q+q}{4\pi r_2^2}$ (b) $E_P = \frac{1}{4\pi\epsilon_0} \cdot \frac{Q+q}{r^2}$

CHAPTER -2 ELECTRIC POTENTIAL AND CAPACITANCE

Q. 1	What will be the equivalent capacitance between X and Y of the given circuit, If The Capacity of each capacitor is C.  (a). 6C (b) 4C (c) ¾ C (d) 6/11 C
Q. 2	**Assertion (A):** Capacity of a conductor is independent on the amount of charge on it. **Reason (R):** Capacitance depends on the dielectric constant of surrounding medium, shape and size of the conductor. a). If both Assertion and Reason are true and Reason is correct explanation of Assertion. b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion. c) If Assertion is true but Reason is false. d) If both Assertion and Reason are false.
Q.3	Two charges of same nature and magnitude +q are kept fixed at points X inside a uniform electric field. Now to shift the charges, Rahul used a path X → Y → Z (shown as 'R' in the diagram) and Amol used a different path of direct X → Z (shown as 'A' in the diagram). Find the ratio of their work done to move the charge from X to Y. 
Q.4	(a) If we cut out two circular plates of radius 10 cm each, from a thin metallic sheet, and kept them parallel to each other at a distance of 1mm. now applied a source of emf of 10V across the plates. What type of capacitor is this? State one application of this capacitor. (b) If radius of each plates is increased by a factor of √3 and the spacing between the plates is decreased to half of its initial value, calculate the ratio of capacitances in the two cases.
Q.5	A parallel plate capacitor, each with plate area **A** and separation ***d***, is charged to a potential difference **V**. The battery used to charge it is then disconnected. A dielectric slab of thickness *d* and dielectric constant K is now placed between the plates. What change, will be observed in following Quantities (if any) (i) Charge on the plates (q) (ii) Electric field intensity between the plates (E) (iii) Capacitance of the Capacitor (C) Justify your answer in each case.

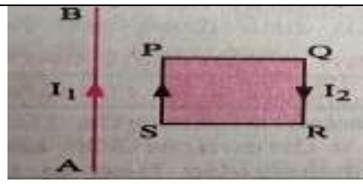
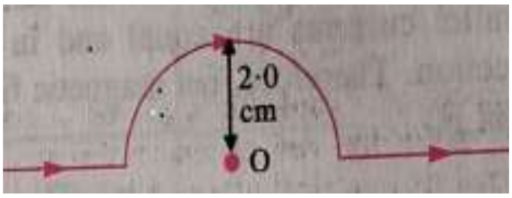
ANSWER

A1	(c) ¾ C
A2	a). If both Assertion and Reason are true and Reason is correct explanation of Assertion.
A3	Work done is path independent. Ratio 1 : 1
A4	(a) Parallel plate capacitor , can be used in oscillatory LC circuit (b) 1:6
A5	(i) The charge *q* on the capacitor plates remains constant because the battery is disconnected from the capacitor. (ii) The electric field intensity between the capacitor plates decreases due to the introduction of a dielectric. Introduction of dielectric field creates an intrinsic electric field directed opposite to the original electric field. This is why the electric field intensity decreases. (iii) The capacitance of the capacitor increases due to the introduction of a dielectric. Electric field decreases, therefore, the capacitor can get more charge to bring back the electric field to its original value. This increases the capacity of holding the charge and hence the capacitance increases

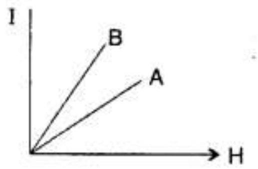
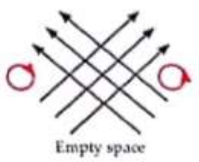
CHAPTER -3 CURRENT ELECTRICITY

Q. 1	A wire of resistance 3 Ω is cut into three pieces, which are then joined to form a triangle. The equivalent resistance between any corners of the triangle is : (a) 2/3 Ω (b) 3/2 Ω (c) 1/2 Ω (d) 1/3 Ω
Q. 2	Two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below. **Assertion:** An electrical bulb starts glowing instantly as it is switched on. **Reason:** Drift speed of electrons in a metallic wire is very small. a). If both Assertion and Reason are true and Reason is correct explanation of Assertion. b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion. c) If Assertion is true but Reason is false. d) If both Assertion and Reason are false.
Q.3	How does the balancing point of a Wheatstone bridge get affected when (i) Position of cell and Galvanometer are interchanged? (ii) Position of the known and time unknown resistances is interchanged ?
Q.4	A wire of 15 Ω resistance is gradually stretched to double its original length. It is then cut into two equal parts. These parts are then connected in parallel across a 3.0 volt battery. Find the current drawn from the battery
Q.5	A boy has two wires of iron and copper of equal length and diameter. He first joins the two wires in series and passes electric current through this combination which increases gradually with time. After that he joins them in parallel and repeat the process of passing the current in this arrangement also. Which wire will glow first in each case and why?
ANSWERS	
A1	(a) 2/3 Ω
A2	(b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion
A3	(1) There will be no change in the balance point condition of Wheatstone bridge even if galvanometer and cell are interchanged. (2) Position of known and unknown resistance is interchanged. 1. There will be no change in the balance point condition of Wheatstone bridge even if galvanometer and cell are interchanged.
A4	R = 15 Ω On stretching to double its original length, the resistance becomes $R_1 = 60\ \Omega$, as on stretching volume is constant and $R \alpha\ l^2$. The two cut parts will have a resistance of 30 Ω each as they are connected in parallel, the $R_{eq} = \frac{30}{2} = 15\ \Omega$ Current drawn from the supply $= I = \frac{V}{R_{eq}}$ *i.e.* $I = \frac{3}{15} = \frac{1}{5} = \mathbf{0.2\ A}$
A5	We know that resistivity of iron is more than that of copper. In series combination, the same current I flows through iron and copper wires. Heat produced, $H = I^2Rt = I^2\ \rho l/A$ i.e. H a ρ As $\rho_{iron} > \rho_{Cu}$ So, $H_{iron} > H_{Cu}$. Therefore, iron will start glowing first in series combination. In parallel combination, the voltage V is same across iron and copper wires, So Heat produced, $H = V^2t/R = V^2\ tA/\rho l$ i.e., H a 1/ρ As, $\rho_{iron} > \rho_{Cu}$ So, $H_{iron} < H_{Cu}$ Therefore, copper will start glowing first in parallel combination of wires.

CHAPTER -4 MOVING CHARGES AND MAGNETISM

Q. 1	A charged particle is projected along the axis of a current carrying loop. Which of the following statements is true? (A) The acceleration of the charged particle will depend on the velocity with which it is projected. (B) The acceleration of the charged particle will depend on the magnitude of the current passing through the coil. (C) The acceleration of the charged particle will depend on the radius of the coil. (D) The charged particle will move with constant velocity.
Q. 2	Two statements are given one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below. (A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion. (B) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion. (C) Assertion is true but Reason is false. (D) Both Assertion and Reason are false. **Assertion (A) :** The resistivity of a moving coil galvanometer is increased by placing a suitable magnetic material as a core inside the coil. **Reason (R) :** Soft iron has a high magnetic permeability and cannot be easily magnetized and demagnetized.
Q.3	When a charged particle moves in a magnetic field, will its kinetic energy remains the same or not? Justify your answer.
Q.4	In the figure, the straight wire AB is fixed while the loop is free to move under the influence of the electric currents flowing in them .In which direction the loop begin to move? Give reason for your answer. 
Q.5	**A** straight wire carrying a current of 12 A is bent into a semi circular arc of radius 2.0 cm as shown in fig. (i) What is the direction and magnitude of magnetic field B at the centre of the arc? (ii) Would the answer change if wire is bent in the opposite way? 
ANSWER	
A1	(D)
A2	(A)
A3	Force on a moving charged particle due to magnetic field is always perpendicular to velocity vector (v). It means this force does not change the magnitude of velocity (i.e. speed) and simply changes the direction of motion of the particle. K.E. = ½ mv^2 Since speed remains the same, K.E. of the charged. particle is not changed
A4	Current in AB and arm PS of the loop are in the same direction, so they attract each other. On the other hand current in AB and the arm QR of the loop are in the opposite direction, so they repel each other. Since arm PS is nearer to AB than the QR, so the net force between the wire AB and the loop is attractive. Hence the loop moves towards the arm AB.
A5	(i) The wire is divided into three sections : (a) The straight section to the left (b) the straight section to the right (c) circular arc Magnetic field due to a current carrying element at a point is given by $dB = \mu_0/4\pi \; Idl\sin\Theta/r^2$ In the given case angle between dl and r for the straight section is o or π. So $\sin 0 = \sin \pi = 0$ Hence magnetic field at the centre o of the arc due to straight sections is zero. Now magnetic field at the centre due to current carrying semi circular section is $B = ½ (\mu_0/4\pi)\, 2\pi I/r$ $= (\mu_0/4\pi)\; \pi I/r$ $= 10^{-7} \times 3.142 \times 12/ 2 \times 10^{-2}$ $= 1.89 \times 10^{-4}$ T The magnetic field is directed into the plane of the paper. (ii) Direction of the magnetic field will be opposite to that found in (i).

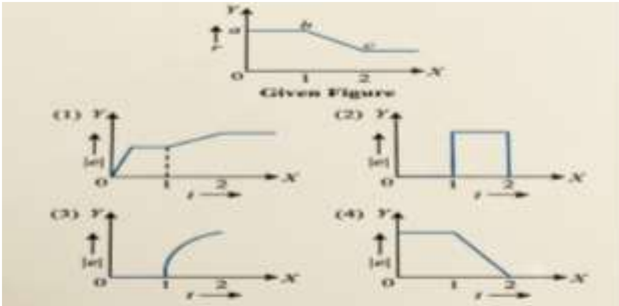
CHAPTER -5 MAGNETISM AND MATTER

Q. 1	Needles N_1, N_2 and N_3 are made of a ferromagnetic, a paramagnetic and a diamagnetic substance respectively. A magnet when brought close to them will? a) Attract all three of them b) Attract N_1 strongly, N_2 weakly and repel N_3 weakly **c)** Attract N_1 strongly but repel N_2 and N_3 weakly **d)** Attract N_1 and N_2 strongly but repel N_3
Q. 2	**Assertion:** When radius of a circular loop carrying current is doubled, its magnetic moment becomes four times. **Reason:** Magnetic moment depends on the area of the loop. a)Assertion is True, Reason is True, Reason is a correct explanation for Assertion b)Assertion is True, Reason is True, Reason is not a correct explanation for Assertion c)Assertion is true, Reason is false d) Assertion is False but, Reason is True
Q.3	In what way is the behavior of a diamagnetic material different from that of a paramagnetic, when kept in an external magnetic field?
Q.4	The figure shows the variation of intensity of magnetization versus the applied magnetic field intensity, H, for two magnetic materials A and B :  (a) Identify the materials A and B. (b) Why does the material B, has a larger susceptibility than A, for a given field at constant temperature?
Q.5	The figures given below show magnetic field lines wrongly (**thick lines shown in the figure**). Point out what is wrong with them: (a)  (b)  (c) 
ANSWERS	
A1	b) Attract N_1 strongly, N_2 weakly and repel N_3 weakly
A2	a)Assertion is True, Reason is True, Reason is a correct explanation.
A3	The affinity of the paramagnetic material towards an external magnetic field is much higher than a diamagnetic material. The magnetic field lines pass through the paramagnetic material while the magnetic field lines move away from the diamagnetic material.
A4	(a) Material A is Paramagnetic. Material B is Ferromagnetic. (b) Since paramagnetic substances have a tendency to pull in magnetic field lines when placed in a magnetic field.
A5	a) Wrong, because magnetic field lines do not cross one another. b) Wrong, because magnetic lines of force never emanate from a single point as shown. The field lines shown represent electric field of a single positive charge. c) Wrong, magnetic field lines between two poles cannot be precisely straight at the ends. Some deviation of lines is inevitable, otherwise, Ampere's law is violated. This is true also for electric field lines.

CHAPTER -6 ELECTROMAGNETIC INDUCTION

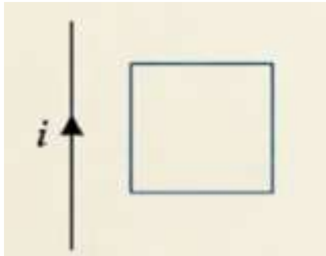
Q. 1

A flexible wire bent in the form of a circle is placed in a uniform magnetic field directed perpendicularly to the plane of the coil. The radius of the coil changes as shown in figure. The graph of magnitude of induced emf in the coil is represented by



Q. 2

A square loop is placed near a long straight current carrying wire as shown in figure. What happen when the current is increased in the wire.



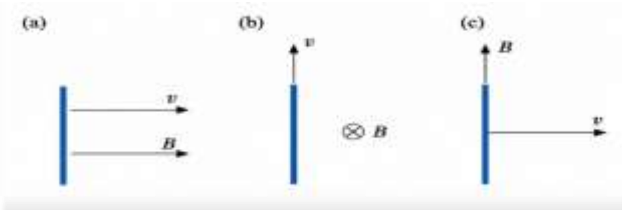
(1) Induced current in loop is clockwise
(2) Induced current in loop is anticlockwise
(3) Wire will attract the loop
(4) Wire will repel the loop

Choose the correct options

(a) Only 1 (b) 2 and 4 (c) only 2 (d) 1 and 3

Q.3

A rod of length L is moving with velocity 'v' in magnetic field as seen in figure. Find the emf induced in all three cases.



Q.4

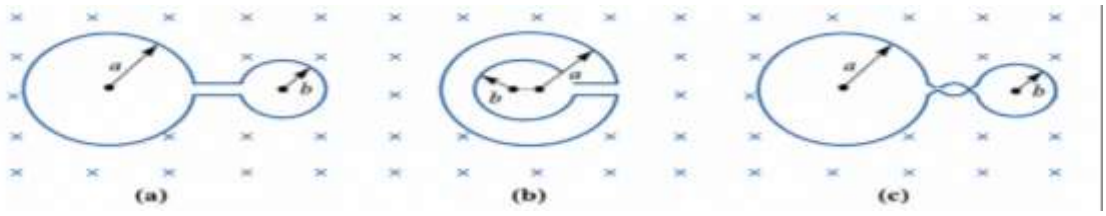
The magnetic flux through a closed conducting loop changes with time according $\varphi = at^2 + bt + c$. Answer the following question

(a). Find SI unit of a, b and c.

(b). If the magnitude of a , b and c are 0.20, 0.40 and 0.60 respectively . Find the induced emf at t=2

Q.5

Figure (a) shows two circular rings of radii **a** and **b** (**a** > **b**) joined together with wires of negligible resistance. Figure (b) shows the pattern obtained by folding the small loop in the plane of the large loop. The pattern shown in Figure (c) is obtained by twisting the small loop of Figure (a) through **180°**.



All the three arrangement are placed in a uniform **time varying magnetic field dB/dt= k** ,perpendicular to the plane of paper of the loop . If the resistance per unit length of the wire is λ , then determine the induced emf in each case.

ANSWERS

A1

(b)

Explanation : from a to b radius is constant so emf =0 , from b to c radius is linearly decreasing hence emf also increases linearly $e = -\frac{BdA}{dt} = -B\frac{d(\pi r^2)}{dt} = -B(2\pi r)$

From c to d , radius is again constant so emf is again zero. Second option matches the answer.

A2	(b) Explanation : when current in the wire increases and magnetic field around the wire which in into the plane of paper in the region where loop is placed also increases. According to lenz law induced current will be such that it opposed the cause, so current in the coil will be anticlockwise direction and will also repel the wire.
A3	(a) Zero as B parallel to v (b) zero as length l is parallel to v (c) zero as L is parallel to B
A4	(a) SI units a= volt/sec , b= volt , c= volt-sec (weber) (b) Induced emf = 1.2 volt $\varphi = 0.20t^2 + 0.4t + 0.60$ $e = -\frac{d\varphi}{dt} = 0.4t + 0.4$, emf at t=2 sec $e = 0.4 \times 2 + 0.4 = 1.2\,V$
A5	Area of coil $A = \pi(a^2 + b^2)$, resistance per unit length is λ, so resistance of the loops will be $R = \lambda \times 2\pi(a+b)$ Also dB/dt= k (a) In figure a , magnetic flux is in same direction in both loop so net Magnetic flux in case a $\varphi = BA = B\pi(a^2 + b^2)$ Magnitude of emf= $\frac{d\varphi}{dt} = \frac{AdB}{dt} = Ak$; and magnitude of current I= Ak/R Induced current $I = k \times \pi(a^2 + b^2)/2\pi\lambda(a+b)$ (b) Here magnetic flux will be opposite in each loop so magnetix flux in case B $\varphi = BA = B\pi(a^2 - b^2)$ $e = \frac{d\varphi}{dt} = \pi(a^2 - b^2) \times \frac{dB}{dt} = \pi(a^2 - b^2)k$ Induced current $I = \frac{e}{R} = \frac{\pi(a^2-b^2)k}{2\pi\lambda(a+b)} = \frac{k(a-b)}{2\lambda}$ (c) In diagram C also the magnetic flux in both loop are in opposite direction so solution will be exactly like part B.

CHAPTER -7 ALTERNATING CURRENT

Q. 1	An ac voltage is given as v = 14 sin(314t) V. The average and the effective (rms) value over one cycle are: (A) 14 and 7 (B) 10 and 14 (C) 0 and 10 (D) 10 and 0
Q. 2	Two statements are given one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below. (A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion. (B) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion. (C) Assertion is true but Reason is false. (D) Both Assertion and Reason are false. **Assertion (A):** At resonance in a series LCR circuit, the impedance is minimum. **Reason (R):** At resonance, $X_L = X_C$.
Q.3	Define: (i) Resonant frequency (ii) Power factor of a series LCR circuit. For what value of power factor is power dissipated maximum?
Q.4	An inductor of 5/π H, a capacitor of 50/π μF and a resistor of 400 Ω are connected in series across v = 140 sin(100πt) V. Calculate: (i) Impedance (ii) RMS current (Take √2 = 1.4).
Q.5	The primary and secondary turns are 100 and 5000 respectively. An ideal transformer is supplied with 3.3 kW at 220 V. Find: (i) Primary current (ii) Output voltage.

ANSWERS	
A1	(C) Solution: Average over one complete cycle = 0 V. $V_{rms} = V_m/\sqrt{2} = 14/1.4 = 10$ V.
A2	(A). Both A and R are true and R is the correct explanation of A.
A3	Resonant frequency: Frequency at which $X_L = X_C$. $f_0 = 1/(2\pi\sqrt{LC})$ • Power factor = $\cos\varphi = R/Z$. Maximum power is dissipated when $\cos\varphi = 1$ (unity).
A4	Solution: $\omega=100\pi$ rad s^{-1} $X_L=500\ \Omega$ $X_C=200\ \Omega$ $Z=\sqrt{(400^2+300^2)}=500\ \Omega$ $V_{rms}=100$ V $I_{rms}=100/500=0.2$ A
A5	Solution: $I_p=3300/220=15$ A $V_s=(5000/100)\times220=11000$ V

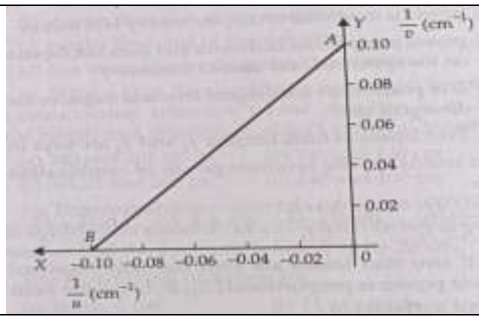
CHAPTER - 8 ELECTROMAGNETIC WAVES

Q. 1	Which electromagnetic wave has the highest frequency? (A) Microwaves (B) Infrared (C) Ultraviolet (D) Gamma rays
Q. 2	Two statements are given one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below. (A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion. (B) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion. (C) Assertion is true but Reason is false. (D) Both Assertion and Reason are false. **Assertion (A):** Electromagnetic waves can travel through vacuum. **Reason (R):** They do not require a material medium
Q.3	A hospital uses electromagnetic waves to detect bone fractures. (i) Identify the wave. (ii) State one property making it suitable.
Q.4	A TV remote works only when pointed at the TV. (i) Name the electromagnetic wave. (ii) State one characteristic making it suitable.
Q.5	Case-based: Satellite communication uses microwaves. (a) Why are microwaves preferred? (b) Mention one advantage of EM waves. (c) Arrange in increasing frequency: Radio, Microwaves, Infrared.
ANSWER	
A1	(D) Gamma rays
A2	(A)
A3	X-rays; penetrate soft tissue, absorbed by bones
A4	Infrared; short-range line-of-sight
A5	(a) Low attenuation (b) No medium required (c) Radio < Microwave < Infrared

CHAPTER -9 RAY OPTICS- REFLECTION AND REFRACTION

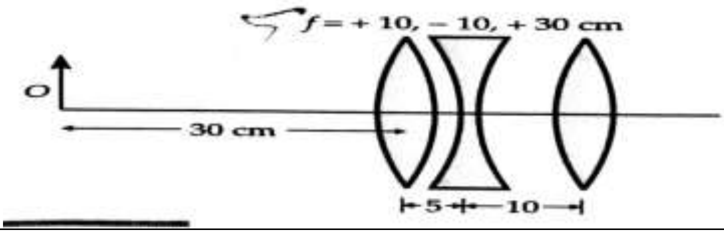
Q. 1 The graph between 1/u and 1/v for a thin convex lens in order to determine its focal length is plotted as shown in figure. The refractive index of lens is 1.5 and its both the surfaces have same radius of curvature R. The value of R will be:
(Where u= object distance, v= image distance)

(a). 5cm (b) 10cm (c)15cm (d) 20cm



Q. 2 A statement of assertion (A) is followed by a statement of reason (R) . Mark the correct choice as:
(a) If both the assertion and reason are true and reason is the correct explanation of assertion.
(b) If both the assertion and reason are true but reason is not the correct explanation of assertion.
(c) If the assertion is true and reason is false.
(d) If both assertion and reason are false.
Assertion-The critical angle for glass-air interface is**C_1** for a glass slab kept in air. Now the same glass slab is dropped in water then critical angle **C_2** for glass-water interface is increased.
Reason: Refractive index of slab in water is less than air and Sin $C_1 = 1/{}^a\mu_g$ Sin $C_2 = 1/{}^w\mu_g$

Q.3 Find the position of image formed by the lens combination in given figure:



Q.4 A convex lens made of material of refractive index n2 is held in a reference medium of refractive index n1. Trace the path of a parallel beam of light passing through the lens when
(i) n1= n2 (ii) n1<n2 (iii) n1>n2

Q.5 The diameter of a glass sphere is 10 cm. A beam of light strikes the sphere, which converges at a point 20 c behind the pole of the spherical surface. Find the position of image if μ=1.5

Q.6 A thin rod of length f/3is placed along the optic axis of a concave mirror of focal length f such that its iage which is real and elonated, just touches the rod. What will be the magnification.?

ANSWERS

A1 (b)

A2 (a)

A3 **Lens 1 (f_1 = 10 cm, u_1 = –30 cm)**

$$\frac{1}{v_1} = \frac{1}{f_1} + \frac{1}{u_1} = \frac{1}{10} - \frac{1}{30} = \frac{2}{30}$$
$$v_1 = +15 \text{ cm (real image, 15 cm to the right of L1)}$$

Lens 2 (f_2 = –10 cm)
L2 is 5 cm to the right of L1, so the image from L1 lies 15 – 5 = 10 cm to the right of L2. Since this is on the same side as outgoing light (before the rays actually converge there), it acts as a **virtual object** for L2:

$$u_2 = +10 \text{ cm}$$
$$\frac{1}{v_2} = \frac{1}{f_2} + \frac{1}{u_2} = \frac{1}{-10} + \frac{1}{10} = 0$$
$$v_2 = \infty$$

So after passing through L2, the rays emerge **parallel** (image at infinity).
Lens 3 (f_3 = +30 cm)
Parallel rays incident on a lens converge at its focal point:

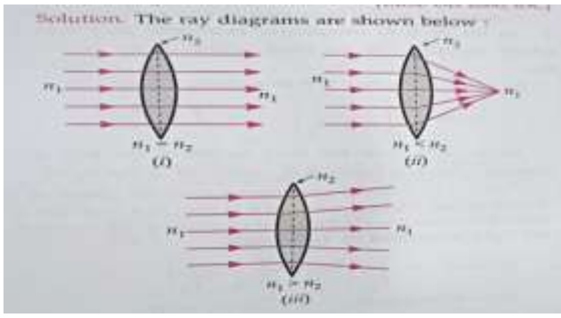
$$v_3 = f_3 = +30 \text{ cm}$$

A4

(i). $n_1 = n_2$ — no bending, lens has no effect

(ii). $n_1 < n_2$ — lens converges, real focus FF

(iii). $n_1 > n_2$ — lens diverges, virtual focus



A5

Given:

- Radius of sphere, R = 5 cm
- $\mu_1 = 1$ (air), $\mu_2 = 1.5$ (glass)
- Object: beam converges at 20 cm behind the pole (virtual object for refracting surface)
- So u = +20 cm

Refraction at first surface (using):

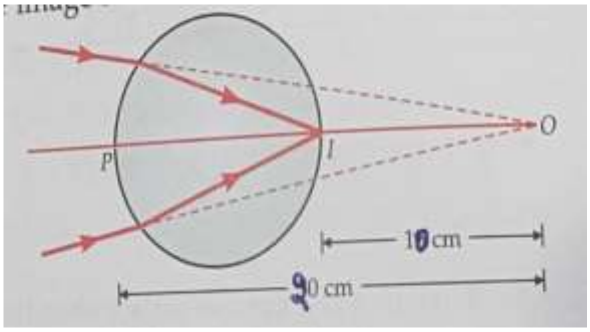
$\mu_2/v - \mu_1/u = (\mu_2 - \mu_1)/R$

$1.5/v - 1/20 = (1.5 - 1)/5$

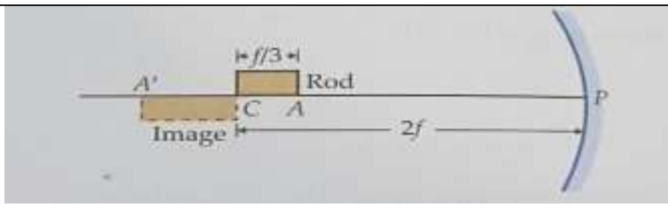
$1.5/v - 1/20 = 0.5/5 = 0.1$

$1.5/v = 0.1 + 0.05 = 0.15$

$v = 1.5/0.15 =$ **10 cm**



A6



If u = PA = 5f/3 the

i/f = 1/v - 1/u => v = 5f/2

length of image = f/ magnification = (f/2)/(f/3) = 1.5

CHAPTER -9 -Ray optics: Dispersion and optical instruments

Q. 1 Four lenses of focal length ±15 cm and ±150 cm are available for making a telescope. To produce the largest magnification, the focal length of the eyepiece should be

(a) + 15 cm (b) + 150 cm (c) – 150 cm (d) – 15 cm

Q. 2 **Assertion** – When white light passes through a parallel sided glass slab, it undergoes dispersion.

Reason – The frequencies of the different colours in white light change as it moves from air to glass.

(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) Both are false.

Q.3 Calculate the value of the angle of incidence when a ray of light incident on one face of an equilateral glass prism produces the emergent ray, which just grazes along the adjacent face, Refractive index of the prism is $\sqrt{2}$.

Q.4 A giant refracting telescope at an observatory has an objective lens of focal length 15 m . If this telescope is used to view the moon, what is the diameter of the moon formed by the objective lens ? The diameter of the moon is 3.48×10^6 m, and the radius of lunar orbit is 3.8×10^8 m.

Q.5 An angular magnification of 30 X is desired using an object of focal length 1.25 cm and an eyepiece of focal length 5 cm, How will you set up the compound microscope (for the final image formed at the least distance of distinct vision) ?

ANSWERS	
A1	(a). +15 cm
A2	(d). Both are false
A3	Given: A =60°, $\mu = \sqrt{2}$, e=90° (Applying Snell's law at the second face,) $\mu \sin r_2 = 1 \times \sin 90°$ $r_2 = 45°$ since, $r_2 + r_1 = A$ Therefore, $r_1 = 15°$ (Again applying Snell's law at the first face,) $1 \times \sin i = \mu \sin r_1$ or $\sin i = \sqrt{2} \sin 15°$ $= \sqrt{2}(\sqrt{3}-1)/2\sqrt{2}$ $i = 21.47°$
A4	Given: f_0 =15 cm, d = 3.48 x 10^6 m, r = 3.8 x 10^8 m α = Diameter of moon/Distance to moon = d/r & α = Diameter of image/Focal length of objective $= d'/f_0$ Therefore, $d/r = d'/f_0$ d'= 0.1374 m
A5	1) Given: D=25 cm, f_e = 5 cm Angular magnification of eyepiece, $m_e = 1 + (D/f_e)$ $=1 + (25/5)$ $= 6$ Total angular magnification, $m = m_0 \times m_e$ $30 = m_o \times 6$ Therefore, $m_o = 5$ $m_0 = v_o/(-u_o)$, $v_0 = -5u_o$ So, $1/f_o = 1/v_o - 1/u_o$ $u_o = -1.5$ cm Therefore, $v_o = 7.5$ cm For the eyepiece: f_e= 5 cm $1/f_e = 1/v_e - 1/u_e$ $u_e = -4.17$ cm Tube length, $L = \lvert v_o \rvert + \lvert u_e \rvert$ = 11.67 cm

CHAPTER -10 WAVE OPTICS

Q. 1	A soap bubble appears colourful in sunlight mainly due to: (a) Diffraction of light (b) Interference of light (c) Polarisation of light (d) Dispersion of light
Q. 2	Assertion (A): Ripples spreading out on a pond after a stone is dropped can be used to visualise how a light wavefront spreads out from a point source. Reason (R): According to Huygens' principle, every point on a wavefront acts as a source of secondary wavelets, and the new wavefront is the envelope of these wavelets. (a) Both A and R are true, and R is the correct explanation of A (b) Both A and R are true, but R is not the correct explanation of A (c) A is true, but R is false (d) A is false, but R is true
Q.3	At a science exhibition, a laser beam is split into two beams by a beam splitter and the two beams are made to overlap on a screen, producing a steady pattern of bright and dark fringes. When two separate laser pointers of the same colour are instead pointed at the screen together, no such steady pattern is seen — the screen just looks uniformly lit. (a) What name is given to two sources, like the two beams from the beam splitter, that are capable of producing a sustained interference pattern? (b) Briefly explain why two independent laser pointers of the same colour fail to produce a sustained interference pattern.
Q.4	When a laser pointer is shone through a narrow vertical slit (or through the narrow gap left between two fingers held close together) onto a wall, a pattern is seen consisting of a wide, bright central band flanked by narrower, alternately dark and faint bright bands. (a) Identify the phenomenon responsible for this pattern. (b) If the slit width is decreased, state and briefly explain what happens to the width of the central bright band.
Q.5	A student uses a laser pointer (assumed to behave as a monochromatic point source) and a double-slit arrangement to observe interference fringes — a method also used to measure the wavelength of light precisely, as in instruments like barcode scanners. In the set-up, the two slits are separated by 0.2 mm, the screen is placed 1.5 m away, and the laser has a wavelength of 632.8 nm. (a) Write the expression for the fringe width β in Young's double slit experiment, stating the meaning of each term used. (b) Using this expression, calculate the fringe width obtained on the screen in the above set-up. (c) If the laser is replaced by one emitting blue light (wavelength $\approx$ 450 nm), keeping the slit separation and screen distance unchanged, will the fringe width increase or decrease? Justify your answer.
	ANSWERS
A1	Correct option: (b) Interference of light. Explanation: Light reflects from both the outer and inner surfaces of the thin soap film. The two reflected waves have a path difference depending on the film thickness, so different wavelengths interfere constructively or destructively at different points, producing colours.
A2	Correct option: (a) Both A and R are true, and R is the correct explanation of A. Explanation: Ripples spreading outward on a pond are a good everyday picture of a wavefront moving outward from a point source. Huygens' principle states that every point on a wavefront becomes a source of secondary wavelets, and the envelope of these wavelets forms the new wavefront a moment later — this is exactly how the ripple pattern grows outward.
A3	(a) They are called coherent sources. (b) Two independent laser pointers, even of the same wavelength, emit light due to independent atomic/molecular emissions, so the phase difference between the two beams keeps changing randomly and rapidly with time. The interference pattern therefore also shifts randomly and averages out over time, so no stable pattern is seen. Only sources derived from a single original source (so that they maintain a constant phase relationship, i.e. coherent sources) can produce a sustained interference pattern.

A4	(a) The phenomenon responsible is diffraction of light (single-slit diffraction). (b) If the slit width is decreased, the central bright band becomes wider. This is because the angular width of the central maximum is inversely proportional to the slit width — a narrower slit spreads the diffracted light over a larger angle, so the central band widens on the wall/screen.
A5	(a) The fringe width is given by $\beta = \lambda D/d$, where λ is the wavelength of the light used, D is the distance between the slits and the screen, and d is the separation between the two slits. (b) Calculation: Given $\lambda = 632.8$ nm $= 632.8 \times 10^{-9}$ m, D = 1.5 m, d = 0.2 mm $= 0.2 \times 10^{-3}$ m. $\beta = \lambda D/d = (632.8 \times 10^{-9} \times 1.5) / (0.2 \times 10^{-3}) = 4.746 \times 10^{-3}$ m ≈ 4.75 mm. (c) The fringe width will decrease. Since $\beta \propto \lambda$ (with d and D kept unchanged), and blue light has a shorter wavelength (≈ 450 nm) than the laser used earlier (632.8 nm), the fringe width will be smaller with blue light.

CHAPTER -11 DUAL NATURE OF MATTER AND RADIATION

Q. 1	The stopping potential Vo for photoelectrons emitted from a photosensitive surface depends on: (A) The intensity of the incident light only (B) The frequency of the incident light and nature of the work function (C) The continuous time of exposure of light (D) The area of the photosensitive metal surface
Q. 2	**Assertion (A)**: The photoelectric current increases linearly with the increase in the intensity of incident radiation of a given frequency. **Reason (R):** The number of photoelectrons emitted per second is directly proportional to the intensity of incident light. (A) Both (A) and (R) are true, and (R) is the correct explanation of (A). (B) Both (A) and (R) are true, but (R) is not the correct explanation of (A). (C) (A) is true, but (R) is false. (D) (A) is false, but (R) is true
Q.3	Define work function and threshold frequency of a metal surface for photoelectric emission. State how they are related to each other.
Q.4	Calculate the de-Broglie wavelength associated with an electron accelerated through a potential difference of 100 V.
Q.5	In Rutherford's alpha-particle scattering experiment, two alpha particles are directed towards the nucleus with the same kinetic energy. Alpha particle A approaches the nucleus with a very small impact parameter, while alpha particle B has a larger impact parameter. **(a)** Which alpha particle will undergo a larger angle of scattering? **(b)** What happens to the distance of closest approach when the impact parameter is decreased? **(c)** Why does the alpha particle momentarily stop at ?
	ANSWERS
A1	(B) The frequency of the incident light and nature of the work function
A2	(A) Both (A) and (R) are true, and (R) is the correct explanation of (A).

A3	The **minimum amount of energy required to just remove an electron from the surface of a metal** is called its work function. $$\boxed{\phi = h\nu_0}$$ Its SI unit is **joule (J)**; it is also commonly expressed in **electron volt (eV)**. **2. Threshold Frequency (ν_0):** The **minimum frequency of incident radiation required to just eject photoelectrons from a metal surface** is called the threshold frequency. **Relation between Work Function and Threshold Frequency** At threshold frequency, the emitted electron has zero maximum kinetic energy. From Einstein's photoelectric equation: $$h\nu_0 = \phi + K_{\max}$$ Since $K_{\max} = 0$, $$\boxed{\phi = h\nu_0}$$ Therefore, **work function is directly proportional to the threshold frequency of the metal.**
A4	$$\lambda = \frac{h}{\sqrt{2meV}}$$ For electrons, this can be written as $$\lambda = \frac{12.27}{\sqrt{V}}\ \text{Å}$$ Given: $$V = 100\ \text{V}$$ Therefore, $$\lambda = \frac{12.27}{\sqrt{100}} = \frac{12.27}{10}$$ $$\boxed{\lambda = 1.227\ \text{Å}}$$
A5	**(a)** Alpha particle **A** will undergo a **larger angle of scattering** because a smaller impact parameter means that it passes closer to the nucleus and experiences a stronger electrostatic repulsive force. **(b)** As the impact parameter decreases, the alpha particle approaches the nucleus more closely. Hence, the **distance of closest approach decreases**. **(c)** In a head-on collision, the positively charged alpha particle is repelled by the positively charged nucleus. Its kinetic energy is completely converted into electrostatic potential energy at the closest approach.

CHAPTER -12 ATOMS

Q. 1	An electron in a hydrogen atom jumps from orbit n = 3 to n = 2. The emitted photon will have: A) Higher wavelength than Lyman series B) Lower energy than Balmer series transitions from higher levels C) Same energy as ionization energy D) Zero energy
Q. 2	**Assertion**: Spectral lines of hydrogen are discrete. **Reason**: Electrons occupy specific energy levels. (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is NOT the correct explanation of A. (c) A is true but R is false. (d) A is false and R is also false.
Q.3	In a hydrogen atom, an electron revolves in the orbit. A student claims that if the electron moves to the orbit, its distance from the nucleus becomes twice the original distance. **(a)** Is the student's statement correct? **(b)** Find the ratio of the radii of the and orbits.
Q.4	An electron in a hydrogen atom makes a transition from the orbit to the orbit. **(a)** Is energy emitted or absorbed during this transition? **(b)** If the electron instead makes a transition from to , how will the energy change?
Q.5	A hydrogen atom is initially in the excited state. The electron makes a transition directly to the state. **(a)** Compare the radius of the orbit with the orbit. **(b)** Calculate the energy of the photon emitted during the transition. **(c)** To which spectral series does this transition belong?
	ANSWERS
A1	B) Lower energy than Balmer series transitions from higher levels
A2	(a) Both A and R are true and R is the correct explanation of A.
A3	For a hydrogen atom, $r_n = n^2 r_1$ Therefore, $\frac{r_4}{r_2} = \frac{4^2}{2^2} = \frac{16}{4} = \boxed{4}$ Thus, the statement is **incorrect**. The radius becomes **four times**, not twice.

A4	The energy of the electron in the n^{th} orbit is $$E_n = -\frac{13.6}{n^2}\ \text{eV}$$ For transition $3 \to 2$, the electron moves to a **lower energy state**, so energy is **emitted** as a photon. For transition $2 \to 3$, the electron moves to a **higher energy state**, so energy must be **absorbed**. The photon energy is given by $$\boxed{h\nu = \lvert E_f - E_i \rvert}$$
A5	$$r_n = n^2 r_1$$ Therefore, $$\frac{r_4}{r_2} = \frac{4^2}{2^2} = 4$$ $$\boxed{r_4 = 4r_2}$$ (b) Energy of the n^{th} orbit: $$E_n = -\frac{13.6}{n^2}\ \text{eV}$$ For $n = 4$: $$E_4 = -\frac{13.6}{16} = -0.85\ \text{eV}$$ For $n = 2$: $$E_2 = -\frac{13.6}{4} = -3.4\ \text{eV}$$ Hence, energy emitted is $$\Delta E = E_4 - E_2$$ $$= -0.85 - (-3.4)$$ $$\boxed{\Delta E = 2.55\ \text{eV}}$$ (c) Since the electron finally reaches $n = 2$, the transition belongs to the **Balmer series**.

CHAPTER -13 - NUCLEI

Q. 1	Which of the following statements about nuclear forces is not true? (A) The nuclear force between two nucleons falls rapidly to zero as their distance is more than a few femtometres. (B) The nuclear force is much weaker than the Coulomb force. (C) The force is attractive for distances larger than 0.8 fm are separated by distances less than 0.8 fm. (D) The nuclear force between neutron-neutron, proton-neutron and proton-proton is approximately the same.
Q. 2	**Assertion (A):** Nuclear force is same between neutron-neutron, proton-proton and neutron-proton. Reason (R): Nuclear force is charge independent. (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is NOT the correct explanation of A. (c) A is true but R is false. (d) A is false and R is also false.

Q.3 What is the nuclear radius of ^{125}Sn, if that of ^{27}Al is 3.6 fermi?

Q.4 A student says: *"A heavier nucleus must have a greater nuclear density because it contains more nucleons."* Is this statement correct? Give a reason.

Q.5 Explain the process of nuclear fission and nuclear fusion by using the plot of binding energy per nucleon (BE/A) versus the mass number A.

ANSWERS

A1 (B) The nuclear force is much weaker than the Coulomb force.

A2 (a) Both A and R are true and R is the correct explanation of A.

A3 **: R = $R_0 A^{1/3}$, where R_0 is a constant and A is the mass number of the nucleus** $\frac{R_{Sn}}{R_{Al}} = \frac{A_{Sn}^{1/3}}{A_{Al}^{1/3}} = \frac{125^{1/3}}{27^{1/3}}$

$R_{Sn} = \frac{5}{3} R_{Al} = \frac{5}{3}$ X 3.6 = 6 fermi

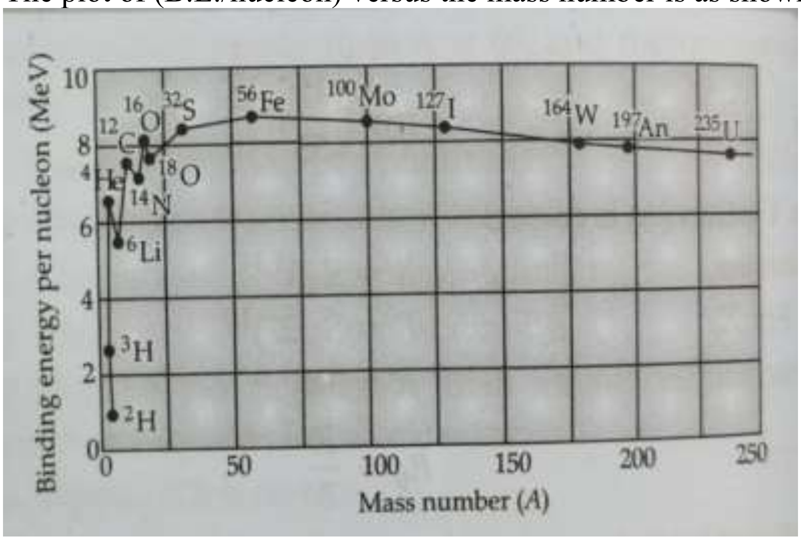
A4 **No.** Nuclear density is approximately the same for all nuclei because both nuclear mass and volume are proportional to A:

$$M \propto A, \qquad V \propto R^3 \propto A$$

Therefore,

$$\boxed{\rho = \frac{M}{V} \approx \text{constant}}$$

A5 The plot of (B.E./nucleon) versus the mass number is as shown.



From the plot, we note that

(i) During nuclear fission

A heavy nucleus in the larger mass region (A > 200) breaks into two middle level nuclei, resulting increase in B.E/nucleon. This results in a release of energy.

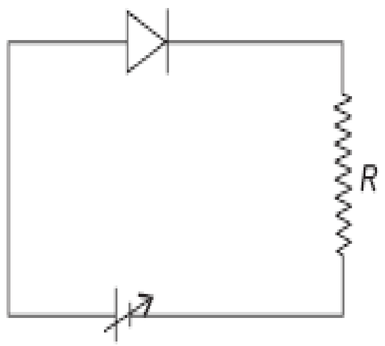
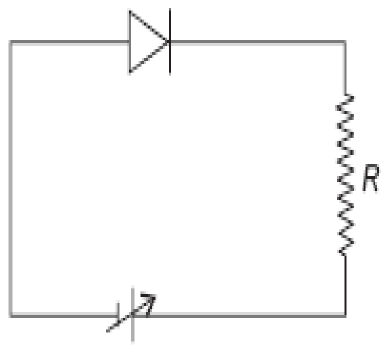
(ii) During nuclear fusion

Lighter nuclei in the lower mass region (A<20) fuse to form a nucleus having higher B.E./nucleon. Hence, energy gets released.

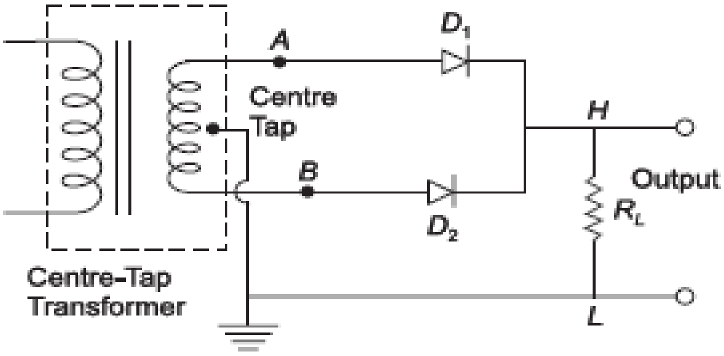
CHAPTER -14 SEMICONDUCTOR DEVICES

Q. 1	Electrical conductivity of a semiconductor (a) decreases with the rise in its temperature. (b) increases with the rise in its temperature. (c) does not change with the rise in its temperature. (d) first increases and then decreases with the rise in its temperature.
Q. 2	**Assertion:** Conductivity of an n-type semiconductor is greater than that of p-type semiconductor. **Reason:** Electrons have greater mobility than holes. (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is NOT the correct explanation of A. (c) A is true but R is false. (d) A is false and R is also false.
Q.3	Distinguish between ‘intrinsic’ and ‘extrinsic’ semiconductors.
Q.4	Draw the circuit diagrams showing how a *p–n* junction diode is (i) forward biased and (ii) reverse biased. How is the width of depletion layer affected in the two cases?
Q.5	Draw the circuit diagram of a full-wave rectifier using p–n junction diode. Explain its working and show the output and input waveforms.

ANSWERS

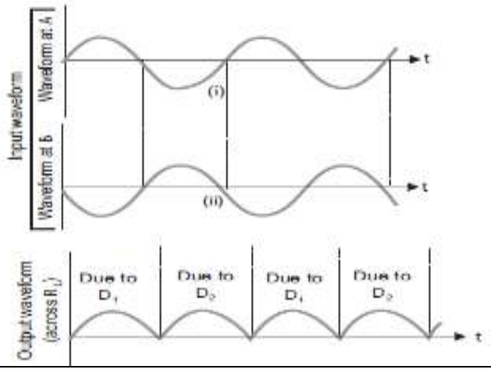
A1	(b) With temperature rise, the conductivity of semiconductor increases
A2	(a) Both A and R are true and R is the correct explanation of A.
A3	Intrinsic semiconductors (i) There are no impurity atoms. (ii) The number density of electrons is equal to the number density of holes, i.e. $n_e = n_h$. Extrinsic semiconductors (i) They are doped with impurity atoms (trivalent/pentavalent). (ii) $n_e \neq n_h$.
A4	The following figures show the required circuit diagram.  (*i*) Forward biased *p–n* junction  (*ii*) Reverse biased *p–n* junction When the *p–n* junction is forward biased as in Figure (i), the width of the depletion layer decreases. When an external voltage is applied, the barrier potential is reduced thereby, decreasing the width of depletion layer. When the *p–n* junction is reverse biased as in Figure (ii), the barrier potential increases, thereby, increasing the thickness of the depletion layer.

A5	During the first half of the cycle, if A is at higher potential with respect to centre tap and B is at lower potential, diode D_1 is forward biased and conducts, while diode D_2 is reverse biased and does not conduct. The current flows through the load from H to L. During the second half of the cycle, the conditions reverse and only diode D_2 conducts. Again, the current flows through the load from H to L.



A full-wave rectifier

Thus, in the output, we get a unidirectional current



MIND MAPS
CLASS XII

1.ELECTROSTATICS

Electric Field Intensity:- $E=\dfrac{1}{4\pi\varepsilon_0}\dfrac{Q}{r^2}$ vector | unit:- $\dfrac{N}{C}$ | $E=-\dfrac{dV}{dr}$ | **Electric Potential** $V=\dfrac{1}{4\pi\varepsilon_0}\dfrac{Q}{r}$ scalar | unit:- $\dfrac{J}{C}$ | $V=-\int \vec{E}.d\vec{r}$

Electric Dipole:- Equal and Opposite charge separated by small distance, **Dipole moment** $\vec{P}=2q\vec{l}$ vector(direction from negative to positive charge **unit:-** C m

E & V on Axial Line:- $\vec{E}$ at pt. P on axial line

is $\vec{E}=\vec{E}_B+(-\vec{E}_A)$

$$\vec{E}=\frac{1}{4\pi\varepsilon_0}\frac{q}{(r-l)^2}-\frac{1}{4\pi\varepsilon_0}\frac{q}{(r+l)^2}$$

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

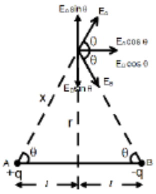
$$\vec{E}=\frac{2\times 2qrl}{4\pi\varepsilon_0\left(r^2-l^2\right)^2}=\frac{2pr}{4\pi\varepsilon_0\left(r^2-l^2\right)^2}$$

$\vec{E}=\dfrac{2P}{4\pi\varepsilon_0 r^3}$ For short dipole r >> l (direction (-) to (+))

$$V=V_A+V_B=\frac{1}{4\pi\varepsilon_0}\frac{-q}{(r+l)}+\frac{1}{4\pi\varepsilon_0}\frac{q}{(r-l)}$$

$$=\frac{1}{4\pi\varepsilon_0}\frac{P}{\left(r^2-l^2\right)}\Rightarrow V=\frac{P}{4\pi\varepsilon_0 r^2}$$

E & V on Equitorial line:-



$\vec{E}=E_A\cos\theta+E_B\cos\theta$

since

$E_A=E_B$

$\therefore \vec{E}=2E_A\cos\theta$

$$\vec{E}=2\times\frac{1}{4\pi\varepsilon_0}\frac{q}{x^2}\times\left(\frac{l}{x}\right)\quad \because \cos\theta=\frac{l}{x}$$

$$\vec{E}=\frac{2ql}{4\pi\varepsilon_0 x^3}=\frac{P}{4\pi\varepsilon_0\left(\sqrt{x^2+l^2}\right)^3}$$

$$\vec{E}=\frac{P}{4\pi\varepsilon_0\left(r^2+l^2\right)^{\frac{3}{2}}}$$

$\vec{E}=\dfrac{P}{4\pi\varepsilon_0\left(r^3\right)}$ For short dipole r >> l

Direction (+) to (-)

$$V=V_A+V_B=\frac{1}{4\pi\varepsilon_0}\frac{q}{x}+\frac{1}{4\pi\varepsilon_0}\frac{(-q)}{x}=0$$

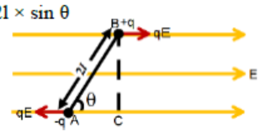
Torque on Dipole:- Net force = +qE – qE = 0

Torque = Force × ⊥ distance

= qE × BC [BC = 2l × sin θ

= qE 2l sin θ

= E (2ql) sin θ



τ = PE sin θ = $\vec{P}\times\vec{E}$

τ_{max} = PE for θ = 90°

work done in Rotating Dipole

$$W=\int \tau\, d\theta=(1-\cos\theta)PE$$

Energy of Dipole: U = –PE cos θ

Stable equilibrium θ = 0, U= –PE

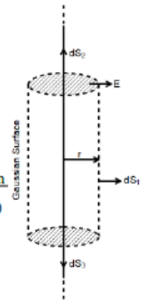
Unstable equilibrium

Θ = 180° ⇒ U = PE.

Gauss Theorem:- Total electric flux (total no. of lines of forces) emerges from closed surface is $\dfrac{1}{\varepsilon_0}$ times the charge enclosed $\oint E.dS=\dfrac{q_{in}}{\varepsilon_0}$

$\vec{E}$ due to long charged wire:

Linear charge density $\lambda=\dfrac{q}{l}$



$$\oint E.dS=\frac{q_{in}}{\varepsilon_0}$$

$$\int E.dS_1+\int E.dS_2+\int E.dS_3=\frac{q_{in}}{\varepsilon_0}$$

For dS_2 and dS_3 θ = 90°

For curved surface dS_1 θ = 0

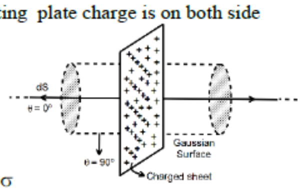
$$\therefore E\int dS=\frac{q}{\varepsilon_0}\Rightarrow E(2\pi rl)=\frac{q}{\varepsilon_0}$$

$$E=\frac{q}{2\pi rl\varepsilon_0}=\frac{\frac{2q}{l}}{\pi 4\varepsilon_0 r}\Rightarrow \vec{E}=\frac{1}{4\pi\varepsilon_0}\frac{2\lambda}{r}$$

$\vec{E}$ due to charged plane sheet:

Surface charge density $\sigma=\dfrac{q}{A}$

For non conducting plate charge is on both side



$$2\int E.dS=\frac{q}{\varepsilon_0}$$

$$2EA=\frac{q}{\varepsilon_0}$$

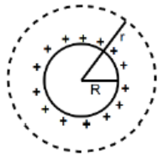
$$E=\frac{q}{2\varepsilon_0 A}\quad E=\frac{\sigma}{2\varepsilon_0}$$

For conducting sheet $E=\dfrac{\sigma}{\varepsilon_0}$

* E is independent of distance from the sheet.

$\vec{E}$ due to charged Hallow Sphere:

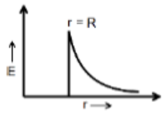
Volume charge density $\rho=\dfrac{q}{V}$



$$\oint E.dS=\frac{q_{in}}{\varepsilon_0}$$

$$\therefore E\int dS=\frac{q}{\varepsilon_0}$$

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



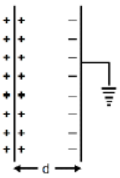
$E=\dfrac{1}{4\pi\varepsilon_0}\dfrac{q}{R^2}$ On surface

$E=\dfrac{1}{4\pi\varepsilon_0}\dfrac{q}{r^2}$ Outside & $\vec{E}=0$ as q = 0 inside

Capacitor:- Q = CV **unit:-** Farad, * C depends on dimensions

Capacitance for parallel plate capacitor

Consider || plate capacitor with area of plate A, capacitance C and dist. b/w plates d



$$C=\frac{Q}{V}=\frac{Q}{E\times d}$$

$E=\dfrac{\sigma}{\varepsilon_0}$ for charged sheet

$\sigma=\dfrac{Q}{A}$ for surface charge density

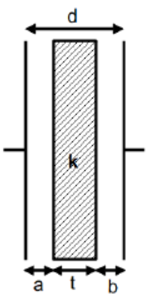
$$C=\frac{\sigma A}{\frac{\sigma}{\varepsilon_0}\times d}=\frac{\varepsilon_0 A}{d}$$

If dielectric with dielectric constant k is filled b/w the plates. C' = kC

Surface charge Density

$\sigma=\dfrac{Q}{A}\therefore Q=\sigma A$

Electric field



$$\vec{E}=E_{air}+E_{dielectric}$$

$$=\frac{\sigma}{\varepsilon_0}+\frac{\sigma}{k\varepsilon_0}$$

Potential V = E × d

$$\therefore V=\frac{\sigma}{\varepsilon_0}(a+b)+\frac{\sigma}{k\varepsilon_0}t$$

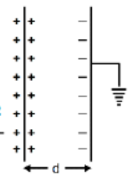
$$V=\frac{\sigma}{\varepsilon_0}\left(a+b+\frac{t}{k}\right)$$

$$V=\frac{\sigma}{\varepsilon_0}\left(d-t+\frac{t}{k}\right)$$

Now $C=\dfrac{Q}{V}=\dfrac{\sigma A}{\frac{\sigma}{\varepsilon_0}\left(d-t+\frac{t}{k}\right)}$

Energy of Capacitor

Energy = work done in bringing charge at potential V



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

$$U=\int_0^Q dW=\frac{1}{C}\int_0^Q q\times dq=\frac{1}{C}\left(\frac{q^2}{2}\right)_0^Q=\frac{1}{2}\frac{Q^2}{C}$$

$$U=\frac{1}{2}\frac{Q^2}{C}=\frac{1}{2}CV^2=\frac{1}{2}QV$$

Energy Density (energy per unit volume)

$$=\frac{\frac{1}{2}CV^2}{volume}=\frac{\frac{1}{2}\frac{\varepsilon_0 A}{d}(E\times d)^2}{A\times d}=\frac{1}{2}\varepsilon_0 E^2$$

Unit of energy density:- J/m³

2. CURRENT ELECTRICITY

Electric Current: $i = \frac{q}{t}$, **unit** - Ampere

* Scalar quantity

Drift velocity:- $v = u + a\tau$

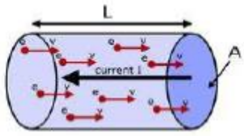
if $u = 0$ $\quad \tau$ – relaxation time (10^{-14} s)

$V_d = a\tau$

Also $ma = eE = f \quad \therefore a = \frac{eE}{m}$

$V_d = \frac{eE\tau}{m}$ $\quad$ (10^{-5} m/s) $\quad$ as $\quad V = Exl$

$V_d = \frac{eV\tau}{ml}$



Current $I = neAV_d$

$I = neA\frac{eV\tau}{ml}$ $\qquad \frac{I}{V} = \frac{ne^2\tau A}{ml}$

$V = IR$

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

Mobility $\mu = \frac{V_d}{E}$ $\qquad$ (m^2/sV)

A – Area

n – number of free electrons in unit volume

resistivity $\rho = \frac{RA}{l}$ $\qquad \rho = \frac{m}{ne^2\tau}$

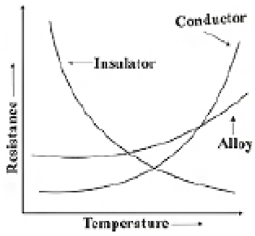
Also $\bar{J} = \sigma\bar{E}$

$J = \frac{I}{A}$ = **current density (vector)**

Temperature dependence of resistivity

with increase in temperature

$\begin{cases} \text{conductors : } \tau \text{ decrease. } \rho \uparrow \text{ inc.} \\ \text{semiconductors; n increase } \rho \uparrow \text{ dec} \end{cases}$



Electric Energy & power

Power = Energy / Time = Work done / Time

It is a scalar quantity

$E = V.I.t = I^2Rt = \frac{V^2}{R}t$

$P = V.I = I^2R = \frac{V^2}{R}$

1 unit = 1 KWh

KIRCHOFF'S LAW

i. $\Sigma i = 0$ $\qquad$ **Junction law**

ii. $\Sigma iR = \Sigma E = 0$ $\qquad$ **Voltage law**

Cell in series $\qquad I = nE / nr + R$

Cell in parallel $\qquad i = \frac{nE}{r + nR}$

$E = V + ir$ charging

$E = V - ir$ discharging

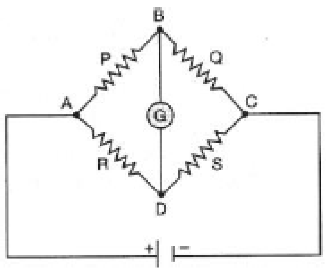
Wheatstone Bridge:

Balance condition $\quad P / Q = R / S$

Potential at A & B same at null pt.

Position of Galvanometer &

battery can be interchanged at null pt.



Cell in series $\qquad I = nE / nr + R$

Cell in parallel $\qquad i = \frac{nE}{r + nR}$

Resistivity $\rho = \frac{RA}{L}$

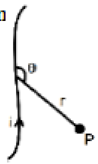
3.MOVING CHARGES & MAGNETISM

Magnetic Field:- Produced by magnet, moving charge, Vector quantity. Unit:- Tesla (weber/m^2), gauss (maxwell/cm^2)

Oested Experiment:- Current carrying conductor produces magnetic field.

Bio Savart Law:- It gives M.F. at a point aroun current carrying conductor.

$$dB = \frac{\mu_0}{4\pi}\frac{idl\sin\theta}{r^2}$$



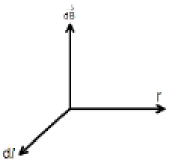
$$\frac{\mu_0}{4\pi} = 10^{-7}\ TmA^{-1}$$

μ_0 – Permeability of free space

Direction of B:- Perpendicular to dl and r.

B = 0 if sin θ = 0

B = max sin θ = 1 θ = 90°



Vector Form $\overrightarrow{dB} = \frac{\mu_0}{4\pi}\frac{i\vec{dl}\times\vec{r}}{|\vec{r}|^3}$

Ampere's Circuital Law:- $\oint B.dl = \mu_0 i$ The line integral of magnetic field B for any closed circuit is equal to μ_0 times current i threading through this closed loop and this closed loop is called Amperian loop.

B. Due to Infinitely Long Wire:-

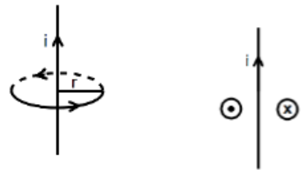
Magnetic field at P due to wire

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

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

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

$$\therefore B = \frac{\mu_0}{4\pi}\frac{2I}{r}$$



Direction:- Right Hand Thumb Rule curly finger gives field direction if thumb of right hand points current outside

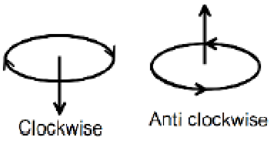
Mag. Field At Centre of Coil:-

$$dB = \frac{\mu_0}{4\pi}\frac{idl\sin 90^o}{r^2}$$

$$\therefore B = \sum dB = \frac{\mu_0}{4\pi}\frac{i}{r^2}\sum dl$$

$$= \frac{\mu_0}{4\pi}\frac{i}{r^2}(2\pi r)$$

$$B = \frac{\mu_0 i}{2r} \quad \text{or} \quad B = \frac{\mu_0 Ni}{2r}$$



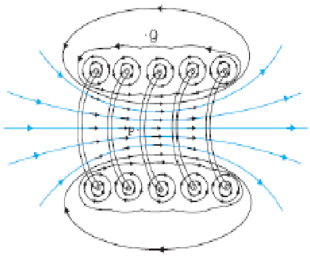
Direction:- Right Hand Thumb Rule.

B. due to Solenoid:-

$$\int Bdl = B.dl\cos\theta$$

N – Total Turns

$$\int_a^d B.dl = \mu_0 i$$



$$\int_a^b B.dl + \int_b^c B.dl + \int_c^d B.dl + \int_d^a B.dl = \mu_0(Ni)$$

$$\int_a^b B.dl + 0 + 0 + 0 = \mu_0(Ni)$$

$$B.\int_a^b dl = \mu_0 Ni \qquad B.L = \mu_0 ni \Rightarrow \therefore B = \mu_0 ni \qquad n = \frac{N}{L} \text{ (Turns per unit Length)}$$

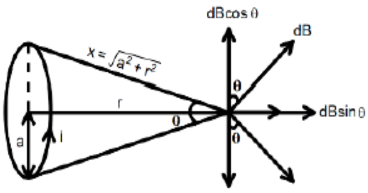
On Axis of Coil:-

$$dB = \frac{\mu_0}{4\pi}\frac{idl\sin 90^o}{x^2}$$

$$\therefore B = \sum dB\sin\theta$$

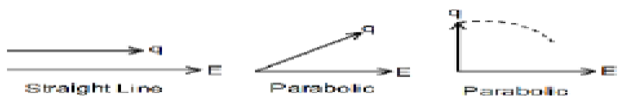
$$= \frac{\mu_0 i(2\pi a)}{4\pi x^2}.\frac{a}{x}$$

$$B = \frac{\mu_0 Nia^2}{2(a^2+r^2)^{3/2}}$$



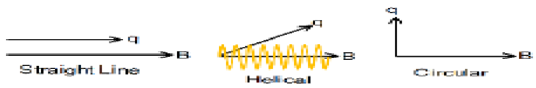
Force on charge in Electric field:-

F = qE (both for rest & motion)



Magnetic Field:-

F = qV Bsin θ (only for moving charge)



Lorentz Force:- F = qE + qvB sin θ = q (E + vB sin θ)

Moving Coil Galvanometer:- Device to detect & measure electric current.

Principle:- Current loop experience torque in uniform M.F.

Construction:- Light Coil, concave magnetic Poles → radial field.

Theory:- Deflecting torque = Restring force (torque)

B × i × N × A × sin θ = CØ

(θ = 90°) as field is radial

$\therefore$ B AiN = CØ ⇒ $i = \frac{C\phi}{ABN}$

Torque Experienced By a Current loop in uniform Magnetic Field:-

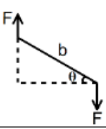
τ = F × ⊥ distance

= Bil × bsin θ

τ = Bi A sin θ

For N Turns:-

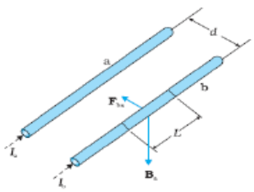
τ = BiNa sin θ



Force b/w 2 parallel current carrying wire:- Force acting on a due to b.

$$F = \left(\frac{\mu_0}{4\pi}\frac{2i_1}{r}\right)i_2 l\sin 90^o$$

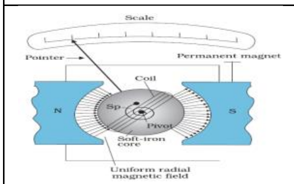
$$F = \left(\frac{\mu_0}{4\pi}\right)\frac{2i_1i_2}{r} \quad \text{(For unit Length)}$$



By Flemings LHR force is of attraction for same direction of current and force of repulsion for opposite direction of current.

if $i_1 = i_2 = 1A,\ r = 1m.$

then F = 2 × 10^{-7} N.



Current Sensitivity:- Deflection per unit current

$$I_s = \frac{\phi}{i} = \frac{BAN}{C} \qquad \frac{Radian}{Ampere}$$

Voltage Sensitivity:- Deflection per unit voltage

$$V_s = \frac{I_s}{R} = \frac{\phi}{V} = \frac{\phi}{iR} = \frac{BAN}{CR} \qquad \left(\frac{Radian}{Volt}\right)$$

Limitation:- Only charged particles can be acceleration

For circular path:-

$$\frac{mv^2}{r} = qvB \Rightarrow r = \frac{mv}{qB} \Rightarrow r \propto v$$

$$K.E. = \frac{1}{2}\frac{q^2B^2r^2}{m}$$

Time period = Distance / Velocity = 2πr / v ⇒ T = 2πm / qB

Frequency of Revolution:- f = 1/T = qB/2πm

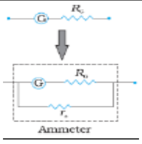
Application:- For nuclear reaction & other research purpose.

Conversion of Galvanometer into Ammeter:-

$(i - i_g)S = i_g.G$

$\therefore S = \dfrac{i_g G}{i - i_g}$

{For Ideal Ammeter R = 0}

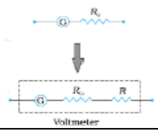


Conversion Into Voltmeter:- By connecting high resistance in series

{For Ideal voltmeter, R = ∞}

$V = i_g(R+G)$

$\dfrac{V}{i_g} = (R+G)$



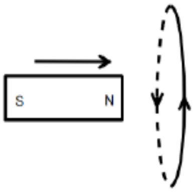
ELECTROMAGNETIC INDUCTION (E.M.I)

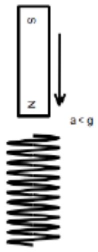
The phenomena of producing induced current due to change in magnetic flux is called electromagnetic induction.

Faraday Law:- (i) Change in magnetic flux induces current which last till there is change.

(ii) $e = \dfrac{-d\phi}{dt}$

Lenz's Law:- Induce current opposes the factor due to which it is produced. acc. to law of conservation of energy.





Method of producing emf:-

$e = \dfrac{-d\phi}{dt} = \dfrac{-dBA\cos\theta}{dt}$

Induced current / charge:-

$e = \dfrac{-d\phi}{dt}, i = \dfrac{e}{R} = \dfrac{-d\phi}{Rdt}, \dfrac{dq}{dt} = \dfrac{-d\phi}{Rdt}$

$dq = \dfrac{-d\phi}{R}$

Motional emf:- The emf induced due to motion of a conductor in M. field.

Motional emf:- $e = \dfrac{-d\phi}{dt}$

$= \dfrac{-dB.A}{dt}$

$= \dfrac{-BdA}{dt} = \dfrac{-Bldx}{dt}$

$e = -Bvl$

Direction = Anticlockwise

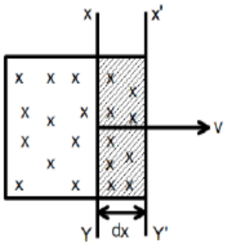
Force:- $i = \dfrac{Bvl}{R}$

$F = Bil = -B\left(\dfrac{Bvl}{R}\right)l$

$F = \dfrac{-B^2vl^2}{R}$

Power:- P = Fv

$P = \dfrac{-B^2v^2l^2}{R}$



Rotating rod:- $e = \dfrac{-d\phi}{dt}$

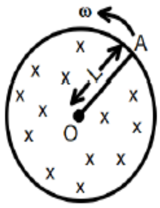
$e = \dfrac{-dBA}{dt}$

$e = \dfrac{BdA}{dt}$

$e = \dfrac{B\pi L^2}{\dfrac{2\pi}{\omega}}$

$e = \dfrac{1}{2}B\omega L^2$ or $e = \dfrac{1}{2}B\omega R^2$

No. of spokes is increased emf remain same.



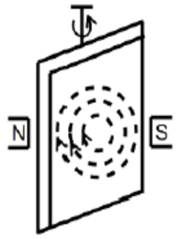
Eddy Current:- The circulating induced current in a oscillating metallic block kept in magnetic field. In can be reduced by using laminated core, or cutting slots in block.

Application:-

(i) Magnetic brakes

(ii) Induction furnace

(iii) Dead beat galvanometer



Self – Induction:- Change in current in a coil, induced current is produced which opposes the change in same coil.

Unit:- L = 1 Henry (H)

Dimension Formula:- $[ML^2T^{-2}A^{-2}]$

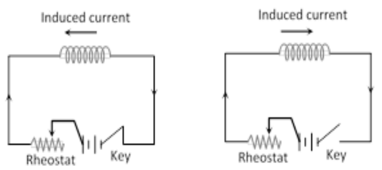
Solenoid:-

$\phi = Li$

$\phi = BAN = (\mu_0 niA) \times N$

$Li = \mu_0 n^2 \times i \times A \times l$ (n = N/l)

$L = \mu_0 n^2 A l$



(A) Main current increasing

(B) Main current decreasing

Mutual – Induction:- when the change in current in primary coil induces current in secondary coil.

$\phi \propto i$

$\phi = Mi$

Unit – Henry

ϵ_0 = Farad/m

μ_0 = Henry/m

Solenoid:- $B_2 = \mu_0 n_2 i_2$

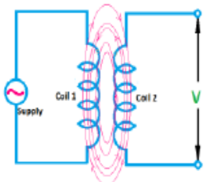
$\phi = B_2 A N_1$

$\phi = (\mu_0 n_2 i_2) A N_1$

$\phi = Mi_2$

$Mi_2 = \mu_0 n_1 n_2 A l i_2$

$M = \mu_0 n_1 n_2 A l$



*No. of turns is double than inductance become four times ($L \propto n^2$).

Electrical Resonance:-

$F = \dfrac{1}{2\pi}\sqrt{\dfrac{1}{LC}}$

Power in A.C. circuit:-

$P = \dfrac{1}{2}V_0 i_0 \cos\phi$

$P = \dfrac{V_0}{\sqrt{2}}\dfrac{i_0}{\sqrt{2}}\cos\phi$

$[P = V_{RMS} i_{RMS} \cos\phi]$

$\left[\cos\phi = \dfrac{R}{Z}\right]$

MAGNETISM & MATTER

Properties of Magnet: 1. Magnets have north pole and south pole. 2. Likes poles repel & unlike attract each other. 3. Freely suspended magnet rests in N – S direction. 4. Monopole do not exist. 5. Mag. Length is eq to 0.84 times of their geometric length.

Magnetic Dipole Moment: $N \leftarrow 2l \rightarrow S$

$M = m2l$ unit: Am^2

$m \rightarrow$ pole Strength.

$M \rightarrow$ Magnetic Dipole Moment

M. Due to Current Loop: When current is passed through a loop it, behaves like a magnet. (M = iA) = current × Area, M = NiA

$$\therefore\ M = \frac{q}{t}\ (\pi r)^2 = \frac{evr}{2} \qquad \{\text{for } e^-,\ v = 2\pi r/t\}$$

Magnetic Dipole Moment of a revolving:

$$M = iA = \frac{q}{t}\left(\pi r^2\right) = \frac{evr}{2}\ \{\text{for } e^-,\ v = 2\pi r/t\}$$

Magnetic Field Intensity due to magnetic Dipole:

1. On Axial line: $B = \frac{\mu_0}{4\pi}\frac{2M}{r^3}$

2. On Equatorial line: $B = \frac{\mu_0}{4\pi}\frac{M}{r^3}$

Torque Acting on dipole in Mag. field:

$\tau = f \times \text{dis.} = mB2l\sin\theta = m2lB\sin\theta$

$= MB\sin\theta$

$\therefore\ \tau = MB\sin\theta$

$\rightarrow$Torque is $\perp$ to mag. field and mag. dipole moment (M)

$\rightarrow \tau_{max} = MB$ $(\sin\theta = 1)$, $\theta = 90°$ {Due to torque rotation motion or liner. }

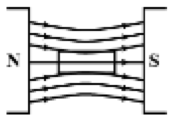
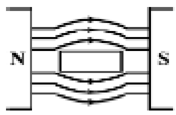
$\rightarrow \tau_{min} = 0 = (\sin\theta = 0)$, $\theta = 0$

Work done in Rotating the Dipole:

$W = MB\,[\cos\theta_1 - \cos\theta_2]$

Electromagnets: Are prepended by passing electric current in a solenoid. The magnet lasts till the current is passed. It can be increased by: 1. Increasing number of turns. 2. Increasing current. 3. using soft iron core.

Magnetic Material:

Paramagnetic	Diamagnetic	Ferromagnetic
1. odd no of e^- in outer most orbit & possess net dipole moment.	1. Even no of e– and possess net dipole moment is 0.	**1.Ferromagnetic Materials have some Unpaired electrons so their atoms have a net magnetic moment. They get their strong magnetic properties due to the presence of magnetic domains.**
2. Aligns || to field & get weakly magnetized along ext. field.	2. Align $\perp$ to ext. field.	**2. When a magnetizing force is applied, the domains become aligned to produce a strong magnetic field within the part.**
3. Mag. field pass through substance  Para-magnetic	3. Mag. field repelled by substance.  Dia-magnetic	3. Temp. at which ferromagnetic substance becomes paramagnetic called curie Temperature.
4.Increase with decrease in temp.	4. Increase with increase in temp	

5.ALTERNATING CURRENT (A.C)

TRANSFORMER: - It is a device use the change AC voltage.

Principle: It is based on principle of mutual induction.

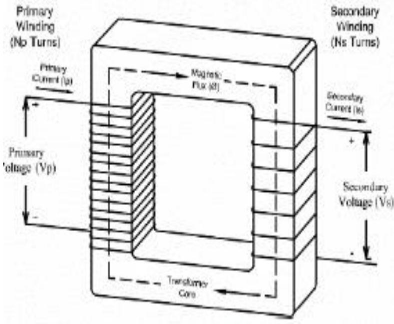
Construction: two coil primary & secondary

Step up: Increase voltage (k>1) and decrease current.

Step down: decrease voltage (k < 1) and increase current.

Theory: $\left[\frac{V_s}{V_p} = \frac{N_S}{N_P} = \frac{i_p}{i_s} = K\right]$

$\left[\eta = \frac{output}{input} \times 100\%\right]$



A.C. Generator :- It is a device which convert mechanical energy into electrical energy.

Principle: It is based on principle of electromagnetic induction.

Construciton:

(i) Arumature coil.

(ii) Field magnet

(iii) Slip ring

(iv) Brushes .

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

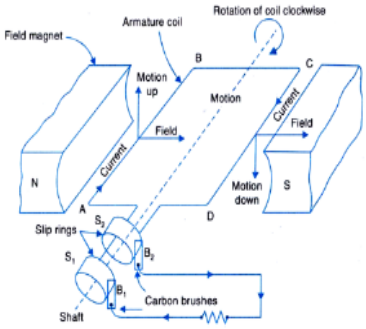
$e = \frac{-dBA\cos\omega t}{dt}$

$e = BA(-\omega\sin\omega t)$

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

$e_{max} = e_0 = BAN\omega$

$e = e_0\sin\omega t$



Alternating Current: -

D.C – Direction & magnitude are fixed.

A.C – Change in both magnitude and direction.

HALF– CYCLE: $V_{avg.} = \int_0^{\pi} \frac{V}{\pi}$

$V_{avg.} = \frac{1}{\pi}\int_0^{\pi} V_0 \sin\theta\, d\theta$

$V_{av} = \frac{1}{\pi}\left[-V_0\cos\theta\right]_0^{\pi}$

$V_{av} = \frac{-V_0}{\pi}\left[\cos\pi - \cos 0\right]$

$V_{av} = \frac{2V_0}{\pi}$ or $I_{av} = \frac{2I_0}{\pi}$

Full Cycle: $V_{av} = \frac{1}{2\pi}\int_0^{2\pi} V\, d\theta$

$V_{avg} = \frac{1}{2\pi}\int_0^{2\pi} V_0 \sin\theta\, d\theta$

$V_{avg} = \frac{V_0}{2\pi}\left(-\cos\theta\right)_0^{2\pi}$

$V_{avg} = \frac{V_0}{2\pi}\left(-\cos 2\pi + \cos\theta\right) = \frac{V_0}{2\pi}(-1+1)$

$V_{avg} = 0$ or $I_{avg} = 0$

Root mean Square:

$V_{RMS} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} V^2}$

$V^2{}_{RMS} = \frac{1}{2\pi}\int_0^{2\pi} V^2 = \frac{1}{2\pi}\int_0^{2\pi} V_0^2 \sin^2\theta\, d\theta$

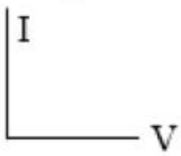
$V^2{}_{RMS} = \frac{V_0^2}{2\pi}(\pi) = \frac{V_0^2}{2}$ $\quad \left[\sin^2\theta = \frac{1-\cos 2\theta}{2}\right]$

$V_{RMS} = \frac{V_0}{\sqrt{2}}$ or $I_{RMS} = \frac{I_0}{\sqrt{2}}$

Pure capacitor circuit (circuit containing capacitor only)

$Q = CV$

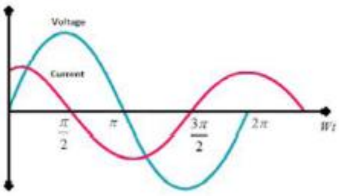
$\frac{d\theta}{dt} = C\frac{dV}{dt}$, $\quad i = C\frac{d}{dt}(V_0 \sin\omega t)$ $\quad i = CV_0\frac{d}{dt}\sin\omega t$



$\omega CV_0 \cos\omega t$

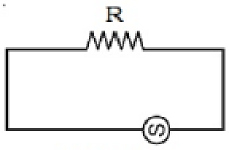
$i = \frac{V_0}{\frac{1}{\omega C}}\sin(\omega t + \pi/2)$

$i = \frac{V_0}{\frac{1}{\omega C}}$

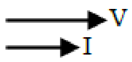


Pure Resistive Circuit: (Circuit containing resistance)

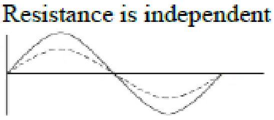
$\frac{V}{R} = \frac{V_0}{R}\sin\omega t$

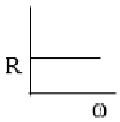


$\left[i = i_0\sin\omega t\right]$ $\left[V = V_0\sin\omega t\right]$



Resistance is independent frequency of A.C.





Pure inductive circuit:

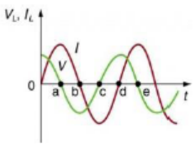
$V = V_0 \sin\omega t$

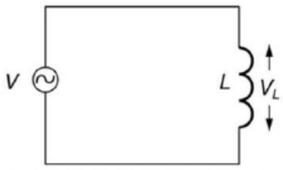
$V = \frac{Ldi}{dt}$

$di = \frac{+Vdt}{L}$

$di = \frac{V_0\sin\omega tdt}{L}$

$\int di = \frac{V_0}{L}\int \sin\omega t\, dt = \frac{V_0}{L}(-\cos\omega t)$





Series LCR circuit: -

$v^2 = V_R^2 + (Vc - Vc)^2$

$(IZ)^2 = (IR)^2 + (IX_L - IX_C)^2$

$Z = \sqrt{R_2 + (X_L - X_C)^2}$

$Z = \sqrt{R^2 + \left(L\omega - \frac{1}{C\omega}\right)^2}$

$\left[\tan\phi = \frac{L\omega - \frac{1}{C\omega}}{R}\right] \Rightarrow \left[\tan\phi = \frac{X_L - X_C}{R}\right]$

6. OPTICS (RAY OPTICS)

Reflection of Light: $i = r$, Magnitization $m = \frac{I}{o} = \frac{-v}{u}$ — real inverted. + virtual erect.

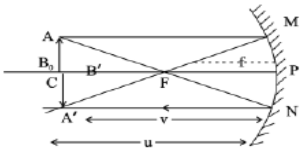
→ Convex Mirror $+f$, $m < 1$ and negative $m > 1$ (enlarged) $m < 1$(small)

→ Concave Mirror $-f, m > 1, < 1, = 1$ both $+ \& -$

Refraction of Light: $\mu = \frac{\sin i}{\sin r}, {}_1\mu_2 = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{1}{{}_1\mu_2} = {}_2\mu_1$

Total Internal Reflection (i) Denser → Rarer (ii) $i > i_c$ $\sin i_c = \left(\frac{1}{\mu_d}\right)$

Mirror formula:



Object AB image A′ B′

$\triangle AFB \approx \triangle PFN$

$$\frac{AB}{PN} = \frac{AB}{A'B'} = \frac{FB}{PF} = \frac{u-f}{f} - \quad (i)$$

$\Delta A'B'F \approx \Delta MFP$

$$\frac{MP}{A'B'} = \frac{AB}{A'B'} = \frac{PF}{FB'} = \frac{f}{v-f} - (ii)$$

from eq – (i) and (ii).

$$\frac{u-f}{f} = \frac{f}{v-f}$$

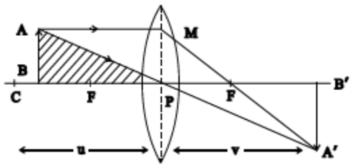
By sing convention u, v, f are -ve.

$$f^2 = (u-f)(v-f)$$
$$f^2 = uv - uf - fv + f^2$$
$$uv = uf + vf.$$

Dividing by uvf

$$\frac{uv}{uvf} = \frac{uf}{uvf} + \frac{vf}{uvf}$$
$$\boxed{\frac{1}{f} = \frac{1}{v} + \frac{1}{u}}$$
$$m = I/0 = -v/u$$

Thin lens formula:



$\triangle ABP \approx \triangle A'B'P$

$$\frac{AB}{A'B'} = \frac{PB}{PB'} = \frac{u}{v} - (i)$$

$\triangle MPF \approx \triangle A'B'F$

$$\frac{PM}{A'B'} = \frac{PF}{FB'} = \frac{f}{v-f} -$$
$$\frac{AB}{A'B'} = \frac{v}{v-f} - (ii)$$

From eq (i) and (ii)

$$\frac{f}{v-f} = \frac{u}{v}$$

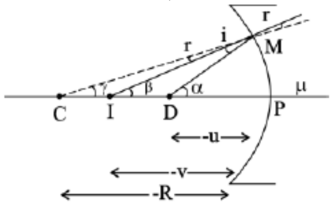
Since u = –ve sign convention

$$vf = (-u)v - (-u)f$$
$$v_f = -uv + uf$$
$$uv = uf - vf$$

Dividing by uvf

$$\boxed{\frac{1}{f} = \frac{1}{v} - \frac{1}{u}}$$

Refraction through Spherical Surface: ASSUMPTION:
(Since i & r are very small)
1. Small Aperture
2. Point size object



By snell's law

$$\mu = \frac{\sin i}{\sin r} = \frac{i}{r}$$

$i = \mu r$

$\triangle$ COM

$\alpha = i + \gamma \quad \therefore i = \alpha - \gamma$

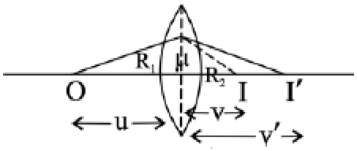
$\triangle$ CIM

$\beta = r + \gamma \quad \therefore r = \beta - \gamma.$

$\alpha - \gamma = \mu(\beta - \gamma)$

$$\frac{PM}{-u} - \frac{PM}{-R} = \mu \frac{(PM}{-v} - \frac{PM)}{-R}$$
$$\frac{1}{u} - \frac{1}{R} = \frac{\mu}{v} - \frac{\mu}{R} \Rightarrow \frac{\mu}{v} - \frac{1}{u} = \frac{\mu}{R} - \frac{1}{R}$$
$$\boxed{\frac{\mu}{v} - \frac{1}{u} = \frac{(\mu-1)}{R}}$$

Lens maker formula:



By Refraction through first surface

$$\frac{\mu}{v'} - \frac{1}{u} = \frac{\mu - 1}{R_1} \cdots (1)$$

I′ acts as an object for second surface so that final image is formed at I, so for second surface.

$$\frac{1/\mu}{v} - \frac{1}{v'} = \frac{1/\mu - 1}{R_2}$$

$$\frac{1}{v} - \frac{\mu}{v'} = \frac{1-\mu}{R_2} - (ii)$$

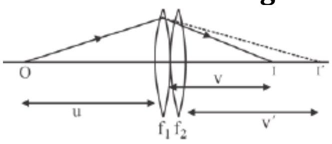
adding eq (i) & (ii).

$$\frac{1}{v} - \frac{1}{u} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$
$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Power of Lens:

$$P = \frac{1}{f(m)} = \frac{100}{f(cm)} \text{ Diopter.}$$

Combined focal length: -



First lens forms image I′ of 0

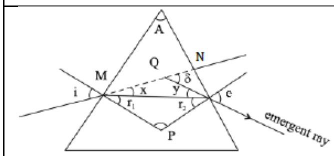
$$\frac{1}{f_1} = \frac{1}{v'} - \frac{1}{u} - (i)$$

I' acts as object for second lens and final image is formed at I, so for second leans.

$$\frac{1}{f_2} = \frac{1}{v} - \frac{1}{v'} - (ii)$$

Adding eq (i) & (ii)

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f_1} + \frac{1}{f_2}$$



In quadrilateral AMPN.

$\angle A + 90° + \angle P + 90° = 360°$

$A + 90° + 180 - (r_1 + r_2) + 90 = 360$

$A = (r_1 + r_2) - - - (2)$

$i + e = A + \delta$

At minimum deviation δ_m

ie, $r_1 = r_2 = r$

$2i = A + \delta_m$

By snell's Low

$$\mu = \frac{\sin i}{\sin r}$$
$$\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

]

$i = r_1 + x$
$e = r_2 + y$ } vertically opposite Angles.

$i + e = (r_1 + r_2) + (x + y)$ ------(1)

$\delta = x + y$ exterior angle is equal to sum of interior angles

$\angle P = 180 - (r_1 + r_2)$.

$\therefore i = \frac{(A + \delta_m)}{2}$ ------ (3)

$A = 2r \therefore r = \left(\frac{A}{2}\right)$ ---- (4)

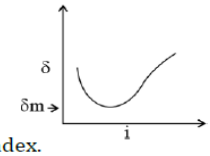
For then prism

$\mu = \frac{\frac{A+\delta_m}{2}}{A/2}$

$\delta_m = (\mu - 1)A$

A-Prism Angle

μ = Refractive Index.



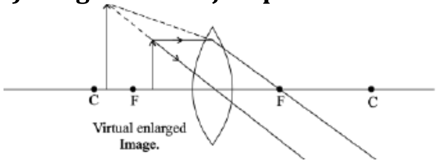
Angular Dispersion: $\theta = \delta_V - \delta_R = (\mu_V - \mu_R)A$

Dispersive Power: $\omega = \frac{\theta}{\delta y} = \frac{\delta_V - \delta_R}{\delta y} = \frac{(\mu_V - \mu_R)A}{(\mu_y - 1)A} \Longrightarrow \boxed{\omega = \frac{(\mu_V - \mu_R)}{(\mu_y - 1)}}$

OPTICAL INSTRUMENTS:

Simple Microscope: Convex lens of low focal length and high power.

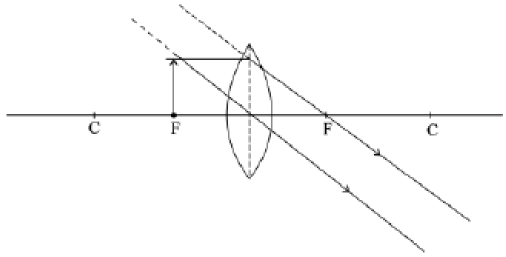
i) Image at D.: Object placed blow Focus and tens.



Magnifying Power.

$$\boxed{m = 1 + \frac{D}{f_e}}$$

$$m = \frac{\beta}{\alpha} = \frac{\text{Angle made by image}}{\text{angle made by object when kept in position of image.}}$$



ii) Image at ∞

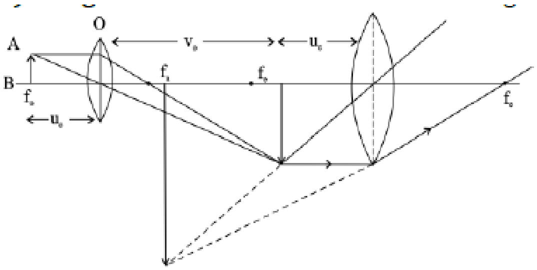
Object placed on focus.

magnifying Power $\boxed{m = \frac{D}{f}}$

Compound Microscope: **Objective** - (convex lens of low focal length and small aperture).

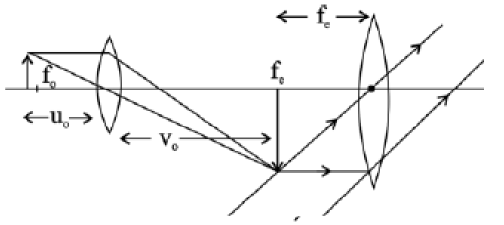
Eyelens - (convex lens of high focal length and large aperture).

i) Image at D.: Final virtual inverted Image.



$$m = m_0 \times me = \frac{v_0}{-u_0}\left(1 + \frac{D}{f_e}\right) \approx \frac{1}{f_e}\left(1 + \frac{D}{f_e}\right)$$

ii) Image at infinity ∞ Final Image at Infinity.



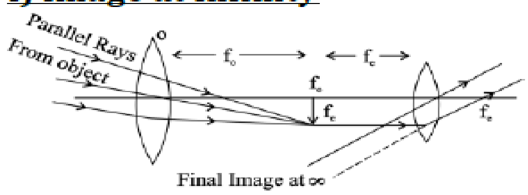
$$m = -\frac{v_0}{u_0}\left(\frac{D}{f_e}\right) \approx \frac{L}{f_0} \cdot \frac{D}{f_e}$$

Length of tube $L = v_0 + f_e$

Astronomical Telescope: Objective - (convex lens of high focal length & large aperture.)

Eyelens - (Convex tens of low focal length & small aperture.)

i) Image at Infinity

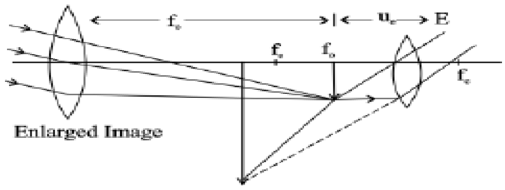


$$m = \frac{f_0}{f_e}$$

$L = f_0 + f_e$ (Length of tube)

Length of the Tube $L = f_0 + u_e$

ii) Image at D

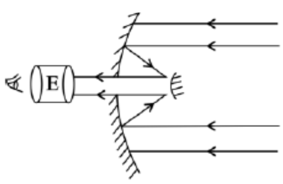


$$m = \frac{f_0}{f_e}\left(1 + \frac{f_e}{D}\right)$$

$$R.P = \frac{D}{1.22\lambda}$$

D-Diameter of objective

Reflecting Telescope: Concave mirror acts as an objective.



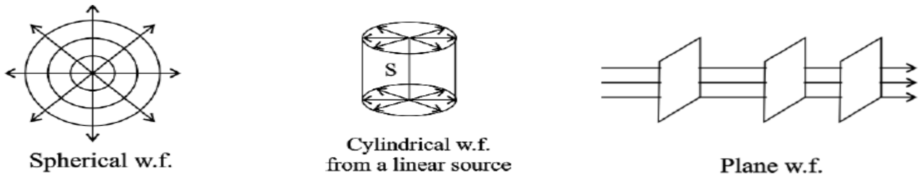
ADVANTAGES:

1) Bright Image is formed.

2) Image free from chromatic aberration.

WAVE OPTICS

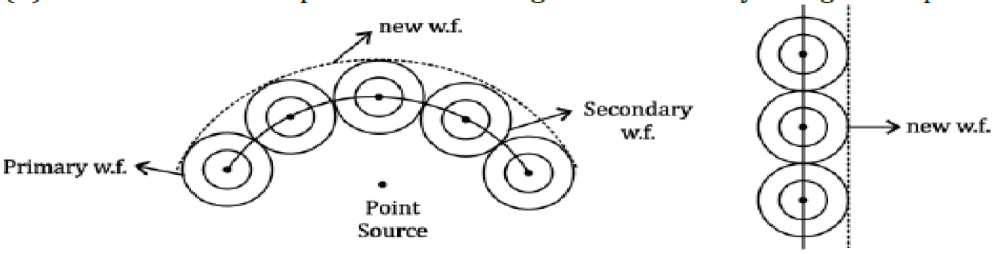
- A wavelet is the point of disturbance due to propagation of light.
- A wavefront(w.f.) is the locus of points having the same phase of oscillation.
- A line perpendicular to a wavefront is called a 'ray'.



HUYGEN'S PRINCIPLE:- Find the shape of wavefront at any particular instance. The two postulate are-

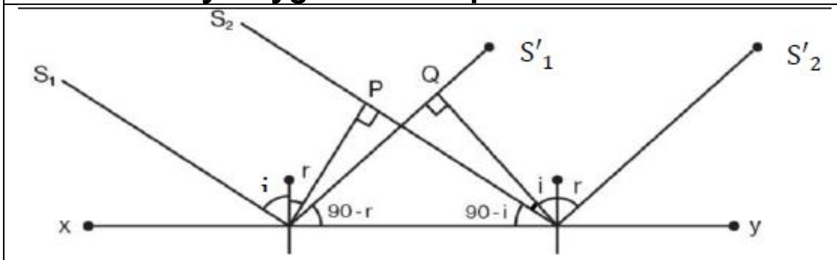
(i) Each paint on primary w. f. acts as a source of secondary w.f. which travel in all direction with speed of light.

(ii) The forward envelope or common tangent of secondary w. f. give shape of new wavefronts.



Backward wavefront do not exists as Amplitude A is proportional to 1+ $\cos 180^0$ =0 (Stoke's law)

Reflection by Huygen's Principle



ΔMPN and ΔMQN, MN = MN common side

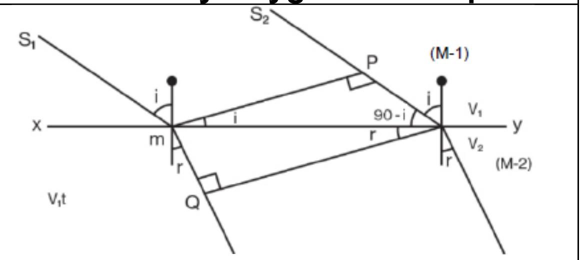
$\angle P = \angle Q = 90°, PN = MQ$ (dist. covered by light in same time)

$\Delta MPN \approx \Delta MQN$ (by SAS)

$90 - i = 90 - r$

$\boxed{i = r}$

Refraction by Huygen's Principle



$PN = V_1t$

$MQ = V_2t$

$\mu_0 = \frac{\sin i}{\sin r} = \frac{PN/MN}{MQ/MN} = \frac{PN}{PQ}$

$\boxed{\mu_0 = \frac{v_1 t}{v_2 t} = \frac{v_1}{v_t}}$

INTERFERENCE OF LIGHT: - Variation of intensity of light due to overlapping of two light waves.

Constructive: - Resultant increase and bright light is formed.

Path diff.:- $\Delta x = 0, \lambda, 2\lambda, \ldots\ldots, 3\lambda$

Phase diff.:- $\Delta\phi = 0, 2\pi, 4\pi, 6\pi, \ldots\ldots, 2n\pi$

Destructive:- **Path diff.:-** $\Delta x = \frac{\lambda}{2}, \frac{3\lambda}{2}, \ldots\ldots, (2n-1)\frac{\lambda}{2}$

Phase diff.:- $\Delta\phi = \pi, 3\pi, 5\pi \cdots (2n-1)\pi$

$$\boxed{\Delta\phi = \frac{2\pi}{\lambda} \times \Delta x}$$

Destructive:- Resultant is minimum.

Young's double slit Experiment (YDS):- A monochromatic light beam is incident in double slit the pattern obtain on screen co alternate bright and dark bands called fringes.

Expression for Interference Pattern:

Let, two interference wave

$y_1 = a_1 \sin\omega t$

$y_2 = a_2(\sin(\omega t + \phi))$ [$\because \phi =$ phase diff.]

by Principle of Superposition-

$y = y_1 + y_2$

$y = a_1 \sin\omega t + a_2 \sin(\omega t + \phi)$

$y = a_1 \sin\omega t + a_2 \sin\omega t \cos\phi + a_2 \cos\omega t \sin\phi$

$y = \sin\omega t (a_1 + a_2\cos\phi) + a_2 \cos\omega t \sin\phi$

$\left\{\begin{array}{l} a_1 + a_2\cos\phi = R\cos\theta \\ a_2\sin\phi = R\sin\theta \end{array}\right\}$

$y = R\sin(\omega t + \theta) \cdot a_1 + a_2\cos\phi + a_2\sin\phi = R\cos\theta + R\sin\theta$

Square both side

$a_1^2 + a_2^2\cos^2\phi + a_2^2\sin^2\phi = R^2\cos^2\theta + R^2\sin^2\theta$

$a_1^2 + a_2^2(\cos^2\phi + \sin^2\phi) = R^2(\sin^2\theta + \cos^2\theta) - 2a_1a_2\cos\phi$

$a_1^2 + a_2^2 + 2a_1a_2\cos\phi = R^2$

$\boxed{R = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\phi}}$

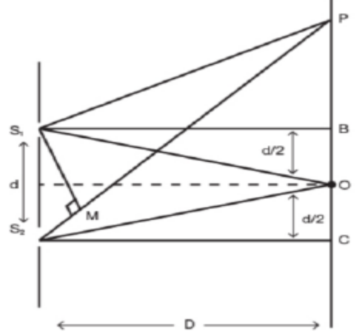
$R_{max} = (a_1 + a_2) \quad \theta = 0°$

$R_{min} = (a_1 - a_2) \quad \theta = 180°$

$\boxed{I \propto a^2 \propto \omega}$

$y = R\sin\omega t\cos\theta + \cos\omega t\, R\sin\theta$

Expression for fringe width:



$S_2M = S_2P - S_1P$ from ΔS_2PC

$S_2P^2 = D^2 + (x + d/2)^2$

from ΔS_1BP_1

$S_1P^2 = D^2 + (x - d/2)^2$

$\boxed{S_2P^2 - S_1P^2 = 2xd}$

$(S_2P - S_1P)(S_2P + S_1P) = 2xd$

$(S_2P - S_1P)(D + D) = 2xd$

$(S_2P - S_1P)(D + D) = 2xd$

$S_2P - S_1P = \dfrac{2xd}{2D}$

From bright fringe for path difference,

$S_2P - S_1P = n\lambda$

$\dfrac{xd}{D} = n\lambda$

$x_n = \dfrac{nD\lambda}{d}$

$\boxed{x = \dfrac{D\lambda}{d}}$

$\beta = x_{n+1} - x_n$

$\beta = \dfrac{(n+1)\lambda D}{d} - \dfrac{n\lambda D}{d}$

$\boxed{\beta = \dfrac{\lambda D}{d}}$

<u>For destructive interference:</u>

$\dfrac{xd}{D} = (2n-1)\dfrac{\lambda}{2}$

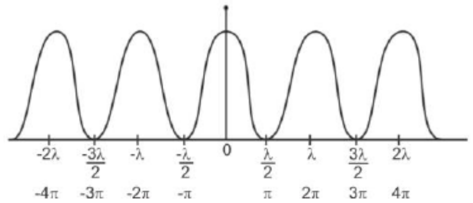
$\boxed{x_n = (2n-1)\dfrac{\lambda D}{2d}}$

$\beta = x_{n+1} - x_n$

$\beta = (2(n+1)-1)\dfrac{\lambda D}{2d} - \dfrac{(2n-1)\lambda D}{2d}$

$\boxed{\beta = \dfrac{\lambda D}{d}}$

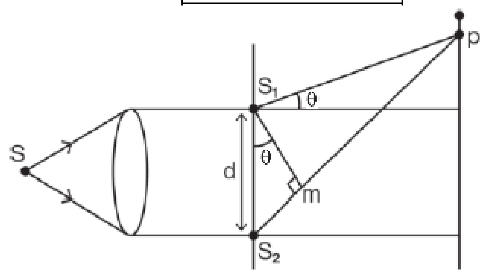
Interference pattern the intensity of all bright band is equal.



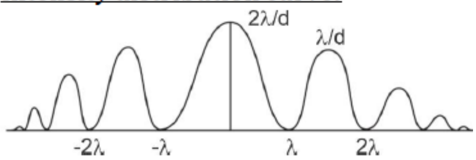
- **Coherent Source** - The two light source behave like coherent source if they belong to same parent source.
- **Diffraction** - It is bending of light at sharp corners or edges.
- **Fresnel's distance** - $\boxed{d_f = d^2/\lambda}$

Single slit diffraction –

- dark band or minima - $\boxed{d\sin\theta = n\lambda}$
- maxima - $\boxed{d\sin\theta = \dfrac{(2n+1)}{2}\lambda}$



<u>Intensity distribution curve:</u>



<u>Linear width of central maxima:</u>

$\left[\text{angle} = \dfrac{\text{arc}}{\text{raclius}}\right]$, $\beta_0 = \theta \times D$

$\boxed{\beta_0 = \dfrac{\lambda D}{d}}$

- Ang. Width of Central Maxima : λ/d –(- λ/d) =2λ/d
- Ang. Width of secondary Maxima : 2 λ/d - λ/d =λ/d
- Hence Central maxima = 2 x secondary maxima

- Interference : Change in Fringe width with d,D, λ , apparatus in other liquid:

- Diffraction: Change in central maxima with d,D, λ, white light

7.DUAL NATURE Of MATTER AND RADIATION

Photoelectric emission: The emission of electron due to action of light of suitable energy is called photoelectric emission. The e^- emitted are called photoelectrons.

Properties of Photon- **(a)** Photon is a bundle of energy- $E = n_0 \Rightarrow E = hc/\lambda$

(b) Photon travel with speed of light.

(c) Rest mass of photon is zero.

(d) momentum of photon is $p = E/C$.

Photoelectric effect → The of e^- from a metal surface when light of suitable frequency is incident on it is called photoelectric effect. Alkali metals like Li, Na, K show photoelectric effect with visible light metal like Zn, mg, Ca respond to ultraviolet light,

Laws of Photoelectric emission -

(a) minimum energy required called threshold energy or work function. The freq. corresponding to threshold energy called threshold freq.

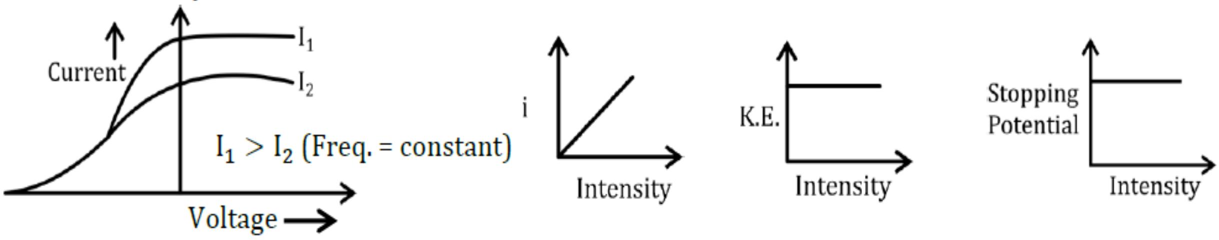
$E = f = h\nu_0$ $\quad\quad$ $\nu_0 = \text{threshold frequency}$

Work function$(E = f)$

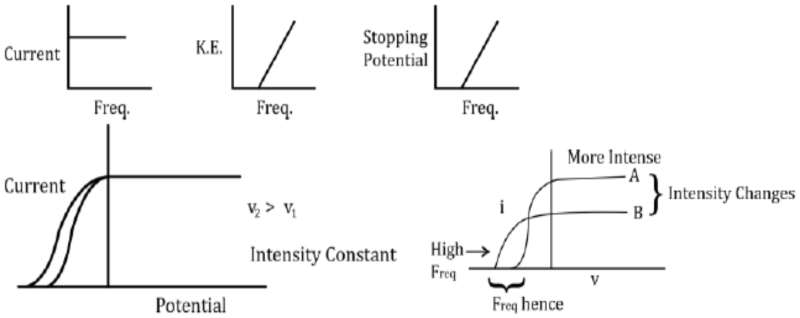
(b) Every photon interact with a single electron.

(c) increasing the energy of incident photon the Kinetic energy of e^- emitted increase.

Effect of Intensity:-



Effect of frequency:



Determination of Plank's constant:- frequency From Einstein Photoelectric equation –

$h\nu = h\nu_0 + K \cdot E$

$e\nu_0 = K \cdot E$

$h\nu = h\nu_0 + e\nu_0$

Einstein Phataelectric Equation:

Photoelectric effect was explained using quantum theory by Einstein.

$E = \phi + K \cdot E$

$$h\nu = h\nu_0 + \frac{1}{2}mv^2$$

$$h\nu - h\nu_0 = \frac{1}{2}mv^2$$

$$\boxed{h(\nu - \nu_0) = \frac{1}{2}mv^2}$$

In terms of wavelength:-

$$h\left(\frac{c}{\lambda} - \frac{c}{\lambda_0}\right) = \frac{1}{2}mv^2$$

$$\boxed{hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right) = \frac{1}{2}mv^2}$$

Dual Nature of Matter:

De-broglie Hypothesis – Acc. to De-Broglie a wave is associated with every moving particle. This wave is called matter wave and its wavelength is known as de-Broglie wavelength.

Expression for λ :	**In term of Energy:**	**In term of charge & potential:**
By particle nature, $E = mc^2$ By wave nature $E = h\nu$ equate both the energy $mc^2 = h\nu$ $m = \frac{hc}{\lambda c^2}$ $m = \frac{h}{\lambda c}$ $\lambda = \frac{h}{mc}$ $\lambda = \frac{h}{p}$	$P = mv^2$ $E = \frac{1}{2}mv^2$ $2E = mv^2$ $2mE = m^2v^2$ $2mE = p^2$ $P = \sqrt{2mE}$ Therefore $\lambda = \frac{h}{P} = \frac{h}{\sqrt{2mE}}$ ($P =$ momentum)	$E = qV$ $\lambda = \frac{h}{\sqrt{2qVm}}$ For electron:- $\lambda = \frac{h}{\sqrt{2meV}}$ $\lambda = \frac{12{\cdot}3\ \mathring{A}}{\sqrt{V}}$ Temp:- $\lambda = \frac{h}{\sqrt{3mKT}}$ $E = \frac{3}{2}kT$ $K =$ Boltzmann constant

Hertz's observations:

- The phenomenon of photoelectric emission was discovered in 1887 by Heinrich Hertz (1857-1894).
- Hertz observed that high voltage sparks across the detector loop were enhanced when the emitter plate was illuminated by ultraviolet light from an arc lamp

Hallwachs' and Lenard's observations :

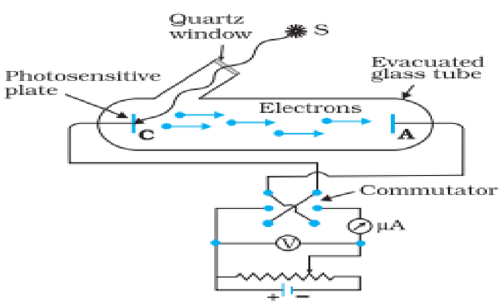
- Lenard (1862-1947) observed that when ultraviolet radiations were allowed to fall on the emitter plate of an evacuated glass tube enclosing two electrodes (metal plates), current flows in the circuit

- Lenard studied variation in photo current with collector plate potential, and with frequency and intensity of incident light

- Lenard observed that when ultraviolet light fell on the emitter plate, no electrons were emitted at all when the frequency of the incident light was smaller than a certain minimum value, called the threshold frequency. This minimum frequency depends on the nature of the material of the emitter plate.

EXPERIMENTAL STUDY OF PHOTOELECTRIC EFFECT

schematic arrangement used for the experimental study of the photoelectric effect is shown below:

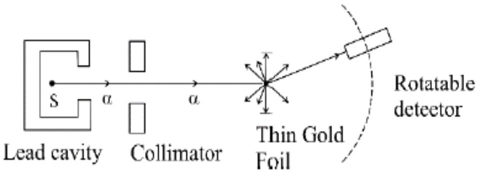
- Light of different **frequencies** can be used by putting appropriate coloured filter or coloured glass in the path of light falling on the emitter C. - The **intensity** of light is varied by **changing the distance of the light** source from the emitter. - Keeping the frequency of the incident radiation and the potential fixed, the intensity of light is varied and the resulting photoelectric current is measured each time. It is found that the **photocurrent increases linearly with intensity of incident light.** - Keeping the intensity of light radiation same **at various frequencies** and study the variation of photocurrent with collector plate potential. The stopping potential is more negative for higher frequencies of incident radiation.	

8. ATOM & NUCLEI

ATOM

Rutherford α-particle scattering Exp:

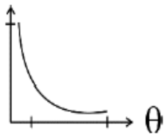
Exp. Setup:



OBSERVATIONS:

(i) Most of the α-particle passed underiated.

(ii) Few α-particle scattered at angle θ



$$N \propto \frac{1}{\sin^4\left(\frac{\theta}{2}\right)}$$

(iii) Very few retraces their path.

RUTHERFORD'S MODEL OF ATOM: (1909)

i) Most of the part of atom is hollow.

ii) The central core is (+) very charged called nucleus (10-15m) e^- revolves around the nucleus & radius of orbit decreases due to decrease in energy (dement).

Distance of closest approach:

$$\frac{1}{2}mv^2 = \frac{1}{4\pi\varepsilon_0}\frac{(2e)(ze)}{r_0}$$

$$\therefore \boxed{r_0 = \frac{2ze^2}{4\pi\varepsilon_0\left(\frac{1}{2}mv^2\right)}}$$

Impact parameter: It is perpendicular distance of the velocity vector when α –particle from centre of nucleus when α particle is far away from atom.

$$\boxed{b = \frac{1}{4\pi\varepsilon_0}\frac{2ze^2}{mv^2}\cot\frac{\theta}{2}}$$

smaller is b' larger is angle of scattering θ

$$\cot\frac{\theta}{2} = \frac{2b}{r_0}$$

for θ = 180° (rebounds) b = 0

BOHR'S MODEL: (1913)

1. The e^- can exist in certain orbit without radiating energy.

$$\boxed{\frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0}\frac{ze^2}{r^2}}$$

2. Only those orbit are allowed for which the angular momentum (mvr) is integral multiple of $h/2\pi$.

$\boxed{mvr = \frac{nh}{2\pi}}$ n = 1, 2, 3.... Quantum No.

3. Electrons Reboring in their stationary orbit do not radiate energy (non-radiative orbits or BOHR'S orbits)

4. If the e^- goes from orbit of energy E_1 to other orbit of energy E_2 then a photon of energy hv is radiated such that $\boxed{hv = E_2 - E_1}$

Radius of Bohr orbit: $r_n = \frac{\varepsilon_o n^2 h^2}{\pi m e^2 z}$

for hydrogen z = 1

ENERGY OF BOHR ORBITS:-

$$E = KE + PE = \frac{1}{2}mv^2 + \frac{ze(-e)}{4\pi\varepsilon_o r}$$

$$= \frac{1}{2}\frac{ze^2}{4\pi\varepsilon_o r} - \frac{ze^2}{4\pi\varepsilon_o r}\left(\frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_o}\frac{2e^2}{r}\right)$$

$$E_n = \frac{-Ze^2}{8\pi\varepsilon_o r_n}$$

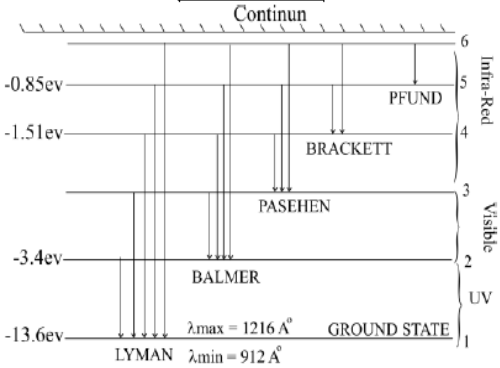
For H Atom $\boxed{E_n = \frac{-e^2}{8\pi\varepsilon_o r_n}} = \boxed{\frac{-13.6}{n^2}eV}$

HYDROGEN SPECTRUM:-

Hydrogen spectrum consist of group of radiation emitted by a h-atom whose wavelength is given as

$$\boxed{\frac{1}{\lambda} = Rz^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)}$$ Rydberg constant $R = 1.09 \times 107.\ m^{-1}$

$$\boxed{E_n = \frac{-e^2}{8\pi\varepsilon_o r_n}}$$



Lyman Series:

Electron jump from higher orbit to first orbit.

$n = L, n_2 = 2, 3, 4........$

$$\left.\begin{aligned} v_1 &= R,\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = \frac{3}{4}R \\ v_2 &= R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = \frac{8}{9}R \end{aligned}\right\} \text{Ultra Voilet Region}$$

BALMER: Visible Region

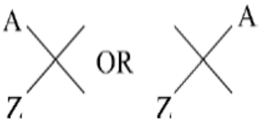
Paschen, Brackett, P Fund :- Far Infrared

NUCLEI

Nucleons = Protons + Neutrons

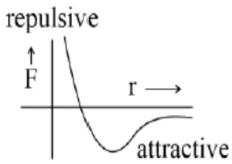
A = Z + N.

Mass = Atomic No. + No. of Neutrons.



Nuclear force

- strong
- short range
- spin dependent
- charge independent



Nuclear volume ∝ Mass No.

$\frac{4}{3}\pi R^3 \propto A$

OR $\boxed{R = R_0 A^{1/3}}$

$R_0 = 1.4 \times 10^{-15}$ m

1 Fermi = 10^{-15} m.

$1\text{ amu} = \frac{1}{12(^{12}_{6}C)}$

$= 1.66 \times 10^{-22}$ kg

Electron volt (ev) – unit of energy

$1\text{ eV} = 1.6 \times 10^{-19}$ J.

1 amu = 931MeV

NUCLEAR DENSITY: 10^{17} kg/m^3

Independent of mass no. and same For all elements

$$e = \frac{m \cdot A}{4/3\pi R_0{}^3 A} = \frac{3m}{4\pi R_0^3}$$

Isotopes: Same protons (Z) but different(A) No. of Neutron. Ex : $_1H^1$, $_1H^2$, $_1H^3$; $_2H^3$, $_2H^4$, $_2H^6$

Isobars: Same (A) but different (2) Ex : $_{11}Na^{22}$; $_{10}Ne^{22}$; $_{20}Ca^{40}$; $_{18}Ar^{40}$

Isotones: Same no. of neutrons. Ex: $_1H^3$; $_2He^4$; $_8O^{16}$; $_6C^{14}$

Mass Energy Relation:

$$\boxed{E = \Delta mc^2}$$

Energy & mass are interconvertible.

Mass Defect: Difference in masses. of nucleons & nucleus.

$$\Delta m = [ZM_p + (A - Z)M_n] - [\text{mass of } {}_ZX^A \text{ nucleus}]$$

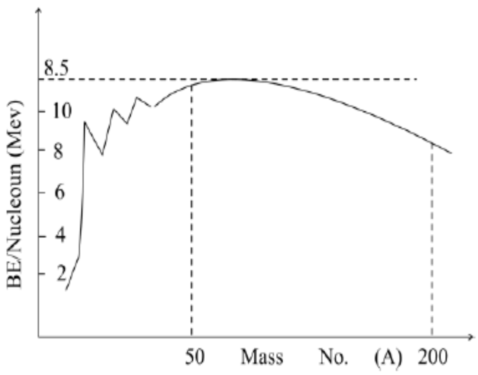
Binding, Energy: Energy equivalent. to mass defect. B. E. = $\Delta M \cdot C^2$

Packing Fraction: B.E per nucleon.

P. F = B · E/A

Variation in B.E/Nucleon with mass no.

1. B. E/A is very less for A = 8 and then increases up to A = 60°
2. Decreases after A = 120°
3. Maximum 10.8mev for Range A = 30° to A = 120°
4. Peak for $_2He^4$, $_6C^{12}$, $_8O^{16}$ etc indicate more stability
5. More is B. E/A, more is stability of a nucleus.



NUCLEAR FISSION: Splitting of heavy nucleus. $_{92}U^{255} + {}_0n^1 \rightarrow {}_{56}BC^{141} + {}_{36}Kr^{92} + 3\,{}_0n^1 + \theta(200\text{Mev})$

NUCLEAR FUSSION: Fusing two or more lighter nuclei. $_1H^1 + {}_1H^1 \rightarrow {}_1H^2 + e^+ + v$

9. ELECTRONIC DEVICES

Intrinsic semiconductor: Pure semiconductors:

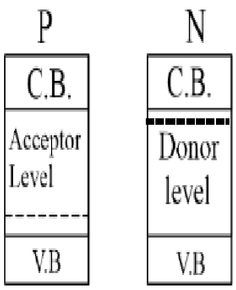
Extrinsic semiconductor: (Impure semiconductor)

P-Type: (Acceptor type) trivalant (B, Al, In, Ga) Majority carrier holes

N-Type: (Donor Type) Pentavalent (Bi, P, Ar, Sb) Majority carrier electrons.

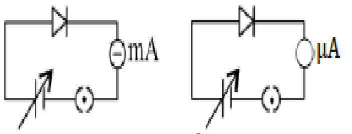
Doping: Mixing suitable impurity in Ge Si

NET CHARGE ON PURE OR IMPURE SEMICONDUCTOR IS 0 ZERO.

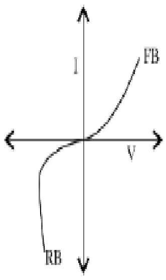


PN Junction:

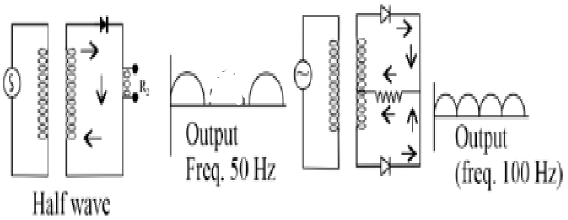
- **Depletion layer:** Layer near- junction having no free charge (10^{-6} m)
- Width of Depletion layer decreases with F.B. and Vice Versa
- **Potential Barrier:** Potential Developed across junction.



Reverse current induce to minority charge carriers

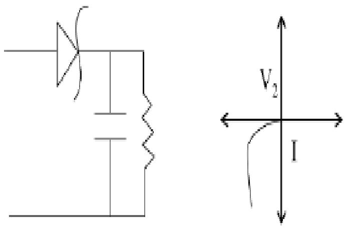


Rectifiers: conversion of a.c into d.c



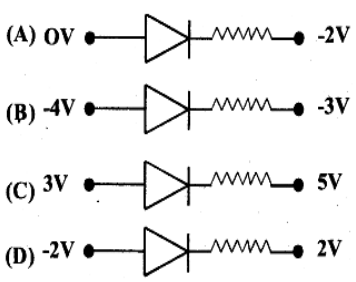
Principle: Diode conduct in FB and do not conduct in RB.

Zener: Diode Used in reverse biased as voltage stabilize



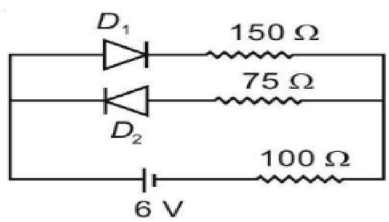
- Energy bands are formed due to interaction of energy levels of closely lying atoms.
- Energy bands are continuous range of energy.
- Conduction Band contains free electrons
- Valence bands contains holes & bound electrons
- Conduction Band is separated by Energy gap called Forbidden Energy gap where no electron exists.

- Two process involved in formation of PN junction are
  Diffusion- motion of majority charge carries due to concentration gradient. Current is P to N
  Drift- motion of minority charge carries due to EF developed across the junction. Current is from N to P
  At equilibrium, Diffusion current is equal to Drift current.



Diode A is FB

Find current in each resistor if forward resistance of each diode is 50 ohms



UNIT–I ELECTROSTATICS (8marks)

Chapter -1: Electric Charges and Fields Electric charges:

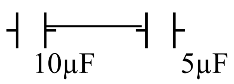
Conservation of charge, Coulomb's law-force between two- point charges, forces between multiple charges; superposition principle and continuous charge distribution. Electric field, electric field due to a point charge, electric field lines, electric dipole, electric field due to a dipole, torque on a dipole in uniform electric field.

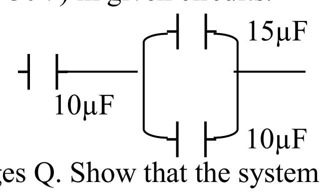
Electric flux, statement of Gauss's theorem and its applications to find field due to infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell (field inside and outside).

Chapter–2: Electrostatic Potential and Capacitance Electric potential, potential difference, electric potential due to a point charge, a dipole and system of charges; equipotential surfaces, electrical potential energy of a system of two-point charges and of electric dipole in an electrostatic field.

Conductors and insulators, free charges and bound charges inside a conductor. Dielectrics and electric polarization, capacitors and capacitance, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, energy stored in a capacitor (no derivation, formulae only).

1. Explain briefly (i) charge quantization (ii) conservation of charge.
2. Write vector form of coulomb’s law. How force depends on intervening medium.
3. Define Electric field intensity and electric potential due to a point charge. Give their S.I. units.
4. Derive expression for electric potential due to a point charge.
5. Define Electric dipole moment and give its unit and direction.
6. Find expression for electric field intensity and potential on axial and equatorial line of a electric dipole.
7. State Gauss’ theorem . Calculate electric flux due to surface enclosing charge of 1C.
8. Obtain the expression for the electric field intensity E due to infinite plane sheet of charge .
9. Derive an expression for the E at a point near an infinitely long , thin ,uniformly charged straight wire.
10. Find expression for torque on electric dipole in uniform electric field. Give its equilibrium state.
11. Derive expression for capacitance of a parallel plate capacitor i)without dielectric ii)with dielectric slab.
12. Derive expression for energy stored and energy density ($\frac{1}{2}\varepsilon_o E^2$) of a charged capacitor.
13. How Voltage, charge , capacity ,energy and electric field changes when dielectric is introduced between the plates of capacitor i)with battery connected and ii)without battery.
14. Draw lines of forces for i) q>0 ii)q<0 .Why lines are not discontinuous and never intersect .
15. What is equipotential surface? Find work done on moving charge on such surface.
16. Explain Polar and Non polar dielectrics. What is Dielectric Polarisation & Dielectric Breakdown?
17. Find charge and voltage on each capacitor (connected to 30V) in given circuits.

(i) 

(ii) 

18. A charge q is placed at the centre of line joining two equal charges Q. Show that the system of three charges will be in equilibrium if q = -Q/4.
19. Two point charges 3μC and -3μC are located 20cm apart in vacuum. Find electric field and electric potential at midpoint of line. Also find force and its direction experienced by charge 1.5nC kept at midpoint.
20. A 10μF capacitor is charged by a 30V d.c. and then connected across an uncharged 50μF capacitor. Calculate (i) the final potential difference of the combination, and (ii) the initial and final energies. How will you account for the difference in energy?
21. An electric dipole of length 4cm, when placed with its axis making an angle of 60° with uniform electric field experiences a torque of 4 /3Nm. Calculate the (i) magnitude of electric field, (ii)the potential energy of dipole ,if the dipole has charges of +8nC.

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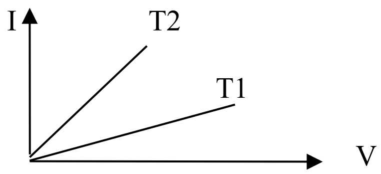
UNIT–II CURRENT ELECTRCITY (8 marks)

Electric current, flow of electric charges in a metallic conductor, drift velocity, mobility and their relation with electric current;
Ohm's law, V-I characteristics (linear and non-linear), electrical energy and power, electrical resistivity and conductivity, temperature dependence of resistance,
Internal resistance of a cell, potential difference and emf of a cell, combination of cells in series and in parallel,
Kirchhoff's rules, Wheatstone bridge

1. Give statement of Ohm's law. What are ohmic and non ohmic conductors?
2. Briefly mention effect of temperature on conductor, semiconductor and insulators.
3. Define the term resistivity or specific resistance. Give its S.I. unit. Show that resistance R of a conductor is given by $ml/(ne^2\tau A)$, where symbols have their usual meanings.
4. Out of two temperatures T_1, and T_2 which one is greater in figure given below for (a) metal (b) semiconductor



5. How is resistance , resistivity and drift velocity is affected if length of the wire is doubled keeping voltage constant?
6. Derive $i = neAV_d$ and Also prove $J = \sigma E$ (ohm's law).
7. State Kirchoff's laws for electrical network.
8. Distinguish between emf and terminal potential difference and also relate them with internal resistance r for (i) charging and (ii) discharging of a cell. State factors on which internal resistance depends.
9. What is Wheatstone bridge. Derive condition for balanced wheastone bridge.
How null point gets affected on interchanging position of galvanometer and battery in balanced wheatstone bridge.
10. Find the current in external circuit when n cells each of emf E and internal resistance r are connected in (i) series and (ii) parallel , to external resistance R.
12. A wire of resistance R is cut into two equal parts . The two parts are connected in series and then in parallel. Find the ratio of power consumed in two case.
13. Two wires X and Y of same material but area of cross section in ratio 2:3 and lengths 1:2 .They are connected in series and parallel to dc source Find ratio of drift velocity of electrons in both case. (3/2, 2/1)
14. Find net resistance between points A and B in following circuits and current through various resistances.

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UNIT–III MAGNETIC EFFECTS OF CURRENT AND MAGNETISM (8marks)

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SYLLABUS:

Chapter–4: Moving Charges and Magnetism

Concept of magnetic field, Oersted's experiment. Biot - Savart law and its application to current carrying circular loop. Ampere's law and its applications to infinitely long straight wire. Straight solenoid (only qualitative treatment),

force on a moving charge in uniform magnetic and electric fields. Force on a current-carrying conductor in a uniform magnetic field,

force between two parallel current-carrying conductors-definition of ampere, torque experienced by a current loop in uniform magnetic field; Current loop as a magnetic dipole and its magnetic dipole moment, moving coil galvanometer- its current sensitivity and conversion to ammeter and voltmeter.

Chapter–5: Magnetism and Matter Bar magnet, bar magnet as an equivalent solenoid (qualitative treatment only), magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis (qualitative treatment only), torque on a magnetic dipole (bar magnet) in a uniform magnetic field (qualitative treatment only), magnetic field lines. Magnetic properties of materials- Para-, dia- and ferro - magnetic substances with examples, Magnetization of materials, effect of temperature on magnetic properties.

1. State Biot- Savart law and its vector form.
2. Derive expression for magnetic field at center and on axis of current carrying circular loop. Also draw the magnetic field lines due to a circular current carrying loop.
3. State Ampere's circuital law.
4. Using Ampere's circuital law, Derive the expression for magnetic field due to (i) infinitely long straight wire (ii) straight solenoid (iii) toroidal solenoid. Draw magnetic lines and give direction of field in each case.
5. What is Lorentz force. Give its expression.
6. What is difference between force acting on charged particle in magnetic field and in electric field? State condition for charge particle to pass undeflected through crossed fields.
7. Write expression for force on current-carrying conductor in uniform magnetic field .How is the direction of force determined ?
8. **Derive the expression for force between two parallel current-carrying conductors and hence give definition of ampere. Draw diagram representing direction of force for current in same direction.**
9. Derive the expression for torque experienced by a current loop in a uniform magnetic field.
10. **Give principle, construction, working and labeled diagram of a moving coil galvanometer. Find the expression for its current sensitivity and Voltage sensitivity.**
11. How a galvanometer be converted into ammeter and voltmeter Which one of the two, an ammeter or a milliammeter, has a higher resistance and why?
12. How can a galvanometer of 100Ohm be converted into Voltmeter(0-10V) and ammeter (0-2A) if current for maximum deflection is 5mA.
13. What is resistance of ideal ammeter and ideal voltmeter?
14. Derive evr/2 for revolving electron.
15. Distinguish between Paramagnetic, Diamagnetic and Ferromagnetic substances.
16. How the length of spring gets affected on passing current.
17. A particle of mass 'm' and charge 'q' moving with speed 'v' , normal to a uniform magnetic field 'B' describes a circular path of radius 'r'. Derive expressions for the (i) time period of revolution and (ii) kinetic energy of the particle.
18. An electron is moving at 10^6 m/s in the direction parallel to current of 5A through a long wire separated by a distance of 10 cm. Calculate magnitude of force.
19. A proton and deuteron enter normally to magnetic field of same magnitude. Find the ratio of their radii if they have same (i) speed (ii) momentum (iii) energy

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UNIT – 4. Electromagnetic induction and Alternating currents (8marks)

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SYLLABUS:

Electromagnetic induction; Faraday's law, induced emf and current: Lenz's law, Eddy currents. Self and mutual inductance.

Alternating currents, peak and RMS value of alternating current/voltage; reactance and impedance; LCR series circuit (phasors only), resonance, power in AC circuits, power factor, wattless current. AC generator, Transformer.

1. State Faraday's laws of electromagnetic induction.
2. State Lenz's law . Show that it is in accordance to law of conservation of energy.State Fleming's RH rule for direction of induced current What is the value of acceleration due to gravity 'g' for magnet falling inside a coil?
3. What are ways of inducing emf. Derive expression for motional emf (Bvl) , force and power. Also derive expression for emf for rotating rod in magnetic field ($e= B\omega l^2/2$) Distinguish between 'Magnetic Flux' and 'Magnetic Flux density'. Give their S.I. and c.g.s units.
4. What are Eddy currents? Write its two applications. How eddy currents can be minimised?
5. Define self and mutual induction. On which factors do mutual inductance between two coils depends?
6. What is displacement current? Derive expression for self inductance of a coil.
7. Give Principle ,construction , working and theory of (i) Transformer (ii) AC Generator
8. What are various losses in transformer and how can they be minimised?

9. Distinguish between resistance, reactance and impedance? How they vary with frequency of a.c ?
10. How the current in ac circuit change on inserting (i) iron rod in inductor (ii) dielectric slab in capacitor?
11. Briefly explain LC oscillations.
12. Derive expression for peak and rms value of alternating current/voltage .
13. Show that there is phase difference of 90^0 between ac current and voltage for pure capacitive or pure inductive circuit.
14. Using phasor diagram derive expression for impedance , phase angle for series LCR circuit.
15. What is condition for resonance. Derive expression for resonant frequency.
16. Show that power consumed by ideal inductor or capacitor is zero. What is wattles current ?
17. A 25μF capacitor,0.1H inductor and a 25 ohm resistor atre connected in series with an a.c. source whose emf is given by $E = 310 \sin 314t$. Find (i) peak value , rms value, frequency of emf (ii)reactance of the circuit (iii) impedance (iv) current (v)resonant frequency for circuit.
18. Calculate current drawn by primary of a transformer ,which steps down 200V to 20V to operate a device of 10ohm. Given efficiency of transformer is 50%.
19. How the brightness of a bulb in series LCR circuit changes when (i) soft iron rod is inserted in inductor (ii) dielectric slab is inserted between the plates .
20. An 80V ,800W heater is to be operated on a 100V ,50Hz supply. Calculate the inductance of Choke required . (0.019H)
21. A jet plane is travelling towards west at a speed of 1800 km/h . What is the voltage difference developed between the ends of the wing having a span of 25 m, if the Earth's magnetic field at the location has a magnitude of 5×10^{-4} T and the dip angle is 30^o ?

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UNIT –5. Electromagnetic Waves (4 marks)

SYLLABUS:
Electromagnetic waves and their characteristics, their transverse nature (qualitative ideas only).
Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, Xrays, gamma rays) including elementary facts about their uses.

1. Mention properties of electromagnetic waves.
2. Name the phenomena which proves transverse nature of e.m . waves.
3. Describe properties ,uses ,application of E.m spectrum.
4. A capacitor , made of two parallel plates each of plate area A and separation d , is being charged by an external ac source. Show that the displacement current inside the capacitor is the same as the current charging the capacitor.

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UNIT – 6. Optics (14 marks)

Ray Optics: Reflection of light, spherical mirrors, mirror formula, refraction of light, total internal reflection and optical fibers, refraction at spherical surfaces, lenses, thin lens formula, lens maker's formula, magnification, power of a lens, combination of thin lenses in contact, refraction of light through a prism.
Optical instruments: Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers.

Wave optics: Wave front and Huygen's principle, reflection and refraction of plane wave at a plane surface using wave fronts. Proof of laws of reflection and refraction using Huygen's principle. Interference, Young's double slit experiment and expression for fringe width (No derivation final expression only), coherent sources and sustained interference of light, diffraction due to a single slit, width of central maxima (qualitative treatment only).

1. What is total internal reflection and state two conditions required for it. Mention its applications.
2. Derive relation between μ u,v and R for a spherical surface and hence derive lens maker formula.
3. Derive thin lens formula. Explain Magnification and Power of a lens.
4. Derive expression for focal length for combination of thin lenses in contact.
5. Derive prism formula. Also show graphically variation of angle of deviation with angle of incidence.
6. Draw **ray diagram of compound microscope** to show image formation in normal and far point position. Derive expression for magnifying power also.
7. Draw ray diagram for normal adjustment of a **astronomical telescope** in and derive expression for magnifying power also.
8. Draw ray diagram for image formation by reflecting telescope. Give two merits of reflecting telescope.
9. How the magnifying power of microscopes and astronomical telescopes changes with length of tube .
10. State Huygens' principle and prove laws of reflection and refraction of plane wave at a plane surface on its basis .
11. Draw the shape of wave front (i) converging to a point (ii) diverging from a point (iii) produced from point source (iv) at far distance (v) reflected from plane mirror (vi) refracted from convex lens (for parallel incidence) .
12. Describe Young's double slit experiment. Write conditions required for sustained interference of light. What are coherent sources?
13. Derive expression for fringe width in double slit experiment.
14. What is diffraction of light? Write the condition required and derive expression for width of central maximum in single slit diffraction.
    How does angular and linear width of central maxima change with distance of single slit from screen?

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UNIT – 7. Dual Nature of Matter and Radiation (4 marks)

Dual nature of radiation. Photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation-particle nature of light. Experimental study of dual nature of light.

Matter waves-wave nature of particles, de Broglie relation.

1. What is Photo electric effect ? Write laws of photoelectric emission.
2. Explain the terms (i)stopping potential (ii) Threshold frequency (iii) threshold energy.
3. **Show variation of photo current with frequency and intensity of incident light.**
4. Derive the Einstein's photoelectric equation.
5. Draw a labeled diagram of photo cell and explain its working. Mention its two applications.
6. What are matter waves? Derive expression for De broglie wavelength of an electron in electric field.
7. Ultraviolet light is incident on two photosensitive material having work functions W_1 and W_2 ($W_1 > W_2$). In which case will the kinetic energy of the emitted electron be greater why ?
8. **If KE of emitted photo electron is 2.5 eV, what is value of stopping potential?**
9. Derive the Einstein's photoelectric equation.
10. Light of Wavelength $5000A^0$ falls on a metal surface of work function 1.9eV. Find (a) energy of photons in eV (b) K.E of photoelectrons and (c) stopping potential.

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UNIT – 8. Atoms and Nuclei (8 marks)

Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum.
Composition and size of nucleus, Mass-energy relation, mass defect, nuclear fission, nuclear fusion.

1. Explain Alpha-particle scattering experiment and mention important inferences of it.
2. Give main postulates of Rutherford's model of atom . Give its merits and demerits.
3. Give postulates of Bohr's model of atom.
4. Explain Hydrogen spectrum .
5. Derive relation between Atomic No. and radius of a nucleus.
6. **Write two properties of nuclear forces.**
7. Two nuclei have mass no. in ratio 1:8. What is the ratio of their nuclei, radii?
8. State Mass energy relation and convert 1 eV into Joules.
9. What is mass defect and Binding energy?
10. Distinguish between Nuclear fission and nuclear fusion.
11. Calculate the binding energy per nucleon of ${}^{40}_{20}Ca$ nucleus. Given : m(${}^{40}_{20}Ca$) =39.962589.u , m_n = 1.008665u m_p = 1.007825u.
12. A neutron is absorbed by a ${}_3Li^6$ nucleus with subsequent emission of an alpha particle. Write the corresponding nuclear reaction and Calculate the energy released in this reaction in MeV. Given M(${}_3Li^6$) =6.015126a.m.u , M(${}_2He^4$) = 4.0026044 a.m.u M(${}_0n^1$) = 1.0086654 a.m.u , M(${}_1H^3$) = 3.016049 a.m.u

11. Draw a plot of potential energy of a pair of nucleons as a function of their separations. Mark the regions Where the nuclear force is (i) attractive and (ii) repulsive .

12. The ground state energy of hydrogen atom is -13.6eV. What are the KE and PE of electron in this state?

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UNIT – 9. Electronic Devices (7 marks)

Energy bands in conductors, insulator and semiconductor (qualitative ideas only);
semiconductor diode - I-V characteristics in forward and reverse bias, diode as a rectifier;

1. Describe Energy bands in solids and differentiate between conductors ,insulators and semiconductors on the basis of it.
2. Differentiate between pure and impure semiconductors .
3. How does conductivity vary with increase in temperature of semiconductor.
4. Differentiate between P type and N type semiconductors . Draw their energy Band diagram.
5. What is PN junction? Name the two process involved in formation of pn junction.
6. Explain i) depletion layer ii) barrier potential .
7. What is Forward and Reverse biasing of a diode. What is an ideal diode?
8. Draw characteristics curve of PN junction for forward and reverse biasing.
9. How does width of depletion layer changes with forward and reverse biasing.
10. What is rectification? Give principle, circuit diagram, construction, working and input output waveforms for (i) half wave rectifier (ii) full wave rectifier

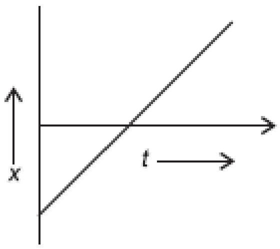
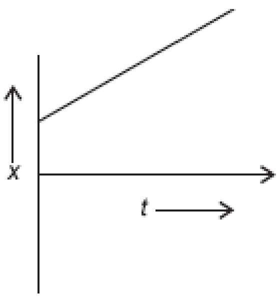
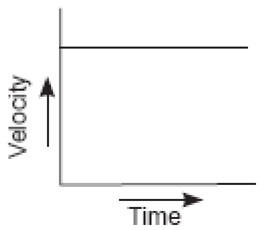
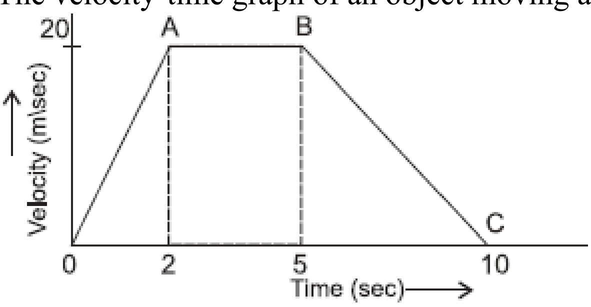
Arise, Awake and Stop not……till the Goal is reache

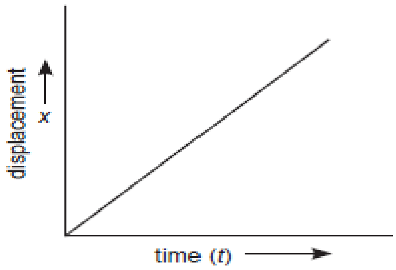
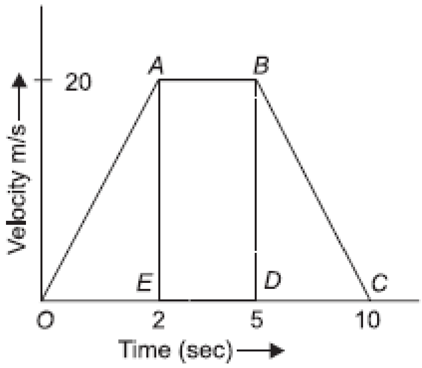
COMPETENCY BASED QUESTIONS FOR CLASS XI

Chapter -1: UNITS AND MEASUREMENT

Q. 1	The division of energy by time is X. The dimension formula of X is same as that of (a) Power (b) Electric field (c) Momentum (d) Torque
Q. 2	**Assertion**: Light year and year, both measure time. **Reason**: Because light year is the time that light takes to reach the earth from sun. (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is NOT the correct explanation of A. (c) A is true but R is false. (d) A is false and R is also false.
Q.3	If F force acts on a tyre of car and depends on time as given in equation $F= a/t +bt^2$ where F denotes Force and t time .What should be the dimensions of a and b .
Q.4	If pressure P , velocity V and time T are taken as fundamental physical quantities, the dimensional formula of force ?
Q.5	An engineering team is developing a drone. They hypothesize that the lift force **F** acting on the drone depends upon air density ρ , velocity V and wing area A Using the method of dimensions, obtain the relation between these quantities.
ANSWER	
A1	(a) Power
A2	(d) A is false and R is also false.
A3	$a= MLT^{-1}$ $b=ML$
A4	$F = P^{x} V^{y} T^{z}$ **By substitution dimensions of P,V AND T** $F= (ML^{-1} T^{-2})^x \ (L T^{-1})^y \ T^z$ solving both sides $F= PV^2 T^2$
A5	**Solving for the Powers** • Mass (M) power: $a = 1$ • Time (T) power: $-b = -2 \rightarrow b = 2$ • Length (L) power: $-3a + b + 2c = 1$ • Solve for c: $-3(1) + 2 + 2c = 1 \rightarrow -1 + 2c = 1 \rightarrow c = 1$ **Final Result** • Put $a = 1$, $b = 2$, and $c = 1$ back into the formula • Final equation: $F = k\rho v^2 A$

Chapter -2 :- MOTION IN A STRAIGHT LINE

Q. 1	A stone is dropped from a certain height and at the same time another stone is thrown horizontally from the same height which one will reach the ground earlier. (a) first stone (b) second stone (c) simultaneously (d) not sure.
Q. 2	**Assertion:** The position-time graph in uniformly accelerated motion is a parabola. **Reason:** An object can have non-zero acceleration while maintaining constant speed (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is NOT the correct explanation of A. (c) A is true but R is false. (d) A is false and R is also false.
Q.3	What is common between two graphs shown below?  Graph (*a*)  Graph (*b*)
Q.4	Velocity-time graph of a moving object is shown below. What is the acceleration of the object? Also draw displacement-time graph for the motion of the object. 
Q.5	The velocity-time graph of an object moving along a straight line is as shown.  Calculate distance covered by object between : (i) t = 0 to t = 5 sec. (ii) t = 0 to t = 10 sec.
ANSWER	
A1	Ans. (c) Since the initial vertical velocity of both the stones is zero and both are accelerated vertically downwards by equal acceleration, hence they reach earth simultaneously.

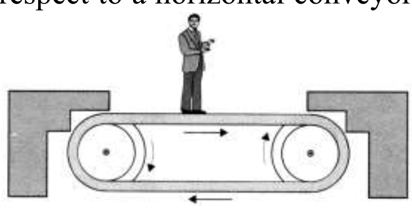
A2	(b) Both A and R are true but R is NOT the correct explanation of A
A3	Both graphs (a) and (b) represent positive and constant (different) velocity.
A4	Acceleration = zero. $x - t$ graph is as shown below. 
A5	(i) Distance covered by the object $t = 0$ to $t = 5$ sec.  = area OABDO $= \frac{1}{2}$ (sum of parallel side) $\times h$ $= \frac{1}{2}(3 + 5) \times 20$ $= 4 \times 20 = 80$ m. (ii) Distance covered by the object between $t = 0$ to $t = 10$ sec. = area OABCO $= \frac{1}{2}$(sum of parallel side) $\times h$ $= \frac{1}{2}(3 + 10) \times 20$ $= 130$ m.

Chapter-3 :- MOTION IN A PLANE

Q. 1	A particle moves from an initial position P to a final position Q along a curved path. According to the principles of kinematics in a plane, which statement correctly describes the relationship between the magnitude of the displacement vector and the actual path length? (a) The magnitude of displacement is always strictly greater than the path length. (b) The magnitude of displacement is always equal to the path length regardless of the trajectory. (c) The magnitude of displacement is always less than or equal to the actual path length. (d) The magnitude of displacement is unrelated to the path length of the particle.
Q. 2	**Assertion (A):** The horizontal component of velocity of a projectile remains constant throughout its flight, provided air resistance is neglected. **Reason (R):** The acceleration due to gravity acts solely in the vertical direction, meaning there is no acceleration in the horizontal direction. (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is NOT the correct explanation of A. (c) A is true but R is false. (d) A is false and R is also false.
Q.3	(a) Define a 'Null Vector' and state its properties regarding magnitude and direction. (b) Provide a specific physical example involving displacement where the resulting vector is a null vector.
Q.4	In uniform circular motion, an object travels along a circular path at a constant speed. Explain why the acceleration vector in this motion is not considered a constant vector, even though its magnitude (v^2/R) remains the same.
Q.5	A cricket ball is thrown with an initial speed of 28 m s^{-1} at an angle of 30° above the horizontal. Using g = 9.8 m/s^2 calculate: (a) The maximum height reached by the ball. (b) The horizontal range of the ball.
ANSWER	
A1	(c) The magnitude of displacement is always less than or equal to the actual path length.
A2	(a) Both A and R are true and R is the correct explanation of A.

A3	**Definition:** A null vector (or zero vector) is defined as a vector that has zero magnitude. Because its magnitude is zero, its direction is indeterminate and cannot be specified. [1 Mark] **Example:** If an object moves from a starting point P to any other point and subsequently returns exactly to point P, the initial and final positions coincide. The resulting displacement is therefore a null vector. [1 Mark]
A4	**Explanation:** Acceleration in uniform circular motion is centripetal acceleration, which always points towards the centre of the circular path. Although the magnitude is constant (v^2/R), the direction of the vector changes continuously as the object moves around the centre. Since a vector is only constant if both its magnitude and direction remain unchanged, the acceleration vector is not constant
A5	Initial speed ($v0 = 28\ m\ s^{-1}$ Angle of projection $\alpha = 30°$ Acceleration due to gravity (g) = $9.8\ m\ s^{-2}$ (a) Maximum Height Formula: Calculation: $h = u^2 \sin^2 \alpha / g = 10.0$ m (b) Horizontal Range (R):Formula: $R = u^2 \sin 2\alpha / g = = 69$ m

Chapter-4 - LAWS OF MOTION

Q. 1	A particle of mass 10 kg is moving in a straight line. If its displacement, x with time t is given by $x = (t^3 - 2t - 10)$ m, then the force acting on it at the end of 4 seconds is (a) 24 N (b) 240 N (c) 300 N (d) 1200 N
Q. 2	**Assertion:** A cricketer moves his hands forward to catch a ball so as to catch it easily without hurting. **Reason:** He tries to decrease the distance travelled by the ball so that it hurts less. (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is NOT the correct explanation of A. (c) A is true but R is false. (d) A is false and R is also false.
Q.3	A spring weighing machine inside a stationary lift reads 10 kg, when a man stands on it. What would happen to the scale reading, if the lift is moving upward with (i) constant velocity and (ii) constant acceleration?
Q.4	A monkey is ascending a branch with constant acceleration. If the breaking strength is 160% of the monkey's weight, what is the maximum acceleration permitted for the monkey ?
Q.5	(A) Figure shows a man standing stationary with respect to a horizontal conveyor belt that is accelerating with 1 ms^{-2}. What is the net force on the man ? If the coefficient of static friction between the man's shoes and the belt is 0.2, up to what acceleration of the belt can the man continue to be stationary relative to the belt ? (Mass of the man = 65 kg.)  (B)Ten one-rupee coins are put on top of each other on a table. Each coin has a mass 'm'. Give the magnitude and direction of (i) the force on the 7th coin (counted from the bottom) due to all the coins on its top. (ii) the force on the 7th coin by the eighth coin. (iii) the reaction of the 6th coin on the 7th coin.

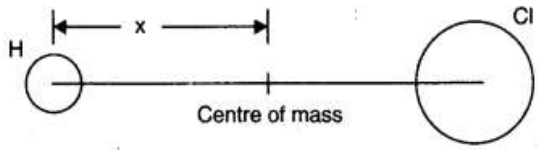
ANSWER	
A1	(b) $m = 10$ kg $x = (t^3 - 2t - 10)$m $\frac{dx}{dt} = v = 3t^2 - 2$ $\frac{d^2x}{dt^2} = a = 6t$ At the end of 4 sec, $a = 6 \times 4 = 24$ m/s^2 $F = ma = 10 \times 24 = 240$ N
A2	(d) A cricket player moves his hands backward to increase the time interval for reducing the momentum of the ball to zero. Thus, the ball does not hit him hard as force is directly proportional to change of momentum.
A3	The apparent weight, $W = m(g + a)$, where a is the acceleration with which the lift moves upwards. (i) when lift moves with constant velocity, $a = 0$, Therefore, $W = m(g + 0)$ $= mg = 10$ kg. (no changes) (ii) when lift moves with acceleration a in upward direction, then $W = m(g + a)$ $= mg(1 + a/g) \geq 10$ kg (Apparent weight will increase).
A4	Breaking strength $= \frac{160}{100}mg$, where m is the mass of the monkey. While ascending the apparent weight $w = m(g + a)$. For safety, $m(g + a) \leq \frac{160}{100}mg$ $\therefore\ a \leq \left(\frac{160}{100} - 1\right)g$, *i.e.*, $a \leq 0.6$ m/s^2.
A5	(A) Acceleration of conveyor belt a = 1 ms^{-2} Force on man = ma = 65 N Force of friction = $\mu_s mg = 0.2 \times 65 \times 10 = 130$ N The man can continue to be at rest till the force equals the frictional (limiting) force. $\therefore\ a_{max} = \frac{F_f}{m} = \frac{130}{65} = 2$ ms^{-2} (B) (i) The seventh coin will experience force equal to the sum of the weights of the three coins above it. As each coin is of m kg. Therefore. force on 7th coin = (3m) kg$f$ = (3mg) N. Vertically downwards. where g is acceleration due to gravity. (ii) The eight coin supports the weights of two coins above it. Therefore, force on seventh coin due to the eighth coin willbe equal to the sum of the weights of the eighth coin and the two coins above it. Therefore, force on 7th coin due to 8th coin = $m + 2m = (3m)$ kg$f$ = (3mg) N. Vertically downwards. (iii) The 6th coin experiences force equal to weights of the four coins above it. Hence, reaction due to 6th coin on the 7th coin R = – F = – 4 m kg$f$ = (4mg)N. Vertically upwards opposite to weight

Chapter-5 -Work, Energy and Power

Q. 1	A particle moves in a circle with constant speed under a centripetal force. The work done by the centripetal force after one complete revolution is: (A) Positive (B) Negative (C) Zero (D) Depends on radius
Q. 2	Assertion: A body can have zero work done on it even when a force acts continuously. Reason: Work depends on the angle between force and displacement. (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is NOT the correct explanation of A. (c) A is true but R is false. (d) A is false and R is also false.
Q.3	A 4 kg block slides 5 m down a rough incline (30°). If $\mu=0.2$, calculate the work done by friction. ($g=10\ m/s^2$) $f=\mu mg\cos30° \approx 6.93$ N; $W=-fs \approx -34.6$ J.
Q.4	A variable force $F=(4x+2)$ N acts on a body from $x=0$ to 3 m. Find the work done
Q.5	A 2 kg block is projected up a rough incline (37°) with speed 10 m/s. $\mu=0.25$, $g=10\ m/s^2$. Calculate the distance travelled before coming to rest using the work-energy theorem.
ANSWER	
A1	(C)Force is always perpendicular to displacement.
A2	(a) Both A and R are true and R is the correct explanation of A.
A3	$f=\mu mg\cos30° \approx 6.93$ N; $W=-fs \approx -34.6$ J.
A4	$W=\int(4x+2)dx \quad = [2x^2+2x]_0^3 \quad = \ 24$ J.
A5	Initial KE=100 J. Retarding force=mg(sin37+μcos37)=20(0.6+0.2)=16 N. Distance=100/16=6.25 m.

Chapter-6 - SYSTEM OF PARTICLE AND ROTATIONAL MOTION

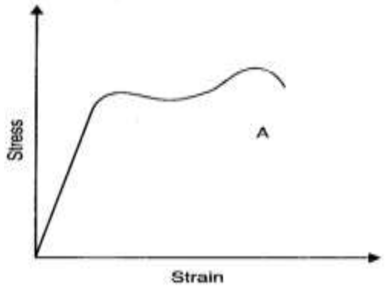
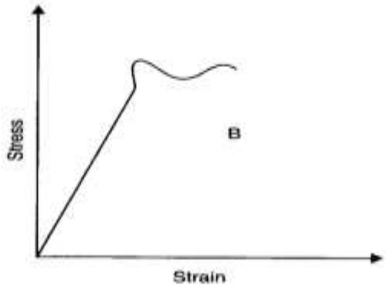
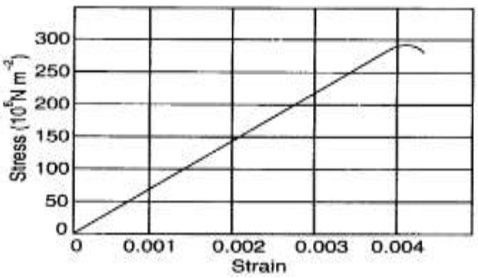
Q. 1	Any particle performing rotator motion has angular momentum L, If its angular velocity becomes twice whereas Rotational Kinetic energy becomes half then new angular momentum of the particle will be (a) L/2 (b) L/4 (c) 2L (d) 4L
Q. 2	**Assertion :** The centre of mass of a body may lie where there is no mass. **Reason :** Centre of mass of body is a point, where the whole mass of the body is supposed to be concentrated. a)Assertion is True, Reason is True, Reason is a correct explanation for Assertion b)Assertion is True, Reason is True, Reason is not a correct explanation for Assertion c)Assertion is true, Reason is false d) Assertion is False but, Reason is True

Q.3	A child sits stationary at one end of a long trolley moving uniformly with a speed v on a smooth horizontal floor. If the child gets up and runs about on the trolley in any manner, what is the speed of the CM of the (trolley + child) system?
Q.4	In the HCl molecule, the separation between the nuclei of the two atoms is about 1.27 A (1 A = 10-10m). Find the approximate location of the CM of the molecule, given that a chlorine atom is about 35.5 times as massive as a hydrogen atom and nearly all the mass of an atom is concentrated in its nucleus.
Q.5	Three separate particles of masses of 1g, 2g, and 3g have their centre of mass at the precise point (2,2,2). What should be the position of the fourth particle of mass 4g so that the combined centre of mass may be at the point (0,0,0).
	ANSWER
A1	b) L/4
A2	(a) Assertion is True, Reason is True, Reason is a correct explanation for Assertion **Explanation**-As the concept of centre of mass is only theoretical, therefore in practice no mass may lie at the centre of mass. For example, centre of mass of a uniform circular ring is at the centre of the ring where there is no mass.
A3	The system's centre of mass will continue to move at the same speed. On a tram that is travelling ahead with velocity v, the child is running erratically. The child's running, however, will not change the trolley's centre of mass's velocity. This occurs because the force resulting from the child's motion is entirely internal. The motion of the bodies they work on is unaffected by internal forces in the body. The child's motion will not alter the trolley's centre of mass's speed because the (child + trolley) system does not involve any external forces.
A4	Let us choose the nucleus of the hydrogen atom as the origin for measuring distance. Mass of hydrogen atom,m_1= 1 unit (say) Since cholorine atom is 35.5 times as massive as hydrogen atom,•. mass of cholorine atom, m_2 = 35.5 units  Now, $x_1 = 0$ and $x_2 = 1.27\ \text{Å} = 1.27 \times 10^{-10}$ m Distance of centre of mass of HCl molecule from the origin is given by $X = \dfrac{m_1x_1 + m_2x_2}{m_1 + m_2} = \dfrac{1 \times 0 + 35.5 \times 1.27 \times 10^{-10}}{1 + 35.5}$ m $= \dfrac{35.5 \times 1.27}{36.5} \times 10^{-10}$ m $= 1.235 \times 10^{-10}$ m $= 1.235$ Å
A5	Let's assume that r_1, r_2, r_3 are the position vectors of the three mass particles in consideration w.r.t origin. Then their center of mass is given by $\mathbf{r} = \dfrac{m_1\mathbf{r}_1 + m_2\mathbf{r}_2 + m_3\mathbf{r}_3}{m_1 + m_2 + m_3}$ Here, $m_1 = 1g, m_2 = 2g, m_3 = 3g$ $\mathbf{r} = 2\hat{i} + 2\hat{j} + 2\hat{k}$ $= \dfrac{\mathbf{r}_1 + 2\mathbf{r}_2 + 3\mathbf{r}_3}{1+2+3}$ or $\mathbf{r}_1 + 2\mathbf{r}_2 + 3\mathbf{r}_3 = 12(\hat{i} + \hat{j} + \hat{k})$ .... (*i*) If r' be the position vector of the new C.M. then r'= 0 And r_4 be the position vector of the fourth particle from the origin, then $0 = \dfrac{m_1\mathbf{r}_1 + m_2\mathbf{r}_2 + m_3\mathbf{r}_3 + m_4\mathbf{r}_4}{m_1 + m_2 + m_3 + m_4}$ $= \dfrac{1\mathbf{r}_1 + 2\mathbf{r}_2 + 3\mathbf{r}_3 + 4\mathbf{r}_4}{1+2+3+4}$ or $\mathbf{r}_1 + 2\mathbf{r}_2 + 3\mathbf{r}_3 + 4\mathbf{r}_4 = 0$ or $12(\hat{i} + \hat{j} + \hat{k}) + 4\mathbf{r}_4 = 0$ or $\mathbf{r}_4 = -3(\hat{i} + \hat{j} + \hat{k})$ Thus the new particle should be at (-3,-3,-3).

Chapter-7 - GRAVITATION

Q. 1	A satellite is moving in a circular orbit around the Earth. If the mass of the satellite is doubled while the orbital radius remains the same, the gravitational force acting on it will: (a) Remain the same (b) Become half (c) Double (d) Become four times
Q. 2	**Assertion (A):** Astronauts experience weightlessness inside an orbiting spacecraft. **Reason (R):** The spacecraft and astronauts are in continuous free fall towards the Earth. (a)Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is not the correct explanation of A. (c) A is true but R is false. (d) A is false but R is true.
Q.3	Two identical satellites A and B revolve around the Earth. Satellite A is at a height of 400 km and satellite B at a height of 800 km above the Earth's surface. Which satellite has greater gravitational force acting on it? Justify your answer using the law of gravitation
Q.4	The mass of the Moon is about 7.35×1022 kg and its radius is 1.74×106 m. Without performing lengthy calculations, explain whether the value of acceleration due to gravity on the Moon is greater or smaller than that on Earth. Give a reason based on the relation $g=GM/R^2$
Q.5	During a space mission, an astronaut wants to place a communication satellite in a stable circular orbit around the Earth. Explain how the orbital speed depends on the orbital radius. Using the concept of gravitation, justify why satellites in higher orbits move more slowly than satellites in lower orbits.
ANSWER	
A1	(c) Double
A2	(a) Both A and R are true and R correctly explains A.
A3	Since gravitational force varies as $F \alpha \frac{1}{r^2}$ the satellite closer to Earth experiences greater gravitational force. Therefore, **Satellite A** has greater gravitational force because its distance from Earth's centre is smaller.
A4	The Moon has much smaller mass than Earth. Although its radius is also smaller, the ratio M/R^2 is much smaller than that of Earth. Therefore, **acceleration due to gravity on the Moon is smaller (about 1.62 m/s²)**.
A5	For a circular orbit, gravitational force provides the centripetal force: $\frac{GMm}{r^2} = \frac{mv^2}{r}$ Therefore $v = \sqrt{\frac{GM}{r}}$ Hence, orbital speed is inversely proportional to the square root of orbital radius. As the orbital radius increases, orbital speed decreases. Therefore, satellites in higher orbits move more slowly than satellites in lower orbits.

Chapter-8-MECHANICAL PROPERTIES OF SOLID

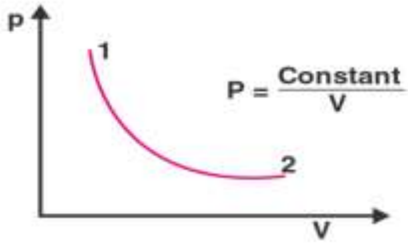
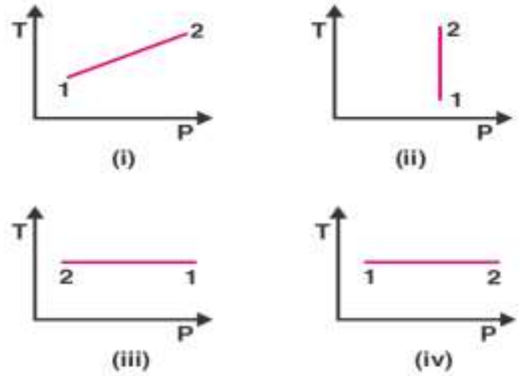
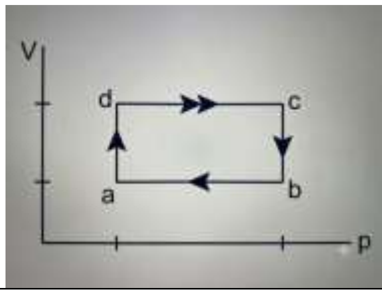
Q. 1	Which of the following materials is most elastic? (a) Steel (b) Rubber (c) Copper (d) Glass
Q. 2	**Assertion**: Bulk modulus of elasticity (B) represents incompressibility of the material. **Reason**: Bulk modulus of elasticity given by $B = P\ \Delta v/v$) (a)Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is not the correct explanation of A. (c) A is true but R is false. (d) A is false but R is true.
Q.3	A wire is stretched by a certain amount under a load if the load and radius both are increased to four times ,find the stretch caused in the wire
Q.4	**The stress-strain graphs for materials A and B are shown in figure.**  The graphs are drawn to the same scale. (a) Which of the materials has the greater Young's modulus? (b) Which of the two is the stronger material?
Q.5	Figure shows the strain-stress curve for a given material. What are (a) Young's modulus and (b) approximate yield strength for this material? 
ANSWER	
A1	(a) Steel
A2	(c) A is true but R is false.
A3	$\Delta l \propto F/A$, $\Delta l_2/\Delta l_1 = 4F/F * A/16A = 1/4$
A4	(a) From the two graphs we note that for a given strain, stress for A is more than that of B. Hence Young's modulus =(Stress /Strain) is greater for A than that of B. (b) Strength of a material is determined by the amount of stress required to cause fracture. This stress corresponds to the point of fracture. The stress corresponding to the point of fracture in A is more than for B. So, material A is stronger than material B
A5	**(a)** Young's modulus of the material (Y) is given by Y =Stress/Strain $=150 \times 10^6/0.002$ $=150 \times 10^6/2 \times 10\text{-}3 = 75 \times 10^9$ Nm^{-2} $=7.5 \times 10^{10}$ Nm^{-2} (b)Yield strength of a material is defined as the maximum stress it can sustain. From graph, the approximate yield strength of the given material $= 300 \times 10^6$ $Nm^{-2} = 3 \times 10^8$ Nm^{-2} .

Q. 1	Surface tension of a liquid generally: A. Increases with temperature B. Decreases with temperature C. Remains constant with temperature D. Becomes infinite at boiling point
Q. 2	Assertion (A): As the radius of a soap bubble increases, its excess pressure decreases. Reason (R): Excess pressure inside a soap bubble is $\Delta P = 4T/r$. (a) Both A and R are true and R is the correct explanation. (b) Both A and R are true but R is not the correct explanation. (c) A is true but R is false. (d) A is false but R is true.
Q.3	Two small spherical metal balls having equal masses are made from materials of densities ρ_1 and ρ_2, where $\rho_1 = 8\rho_2$. Their radii are 1 mm and 2 mm respectively. They are allowed to fall vertically from rest through a viscous liquid of viscosity η and density equal to $\rho_2/10$. Calculate the ratio of their terminal velocities.
Q.4	When a thin capillary tube is dipped vertically into water, water rises inside the tube. The height of rise is found to decrease when a capillary tube of larger radius is used. **(a)** Why does water rise in a capillary tube? **(b)** How does the height of capillary rise depend on the radius of the tube?
Q.5	A student observes that a small needle can float on the surface of water when it is placed carefully, although the density of steel is much greater than that of water. However, when a few drops of detergent are added to the water, the needle tends to sink. **Answer the following:** **(a)** Why can the needle float on the water surface? **(b)** What happens to the surface tension of water when detergent is added? **(c)** Explain why the needle sinks after adding detergent.
ANSWER	
A1	B. Decreases with temperature
A2	(a) Both A and R are true and R is the correct explanation.

A3	$$v_t = \frac{2r^2 g(\rho_s - \rho_l)}{9\eta}$$ Given: $$\rho_1 = 8\rho_2, \quad r_1 = 1\,\mathrm{mm}, \quad r_2 = 2\,\mathrm{mm}$$ and liquid density $$\rho_l = \frac{\rho_2}{10}$$ **For ball 1** $$v_1 \propto r_1^2(\rho_1 - \rho_l)$$ $$v_1 \propto (1)^2\left(8\rho_2 - \frac{\rho_2}{10}\right)$$ $$v_1 \propto \frac{79}{10}\rho_2$$ **For ball 2** $$v_2 \propto r_2^2(\rho_2 - \rho_l)$$ $$v_2 \propto (2)^2\left(\rho_2 - \frac{\rho_2}{10}\right)$$ $$v_2 \propto 4\left(\frac{9}{10}\rho_2\right) = \frac{36}{10}\rho_2$$ Therefore, $$\frac{v_1}{v_2} = \frac{79/10}{36/10} = \boxed{\frac{79}{36}}$$ Hence, $$\boxed{v_1 : v_2 = 79 : 36}$$ or approximately, $$\boxed{v_1 : v_2 = 2.19 : 1}$$ **Answer:** $\boxed{79 : 36}$.
A4	**(a)** Water rises in the capillary due to **surface tension and adhesive force between water molecules and the glass surface**. The upward component of surface tension balances the weight of the water column. **(b)** The height of capillary rise is inversely proportional to the radius of the capillary: $$\boxed{h = \frac{2T\cos\theta}{\rho g r}}$$ Therefore, $$\boxed{h \propto \frac{1}{r}}$$ Hence, a **narrower capillary produces a greater rise** of water.
A5	**(a)** The needle can float because **surface tension** produces an upward force along the surface of water that can balance the weight of the needle when it is placed carefully. **(b)** Addition of detergent **decreases the surface tension** of water. **(c)** Due to the decrease in surface tension, the upward force provided by the water surface becomes insufficient to balance the weight of the needle. Hence, the needle sinks.

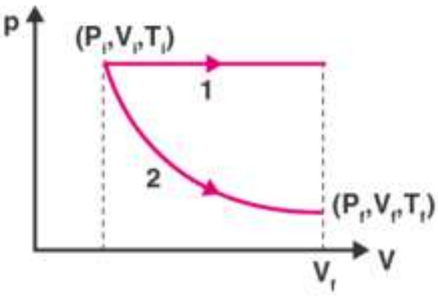
Chapter-10- Thermal Properties of Matter

Q. 1	A black surface and a polished silver surface are exposed to the same thermal radiation. The black surface generally absorbs more radiation because it is: A. good reflector B. good absorber C. poor emitter D. poor conductor
Q. 2	Assertion (A): During melting, the temperature of a pure substance remains constant. Reason (R): The supplied heat is used as latent heat to change the state. (a) Both A and R are true and R is the correct explanation. (b) Both A and R are true but R is not the correct explanation. (c) A is true but R is false. (d) A is false but R is true
Q.3	In cold regions, lakes may freeze at the surface while water below remains liquid. How does the anomalous expansion of water help aquatic life survive?
Q.4	Equal masses of water and copper are supplied with the same amount of heat. Which one will undergo a greater rise in temperature? Give a reason.
Q.5	A steel railway track is 20 m long at a temperature of 20°C. The coefficient of linear expansion of steel is $1.2 \times 10^{-5}\ K^{-1}$ **(a)** Calculate the increase in length of the rail when its temperature rises to 50°C . **(b)** What minimum gap should be provided between two consecutive rails at 20°C to accommodate this expansion? **(c)** If the gap provided is only 5 mm , what additional expansion has to be accommodated by the rail?
ANSWER	
A1	B. A good absorber
A2	(a) Both A and R are true, and R is the correct explanation of A.
A3	Water has maximum density at . As the surface water cools below , it expands and becomes less dense, so it remains at the top and eventually freezes. The ice layer acts as an **insulator**, preventing the water below from freezing completely.
A4	Copper will undergo a **greater rise in temperature** because its specific heat capacity is much lower than that of water. Using $Q = mc\Delta T$ for the same Q and m, $\Delta T \propto \frac{1}{c}$ Hence, lower c gives greater temperature rise.
A5	$L = 20\,m, \quad \alpha = 1.2 \times 10^{-5}\,K^{-1}$ $\Delta T = 50 - 20 = 30\,K$ **(a) Increase in length** Using $\Delta L = L\alpha\Delta T$ $\Delta L = 20(1.2 \times 10^{-5})(30)$ $\Delta L = 7.2 \times 10^{-3}\,m$ $\boxed{\Delta L = 7.2\,mm}$ **(b) Minimum gap** The gap should be at least equal to the expansion: $\boxed{\text{Minimum gap} = 7.2\,mm}$ (c) Additional expansion =7.2- 5 = 2.2 mm

Q. 1	Consider PV diagram for an ideal gas as shown in figure  Out of the diagram given in the option which would represents the T-P diagram? 
Q. 2	**Assertion (A):**If heat is added to a system, its temperature must increase**.** **Reason (R):** If positive work is done by the system in a thermodynamic process, Its volume must increase (a) Both A and R are true and R is the correct explanation. (b) Both A and R are true but R is not the correct explanation. (c) A is true but R is false. (d) A is false but R is true
Q.3	The initial state of a certain gas is (P_1 , V_1, T_1). It undergoes expansion till its volume become V_2. Consider the following two cases. (a) The expansion takes place at constant temperature. (b) The expansion takes place at constant pressure. Plot the P-V diagram for each case (in the same P-V graph) . In which of the two cases work done is more.
Q.4	When a system is taken through the process '*abc*' shown in figure, 80 J of heat is absorbed by the system and 30 J of work is done by it. If the system does 10 J of work during the process '*adc* ', how much heat flows into it during the process '*adc' ?* 
Q.5	Find the change in the internal energy of 2 kg of water as it is heated from$0^oC\ to\ 4^oC$. The specific heat capacity of water is $4200\ J\ kg^{-1}K^{-1}$ and its densities at $0^oC\ to\ 4^oC$ are $999.9\frac{kg}{m^3}$ & $1000.0\ kg/m^3$ respectively. Take Atmospheric pressure as $10^5\ Pa$. Also explain the anomalous behaviour of water based on the results.

<table>
<tr><th colspan="2">ANSWER</th></tr>
<tr><td>A1</td><td>: (c)

Explanation: The given P-V curve represents isothermal process, and only option c and d represents isothermal process. Moreover pressure at 1 is more than pressure at 2. This is clearly represented by option C</td></tr>
<tr><td>A2</td><td>(d) A is false but R is true</td></tr>
<tr><td>A3</td><td>



Clearly area under curve for process 1 (isochoric – constant pressure) is more than area under curve 2 (isothermal- constant temperature).

Area under curve represents Work done. So work done at constant pressure is more than work done at constant temperature.</td></tr>
<tr><td>A4</td><td>60 J

Solution : Given Heat Absorb Q(abc)= 80 J , Work done W(abc)= 30 J

By first law of thermodynamics , Change In internal energy U(abc)= 80-30 J= 50 J

Also Given W(adc)= 10 J

Since Internal energy is a state Variable (it depends only on initial and final state and not the process) U(abc)= U(adc)= 50 J

So again by first law of thermodynamics Q(adc)= U(adc)+ W(adc) = 50+10 = 60 J</td></tr>
<tr><td>A5</td><td>Heat absorbed during heating of 2 kg of water from $0^oC\ to\ 4^oC$.

Heat Absorbed $Q = mC(4-0) = 2 * 4200 * 4 = 33600\,J$

Work done $w = P(V2 - V1) = P\left(\frac{m}{d2} - \frac{m}{d1}\right) = 10^5\left(\frac{2}{999.9} - \frac{2}{1000}\right) =$ $10^5(0.02 \times 10^{-5}) = 0.02\,J$

Change in internal energy $U = Q - W = 33600 - 0.02 = 33599.98\,J$</td></tr>
</table>

Chapter-12- KINETIC THEORY OF GASES

Q. 1	A football is kept in the Sun for some time. After a while, it becomes harder. The most appropriate reason is: (A) The number of gas molecules increases. (B) The average kinetic energy of gas molecules increases, increasing the pressure inside the ball. (C) The mass of the gas increases. (D) The volume of the gas molecules increases.
Q. 2	**Assertion (A):** At the same temperature, hydrogen molecules have a higher rms speed than oxygen molecules. **Reason (R):** The rms speed of gas molecules is inversely proportional to the square root of their molar mass. (A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.
Q.3	A sealed aerosol can is left inside a parked car on a hot summer day. Using the kinetic theory of gases, explain why the pressure inside the can increases and why this may become dangerous
Q.4	Two identical containers hold helium and nitrogen gas separately at the same temperature. Predict which gas has the higher rms speed and explain your answer using the kinetic theory of gases
Q.5	A scientist observes that heating a gas in a rigid container increases its pressure. Using the assumptions of the kinetic theory of gases, explain how the motion of gas molecules changes and why the pressure increases.
ANSWER	
A1	(B) The average kinetic energy of gas molecules increases with temperature. Faster-moving molecules collide more frequently and more forcefully with the walls, increasing the pressure inside the football.
A2	(A) Both A and R are true and R is the correct explanation of A.
A3	On a hot day, the temperature inside the car rises. According to the kinetic theory, the average kinetic energy of gas molecules increases, so they move faster and collide with the container walls more frequently and with greater force. As the can is sealed, its volume remains constant, causing the pressure to increase. If the pressure exceeds the can's safe limit, it may burst.
A4	Helium has the higher rms speed. At the same temperature, all gases have the same average kinetic energy, but rms speed depends on molar mass: □. Since helium (4 g/mol) has a much lower molar mass than nitrogen (28 g/mol), helium molecules move faster.
A5	In a rigid container, the volume remains constant. When the gas is heated, the average kinetic energy of the molecules increases, causing them to move faster. Faster molecules strike the container walls more frequently and with greater momentum, increasing the force on the walls. Therefore, the pressure of the gas increases according to the kinetic theory of gases.

Q. 1	**The time period of a simple pendulum depends upon:** A. Mass of the bob B. Amplitude (for small oscillations) C. Length of the pendulum D. Shape of the bob
Q. 2	**.Assertion (A):** In SHM, the restoring force is directly proportional to displacement from the mean position. **Reason (R):** The restoring force always acts towards the mean position. A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, but R is not the correct explanation of A. C. A is true, but R is false. D. A is false, but R is true.
Q.3	A particle vibrates simple harmonically with amplitude of 4 cm. (a) Locate the position of the point where its speed is half its maximum speed. (b) At what displacement is P.E. = K.E.?
Q.4	A man is standing on a platform executing S.H.M. in the vertical direction and attached to a weighing machine. Will there be any change in his weight?
Q.5	The displacement of a particle in S.H.M. may be given by $x = A \sin(\omega t + \Phi)$ Show that if the time (t) is increased by $2\pi/\omega$, the value of x remains the same.
ANSWER	
A1	**C. Length of the pendulum**
A2	A. Both A and R are true, and R is the correct explanation of A.
A3	For SHM, $$v = \omega\sqrt{A^2 - x^2}$$ and maximum speed, $$v_{max} = \omega A$$ **(a) Speed is half the maximum speed** $$v = \frac{v_{max}}{2}$$ Therefore, $$\omega\sqrt{A^2 - x^2} = \frac{\omega A}{2}$$ $$\sqrt{A^2 - x^2} = \frac{A}{2}$$ Squaring, $$A^2 - x^2 = \frac{A^2}{4}$$ $$x = \pm\frac{\sqrt{3}}{2}A$$ Putting $A = 4$ cm: $$x = \pm\frac{\sqrt{3}}{2}(4)$$ $$\boxed{x = \pm 2\sqrt{3}\ \text{cm}}$$

	$$PE = \frac{1}{2}m\omega^2x^2$$ Hence, $$KE = E - PE$$ For $PE = KE$, $$PE = \frac{E}{2}$$ Therefore, $$\frac{1}{2}m\omega^2x^2 = \frac{1}{4}m\omega^2A^2$$ $$x^2 = \frac{A^2}{2}$$ $$x = \pm\frac{A}{\sqrt{2}}$$ Putting $A = 4$ cm: $$\boxed{x = \pm 2\sqrt{2}\ \text{cm}}$$
A4	Depending on the motion of the platform from its mean position, the weight of the man will change when the platform moves down from the mean position to the lowermost point and return back to the mean position, 'the acceleration acts vertically upwards and hence the weight of the man j will increase. But when the platform moves up from its mean position to the uppermost point and returns back to the mean position, the acceleration in S.H.M. acts downwards, so the weight of the man is decreased.
A5	The displacement of a particle in S.H.M. at a time t is given $x = A \sin(\omega t + \Phi)$ …. (i) Let x1 be the displacement of the-particle at time $t' = (t + 2\pi/\omega)$, To prove $x_1 = x$ From equation (i), we get $x1 = A \sin[\omega(t + 2\pi/\omega) + \Phi)]$ $= A \sin[\omega t + 2\pi + \Phi] = A \sin 2\pi + (\omega t + \Phi)$ $= A \sin(\omega t + \Phi)$ $[\because \sin(2\pi + \theta) = \sin\theta$ I.e. the displacement of the particle in S.H.M. is same for times t and $t + 2\pi/\omega$. Hence proved

Chapter-14: Waves

Q. 1	A student creates ripples in a pond by dipping a finger into the water at regular intervals. He notices that the frequency of dipping is doubled while the speed of the waves remains unchanged. Which of the following will happen? A. Wavelength will double. B. Wavelength will become half. C. Wave speed will double. D. Frequency will remain unchanged.
Q. 2	**Assertion (A):** Sound waves cannot travel through a vacuum. **Reason (R):** Sound waves are mechanical waves and require a material medium for propagation. A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, but R is not the correct explanation of A. C. A is true, but R is false. D. A is false, but R is true.
Q.3	A rope is tied at one end and shaken at the other end. The wave travels with a speed of 20 m/s. The frequency of vibration is 5 Hz. 1. Calculate the wavelength. 2. If the frequency is increased to 10 Hz without changing the tension, what will be the new wavelength?
Q.4	A student notices that when a vibrating tuning fork is held near another tuning fork having the same natural frequency, the second tuning fork also starts vibrating. However, this effect is not significant when the natural frequencies of the two tuning forks are very different. **(a)** Name the phenomenon responsible for this observation. **(b)** Under what condition is this phenomenon most effective?
Q.5	**An open organ pipe** and a **closed organ pipe** have the same length of **0.85 m**. The speed of sound in air is . **(a)** Calculate the fundamental frequency of the open organ pipe. **(b)** Calculate the fundamental frequency of the closed organ pipe. **(c)** What is the ratio of their fundamental frequencies?
ANSWER	
A1	B. Wavelength will become half.
A2	A. Both A and R are true, and R is the correct explanation of A.

A3	$$v = f\lambda$$ **1. Wavelength** $$\lambda_1 = \frac{v}{f_1} = \frac{20}{5}$$ $$\boxed{\lambda_1 = 4\,\mathrm{m}}$$ **2. When frequency is increased to 10 Hz** The tension and linear mass density of the rope are unchanged, so the **wave speed remains 20 m/s.** $$\lambda_2 = \frac{v}{f_2} = \frac{20}{10}$$ $$\boxed{\lambda_2 = 2\,\mathrm{m}}$$
A4	**(a)** The phenomenon is called **resonance**. **(b)** Resonance occurs when the **frequency of the external periodic force is equal or very close to the natural frequency of the vibrating system**. At resonance, the amplitude of vibration becomes maximum.
A5	For an **open organ pipe**: $$f_o = \frac{v}{2L}$$ $$f_o = \frac{340}{2(0.85)} = \boxed{200\,\mathrm{Hz}}$$ For a **closed organ pipe**: $$f_c = \frac{v}{4L}$$ $$f_c = \frac{340}{4(0.85)} = \boxed{100\,\mathrm{Hz}}$$ Therefore, $$\frac{f_o}{f_c} = \frac{200}{100}$$ $$\boxed{f_o : f_c = 2 : 1}$$

MOST IMPORTANT 20 QUESTIONS FOR REVISION OF CLASS XI PHYSICS

Q.No. 1. Let us consider an equation $1/2\ mv^2 = mgh$ where m is the mass of the body, v its velocity, g is the acceleration due to gravity and h is the height. Check whether this equation is dimensionally correct

Q.No. 2. E, m, L and G denote energy, mass, angular momentum, and gravitational constant respectively. Determine the dimensions of EL^2/m^5G^2..

Q.No. 3. A ball is thrown vertically upwards with a velocity of 20 m s^{-1} from the top of a multistorey building. The height of the point from where the ball is thrown is 25.0 m from the ground. (a) How high will the ball rise ? and (b) how long will it be before the ball hits the ground? Take g = 10 m s^{-2} .

Q.No. 4. State Parallelogram law of vectors addition and find the magnitude of the resultant of two vectors A and B in terms of their magnitudes and angle between them.

Q.No. 5 A ball is projected from the ground with an initial velocity voat an angle θ above the horizontal

(a)Find the time of flight (b)Determine the horizontal range R

(c)Determine the maximum height obtained by the ball (d)Obtain an expression for the trajectory of projectile

Q.No. 6. Derive equation of motion using graphical and calculus method.

Q.No. 7. What is meant by banking of roads? Explain the need for it. Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at angle θ. The coefficient of friction between road and wheels is μ.

Q.No.8 (a) Define friction. (b) Show that kinetic friction is less than the static friction. (c) Establish that static friction is a self- adjusting force. (d) Write the basic laws of limiting friction..

Q.No. 9 (a) State the law of conservation of linear momentum. (b) Explain, why the gun recoils back when bullet is fired from it. Obtain the expression for recoil velocity of gun.

Q.No.10. Describe the collision and its types.

Q.No. 11. (a) Give two examples of conservative forces. (b) State and prove work energy theorem.

Q.No. 12. (a) Define Centre of mass.

(b) Three point masses of 1 kg, 2 kg and 3 kg lie in X-Y plane at (1,2), (0,-1) and (2,-3) respectively. Calculate the co-ordinates(X_{cm}, Y_{cm}) of the centre of mass of the system.

Q.No. 13. (a) State and prove the law of conservation of angular momentum. (b) Explain, how does an ice-skater, a ballet dancer or an acrobat vary her angular speed by outstretching her arms and legs?

Q.No. 14. Write the expressions for the 'g' at height 'h' and depth 'd' from the surface of earth. Explain, why is the value of 'g' decreases with height and depth from the surface of the earth?

Q.No. 15. Define the term bulk modulus of elasticity, Give its SI unit. Write the relation between bulk modulus and compressibility.

Q.No.16 Define Poisson's ratio. Write an expression for it. What is the significance of negative sign in this expression.

OR

Compute the fractional change in volume of a glass slab, when subjected to a hydraulic pressure of 10 atm. [Bulk modulus for glass = 37 x 109 Pa].

Q.No.17. (a) A liquid is in streamlined flow through a tube of non-uniform cross- section. Prove using a diagram that sum of its kinetic energy, pressure energy and potential energy per unit volume remain constant.

(b) Explain why

(i) To keep a piece of paper horizontal, you should blow over, not under, it.

(ii) The size of the needle of a syringe controls flow rate better than the thumb pressure exerted by a doctor while administering an injection.

OR

(a) Define critical velocity of liquid flow and state the factors affecting the critical velocity of liquid.

(b) Define terminal velocity. Establish an expression for it for a spherical body falling through a viscous medium.

Q.No. 18. (a) State Wein's displacement law.

(b) Explain the anomalous expansion of water from 0 ^{0}C to 4 ^{0}C and its importance for aquatic life.

Q.No. 19 State first law of thermodynamics and using it establish relation between molar specific heats of gas at constant pressure and at constant volume..

Q.No. 20. (a) State the law of equipartition of energy

(b) Calculate the ratio of specific heats (γ) for a (i) Diatomic gas and (ii) Poly atomic gas for rigid molecules.

Q.No. 21. (a) Calculate the length of a simple pendulum, which takes one second from one extreme position to other.

(b) Show the variation of kinetic energy, potential energy and total energy as a function of displacement of a particle in simple harmonic motion.

Q.No. 22.(a) Explain the meaning of the terms (i) Nodes and (ii) Anti nodes in respect of standing waves.

(b) Explain the formation of harmonics in a stretched string with the help of suitable diagrams and show that in case of a stretched string the first three harmonics are in the ratio 1:2:3.

OR

(a) Show the formation of standing waves :
   (i) in a closed organ pipe and,
   (ii) In an open organ pipe
   (Draw only first three harmonics in each case)

(b) A pipe, 30.0 cm long, is open at both ends. Which harmonic mode of the pipe resonates a 1.1 kH_z source? Take the speed of sound in air as 330 m s^{-1}