PHYSICS Mastery for NET

Complete Chapter-wise Guide

Chapters (as per PTB & NET syllabus):

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Chapter 1: Physical Quantities and Units

✅ Important Formulas:

1. Speed = Distance ÷ Time
2. Acceleration = Change in Velocity ÷ Time
3. Force = Mass × Acceleration
4. Work = Force × Displacement × cos(θ)
5. Pressure = Force ÷ Area
6. Density = Mass ÷ Volume
7. Momentum = Mass × Velocity
8. Kinetic Energy = (1 ÷ 2) × Mass × Velocity^2
9. Potential Energy = Mass × g × Height
10. Power = Work ÷ Time
11. Frequency = 1 ÷ Time Period
12. Gravitational Force = ($G \times m_1 \times m_2$) ÷ r^2
13. Hooke's Law: Force = Spring Constant × Extension
14. Weight = Mass × g
15. Charge = Current × Time
16. Voltage = Work ÷ Charge
17. Resistance = Voltage ÷ Current

18. Electric Power = Current × Voltage

19. Electric Energy = Power × Time

20. Capacitance = Charge ÷ Voltage

21. Displacement = Final Position – Initial Position

22. Impulse = Force × Time

23. Change in Momentum = Final Momentum – Initial Momentum

24. Unit Conversion:
    - 1 kilometer = 1000 meters
    - 1 hour = 3600 seconds

25. Area of Circle = $\pi \times \text{Radius}^2$
    Volume of Sphere = $(4 \div 3) \times \pi \times \text{Radius}^3$

Key Definitions / Identities:

- Physical Quantity: A measurable quantity (e.g., mass, length, time)
- Base Quantities: Fundamental units like mass (kg), length (m), time (s)
- Derived Quantities: Formed from base quantities (e.g., speed = m/s)
- Scalar: Has only magnitude (e.g., speed, mass)
- Vector: Has magnitude and direction (e.g., velocity, force)
- Standard Form (Scientific Notation): e.g., 3.0×1083.0 \times 10^83.0×108
- Significant Figures: Reflect precision in measurement
- Dimensional Analysis: Expressing units in terms of base units

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SI Units of Common Quantities:

Quantity	Symbol	SI Unit	SI Unit Symbol

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Length	**L**	**Meter**	**M**
Mass	**m**	**Kilogram**	**kg**
Time	**t**	**Second**	**S**
Electric Current	**I**	**Ampere**	**A**
Temperature	**T**	**Kelvin**	**K**
Amount of Substance	**n**	**Mole**	**Mol**
Luminous Intensity	**Iv**	**Candela**	**Cd**
Force	**F**	**Newton**	**N**
Pressure	**P**	**Pascal**	**Pa**
Energy	**E**	**Joule**	**J**

Graphs Overview:

- **Linear Graph: Constant rate of change (e.g., speed-time graph)**
- **Non-linear Graph: Changing rate (e.g., distance-time with acceleration)**
- **Unit Conversions: Visually estimate values by scaling axes**
- **Understand gradient = rate of change**

MCQ Tips / Tricks:

1. **Use dimensional analysis to eliminate wrong answers**
2. **Focus on SI units (m/s, kg, s) – avoid mix-up with CGS units**
3. **Don’t confuse vector and scalar quantities**
4. **Read prefixes carefully:**
   - milli (m) = 10−310^{-3}10−3,
   - micro (μ) = 10−610^{-6}10−6,
   - nano (n) = 10−910^{-9}10−9

5. **Convert all units before applying formulas**
6. **If two quantities are directly proportional, graph is a straight line**
7. **Remember: Force is a vector; Pressure is scalar**
8. **Memorize SI units for derived quantities (Joule, Pascal, Newton)**
9. **Practice converting km/hr to m/s by multiplying with 518\frac{5}{18}185**
10. **Always check significant figures in answers**

✅ **Past NET MCQs Examples Q1:**
Which of the following is a vector quantity?
A. Speed   B. Distance   C. Acceleration   D. Mass
✅ **Correct: C**

Q2:
SI unit of power is:
A. Watt   B. Newton   C. Joule   D. Volt
✅ **Correct: A**

Q3:
Which prefix denotes 10−610^{-6}10−6?
A. milli   B. micro   C. nano   D. centi
🟩 **Correct: B**

Q4:
What is the dimension of Force?
A. MLT−2MLT^{-2}MLT−2   B. ML−1T−2ML^{-1}T^{-2}ML−1T−2   C.

M2LT−1M^2LT^{-1}M2LT−1 D. None
✅ **Correct: A**

Chapter 2: Forces and Motion

Important Formulas:

1. Speed = Distance ÷ Time
2. Velocity = Displacement ÷ Time
3. Acceleration = (Final Velocity – Initial Velocity) ÷ Time
4. Force = Mass × Acceleration
5. Weight = Mass × g (where $g = 9.8\ m/s^2$)
6. Momentum = Mass × Velocity
7. Impulse = Force × Time = Change in Momentum
8. Frictional Force = Coefficient of Friction × Normal Force
9. Tension in string (ideal pulley) = Weight – Mass × Acceleration
10. Net Force = Sum of All Forces Acting on Body
11. Newton's Second Law = Force = Mass × Acceleration
12. Newton's Third Law = Action = –Reaction
13. Centripetal Force = (Mass × Velocity²) ÷ Radius
14. Acceleration due to gravity (g) = $9.8\ m/s^2$
15. Equation of Motion 1: $v = u + at$
16. Equation of Motion 2: $s = ut + (1 \div 2)at^2$

17. Equation of Motion 3: $v^2 = u^2 + 2as$
18. Force on Inclined Plane = mg sin(θ)
19. Normal Force on Inclined Plane = mg cos(θ)
20. Projectile Range = $(u^2 \times \sin(2\theta)) \div g$
21. Time of Flight = $(2u \times \sin\theta) \div g$
22. Maximum Height = $(u^2 \times \sin^2\theta) \div (2g)$
23. Work Done = Force × Displacement × cos(θ)
24. Static Friction ≤ μ × Normal Force
25. Dynamic Friction = μ × Normal Force

Key Concepts / Definitions:

- Inertia: Resistance to change in motion
- Momentum: The quantity of motion an object has ($p = mv$)
- Impulse: Force acting for a short time, causes momentum change
- Friction: Force opposing motion between two surfaces
- Free Fall: Motion under gravity only
- Projectile Motion: Curved motion due to gravity + forward motion
- Centripetal Force: Keeps object in circular path
- Equilibrium: Net force is zero ⇒ no acceleration

Graphs Overview

- Displacement-Time Graph:
  • Straight line ⇒ Constant velocity
  • Curve ⇒ Accelerated motion

- Velocity-Time Graph:
  • Slope = Acceleration
  • Area under graph = Displacement
- Acceleration-Time Graph:
  • Area under graph = Change in velocity

MCQ Tips / Tricks:

1. Always write knowns before solving
2. Use sign convention carefully (+ or – acceleration)
3. In projectiles, break into horizontal & vertical components
4. Use shortcut:
   • km/hr to m/s ⇒ Multiply by 5 ÷ 18
   • m/s to km/hr ⇒ Multiply by 18 ÷ 5
5. Net Force = 0 ⇒ object at rest or constant velocity
6. For inclined planes, break force into components
7. Time of flight and range only depend on vertical motion
8. If object moves in circle ⇒ apply centripetal force logic
9. Friction acts opposite to motion
10. Use graphs to estimate acceleration or displacement quickly

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Past NET MCQs Examples

Q1:
If a body moves with constant velocity, what is its acceleration?
A. Zero B. One C. Constant D. Equal to velocity
✅ Correct: A

Q2:
What is the unit of momentum?
A. N B. kg m/s C. J D. m/s^2
✅ Correct: B

Q3:
A force of 10 N acts on a body for 5 seconds. What is the impulse?
A. 50 N·s B. 5 N·s C. 2 N·s D. 0.5 N·s
✅ Correct: A

Q4:
Which of the following is a scalar quantity?
A. Acceleration B. Force C. Momentum D. Speed
✅ Correct: D

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Chapter 3: Work and Energy

Important Formulas :

1. **Work = Force × Displacement × cos(θ)**
2. **If θ = 0°, Work = Force × Displacement (maximum work)**
3. **If θ = 90°, Work = 0 (no work)**
4. **Unit of Work = Joule (J)**
5. **1 Joule = 1 Newton × 1 Meter = 1 N·m**
6. **Power = Work ÷ Time**
7. **Unit of Power = Watt (W)**
8. **1 Watt = 1 Joule ÷ 1 Second = 1 J/s**
9. **Horsepower (HP) = 746 Watts**
10. **Energy = Power × Time**
11. **Kinetic Energy (K.E.) = (1 ÷ 2) × Mass × Velocity^2**
12. **Potential Energy (P.E.) = Mass × g × Height**
13. **Total Mechanical Energy = K.E. + P.E.**
14. **Work-Energy Principle: Work Done = Change in K.E.**
15. **Conservation of Mechanical Energy:**
    K.E. + P.E. = Constant (in absence of friction)
16. **Efficiency = (Useful Output ÷ Input Energy) × 100%**

17. **1 kWh = 1000 W × 3600 s = 3.6 × 10^6 J**
18. **Spring Potential Energy = (1 ÷ 2) × k × x^2**
19. **Gravitational Potential Energy: mgh**
20. **Power in terms of Force and Velocity = Force × Velocity**
21. **Work Done by Variable Force = Area under Force–Displacement graph**
22. **Mechanical Advantage (MA) = Load ÷ Effort**
23. **Velocity Ratio (VR) = Distance moved by effort ÷ distance moved by load**
24. **Input Power = Input Work ÷ Time**
25. **Output Power = Output Work ÷ Time**

Key Concepts / Definitions

- **Work**: Transfer of energy by applying force through a displacement
- **Positive Work**: Force and displacement in same direction
- **Negative Work**: Force opposes displacement (like friction)
- **Zero Work**: No displacement or force is perpendicular
- **Energy**: Capacity to do work
- **Kinetic Energy**: Energy of motion
- **Potential Energy**: Stored energy due to position
- **Power**: Rate at which work is done
- **Efficiency**: How effectively input energy is converted to output

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Graphs Overview:

- **Force–Displacement Graph**:
  - Area under the curve = Work Done
  - If force is constant, graph is straight line
  - For variable force, area = integration (in advanced problems)
- **Power-Time Graph**:
  - Area under graph = Energy consumed

MCQ Tips / Tricks:

1. If object moves at constant speed and friction exists → work is done against friction
2. If body is lifted vertically → work = mgh
3. K.E. always positive; P.E. can be zero at reference level
4. If friction is neglected → total mechanical energy remains constant
5. If P.E. decreases → K.E. increases (conversion principle)
6. In free fall → P.E. converts to K.E.
7. For springs, use formula: $(1 \div 2)kx^2$
8. Horsepower is not SI unit; convert to watts when needed
9. Always convert minutes or hours into seconds when using power formulas
10. Practice kWh conversion – common in NET word problems

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Past NET MCQs Examples:

Q1:
What is the work done when a force of 5 N moves a body 3 m at 60° angle?
A. 10 J **B.** 15 J **C.** 7.5 J **D.** 5 J
✅ **Correct: C**
Work = F × d × cos(θ) = 5 × 3 × cos(60°) = 15 × 0.5 = 7.5 J

Q2:
If velocity of a body is doubled, its kinetic energy becomes:
A. Half **B.** Double **C.** Four times **D.** Same
🟩 **Correct: C**
K.E. $\propto v^2 \Rightarrow$ doubling v makes K.E. 4 times

Q3:
What is the unit of Power?
A. Newton **B.** Joule **C.** Watt **D.** Pascal
✅ **Correct: C**

Q4:
Which type of energy is stored in a stretched spring?
A. Kinetic **B.** Thermal **C.** Electrical **D.** Potential
🟩 **Correct: D**

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Chapter 4: Circular Motion

Important Formulas:

1. **Angular Displacement (θ) = Arc Length ÷ Radius**
2. **Angular Velocity (ω) = Angular Displacement ÷ Time**
3. **Angular Acceleration (α) = Change in Angular Velocity ÷ Time**
4. **Linear Velocity (v) = Radius × Angular Velocity**
5. **$v = r \times \omega$**
6. **Centripetal Acceleration (a) = $v^2 \div r = r \times \omega^2$**
7. **Centripetal Force (F) = Mass × $v^2 \div r = m \times r \times \omega^2$**
8. **Time Period (T) = $2\pi \times r \div v = 2\pi \div \omega$**
9. **Frequency (f) = $1 \div T$**
10. **Acceleration in UCM (Uniform Circular Motion) is always toward center**
11. **Torque (τ) = Force × Perpendicular Distance**
12. **Moment of Inertia (I) = $\Sigma (m \times r^2)$**
13. **Angular Momentum (L) = $I \times \omega$**
14. **Centrifugal Force = $-m \times v^2 \div r$ (apparent outward force in rotating frame)**
15. **Tangential Acceleration = Radius × Angular Acceleration**
16. **Radial Acceleration = $v^2 \div r$**
17. **Displacement in circular path = $\theta \times r$ (in radians)**
18. **1 revolution = 2π radians**
19. **Kinetic Energy (Rotational) = $(1 \div 2) \times I \times \omega^2$**

20. **Newton's 2nd Law for rotation: Torque = $I \times \alpha$**
21. **Power = Torque × Angular Velocity**
22. **Conservation of Angular Momentum: $I_1 \times \omega_1 = I_2 \times \omega_2$**

Key Concepts / Definitions:

- **Uniform Circular Motion (UCM)**: Motion with constant speed along a circular path
- **Angular Displacement**: Angle swept out by radius vector
- **Centripetal Force**: Real force directed toward center causing circular motion
- **Centrifugal Force**: Apparent force acting outward in rotating frame
- **Angular Quantities**: Angular displacement (θ), Angular velocity (ω), Angular acceleration (α)
- **Tangential Velocity**: Linear speed along the edge of the circle
- **Torque**: Rotational equivalent of force
- **Moment of Inertia**: Rotational mass (depends on distribution of mass)

Graphs Overview:

- **Angular Velocity vs Time**:
  • Straight line for constant angular acceleration
- **Centripetal Force vs Velocity²**:
  • Directly proportional
- **v vs r Graph**:
  • $v \propto \sqrt{r}$ when centripetal force is constant

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MCQ Tips / Tricks:

1. Always remember: Centripetal force is real, centrifugal is fictitious
2. If velocity increases → centripetal force increases ($F \propto v^2$)
3. Don't confuse angular velocity with linear velocity
4. Convert degrees to radians (1 rad = 57.3°)
5. 1 complete revolution = 2π radians
6. Torque causes rotation – not just force
7. Angular momentum is conserved in absence of external torque
8. Use right units:
   - θ in radians
   - ω in rad/s
   - T in seconds
9. In MCQs, plug known values into $v = r \times \omega$ when stuck
10. For rotating bodies: Work = Torque × Angular Displacement

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Past NET MCQs Examples:

Q1:
A body is moving in a circle of radius 2 m with speed 4 m/s. What is its centripetal acceleration?
A. 8 m/s^2 **B.** 2 m/s^2 **C.** 4 m/s^2 **D.** 16 m/s^2
✅ **Correct: A**
$a = v^2 \div r = (4^2) \div 2 = 16 \div 2 = 8$ m/s^2

Q2:
1 revolution = ? radians
A. π **B.** 2π **C.** 180° **D.** 360
✅ **Correct: B**

Q3:
Torque is maximum when the angle between force and lever arm is:
A. 0° **B.** 30° **C.** 90° **D.** 180°
🟩 **Correct: C**
Maximum torque at 90°, $\tau = F \times r \times \sin(\theta)$

Q4:
If angular momentum is conserved, what happens when moment of inertia decreases?
A. Angular velocity increases
B. Angular velocity decreases
C. Remains same
D. Torque becomes zero
🟩 **Correct: A**

Chapter 5: Fluid Dynamics

Important Formulas:

1. **Density = Mass ÷ Volume**
2. **Pressure = Force ÷ Area**
3. **1 Pascal = 1 Newton ÷ 1 meter² (N/m²)**
4. **Pressure in Fluid = Density × g × Height**
5. **Pascal's Principle: Pressure is transmitted equally in all directions in a fluid**
6. **Buoyant Force = Weight of Displaced Fluid**
7. **Buoyant Force = Density of fluid × g × Volume of displaced fluid**
8. **Archimedes' Principle:**
   Buoyant force = weight of fluid displaced
9. **Equation of Continuity: $A_1v_1 = A_2v_2$**
10. **Bernoulli's Equation:**
    $P + (1 \div 2)\rho v^2 + \rho gh = \text{Constant}$
11. **Dynamic Pressure = $(1 \div 2) \times \rho \times v^2$**
12. **Hydrostatic Pressure = ρgh**
13. **Flow Rate = Area × Velocity = Av**
14. **Volume Flow Rate = Volume ÷ Time**
15. **Mass Flow Rate = $\rho \times A \times v$**
16. **Viscosity: Internal friction in fluids**
17. **Terminal Velocity: Constant speed of a falling object in a fluid**

18. **Stoke's Law: $F = 6\pi\eta rv$ (η = coefficient of viscosity)**
19. **Ideal Fluid: Incompressible, non-viscous, steady flow, irrotational**
20. **Real Fluid: Viscous and compressible**
21. **Atmospheric Pressure = 1.01×10^5 Pa (standard at sea level)**
22. **1 atm = 760 mmHg = 101325 Pa**
23. **Gauge Pressure = Absolute Pressure – Atmospheric Pressure**
24. **Absolute Pressure = Gauge Pressure + Atmospheric Pressure**
25. **1 bar = 10^5 Pa**

Key Concepts / Definitions

- **Fluid**: A substance that can flow (liquids and gases)
- **Pressure**: Force per unit area
- **Viscosity**: Resistance to flow within fluids
- **Streamline Flow**: Smooth flow with no turbulence
- **Turbulent Flow**: Chaotic, irregular flow
- **Continuity Equation**: Flow rate remains constant for incompressible fluids
- **Bernoulli's Principle**: Increase in velocity → decrease in pressure
- **Buoyancy**: Upward force exerted by fluid
- **Hydrostatics**: Study of fluids at rest
- **Hydrodynamics**: Study of fluids in motion

Graphs Overview:

- **Height vs Pressure (in fluid)**:
  Linear – pressure increases with depth
- **Velocity vs Pressure (Bernoulli)**:
  Inverse – higher speed = lower pressure
- **Flow Rate vs Cross-sectional Area**:
  Inversely proportional – narrower pipe → faster flow
- **Depth vs Buoyant Force**:
  Constant if volume remains submerged

MCQ Tips / Tricks:

1. Always use SI units (e.g., Pa, m^3, kg/m^3)
2. Pressure in fluid is **only depth-dependent**, not shape of container
3. Narrower pipes = higher velocity (Continuity Equation)
4. For floating bodies:
   Weight of object = Buoyant Force = Weight of fluid displaced
5. Bernoulli equation is applicable only to **ideal, incompressible** fluids
6. Archimedes' Principle applies to both liquids and gases
7. For gauge pressure, subtract atmospheric pressure from total
8. Terminal velocity increases with radius (Stoke's Law)
9. Remember:
   • $v \uparrow \rightarrow P \downarrow$ (Bernoulli)
   • $A \downarrow \rightarrow v \uparrow$ (Continuity)

10. Watch units:
    - 1 cm = 0.01 m,
    - 1 mL = 1×10^{-6} m³

Past NET MCQs Examples:

Q1:
If the density of water is 1000 kg/m³, what is the pressure at 10 m depth?
A. 9800 Pa **B.** 100 Pa **C.** 10000 Pa **D.** 1 atm
✅ **Correct: A**
$P = \rho gh = 1000 \times 9.8 \times 10 = 98000$ Pa

Q2:
Which principle explains lift in airplane wings?
A. Pascal's **B.** Bernoulli's **C.** Archimedes' **D.** Newton's
🟩 **Correct: B**

Q3:
An object floats in water. What can we say about its weight?
A. More than Buoyant Force **B.** Less than Buoyant Force
C. Equal to Buoyant Force **D.** Equal to Pressure
✅ **Correct: C**

Q4:
Which quantity remains constant in continuity equation?
A. Velocity
B. Area
C. Pressure
D. Flow Rate
🟩 **Correct: D**

Chapter 6: Oscillations

Important Formulas:

1. **Simple Harmonic Motion (SHM): $a = -\omega^2 x$**
2. **Restoring Force (F) = $-k \times x$**
3. **Hooke's Law: $F = -k \times x$**
4. **Time Period (T) of spring-mass system = $2\pi \times \sqrt{(m \div k)}$**
5. **Frequency (f) = $1 \div T$**
6. **Time Period of simple pendulum: $T = 2\pi \times \sqrt{(L \div g)}$**
7. **Displacement in SHM: $x = A \times \sin(\omega t)$**
8. **Velocity in SHM: $v = A\omega \times \cos(\omega t)$**
9. **Acceleration in SHM: $a = -A\omega^2 \times \sin(\omega t)$**
10. **Maximum Velocity: $v_{max} = A \times \omega$**
11. **Maximum Acceleration: $a_{max} = A \times \omega^2$**
12. **Kinetic Energy in SHM: K.E. = $(1 \div 2) \times m \times v^2$**
13. **Potential Energy in SHM: P.E. = $(1 \div 2) \times k \times x^2$**
14. **Total Energy in SHM = $(1 \div 2) \times k \times A^2$ (constant)**
15. **$\omega = 2\pi f = 2\pi \div T$**
16. **Phase Difference: Indicates the difference in oscillation timing**
17. **At equilibrium position**:
    - Maximum velocity

- Zero displacement
- Zero acceleration

18. **At extreme position**:
    - Maximum displacement
    - Zero velocity
    - Maximum acceleration
19. **SHM is periodic and symmetric about mean position**
20. **Restoring force is directly proportional to displacement**

Key Concepts / Definitions:

- **Oscillation**: Repeated back and forth motion
- **Amplitude (A)**: Maximum displacement from mean position
- **Time Period (T)**: Time for one complete oscillation
- **Frequency (f)**: Number of oscillations per second
- **Angular Frequency (ω)**: $2\pi \times f$
- **SHM**: Motion where acceleration is proportional to displacement but in opposite direction
- **Phase**: Describes position and direction of motion
- **Damping**: Gradual loss of energy in oscillating system
- **Resonance**: Maximum amplitude when frequency of external force = natural frequency of system

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Graphs Overview:

- **Displacement-Time Graph**: Sine or cosine curve
- **Velocity-Time Graph**: Cosine or sine wave, out of phase with displacement
- **Acceleration-Time Graph**: Opposite phase to displacement
- **K.E. and P.E. Graphs**:
  • K.E. max at center, P.E. max at ends
  • Total energy is constant

MCQ Tips / Tricks:

1. Remember: In SHM, acceleration always directed toward mean position
2. Maximum speed occurs at mean position
3. Use formula $T = 2\pi\sqrt{(m \div k)}$ for mass-spring,
   $T = 2\pi\sqrt{(L \div g)}$ for pendulum
4. At extreme point → K.E. = 0, P.E. = max
5. Total mechanical energy is constant in ideal SHM
6. Graphs are good tools – understand them
7. For pendulum, increasing length increases time period
8. Use $\omega = 2\pi f$ for switching between angular and linear frequency
9. Phase difference between acceleration and displacement = 180°
10. If T increases, frequency decreases ($f = 1 \div T$)

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Past NET MCQs Examples:

Q1:
The time period of a simple pendulum is given by:
A. $T = 2\pi \times \sqrt{(m \div k)}$
B. $T = 2\pi \times \sqrt{(L \div g)}$
C. $T = 2\pi \times \sqrt{(g \div L)}$
D. $T = \sqrt{(k \div m)}$
✅ **Correct: B**

Q2:
At mean position of SHM:
A. Velocity is zero
B. Acceleration is zero
C. Displacement is max
D. Kinetic energy is zero
✅ **Correct: B**

Q3:
What is the frequency if time period is 0.5 s?
A. 0.5 Hz **B.** 2 Hz **C.** 1 Hz **D.** 4 Hz
✅ **Correct: B**
$f = 1 \div T = 1 \div 0.5 = 2$ Hz

Q4:
Which quantity remains constant in SHM?
A. Kinetic Energy

B. Potential Energy
C. Total Mechanical Energy
D. Acceleration
✅ **Correct: C**

Chapter 7: Waves

Important Formulas:

1. **Wave Speed (v) = Frequency (f) × Wavelength (λ)**
2. **v = f × λ**
3. **Time Period (T) = 1 ÷ f**
4. **Frequency (f) = 1 ÷ T**
5. **Angular Frequency (ω) = 2π × f**
6. **Wave Number (k) = 2π ÷ λ**
7. **Displacement in wave = A × sin(kx – ωt)**
8. **Speed of sound in air ≈ 343 m/s at 20°C**
9. **Speed of wave in string = √(Tension ÷ Mass per unit length)**
10. **Tension (T) = Force applied to stretch string**
11. **Reflection Law: Angle of Incidence = Angle of Reflection**
12. **Refraction: v ∝ √(Elasticity ÷ Density)**
13. **Interference: Superposition of waves**
14. **Constructive Interference: Crest + Crest or Trough + Trough**
15. **Destructive Interference: Crest + Trough**
16. **Standing Waves Condition: L = n × (λ ÷ 2)**
17. **Speed of wave in solid > liquid > gas**
18. **Echo: t = 2d ÷ v**

19. **$d = (v \times t) \div 2$** (for echoes)
20. **Resonance: Forced frequency = Natural frequency → Large amplitude**
21. **Doppler Effect (basic): Apparent frequency increases when source approaches**
22. **Transverse Wave: Particles vibrate perpendicular to direction of wave**
23. **Longitudinal Wave: Particles vibrate parallel to direction of wave**

Key Concepts / Definitions:

- **Wave**: A disturbance that transfers energy without transferring matter
- **Mechanical Waves**: Require medium (sound, water waves)
- **Electromagnetic Waves**: Don't require medium (light, radio waves)
- **Transverse Waves**: Vibration $\perp$ wave direction (light, water)
- **Longitudinal Waves**: Vibration $\parallel$ wave direction (sound)
- **Amplitude (A)**: Maximum displacement
- **Wavelength (λ)**: Distance between two successive crests/troughs
- **Frequency (f)**: Oscillations per second
- **Time Period (T)**: Time for one cycle
- **Phase**: Position of point in cycle
- **Interference**: Combination of waves
- **Standing Waves**: Waves confined between boundaries (e.g. strings)

Graphs Overview:

- **Displacement vs Distance (Waveform)**:
  Sinusoidal curve for transverse wave
- **Displacement vs Time**:
  Also sinusoidal if observing a point in medium
- **Phase Shift**: Shifts sine wave left/right
- **Wavelength (λ)**: Distance between 2 crests or 2 troughs

MCQ Tips / Tricks:

1. Use $v = f \times \lambda$ in any wave speed question
2. When object moves toward observer → frequency increases
3. Sound travels faster in solids > liquids > gases
4. In echo problems, remember sound travels **to wall and back** (double distance)
5. For standing waves:
   $L = n(\lambda \div 2)$ for string fixed at both ends
6. Know differences between transverse and longitudinal waves
7. In interference, same phase = constructive, opposite phase = destructive
8. Resonance leads to maximum amplitude
9. For Doppler shift MCQs, check if source or observer is moving
10. Standing wave nodes = points of no motion, antinodes = max amplitude

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Past NET MCQs Examples

Q1:
What is the speed of a wave with frequency 100 Hz and wavelength 2 m?
A. 200 m/s **B.** 50 m/s **C.** 100 m/s **D.** 2 m/s
✅ **Correct: A**
$v = f \times \lambda = 100 \times 2 = 200$ m/s

Q2:
What type of wave is sound in air?
A. Longitudinal **B.** Transverse **C.** Electromagnetic **D.** Polarized
✅ **Correct: A**

Q3:
In echo problems, time recorded is 2 s and speed of sound is 340 m/s. What is the distance to the wall?
A. 340 m **B.** 170 m **C.** 680 m **D.** 510 m
✅ **Correct: B**
$d = (v \times t) \div 2 = (340 \times 2) \div 2 = 340$ m $\div 2 = 170$ m

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Q4:
In standing waves, distance between two adjacent nodes is:
A. λ
B. $\lambda \div 2$
C. 2λ
D. λ^2
🟩 **Correct: B**

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Chapter 8: Sound

Important Formulas:

1. **Speed of Sound (v) = Frequency (f) × Wavelength (λ)**
2. **$v = f \times \lambda$**
3. **Speed of Sound in Air at 20°C ≈ 343 m/s**
4. **Speed of Sound in Medium ∝ √(Elasticity ÷ Density)**
5. **Speed of Sound in Solids > Liquids > Gases**
6. **Echo: Distance = $(v \times t) \div 2$**
7. **Time Delay = 2 × Distance ÷ Speed of Sound**
8. **Sound Intensity (I) = Power ÷ Area**
9. **Sound Intensity Level (dB) = $10 \times \log_{10} (I \div I_0)$**
   ($I_0 = 1 \times 10^{-12}$ W/m² is reference intensity)
10. **Threshold of Hearing = 0 dB**
11. **Every 10 dB increase = 10 times more intense**
12. **Beat Frequency = $|f_1 - f_2|$**
13. **Fundamental Frequency for open pipe: $f = v \div 2L$**
14. **Fundamental Frequency for closed pipe: $f = v \div 4L$**
15. **Wavelength in pipe (open ends): $\lambda = 2L$**
16. **Wavelength in pipe (one end closed): $\lambda = 4L$**
17. **Doppler Effect (approx.):**
    • Source moves toward observer → Frequency increases
    • Source moves away → Frequency decreases

18. **Resonance: Loud sound when frequency matches natural frequency**
19. **Ultrasound: Frequency > 20,000 Hz**
20. **Infrasound: Frequency < 20 Hz**

Key Concepts / Definitions

- **Sound**: Longitudinal wave caused by vibration in medium
- **Compression**: Region of high pressure
- **Rarefaction**: Region of low pressure
- **Pitch**: Perceived frequency
- **Loudness**: Related to amplitude
- **Quality**: Timbre; helps distinguish instruments
- **Echo**: Reflected sound wave
- **Resonance**: Natural frequency amplification
- **Beats**: Alternating loud and soft sounds due to interference
- **Doppler Effect**: Change in frequency due to relative motion of source or observer

---

Graphs Overview:

- **Displacement vs Time for Sound**:
  Sine wave showing compressions and rarefactions
- **Intensity vs Distance**:
  Inverse-square relation ($I \propto 1 \div r^2$)
- **dB Scale Graph**:
  Logarithmic curve – increases rapidly

MCQ Tips / Tricks:

1. Use $v = f \times \lambda$ for all wave-related questions
2. In echo problems, always divide total time by 2
3. Speed of sound in dry air increases with temperature
4. Closed pipe: odd harmonics only (1st, 3rd, 5th…)
5. Open pipe: all harmonics allowed
6. Beat frequency = absolute difference between two frequencies
7. Remember unit conversions – ms to s, cm to m
8. For dB questions, understand log scale (10 dB = 10× more intense)
9. Higher density medium may slow sound down if elasticity is not high
10. Doppler Effect increases pitch as object moves toward listener

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Past NET MCQs Examples:

Q1:
What is the speed of sound in air at 20°C?
A. 330 m/s **B.** 340 m/s **C.** 343 m/s **D.** 360 m/s
🟩 **Correct: C**

Q2:
An echo is heard 4 seconds after a sound is made. What is the distance of the wall?
A. 343 m **B.** 686 m **C.** 171.5 m **D.** 857.5 m
✅ **Correct: B**
$d = (v \times t) \div 2 = (343 \times 4) \div 2 = 686$ m

Q3:
Two tuning forks produce 10 beats per second. If one has a frequency of 300 Hz, the other is:
A. 310 Hz **B.** 290 Hz **C.** Either A or B **D.** 320 Hz
✅ **Correct: C**

Q4:
In a closed pipe, the first harmonic has:
A. 1 loop
B. 1 node and 1 antinode
C. 2 nodes
D. Only crests
🟩 **Correct: B**

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Chapter 9: Thermodynamics

Important Formulas:

Temperature Scales

- °C to K: T(K) = T(°C) + 273
- °F to °C: T(°C) = (5 ÷ 9) × (T(°F) – 32)

1. **Heat (Q) = m × c × ΔT**
   - Q = Heat
   - m = Mass
   - c = Specific Heat
   - ΔT = Change in Temperature
2. **Latent Heat Formula: Q = m × L**
   - L = Latent heat of fusion/vaporization
3. **First Law of Thermodynamics**:
   ΔU = Q – W
   - ΔU = Change in internal energy
   - Q = Heat added to system
   - W = Work done by system
4. **Work Done in Thermodynamics**:
   W = P × ΔV
5. **Gas Laws**
   - Boyle's Law: **P × V = constant** (T constant)
   - Charles's Law: **V ÷ T = constant** (P constant)
   - Gay-Lussac's Law: **P ÷ T = constant** (V constant)
6. **Ideal Gas Equation**:
   PV = nRT
   - P = Pressure
   - V = Volume
   - n = Number of moles

- R = Universal gas constant (8.31 J/mol·K)
- T = Temperature in Kelvin

7. **Isothermal Process (T constant): $\Delta U = 0 \Rightarrow Q = W$**
8. **Adiabatic Process ($Q = 0$): $\Delta U = -W$**
9. **Internal Energy of Ideal Gas**:
   $U = (3 \div 2) \times nRT$
10. **Efficiency of Heat Engine**:
    $\eta = (W \div Q_{in}) \times 100\%$
    $= [(Q_{in} - Q_{out}) \div Q_{in}] \times 100\%$
11. **Specific Heat Ratio (γ) = $C_p \div C_v$**
12. **For Monoatomic Gases**:
    - $C_v = (3 \div 2)R$, $C_p = (5 \div 2)R$, $\gamma = 5 \div 3$
13. **Entropy (ΔS) = $Q \div T$** (in reversible processes)
14. **Kinetic Theory of Gases**:
    Average K.E. per molecule = $(3 \div 2)kT$
    - k = Boltzmann's constant

Key Concepts / Definitions:

- **Heat**: Energy transferred due to temperature difference
- **Temperature**: Measure of average kinetic energy
- **Internal Energy**: Sum of microscopic K.E. and P.E. of molecules
- **System**: Part of universe under study
- **Isothermal**: Constant temperature ($\Delta U = 0$)
- **Adiabatic**: No heat exchange ($Q = 0$)
- **Isobaric**: Constant pressure
- **Isochoric**: Constant volume

- **Latent Heat**: Heat absorbed or released without temperature change
- **Heat Engine**: Converts heat into work
- **Refrigerator**: Transfers heat from cold to hot region using work

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Graphs Overview:

- **P–V Diagram**:
  • Isothermal: Hyperbolic curve
  • Adiabatic: Steeper than isothermal
  • Work = Area under the curve
- **T–V and T–P Graphs**:
  Linear for ideal gases under constant conditions

MCQ Tips / Tricks:

1. Convert temperatures to Kelvin in all thermodynamic equations
2. Isothermal ⇒ $\Delta U = 0$
3. Adiabatic ⇒ $Q = 0$
4. Heat added = Increase in internal energy + work done
5. Be careful with sign conventions in Q and W
6. Use $PV = nRT$ to relate any 3 variables
7. In P–V graphs, area under curve = work done
8. Specific heat questions often appear in NET – learn values for water, aluminum
9. Latent heat questions will ask about melting/boiling without temp change
10. For efficiency, input $Q >$ output W always

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Past NET MCQs Examples:

Q1:
Which of the following processes has no change in internal energy?
A. Isothermal **B.** Adiabatic **C.** Isobaric **D.** Isochoric
✅ **Correct: A**

Q2:
What is the efficiency of a heat engine which takes in 200 J and gives out 50 J of work?
A. 25% **B.** 50% **C.** 75% **D.** 100%
✅ **Correct: A**
$\eta = (W \div Q_{in}) \times 100 = (50 \div 200) \times 100 = 25\%$

Q3:
If the pressure of a gas is doubled and temperature is kept constant, what happens to volume?
A. Doubled **B.** Halved **C.** Same **D.** Tripled
🟩 **Correct: B**
Boyle's Law: $P \propto 1 \div V$

Q4:
Which gas law shows direct proportionality between temperature and pressure?
A. Boyle's **B.** Charles's **C.** Gay-Lussac's **D.** Avogadro's
🟩 **Correct: C**

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Chapter 10: Electrostatics

Important Formulas:

1. **oulomb's Law:**
   $F = k \times (q_1 \times q_2) \div r^2$
   • F = Electrostatic force
   • $k = 9 \times 10^9$ Nm²/C²
   • q_1, q_2 = Charges
   • r = Distance between charges
2. **Electric Field (E) = F ÷ q = k × (Q ÷ r²)**
   • E = Electric field intensity at a point
   • Q = Source charge
3. **Electric Field due to a point charge:**
   $E = k \times (q \div r^2)$
4. **Electric Potential (V) = k × (q ÷ r)**
5. **Potential Difference (V) = Work ÷ Charge = W ÷ q**
6. **Electric Potential Energy (U) = q × V**
7. **Relation between Electric Field and Potential:**
   $E = -\Delta V \div \Delta x$
8. **Electric Lines of Force:**
   • Start from +ve, end at –ve
   • Never intersect
   • Denser lines → stronger field
9. **Capacitance (C) = q ÷ V**
10. **Capacitance of Parallel Plate Capacitor:**
    $C = \varepsilon_0 \times (A \div d)$
    • A = Area of plate
    • d = Distance between plates
    • ε_0 = Permittivity of free space = 8.85×10^{-12} C²/N·m²

11. **Energy Stored in Capacitor:**
    - $U = (1 \div 2) \times C \times V^2$
    - $U = (1 \div 2) \times q \times V$
    - $U = (1 \div 2) \times q^2 \div C$
12. **Capacitors in Series:**
    $1 \div C_{eq} = 1 \div C_1 + 1 \div C_2 + \ldots$
    - Same charge, different voltage
13. **Capacitors in Parallel:**
    $C_{eq} = C_1 + C_2 + \ldots$
    - Same voltage, different charge
14. **Electric Dipole Moment (p) = q × 2l**
15. **Torque on Dipole:**
    $\tau = p \times E \times \sin(\theta)$

Key Concepts / Definitions:

- **Electric Charge**: Fundamental property of matter
- **Like charges repel, unlike attract**
- **Conductors**: Allow free movement of electrons
- **Insulators**: Do not allow free movement
- **Coulomb's Law**: Force between point charges is directly proportional to the product of charges and inversely proportional to square of distance
- **Electric Field**: Region around a charge where force acts on another charge
- **Potential**: Energy per unit charge
- **Capacitance**: Ability to store charge
- **Dielectric**: Material inserted between capacitor plates to increase capacitance
- **Electric Dipole**: Two equal and opposite charges separated by distance

Graphs Overview:

- **F vs r graph**:
  Inverse square curve ($F \propto 1 \div r^2$)
- **E vs r for point charge**:
  $E \propto 1 \div r^2$
- **V vs r graph**:
  $V \propto 1 \div r$ (for point charge)
- **Capacitance vs Distance (d)**:
  $C \propto 1 \div d$
- **Capacitance vs Area (A)**:
  $C \propto A$

MCQ Tips / Tricks:

1. Use SI units:
   - Charge in Coulombs
   - Distance in meters
   - Force in Newtons
2. Know:
   - $1\ \mu C = 10^{-6}\ C$
   - $1\ nC = 10^{-9}\ C$
3. In series: same charge, in parallel: same voltage
4. Remember: Work done to move a charge = Potential Difference × Charge
5. Always apply vector direction in electric field problems
6. Electric field inside a conductor = 0
7. Field lines never cross; density ∝ strength
8. Electric field is strongest near sharp edges
9. Always consider direction when calculating force
10. Capacitance is independent of charge and voltage—it depends on geometry and medium

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Past NET MCQs Examples:

Q1:
Two point charges of +1 μC and –2 μC are separated by 1 m. What is the force between them?
A. 18 N **B.** 9 N **C.** 1.8 N **D.** 0.9 N
✅ **Correct: A**
$F = 9 \times 10^9 \times (1 \times 10^{-6} \times 2 \times 10^{-6}) \div (1)^2 = 18$ N

Q2:
Which quantity is scalar?
A. Electric Field **B.** Electric Force **C.** Electric Potential **D.** Electric Dipole Moment
✅ **Correct: C**

Q3:
If the distance between two charges is doubled, the force becomes:
A. Double **B.** Half **C.** One-fourth **D.** Four times
✅ **Correct: C**

Q4:
Capacitance of a parallel plate capacitor depends on:
A. Charge on plates
B. Voltage across plates
C. Plate area and distance between plates
D. None

🟩 **Correct: C**

Chapter 11: Current Electricity

Important Formulas:

1. **Electric Current (I) = q ÷ t**
   • I = Current (in Amperes)
   • q = Charge (in Coulombs)
   • t = Time (in seconds)
2. **Ohm's Law: V = I × R**
   • V = Voltage (in Volts)
   • I = Current
   • R = Resistance (in Ohms, Ω)
3. **Resistance (R) = ρ × (L ÷ A)**
   • ρ = Resistivity of material
   • L = Length of conductor
   • A = Cross-sectional area
4. **Resistivity (ρ)** depends on material and temperature
5. **Conductance (G) = 1 ÷ R**
   • Unit: Siemens (S)
6. **Current Density (J) = I ÷ A**
7. **J = σ × E**
   • σ = Conductivity
   • E = Electric field intensity
8. **Power (P) = V × I = I^2 × R = V^2 ÷ R**
9. **Energy (W) = P × t = V × I × t**
10. **Electromotive Force (emf): Total energy provided per unit charge**
   ε = I × (R + r)
   • R = External resistance
   • r = Internal resistance of cell

11. **Terminal Voltage (V) = $\varepsilon - I \times r$**
12. **Resistors in Series:**
    $R\_total = R_1 + R_2 + \ldots$
13. **Resistors in Parallel:**
    $1 \div R\_total = 1 \div R_1 + 1 \div R_2 + \ldots$
14. **Kirchhoff's First Law (Junction Rule):**
    $\Sigma I\_in = \Sigma I\_out$
15. **Kirchhoff's Second Law (Loop Rule):**
    $\Sigma V = 0$ in any closed loop
16. **Drift Velocity (v_d) = I ÷ (n × A × e)**
    • n = Number of charge carriers per unit volume
    • e = Electron charge = 1.6×10^{-19} C
17. **e.m.f. = Work done ÷ Charge**
18. **Units Recap:**
    • V = J/C,   A = C/s,   Ω = V/A,   W = J/s

Key Concepts / Definitions:

- **Current**: Flow of electric charge
- **Resistance**: Opposition to current
- **Ohmic Conductor**: Obeys Ohm's Law
- **Non-Ohmic**: Does not obey Ohm's Law (e.g., diode, filament bulb)
- **Drift Velocity**: Average velocity of electrons in a conductor
- **Internal Resistance**: Resistance within the battery/cell
- **Kirchhoff's Laws**: Used in analyzing complex circuits
- **e.m.f. vs Terminal Voltage**:
  • e.m.f. = Total energy per charge
  • Terminal voltage = Actual voltage available at terminals

- **Series Circuit**: Same current, voltage divides
- **Parallel Circuit**: Same voltage, current divides

Graphs Overview:

- **V–I graph for Ohmic conductor**:
  Straight line passing through origin
- **V–I graph for Non-Ohmic devices**:
  Non-linear (e.g., filament lamp, diode)
- **Resistance vs Temperature (metal)**:
  Positive slope – increases linearly
- **Resistivity vs Temperature**:
  For conductors: increases
  For semiconductors: decreases

MCQ Tips / Tricks:

1. Use consistent units: V (volts), A (amperes), Ω (ohms), C (coulombs), s (seconds)
2. In series:
   • I same
   • V adds
3. In parallel:
   • V same
   • I adds
4. Resistors in series increase total resistance
5. Resistors in parallel reduce total resistance
6. If internal resistance increases, terminal voltage drops
7. Kirchhoff's laws are essential in solving loops and junctions

8. Remember:
   $P = I^2R$ if current is known
   $P = V^2 \div R$ if voltage is known
9. Use drift velocity formula for charge carrier problems
10. Diode allows current in one direction only (acts as a switch)

Past NET MCQs Examples:

Q1:
If current is 2 A and resistance is 5 Ω, what is the voltage?
A. 10 V **B.** 7 V **C.** 5 V **D.** 2.5 V
✅ **Correct: A**
$V = I \times R = 2 \times 5 = 10$ V

Q2:
What is the unit of conductance?
A. Ohm **B.** Volt
C. Siemens **D.** Ampere
✅ **Correct: C**

Q3:
If three resistors of 4 Ω each are connected in parallel, total resistance is:
A. 12 Ω **B.** 1.33 Ω **C.** 4 Ω **D.** 0.75 Ω
✅ **Correct: B**
$1/R = 1/4 + 1/4 + 1/4 = 3/4 \rightarrow R = 4/3 = 1.33\ \Omega$

Q4:
What is drift velocity directly proportional to?
A. Resistance
B. Cross-sectional Area
C. Current
D. Temperature
🟩 **Correct: C**

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Chapter 12: Electromagnetism

Important Formulas:

1. **Magnetic Force on Moving Charge:**
   $F = q \times v \times B \times \sin(\theta)$
   • F = Magnetic force
   • q = Charge
   • v = Velocity of charge
   • B = Magnetic field
   • θ = Angle between **v** and **B**

2. **Magnetic Force on Current-Carrying Wire:**
   $F = I \times L \times B \times \sin(\theta)$
   • I = Current
   • L = Length of conductor
   • B = Magnetic field

3. **Torque on Current Loop:**
   $\tau = N \times I \times A \times B \times \sin(\theta)$
   • N = Number of turns
   • A = Area of loop

4. **Magnetic Field due to Long Straight Current-Carrying Wire:**
   $B = (\mu_0 \times I) \div (2\pi \times r)$
   • $\mu_0 = 4\pi \times 10^{-7}$ T·m/A

5. **Magnetic Field at Center of Circular Loop:**
   $B = (\mu_0 \times I) \div (2R)$
   • R = Radius of loop

6. **Ampere's Law (Conceptual):**
   $\oint B \cdot dl = \mu_0 \times I\_enclosed$

7. **Lorentz Force Law:**
   $F = q(E + v \times B)$

• E = Electric field
• $v \times B$ = Vector cross product

8. **Force Between Two Parallel Conductors:**
$F \div L = (\mu_0 \div 2\pi) \times (I_1 \times I_2 \div d)$
• Attractive if currents in same direction

9. **Magnetic Flux (Φ) = $B \times A \times \cos(\theta)$**
• A = Area vector
• θ = Angle between **B** and normal to surface

10. **Units:**
• Magnetic field (B): Tesla (T) = N·s/(C·m)
• Magnetic flux: Weber (Wb)

Key Concepts / Definitions:

- **Magnetism**: Property of materials that causes attraction/repulsion
- **Magnetic Field (B)**: Region around magnet/current where magnetic force is felt
- **Right Hand Rule**:
  • Thumb = Current/velocity
  • Fingers = Magnetic field
  • Palm = Direction of force (for positive charges)
- **Current-Carrying Conductor**: Produces magnetic field around it
- **Solenoid**: Coil of wire that acts like a magnet
- **Force Between Wires**:
  • Parallel currents attract
  • Opposite currents repel
- **Lorentz Force**: Combination of electric and magnetic force
- **Torque in Motors**: Used in DC motors, based on magnetic torque on loop

- **Ampere's Law**: Magnetic field around current is proportional to enclosed current

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Graphs Overview:

- **B vs r (from long wire):**
  Inverse relationship (B ∝ 1 ÷ r)
- **F vs sin(θ):**
  Max at θ = 90°, zero at θ = 0° or 180°
- **Torque vs θ:**
  Sinusoidal graph, maximum at θ = 90°

MCQ Tips / Tricks:

1. Right-hand rule is essential for direction of force
2. Magnetic force is maximum when motion is perpendicular to B (θ = 90°)
3. Magnetic force on stationary charge = 0
4. Parallel wires with same direction current attract each other
5. Units are tricky – learn Tesla and Weber
6. Use vector form in Lorentz force for cross product
7. Field inside solenoid is uniform and straight
8. More turns = stronger field in coils
9. Magnetic field is stronger near the wire
10. Always check angles when applying sin(θ)

Past NET MCQs Examples:

Q1:
A charge of 1 C moves at 2 m/s in a magnetic field of 3 T at 90°. What is force?
A. 3 N **B.** 6 N **C.** 1.5 N **D.** 0 N
✅ **Correct: B**
$F = qvB \sin(\theta) = 1 \times 2 \times 3 \times \sin(90°) = 6$ N

Q2:
What is the direction of force on a positive charge moving perpendicular to magnetic field?
A. Along field
B. Against field
C. Perpendicular to both field and motion
D. Zero
✅ **Correct: C**

Q3:
What happens when two parallel wires carry current in the same direction?
A. They repel
B. They attract
C. No force
D. Oscillate
⬛ **Correct: B**

Q4:
Magnetic field around a straight wire varies:
A. Directly with distance
B. Inversely with distance
C. Square of distance
D. Constant
🟩 **Correct: B**

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Chapter 13: Electromagnetic Induction

Important Formulas:

1. **Faraday's Law of Induction:**
   $\varepsilon = -d\Phi \div dt$
   • ε = Induced emf (electromotive force)
   • Φ = Magnetic flux = $B \times A \times \cos(\theta)$

2. **Magnetic Flux (Φ) = $B \times A \times \cos(\theta)$**
   • B = Magnetic field
   • A = Area perpendicular to field
   • θ = Angle between **B** and normal to surface

3. **Lenz's Law:**
   Direction of induced emf opposes the change producing it
   (negative sign in Faraday's Law)

4. **Motional emf:**
   $\varepsilon = B \times L \times v \times \sin(\theta)$
   • L = Length of conductor
   • v = Velocity of conductor
   • θ = Angle between velocity and magnetic field

5. **Self-Inductance (L):**
   $\varepsilon = -L \times (dI \div dt)$

6. **Energy Stored in Inductor:**
   $U = (1 \div 2) \times L \times I^2$

7. **Mutual Inductance (M):**
   $\varepsilon_2 = -M \times (dI_1 \div dt)$

8. **Transformer Equation:**
   $V_s \div V_p = N_s \div N_p$
   $I_s \div I_p = N_p \div N_s$

9. **Power in Transformer:**
   $P = V \times I$ (Ideally, input power = output power)
10. **Induced Current (I):**
    $I = \varepsilon \div R$ (Ohm's Law)

Key Concepts / Definitions:

- **Electromagnetic Induction:**
  Induction of emf when magnetic flux through a circuit changes
- **Faraday's Law:**
  Magnitude of emf ∝ rate of change of magnetic flux
- **Lenz's Law:**
  Induced current opposes the cause producing it
- **Motional emf:**
  Induced when a conductor moves in magnetic field
- **Self Induction:**
  A changing current in a coil induces emf in the same coil
- **Mutual Induction:**
  Current change in one coil induces emf in another nearby coil
- **Inductor:**
  A coil that stores energy in magnetic field
- **Transformer:**
  Device to step up or step down AC voltages using magnetic induction

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Graphs Overview:

- **Φ vs Time (Straight Line):**
  Slope = emf ($\varepsilon = -d\Phi/dt$)
- **ε vs Time (for changing B):**
  Spikes when switch is turned on/off
- **I vs Time in an inductor:**
  Exponential growth or decay curve depending on L and R

MCQ Tips / Tricks:

1. Direction of induced current: use **Lenz's Law**
2. No change in magnetic flux = **no induced emf**
3. Flux = 0 when magnetic field is **parallel** to surface ($\theta = 90°$)
4. **Transformer only works on AC** (because changing flux is needed)
5. In transformers:
   • More turns in secondary = step-up
   • Less turns in secondary = step-down
6. **Motional emf** is max when motion is perpendicular to field (sin 90°)
7. Energy stored in inductor = $(1/2) \times L \times I^2$
8. Larger inductance = slower change in current
9. Self-induced emf always **opposes** change in current
10. **Induced emf is zero** when:
    • B is constant
    • A is constant
    • θ is constant

Past NET MCQs Examples:

Q1: Which law gives the direction of induced emf?
A. Ampere’s Law
B. Faraday’s Law
C. Ohm’s Law
D. Lenz’s Law
🟩 **Correct: D**

Q2: In a transformer, if secondary has more turns than primary, it is:
A. Step-up
B. Step-down
C. Short circuit
D. Rectifier
✅ **Correct: A**

Q3: A conductor of length 2 m moves with velocity 3 m/s perpendicular to magnetic field of 0.5 T. Find emf.
A. 3 V **B.** 0.5 V **C.** 1.5 V **D.** 2 V
⬛ **Correct: C**
$\varepsilon = B \times L \times v = 0.5 \times 2 \times 3 = 3$ V

Q4: Induced emf is maximum when angle between B and A is:
A. 0°
B. 90°
C. 180°
D. 45°
✅ **Correct: A**
$\cos(0°) = 1 \rightarrow \Phi = B \times A \times 1 \rightarrow$ max flux

Chapter 14: Alternating Current (AC)

Important Formulas:

1. **AC Voltage (Instantaneous):**
   $V(t) = V_0 \times \sin(\omega t)$
   • V_0 = Peak voltage
   • ω = Angular frequency = $2\pi f$
   • f = Frequency
2. **AC Current (Instantaneous):**
   $I(t) = I_0 \times \sin(\omega t)$
   • I_0 = Peak current
3. **Root Mean Square (RMS) Values:**
   $V_{rms} = V_0 \div \sqrt{2}$
   $I_{rms} = I_0 \div \sqrt{2}$
4. **Average Power in AC Circuit:**
   $P_{avg} = V_{rms} \times I_{rms} \times \cos(\varphi)$
   • φ = Phase angle between V and I
   • $\cos(\varphi)$ = Power factor
5. **Impedance in R-L-C Circuit (Z):**
   $Z = \sqrt{R^2 + (X_L - X_C)^2}$
6. **Reactance:**
   • **Inductive Reactance:** $X_L = \omega L = 2\pi f L$
   • **Capacitive Reactance:** $X_C = 1 \div (\omega C) = 1 \div (2\pi f C)$
7. **Current in R-L-C Circuit:**
   $I = V \div Z$
8. **Resonance Condition (in RLC Series):**
   $X_L = X_C \Rightarrow f_0 = 1 \div (2\pi\sqrt{LC})$
   • At resonance, impedance is minimum, and current is maximum

9. **Power Factor:**
   Power Factor = $\cos(\varphi) = R \div Z$
10. **Phase Relationships:**
    • **Pure Resistor:** V and I are in phase
    • **Pure Inductor:** I lags V by 90°
    • **Pure Capacitor:** I leads V by 90°

Key Concepts / Definitions:

- **Alternating Current (AC):**
  Current which changes direction periodically
- **Frequency (f):**
  Number of cycles per second (Hz)
- **Period (T):**
  Time for one complete cycle = $1 \div f$
- **Peak Value (V_0, I_0):**
  Maximum value of voltage or current
- **RMS Value:**
  Effective value used in power calculations
- **Power Factor:**
  Cosine of phase angle; represents how much power is actually used
- **Impedance (Z):**
  Total opposition to current in AC circuit (includes R, X_L, X_C)
- **Resonance:**
  Condition in which current is maximum in RLC series circuit
- **Phase Difference:**
  Angle between voltage and current waveforms

Graphs Overview:

- **AC Voltage and Current vs Time:**
  Sine wave oscillating about zero
- **I vs Frequency in RLC circuit:**
  Sharp peak at resonant frequency
- **Power vs Phase angle:**
  Maximum at $\varphi = 0°$, zero at $\varphi = 90°$

MCQ Tips / Tricks:

1. **RMS values** are always used for calculating average power
2. **Power factor** = $\cos(\varphi)$; maximum = 1 when $\varphi = 0$
3. In **pure resistance**, V and I are **in phase**
4. In **pure inductance**, I lags V by 90°
5. In **pure capacitance**, I leads V by 90°
6. **At resonance:** $X_L = X_C \Rightarrow Z = R$
7. At **high frequency**, capacitive reactance is low, inductive is high
8. At **low frequency**, capacitive reactance is high, inductive is low
9. If **$X_L > X_C$**, the circuit is inductive ⇒ current lags
10. If **$X_C > X_L$**, the circuit is capacitive ⇒ current leads

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Past NET MCQs Examples

Q1:
What is the RMS value of a current whose peak value is 10 A?
A. 7.07 A **B.** 5 A **C.** 10 A **D.** 8.5 A
🟩 **Correct: A**
$I_{rms} = I_0 \div \sqrt{2} = 10 \div 1.414 = 7.07$ A

Q2:
In a purely inductive circuit, the current:
A. Leads the voltage
B. Is in phase with voltage
C. Lags the voltage
D. None
✅ **Correct: C**

Q3:
In RLC series resonance, the impedance is:
A. Maximum
B. Minimum
C. Zero
D. Infinite
✅ **Correct: B**

Q4:
At resonance in an RLC circuit, what is the condition?
A. $X_L = X_C$
B. $Z = 0$
C. $I = 0$
D. $V = 0$
🟩 **Correct: A**

PHYSICS Mastery for NET

Chapter 15: Physics of Solids

Important Formulas:

1. **Stress = Force ÷ Area = F ÷ A**
   • Unit: Pascal (Pa) or N/m^2
2. **Strain = Change in Length ÷ Original Length = ΔL ÷ L**
3. **Hooke's Law:**
   Stress ∝ Strain ⇒ Stress = E × Strain
   • E = Young's Modulus (Elastic Modulus)
4. **Young's Modulus (E) = (F × L) ÷ (A × ΔL)**
   • L = Original length
   • ΔL = Elongation
   • A = Cross-sectional area
   • F = Applied force
5. **Elastic Potential Energy in a Stretched Wire:**
   U = (1 ÷ 2) × F × ΔL
6. **Bulk Modulus (K) = –ΔP ÷ (ΔV ÷ V)**
   • ΔP = Change in pressure
   • ΔV = Change in volume
   • V = Original volume
7. **Shear Modulus (G) = Shearing stress ÷ Shearing strain**
8. **Density (ρ) = Mass ÷ Volume**
9. **Packing Efficiency (for solids):**
   • Face-Centered Cubic (FCC): ~74%
   • Body-Centered Cubic (BCC): ~68%
   • Simple Cubic: ~52%
10. **Volume of Unit Cell = a^3 (for cubic crystals)**
    • a = edge length of unit cell

Key Concepts / Definitions:

- **Solid:**
  A state of matter with definite shape and volume
- **Elasticity:**
  Ability of a material to return to its original shape after removing force
- **Plasticity:**
  Permanent deformation after force is removed
- **Hooke’s Law:**
  Valid up to elastic limit
- **Stress:**
  Force per unit area
- **Strain:**
  Relative deformation (no unit)
- **Young’s Modulus (E):**
  Measure of stiffness
- **Bulk Modulus (K):**
  Resistance to volume change under pressure
- **Shear Modulus (G):**
  Resistance to shearing forces
- **Ductility:**
  Ability to be drawn into wires
- **Malleability:**
  Ability to be hammered into sheets

Graphs Overview:

- **Stress vs Strain Curve:**
  - Proportional region: Obeys Hooke's Law
  - Elastic limit: End of reversible deformation
  - Yield point: Start of plastic deformation
  - Breaking point: Failure of material

MCQ Tips / Tricks:

1. Stress has **units**, but strain is **unitless**
2. Young's Modulus (E) = slope of stress-strain graph in elastic region
3. Steeper the stress-strain curve, **stiffer** the material
4. Hooke's Law is valid only **within the elastic limit**
5. **Elastic potential energy** is stored when a material is stretched
6. Know the **types of crystal lattices** (FCC, BCC, SCC)
7. Stronger materials = higher Young's modulus
8. **Stress and strain are directly proportional** under elastic conditions
9. At yield point → permanent deformation begins
10. **Elastic limit < yield point < breaking point** on the stress-strain curve

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Past NET MCQs Examples:

Q1:
What is the unit of stress?
A. N
B. N/m
C. N/m²
D. Nm
🟩 **Correct: C**

Q2:
Which of the following is dimensionless?
A. Stress
B. Strain
C. Force
D. Modulus
✅ **Correct: B**

Q3:
What is the slope of the stress-strain graph in elastic region?
A. Strain
B. Modulus of Elasticity
C. Strain Energy
D. Load
✅ **Correct: B**

Q4: What is the breaking point of a stress-strain curve?
A. Start of deformation
B. End of elastic region
C. Maximum stress the material can withstand
D. Zero strain
🟩 **Correct: C**

PHYSICS Mastery for NET

Chapter 16: Electronics

Important Formulas:

1. **Current Gain (β) = $I_C \div I_B$**
   - I_C = Collector current
   - I_B = Base current
2. **$\alpha = I_C \div I_E$**
   - I_E = Emitter current
   - α = Common-base current gain
   - $\beta = \alpha \div (1 - \alpha)$
3. **Transistor Current Relation:**
   $I_E = I_B + I_C$
4. **Voltage Gain (A_V) = $V_{out} \div V_{in}$**
5. **Power Gain (A_P) = $A_V \times \beta$**
6. **Output of NOT gate:**
   $Y = \neg A$ (or $\bar{A}$)
7. **Output of AND gate:**
   $Y = A \cdot B$
8. **Output of OR gate:**
   $Y = A + B$
9. **Truth Tables for Logic Gates:**
   - AND: $1 \cdot 1 = 1$, rest = 0
   - OR: $0+0 = 0$, rest = 1
   - NOT: $1 \rightarrow 0$, $0 \rightarrow 1$
10. **De Morgan's Laws:**
    - $\neg(A + B) = \neg A \cdot \neg B$
    - $\neg(A \cdot B) = \neg A + \neg B$

PHYSICS Mastery for NET

Key Concepts / Definitions:

- **Electronics:**
  Branch of physics dealing with behavior and control of electrons in semiconductors
- **Semiconductors:**
  Materials with conductivity between conductors and insulators
  (e.g., silicon, germanium)
- **Doping:**
  Adding impurities to pure semiconductors to change conductivity
  • N-type: extra electrons (donor)
  • P-type: holes (acceptor)
- **Diode:**
  Allows current in one direction only (forward-biased)
  • Reverse-biased: blocks current
- **Transistor:**
  A three-layer semiconductor device used for switching and amplification
  • Types: NPN, PNP
  • Terminals: Emitter (E), Base (B), Collector (C)
- **Logic Gates:**
  Basic building blocks of digital electronics
  • AND, OR, NOT, NAND, NOR, XOR
- **Boolean Algebra:**
  Mathematical representation of logic operations

Graphs Overview:

- **Diode IV Characteristics:**
  • Forward-biased: exponential rise
  • Reverse-biased: very low current until breakdown
- **Transistor Output Characteristics:**
  Graph between I_C and V_CE at constant I_B
  • Shows saturation, active, and cutoff regions

MCQ Tips / Tricks:

1. **Diode conducts only in forward bias**
2. NPN transistor has **arrow pointing out**; current flows from collector to emitter
3. In transistor:
   • Emitter current is largest
   • Base current is smallest
4. Use **truth tables** to solve logic gate questions
5. Know **De Morgan's Laws** for simplification
6. Logic gates in NET are often asked using symbols and tables
7. A transistor **amplifies current** – power gain = voltage × current gain
8. **Beta (β)** is usually between 20–200
9. Identify whether a circuit is digital (logic gates) or analog (transistors, diodes)
10. Watch for reverse-biased diode questions – **no current flows**

Past NET MCQs Examples:

Q1:
In a common-emitter amplifier, the voltage gain is 100 and current gain is 20. What is the power gain?

A. 200 **B.** 1000 **C.** 120 **D.** 80

🟩 **Correct: B**

Power Gain = $A_V \times \beta = 100 \times 20 = 2000$

Q2:
In a NOT gate, if input is 1, output is:

A. 1 **B.** 0

C. Undefined **D.** None

⬛ **Correct: B**

Q3:
What is output of an AND gate when A = 1 and B = 0?

A. 0 **B.** 1 **C.** 2 **D.** Undefined

✅ **Correct: A**

Q4:
Which region of a transistor is used for amplification?

A. Saturation
B. Cutoff
C. Active
D. Breakdown

🟩 **Correct: C**

PHYSICS Mastery for NET

Chapter 17: Dawn of Modern Physics (Modern Physics)

Important Formulas:

1. **Energy of Photon:**
   $E = h \times f = h \times c \div \lambda$
   • E = Energy (in Joules or eV)
   • h = Planck's constant = 6.63×10^{-34} J·s
   • f = Frequency
   • λ = Wavelength
   • c = Speed of light = 3×10^{8} m/s
2. **Photoelectric Equation (Einstein's):**
   $E = \Phi + K.E.$
   $\Rightarrow hf = \Phi + (1 \div 2) \times m \times v^2$
   • Φ = Work function (minimum energy to eject electron)
   • K.E. = Kinetic energy of ejected electron
   • m = Mass of electron
   • v = Velocity of ejected electron
3. **Threshold Frequency (f_0):**
   $f_0 = \Phi \div h$
4. **Stopping Potential (V_0):**
   $e \times V_0 = (1 \div 2) \times m \times v^2$
5. **de Broglie Wavelength:**
   $\lambda = h \div p = h \div (m \times v)$
   • λ = Wavelength of matter (in meters)
   • m = mass
   • v = velocity
   • p = momentum
6. **Energy-Mass Relation:**
   $E = m \times c^2$
   • m = mass (kg)
   • c = speed of light = 3×10^{8} m/s

7. **Electronvolt (eV):**
   1 eV = 1.6×10^{-19} J
8. **Planck's Quantum Theory:**
   Energy is quantized in packets called **quanta** or **photons**

Key Concepts / Definitions:

- **Photon:**
  Quantum of light energy, has no mass but carries energy and momentum
- **Photoelectric Effect:**
  Emission of electrons from a metal surface when light of suitable frequency shines on it
- **Work Function (Φ):**
  Minimum energy required to eject an electron from a metal surface
- **Threshold Frequency (f_0):**
  Minimum frequency required to emit photoelectrons
- **de Broglie Hypothesis:**
  All moving particles exhibit wave nature (matter waves)
- **Wave-Particle Duality:**
  Light and particles behave both as waves and particles
- **Quantum:**
  Smallest indivisible unit of energy
- **X-Rays:**
  Electromagnetic waves produced when high-energy electrons hit a metal target
- **Line Spectrum:**
  Each element has a unique emission spectrum; supports quantized energy levels

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PHYSICS Mastery for NET

Graphs Overview:

- **K.E. vs Frequency:**
  Straight line graph starting at threshold frequency (f_0)
  • Slope = Planck's constant (h)
  • y-intercept = $-\Phi$
- **Current vs Intensity (Photoelectric):**
  Directly proportional – more intensity, more electrons ejected
- **Current vs Frequency (Photoelectric):**
  No current below threshold frequency, sudden rise at f_0

MCQ Tips / Tricks:

1. Photon energy depends on **frequency**, not intensity
2. If **$f < f_0$, no photoelectric emission** occurs – regardless of intensity
3. Increasing intensity = more electrons (but same K.E.)
4. Increasing frequency = higher K.E. of photoelectrons
5. Use correct units:
   • Energy: eV or J
   • $h = 6.63 \times 10^{-34}$ J·s
6. **de Broglie wavelength** is inversely proportional to momentum
7. **Shorter wavelength = higher energy**
8. X-rays have **very short wavelength (~10^{-10} m)**
9. In stopping potential questions, use:
   $$e \times V_0 = (1/2)mv^2 = hf - \Phi$$
10. Learn difference between:
    • **Classical view**: Light is wave
    • **Quantum view**: Light as particles (photons)

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Past NET MCQs Examples:

Q1:
What is the energy of a photon of wavelength 500 nm?
A. 2.48 eV **B.** 3.5 eV **C.** 1.6 eV **D.** 4.2 eV
✅ **Correct: A**
$E = hc \div \lambda = (6.63\times10^{-34} \times 3\times10^{8}) \div (500\times10^{-9}) = 3.98\times10^{-19}$ J
Convert to eV: $\div (1.6\times10^{-19}) \approx 2.48$ eV

Q2:
The threshold frequency of sodium is 5.5×10^{14} Hz. What is the work function?
A. 2.3 eV **B.** 3.6 eV **C.** 1.8 eV **D.** 4.0 eV
🟩 **Correct: A**
$\Phi = h \times f = 6.63\times10^{-34} \times 5.5\times10^{14} = 3.65\times10^{-19}$ J = 2.3 eV

Q3:
Which property confirms wave nature of matter?
A. Photoelectric effect
B. de Broglie wavelength
C. Black body radiation
D. X-ray production
✅ **Correct: B**

Q4:
If frequency of light is below threshold frequency, then:
A. Photoelectrons will be emitted
B. Electrons will gain energy but remain bound
C. More photons are required
D. No emission, regardless of intensity
🟩 **Correct: D**

PHYSICS Mastery for NET

Chapter 18: Nuclear Physics

Important Formulas:

1. **Mass-Energy Equivalence:**
   $E = m \times c^2$
   • m = mass (kg)
   • $c = 3 \times 10^8$ m/s

2. **1 Atomic Mass Unit (u) = 931.5 MeV**
   $1\ u = 1.66 \times 10^{-27}$ kg
   1 u of mass defect gives 931.5 MeV of energy

3. **Binding Energy = $\Delta m \times c^2$**
   • Δm = Mass defect = $(Z \times m_p + (A–Z) \times m_n)$ – m_nucleus

4. **Binding Energy per Nucleon = Total BE ÷ A**

5. **Radioactive Decay Law:**
   $N = N_0 \times e\text{^}(–\lambda t)$
   • N = Number of undecayed nuclei at time t
   • λ = Decay constant
   • N_0 = Initial number of nuclei

6. **Half-Life (T½):**
   T½ = 0.693 ÷ λ

7. **Activity (A):**
   $A = \lambda \times N$
   • A = Rate of decay
   • Unit = Becquerel (Bq)

8. **Alpha Decay:**
   ${}_{a}Z\text{^}X \rightarrow {}_{a-4}Z_{-2}\text{^}Y + {}^{4}_{2}He$

9. **Beta Decay (β^-):**
   ${}_{a}Z\text{^}X \rightarrow {}_{a}Z_{+1}\text{^}Y + e^- + \bar{v}$

10. **Gamma Emission:**
    Nucleus releases energy without changing atomic number or mass number

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Key Concepts / Definitions:

- **Nucleus:**
  Dense central part of atom containing protons and neutrons
- **Isotopes:**
  Same Z (proton number), different A (mass number)
- **Mass Defect (Δm):**
  Difference between mass of individual nucleons and actual nucleus
- **Binding Energy:**
  Energy required to disassemble nucleus into separate nucleons
- **Nuclear Stability:**
  Stable nuclei have higher binding energy per nucleon
- **Alpha Particles (α):**
  Helium nuclei (${}^{4}_{2}He$), heavy and positively charged
- **Beta Particles (β):**
  High-speed electrons (β^-) or positrons (β^+)
- **Gamma Rays (γ):**
  High energy electromagnetic radiation, no mass or charge
- **Radioactivity:**
  Spontaneous emission of radiation from unstable nuclei
- **Half-Life ($T_{½}$):**
  Time required for half of the radioactive nuclei to decay
- **Nuclear Fission:**
  Splitting of heavy nucleus (e.g., Uranium-235) into lighter nuclei with energy release

- **Nuclear Fusion:**
  Combining of light nuclei (e.g., Hydrogen) to form heavier nucleus and release energy

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Graphs Overview:

- **Binding Energy per Nucleon vs Mass Number (A):**
  • Peaks at **Iron (Fe)** (~8.8 MeV per nucleon)
  • Low for light and very heavy elements
  • Explains fusion for light, fission for heavy
- **N vs Z Curve:**
  • Stable nuclei lie close to N = Z line for lighter elements
  • Heavier elements: N > Z

MCQ Tips / Tricks:

1. **Binding Energy per nucleon** is maximum for **iron (Fe)**
2. Larger mass defect = **more stable nucleus**
3. Use **1 u = 931.5 MeV** for energy conversions
4. Alpha particles: **low penetration, high ionization**
5. Beta particles: **moderate penetration and ionization**
6. Gamma rays: **high penetration, low ionization**
7. After one half-life, $N = N_0 \div 2$; after two → $N_0 \div 4$
8. In fission, a small mass converts to a large amount of energy
9. **Fusion produces more energy than fission**, but requires very high temperatures
10. In beta decay, a neutron converts into proton and emits an electron

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Past NET MCQs Examples:

Q1:
If mass defect of a nucleus is 0.03 u, what is its binding energy?
A. 27.9 MeV **B.** 18.6 MeV
C. 28 MeV **D.** 30 MeV
✅ **Correct: C**
BE = 0.03 × 931.5 = ~27.9 MeV

Q2:
What type of radiation is most penetrating?
A. Alpha
B. Beta
C. Gamma
D. Neutron
✅ **Correct: C**

Q3:
Which element has maximum binding energy per nucleon?
A. Uranium
B. Hydrogen
C. Iron
D. Helium
🟩 **Correct: C**

Q4:
After two half-lives, the fraction of undecayed nuclei is:
A. 1/2 **B.** 1/3 **C.** 1/4 **D.** 1/8
🟩 **Correct: C**