AFCAT SCIENCE

MOTION

(DETAILED ONE LINE APPROACH)

One Line Approach (Q–A Format)

• SI unit of force — **Newton**
• Forces that change speed or direction of motion — **Unbalanced forces**
• Property resisting change in motion — **Inertia**
• Inertia depends on — **Mass**
• Greater inertia: cricket ball or rubber ball (same size) — **Cricket ball**
• Balanced force changes velocity? — **No**
• Force needed to keep moving body in motion? — **No**
• Force stopping motion on table — **Frictional force**
• Ball moving smoothly without force — **Speed remains unchanged**
• Equal and opposite forces on moving body — **Motion unaffected**
• Scientist who gave laws of motion — **Newton**
• Product of mass and velocity — **Momentum**
• SI unit of momentum — **kg·m/s**
• Total momentum of bullet and gun before firing — **Zero (Law of Conservation of Momentum)**
• Force causing bodies to fall on Earth — **Gravitational force**
• Rate of change of momentum — **Force**
• Force doubled → acceleration? — **Doubled**
• Rocket propulsion explained by — **Newton's Third Law**
• Can rocket move in vacuum? — **Yes**
• Unit of impulse — **kg·m/s**
• SI unit of moment of force — **N·m**
• If mass doubled, force constant → acceleration? — **Half**
• Strongest vs Weakest force — **Strong Nuclear / Gravitational**
• Force causing rotation — **Torque**
• Friction depends on area of contact? — **No**

Displacement–Time (s–t) Graph

Case	Graph Type	Observation
Object at rest	Straight line parallel to time axis	Body stationary
Zero acceleration	Straight line	Uniform motion
Uniform positive acceleration	Upward curve	Speed increasing
Uniform negative acceleration	Downward curve	Speed decreasing

Velocity–Time (v–t) Graph

Case	Graph Type	Observation
Constant velocity	Line parallel to time axis	Velocity constant (a = 0)
Positive constant acceleration	Straight line upward	Velocity increases uniformly
Zero initial velocity	Straight line from origin	Velocity increases uniformly
Increasing acceleration	Curve from origin	Velocity increases non-uniformly

Note: *Area under v–t graph = Displacement*

- *Slope of v–t graph = Acceleration*

Equations of Motion

Equation Type	Expression
First equation	$v = u + at$
Second equation	$s = ut + \frac{1}{2}at^2$
Third equation	$v^2 - u^2 = 2as$
Free fall motion	$u = 0, a = g, s = \frac{1}{2}gt^2$
Vertical motion upwards	$a = -g$

Notes:

- u = initial velocity
- v = final velocity
- a = acceleration
- t = time
- s = displacement

Circular Motion Formulae

Concept	Formula
Angular displacement	θ = Arc / Radius
Angular velocity	$\omega = \theta / t$
If $\theta = 2\pi \rightarrow \omega = 2\pi/T = 2\pi f$	$(f = 1/T)$
Angular acceleration	$\alpha = \omega / t$
Centripetal acceleration	$a = v^2 / r$
Relation between Time period & Frequency	$T = 1/f$
Relation between Angular & Linear velocity	$v = r\omega$
Relation between Angular & Linear acceleration	$a = r\alpha$

Lever and Torque (Objective Notes)

- SI unit of torque — **N·m**
- Part of lever you move — **Load**
- Bat / hockey stick is which lever? — **Class III lever**
- Lever with fulcrum between load and effort — **Class I lever**
- Lever with load between effort and fulcrum — **Class II lever**
- Type of motion produced by couple — **Pure rotational motion**

Summary for Quick Revision:

Topic	Formula / Concept	Key Unit
Force	$F = ma$	Newton
Momentum	$p = mv$	kg·m/s
Impulse	$Ft = \Delta p$	N·s
Work	$W = F \times s \times \cos\theta$	Joule
Power	$P = W / t$	Watt
Kinetic Energy	$\frac{1}{2}mv^2$	Joule
Potential Energy	mgh	Joule
Torque	$\tau = r \times F$	N·m