

Physics Unit 3 Cheat Sheet (Motion and Gravity)

Energy (J) and Force (N)

$$E_k = \frac{1}{2}mv^2$$

$$U_g = mgh$$

(only if gravity is constant!)

$$W = Fx \cos \theta$$

$$U_s = \frac{1}{2}kx^2$$

$$F = kx$$

$$F = ma \sin \theta$$

AVOID

Power (W)

$$P = VI$$

$$P = \frac{E}{t}$$

$$P = Fv$$



Momentum (kg m s⁻¹) and Impulse (N s)

$$p = mv$$

$$m_1(v_1 - u_1) = m_2(v_2 - u_2)$$

$$\text{Impulse} = \Delta p = \Sigma F \Delta t = m \Delta v$$

SI Units

Speed: m s⁻¹

Acceleration: m s⁻²

Distance: m

Time: s

Mass: kg

Force: N

Energy: J

Power: W

Current: A

Resistance: Ω

Voltage: V

note that impulse does not depend on acceleration, i.e. a collision will have the same impulse regardless of the presence of padding

Sources of centripetal force:

- Tension, eg:
 - Gravity
 - Along a string
- Sideways frictional forces

Motion (m, m s⁻¹, m s⁻²)

$$v = u + at$$

$$x = \frac{t(u + v)}{2}$$

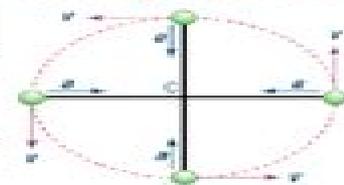
$$x = ut + \frac{1}{2}at^2$$

$$x = vt - \frac{1}{2}at^2$$

$$v^2 = u^2 + 2ax$$

$$V_{avg} = V_B - V_A$$

Centripetal Motion



$$\Sigma F = ma = \frac{mv^2}{r} = \frac{4\pi^2 m r}{T^2}$$

$$v_{centripetal} = \frac{r}{T} = \frac{4\pi^2 r}{T^2}$$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{2\pi r}{T}$$

Inclined Planes



$$\Sigma F = F_d \sin \theta$$

$$a = g \sin \theta$$

(normal force acts at right angles to the surface)

Newton's Laws

1. Every object continues in a state of rest or constant velocity unless acted on by an unbalanced force.
 2. The rate of change of momentum is directly proportional to the magnitude of the net force and is in the direction of the net force.
 3. For every action there is an equal and opposite reaction. Action-reaction forces act on **different objects**, e.g., Joe and wall!
- Newton's laws assume that space and time are absolute, in contrast with Einstein, who proposed that space and time are relative. The inertial frame of reference refers to objects moving at a constant speed, where Newton's laws work (i.e. the third law wouldn't work if Joe broke the wall down).

$$\text{Driving force} = \text{weight force} - \text{normal force}$$

Normal Force

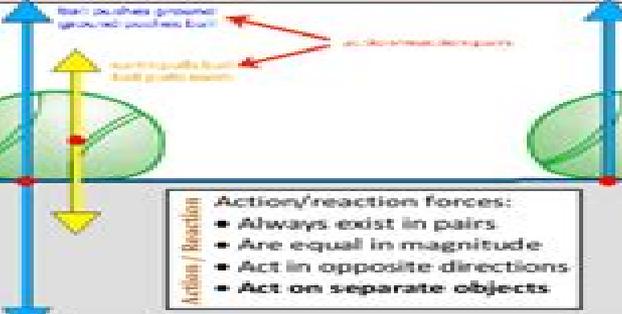


p	pico	10 ⁻¹²
n	nano	10 ⁻⁹
μ	micro	10 ⁻⁶
m	milli	10 ⁻³
c	centi	10 ⁻²
k	kilo	10 ³
M	mega	10 ⁶
G	giga	10 ⁹
t	tonne	10 ³ kg



Graph Interpretation

Graph	Y-axis	Area under	Slope
Extension	Force	U_s	Spr. const.
Time	Velocity	Displ.	Accel.
Time	Accel.	Velocity	-
Time	ΣF	Impulse	-
Displ.	Force	Work	-
Dist	F_p	Work	-
Strain	Stress	E_{mod} / m^2	YM (E)



- Action/Reaction**
- Action/reaction forces:
 - Always exist in pairs
 - Are equal in magnitude
 - Act in opposite directions
 - Act on separate objects

Collisions

- Elastic:**
- Energy conserved
 - Momentum conserved
- Inelastic:**
- Energy lost as heat / sound / deformation
 - Momentum conserved

$$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$$

Acceleration is independent of mass
Force acts equally on both bodies
Velocity is directed at a tangent to the path

Gravity

g	gravitational field strength (N Kg ⁻²)
a	acceleration (M s ⁻²)
F	Force (N)
v	velocity (M s ⁻¹)
M	Central mass (kg)
m	Orbiting mass (kg)
r	radius or orbit (m)
T	period of orbit (s)

$$a = g = \frac{GM}{r^2} = \frac{4\pi^2 r}{T^2} = \frac{v^2}{r}$$

$$F = \frac{GMm}{r^2} = \frac{4\pi^2 Mr}{T^2} = \frac{mv^2}{r}$$

$$v = \frac{2\pi r}{T} = \sqrt{\frac{GM}{r}}$$

$$r^3 = \frac{GM}{T^2} = \frac{4\pi^2}{4\pi^2}$$

$$v_1 \sqrt{R_1} = v_2 \sqrt{R_2}$$

This value is a constant for bodies orbiting the same central mass

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