1. Gravitation

IMP Formulae :

1. Kepler's third law:

- $T^2 \alpha r^3$

Where, T = the period of revolution of a body,

r = the radius of orbit in which the body is revolving.

$$\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{r_1}{r_2}\right)$$

Where T_1, T_2 and r_1, r_2 are periodic times and mean radii of the orbits of two planets around the Sun respectively.

2. Gravitational force between two bodies :

$$\mathbf{F = G\ \frac{m_1 m_2}{r^2}}$$

Where,

m_1 and m_2 = masses of two bodies,

r = distance of separation between them,

G = universal gravitational constant

3. Universal gravitational constant:

$$G = \frac{F r^2}{m_1 m_2}$$

4. Acceleration due to gravity:

On the earth surface, $g = \frac{G M}{r^2}$

Where, M = mass of the earth,

r = radius of the earth.

5. Weight of an object of mass m,

$$W = m g$$

6. Kinematical equations of motion:

i. $v = u + at$

ii. $s = ut + \frac{1}{2} a t^2$

iii. $v^2 = u^2 + 2as$

For a freely falling body:

i. $v = g t$

ii. $h = \frac{1}{2} g t^2$

iii. $v^2 = 2gh$

For a body thrown upwards:

i. $u = -gt$

(negative sign indicates velocity is decreasing)

ii. $h = ut - \frac{1}{2} g t^2$

iii. $u^2 = 2gh$

Where,

u = initial velocity,

v = final velocity,

g = acceleration due to gravity.

h = distance of the body from the surface of the earth

7. Potential energy of a body:

i. On the earth's surface,

$$P.E = -\frac{GMm}{R}$$

ii. At a height h from surface of earth,

$$P.E = -\frac{GMm}{R+h}$$

where,

m = mass of the body.

8. Escape velocity of a body (On the surface of the earth):

$$V_{esc} = \sqrt{2\,g\,R} = \sqrt{\frac{2\,G\,M}{R}}$$

Values to remember

1. Gravitational constant **(G)** = 6.67 x 10^{-11} Nm^2/kg^2
2. Standard value of acceleration due to gravity **(g)** = 9.8 m/s^2
3. Mass of the earth = 6 x 10^{24} kg
4. Radius of the earth = 6.4 x 10^6 m

4. Effects of Electric Current

1. Potential difference:

$$V = I\,R$$

where,

I = Current,

R = Resistance.

2. Electrical power:

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

where,

V = Potential difference,

I = Current,

R = Resistance

3. Heat produced in resistor due to current:

$$H = P\,t = V\,I\,t = I^2 R\,t = \frac{V^2 t}{R}$$

5. Heat

Formulae

1. % Relative humidity (for a given temperature)

$$= \frac{\text{actual mass of water vapour content in the air in a given volume}}{\text{mass of vapour needed to make the air saturated in that volume}} \times 100$$

2. Heat change involved during transformation of state:

Heat change = m x L

where,

m = mass of substance, L = Latent heat for substance.

3. Change in heat energy of the object when its temperature is changed:

$$\mathbf{Q = m \times c \times \Delta T}$$

where, m = mass of object, c = specific heat of object,

Δ T = change in temperature of object.

4. Principle of heat exchange:

Heat energy lost by the hot object = Heat energy gained by the cold object

5. Measurement of specific heat by mixing method:

(Heat lost by hot object) = (Heat gained by calorimeter) + (Heat gained by water in calorimeter)

Values to remember

1. Melting point of ice = 0 °C

2. Boiling point of water = 100 °C
3. Latent heat of fusion / melting of ice: $L_{melt} = 80$ cal/g
4. Latent heat of vaporisation of water: $L_{vap} = 540$ cal/g
5. Specific heat of water: $c_w = 1$ cal/g °C = 1 kcal/kg °C

Units to keep in mind

Physical Quantities	Units
Temperature	°C
Specific latent heat	SI: J/kg CGS: cal/g
Absolute humidity	kg/m^3
Heat	SI: J (joule) CGS: cal (calorie) Higher units: kcal
Specific heat	SI: J/kg °C CGS: cal/g °C

6. Refraction of Light

Formulae

1. Absolute refractive index:

$$n = \frac{V_1}{V_2}$$

Where,

V_1 = velocity of light in vacuum ,

V_2 = velocity of light in medium.

2. Refractive index:

i. $^1n_2 = \frac{V_1}{V_2}$

ii. $^2n_1 = \frac{V_2}{V_1}$

iii. $^1n_2 = \frac{1}{^2n_1}$

Where,

$^1n_2$ = refractive index of second medium with respect to first medium,

$^2n_1$ = refractive index of first medium with respect second medium,

V_1 = velocity of light in first medium,

V_2 = velocity of light in second medium.

3. Second law of refraction / Snell's law :

$$^{1}n_{2} = \frac{sin\ i}{\sin r}$$

Where,

$^{1}n_{2}$ = refractive index of second medium with respect to first medium,

i = angle of incidence,

r = angle of refraction.

Values to remember

1. Velocity of light in air/vacuum = 3×10^{8} m/s
2. Refractive index of air = 1

7. Lenses

1. Lens formula:

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

Where,

v : Image distance,

u : Object distance,

f : Focal length of the lens.

2. Magnification of lens:

$$M = \frac{h_2}{h_1} = \frac{v}{u}$$

Where,

h_2 : Height of the image,

h_1 : Height of the object.

3. Power of lens in dioptre : $P = \frac{1}{f(m)}$

Where,

f : Focal length of lens taken in metre.

4. Power of combination of two lenses

$$P = \frac{1}{f} = \frac{1}{f_1} = \frac{1}{f_2}$$

Or $P = P_1 + P_2$

Where,

f_1 : Focal length of first lens,

f_2 : Focal length of second lens,

P_1 : Power of first lens,

P_2 : Power of second lens.

10. Space Missions

Formulae

1. Critical velocity (tangential velocity) :

$$V_c = \sqrt{\frac{GM}{R+h}}$$

where,

G : Gravitational constant,

M : Mass of the earth, R: Radius of the earth,

h : Height of the satellite from surface of the earth.

2. Escape velocity :

$$V_{esc} = \sqrt{\frac{2GM}{R}}$$

3. Time for one revolution for a satellite :

$$T = \frac{2\pi(R+h)}{V_c}$$

Values to remember

Physical quantity	Symbol	Value
Gravitational constant	G	$6.67 \times 10^{-11}\ Nm^2/kg^2$
Mass of the earth	M	6×10^{24} kg
Radius of the earth	R	6.4×10^{6} m OR 6400 km
Escape velocity from surface of the earth	v_{esc}	11.2 km/s

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