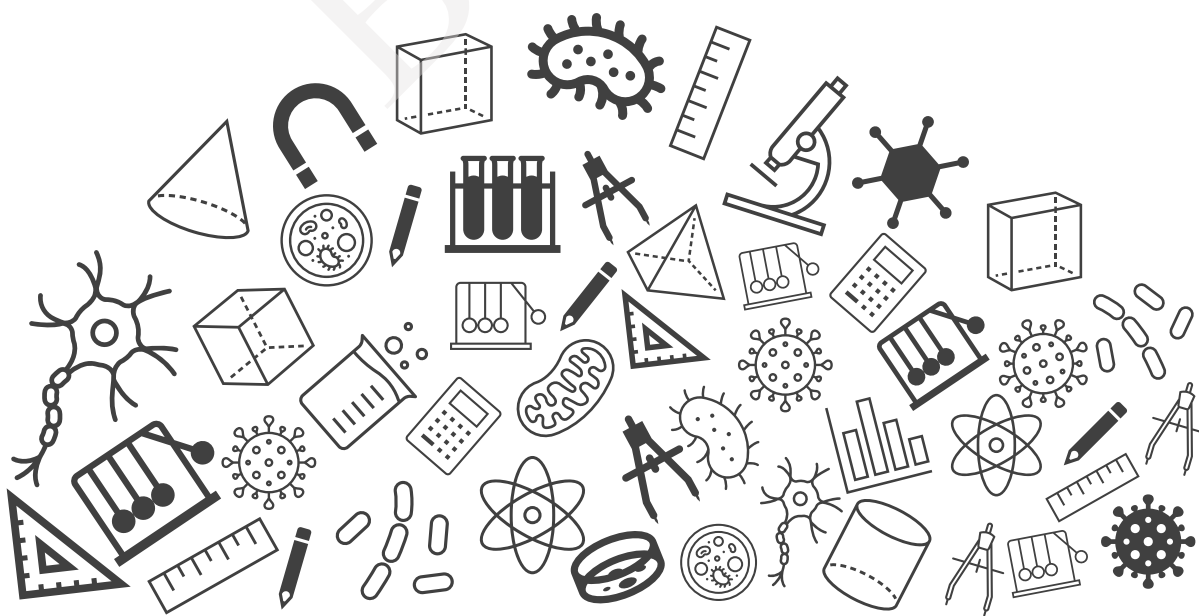




Grade 09

Science Chapter Notes





BYJU'S Classes

Gravitation



Class IX



1. Introduction

→ 1.1 Universal law of gravitation

→ 1.2 Kepler's law



2. Acceleration due to gravity

→ 2.1 Freefall & motion

→ 2.2 Weight & Mass



3. Thrust & Pressure

→ 3.1 Pressure inside a liquid

→ 3.2 Pascal's law



4. Floatation

→ 4.1 Archimedes' principle

→ 4.2 Relative density



Mind Map

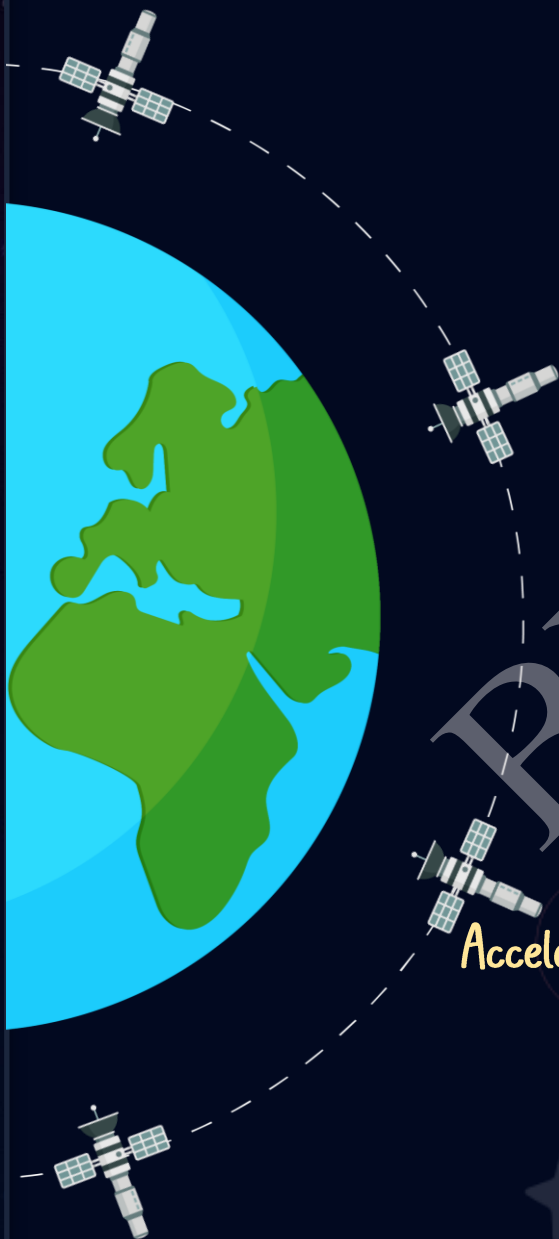
B

Every particle attracts every other particle in the universe

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

Universal law of gravitation

'G' is a universal constant



Kepler's law

1st law

Elliptical orbit with the sun at one of the foci

2nd law

$$A_1 = A_2$$



3rd law

$$T^2 \propto R^3$$

Acceleration due to gravity

$$g = \frac{G \times M}{r^2}$$

Weight, $W = m \cdot g$

Floatation

Pressure inside a liquid

$$p_2 - p_1 = \rho g (h_2 - h_1)$$

Pascal's law

$$F_a / A_a = F_b / A_b$$

Archimedes' principle

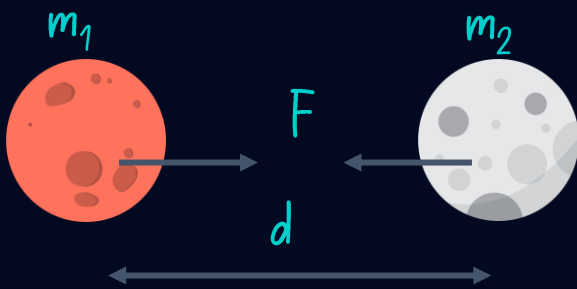
$$F_B = m_{\text{liquid displaced}} \times g$$

1. Introduction

B

1.1 Universal law of gravitation

Every object in the Universe attracts every other object with a definite force.

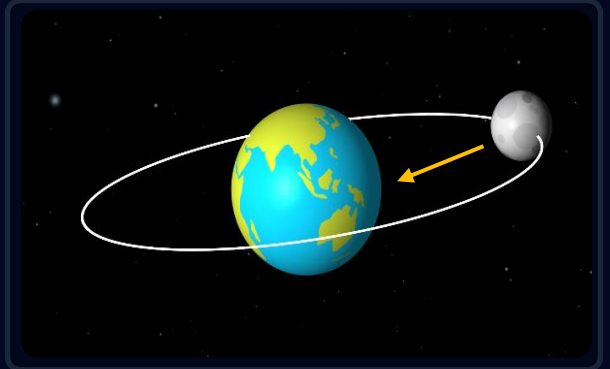


$$F = G \frac{m_1 \times m_2}{d^2}$$

$$G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$$

Gravity as a centripetal force

Gravitational pull prevents the object from flying out and instead keeps it moving at a uniform speed along a circular orbit



Why don't satellites fall into the earth?

- Satellites are always falling towards the Earth, but never reaching it.
- Satellites have high enough horizontal velocity so that they constantly miss the Earth.



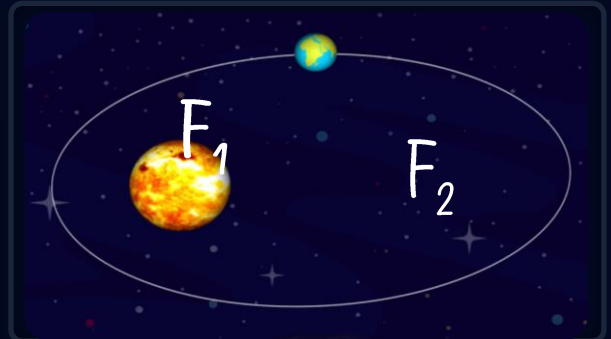
1. Introduction

B

1.2 Kepler's law

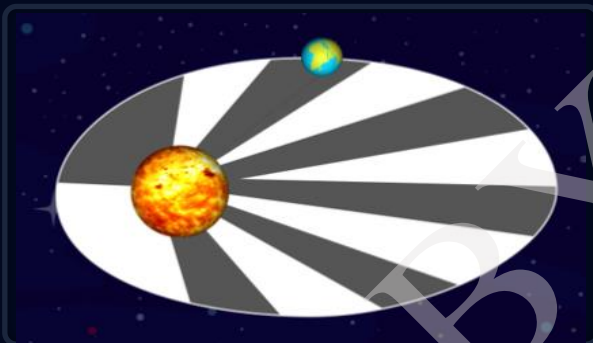
(i) Law of orbits

The orbit of a planet is an ellipse with the Sun at one of the two foci.



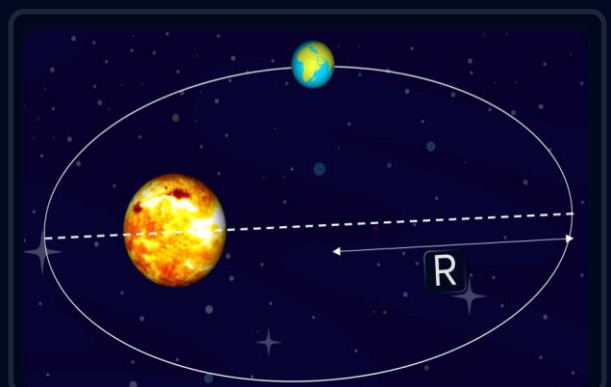
(ii) Law of equal areas

A line segment joining the planet and the Sun sweeps out equal areas in equal intervals of time.



(iii) Law of periods

The square of a planet's orbital time-period is proportional to the cube of the length of the semi-major axis (R) of its orbit.
$$T^2 \propto R^3$$



2. Acceleration Due to Gravity

B

2.1 Freefall and motion



$$g = \frac{G \times M}{r^2}$$

Independent of the mass of the object

$$g_{\text{earth}} = 9.8 \text{ m/s}^2$$
$$g_{\text{moon}} = 1.6 \text{ m/s}^2$$

When upwards direction is taken as positive
 $a = -g$

1st equation

$$v = u - gt$$

2nd equation

$$s = ut - \frac{1}{2} gt^2$$

3rd equation

$$v^2 = u^2 - 2gs$$



2.1 Mass and weight

Mass: Quantity of Matter

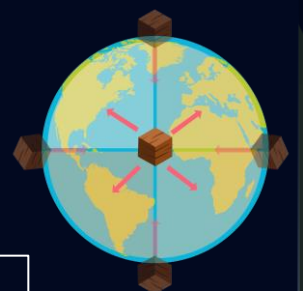


Does not depend on acceleration due to gravity.

Weight: Force of Attraction

Depends on acceleration due to gravity.

$$W = m.g$$



3. Thrust & Pressure

B

Thrust

- Force perpendicular to a surface
- S I unit is newton (N)
- Vector quantity

Pressure

- $\text{Pressure} = \frac{\text{Thrust}}{\text{Area}}$
- S I unit is pascal (Pa)
- Scalar quantity



3.1 Pressure inside a liquid

$$P_2 - P_1 = \rho g (h_2 - h_1)$$

$(P_2 - P_1)$: pressure difference

ρ : density of liquid

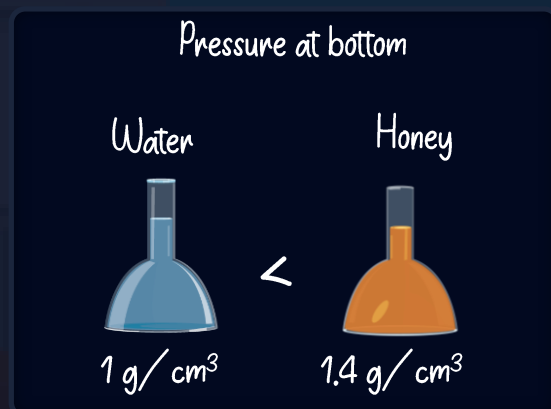
g : acceleration due to gravity

$(h_2 - h_1)$: height difference

Increases with depth



Increases with density

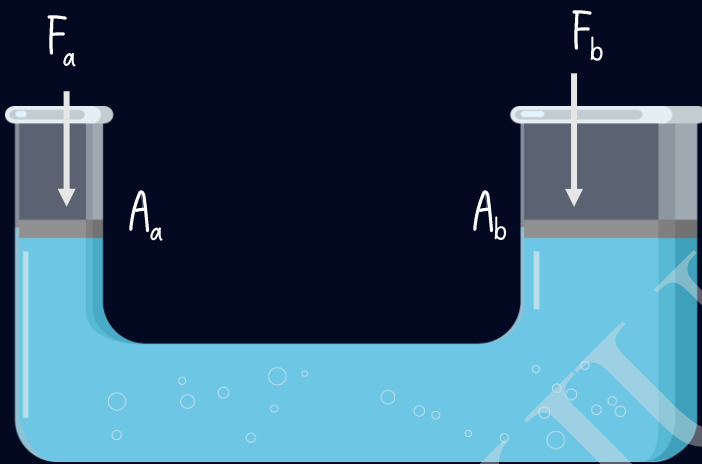


3. Thrust & Pressure

B

3.2 Pascal's law

Pressure exerted anywhere in a confined liquid is transmitted equally and undiminished in all directions throughout the liquid.



$$F_a/A_a = F_b/A_b$$

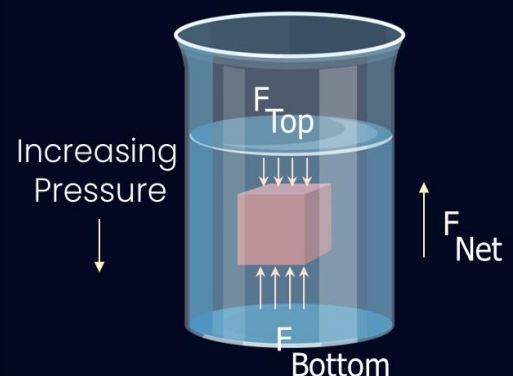
4. Floatation

4.1 Archimedes' principle

An upward force experienced by an object immersed in liquid.

$F_B = \text{Weight of liquid displaced}$

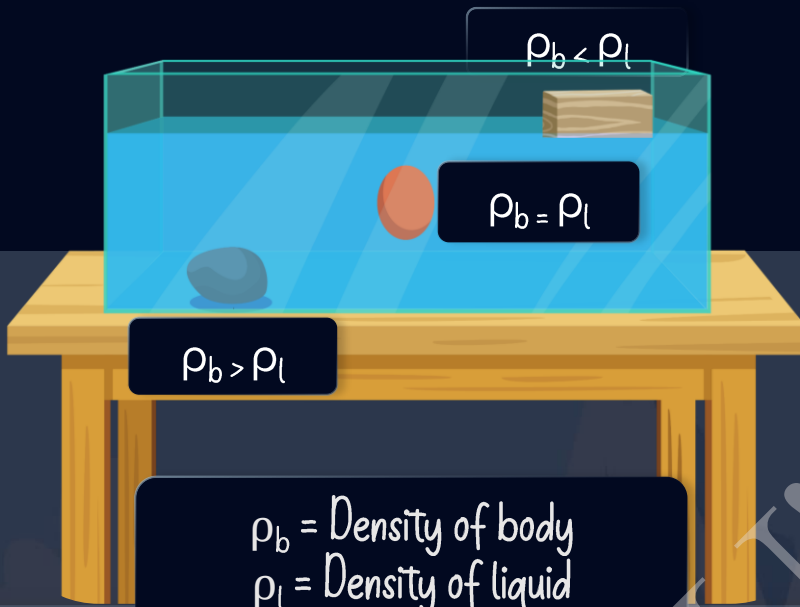
$$F_B = m_{\text{liquid displaced}} \times g$$
$$= \rho_l V_l g$$



4. Floatation

B

Floating & sinking



Floating body

$$\rho_b < \rho_l$$

Suspended body

$$\rho_b = \rho_l$$

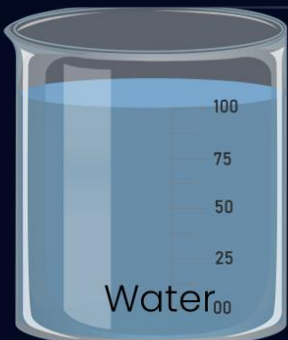
Sinking body

$$\rho_b > \rho_l$$

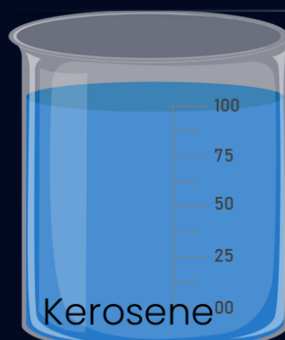
4.2 Relative density

$$\text{R.D of a body} = \frac{\text{Density of the body}}{\text{Density of water}}$$

Mass of 100 cc = 100 g

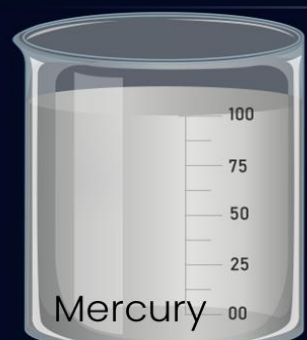


Mass of 100 cc = 80 g



Relative Density = 0.8

Mass of 100 cc = 1360 g



Relative Density = 13.6

Formula Sheet

B

1 Law of gravitation

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

2 Acceleration due to gravity

$$g = \frac{G \times M}{r^2}$$

3 Weight and Mass

$$\begin{aligned} \text{Weight} &= mg \\ \text{Mass (m)} &= \text{constant} \end{aligned}$$

4 Equations of motion

$$\begin{aligned} v &= u - gt \\ s &= ut - \frac{1}{2} gt^2 \\ v^2 &= u^2 - 2gs \end{aligned}$$

5 Buoyant force

$$\begin{aligned} F_B &= m_{\text{liquid displaced}} \times g \\ &= \rho_l V_l g \end{aligned}$$

6 Relative density

$$\text{R.D of a liquid} = \frac{\text{Density of the liquid}}{\text{Density of water}}$$

