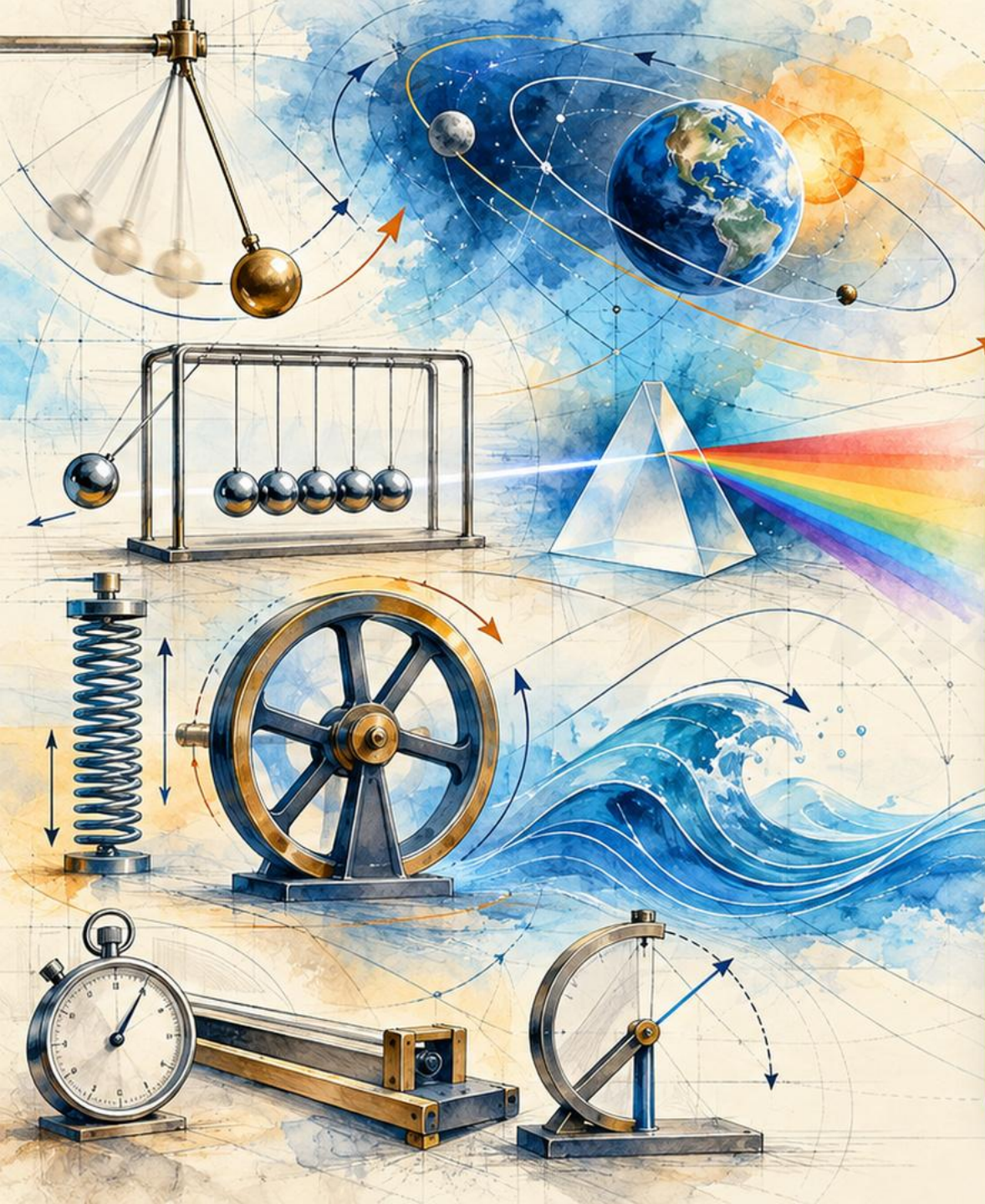




PHYSICS • CLASS 11

9

CHAPTER

Mechanical Properties of Fluids

NCERT SOLUTIONS

EXERCISE SOLUTION: QUESTION 9.1 (a-b)

(a) Why is blood pressure greater at the feet than at the brain?

Answer:

For a person standing upright, the feet are lower than the brain. Gravity makes the hydrostatic contribution to pressure increase downward through the blood column.

$$\Delta P = \rho g \Delta h$$

The lower point supports the effect of more liquid above it. This explains the height-dependent part of the pressure difference.

(b) Why does atmospheric pressure fall to about half its sea-level value at a height of 6 km, although the atmosphere extends beyond 100 km?

Answer:

Air is compressible, so gravity packs much more air into the lower atmosphere. Air density decreases strongly with height. Thus a large part of the atmosphere's weight is in its lower layers. Pressure depends on the weight of air above a point, not simply on the total height of the atmosphere.

We cannot treat the air density as uniform over that entire height.

EXERCISE SOLUTION: QUESTION 9.1 (c)

Q. 9.1 (c): Hydrostatic pressure is force divided by area. Why is pressure still a scalar quantity?

Answer: Pressure is the magnitude of the normal force per unit area. The definition does not assign a direction to pressure itself.

$$p = \frac{F_{\text{normal}}}{A}$$

At a point in a fluid at rest, the pressure is the same for every orientation of a small surface.

The force on a chosen surface does have a direction: it acts perpendicular to that surface. Changing the surface orientation changes the force direction, but does not change the pressure at that point.

Pressure: scalar. Force: vector.

The direction belongs to the force and the surface normal, not to the pressure.

EXERCISE SOLUTION: QUESTION 9.2 (a-b)

(a) Why is the contact angle of mercury with glass obtuse, while that of water with glass is acute?

Answer:

Contact angle is measured inside the liquid at its contact with the solid. Mercury's cohesive attraction is strong compared with its adhesion to clean glass, so it does not wet the glass. Water adheres well to clean glass and wets it.

Mercury: $\theta > 90^\circ$.

Water: $\theta < 90^\circ$.

(b) Why does water on clean glass spread out, while mercury on the same glass forms drops?

Answer:

Water-glass adhesion favours contact with the glass, so water spreads over it. Mercury's stronger tendency to remain together favours a smaller exposed surface and little contact with glass, so it forms drops.

These contrasting shapes reflect wetting and non-wetting behaviour at the liquid-solid boundary.

EXERCISE SOLUTION: QUESTION 9.2 (c-e)

(c) Why is surface tension independent of the liquid's surface area?

Answer: Surface tension is a property of the interface, set by the substances, temperature and impurities. It is energy per unit area, not the total surface energy.

$$E_{\text{surface}} = S A$$

Increasing area increases the total surface energy, not the value of surface tension under unchanged conditions.

(d) Why should water with detergent have a small contact angle?

Answer: A small contact angle allows the liquid to wet and spread over the material and enter small gaps. Detergent improves this wetting action, helping water reach and remove dirt.

(e) Why is a liquid drop free from external forces spherical?

Answer: At equilibrium, without distorting external effects or rotation, surface tension minimises the surface energy. A sphere has the smallest surface area for a fixed volume, so the equilibrium drop is spherical.



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