NCERT Class 11 Physics Solutions: Chapter 10 – Mechanical Properties of Fluids-Part 1

Question 10.1:

Explain why

(a) The blood pressure in humans is greater at the feet than at the brain

(b) Atmospheric pressure at a height of about 6 km decreases to nearly half of its value at the sea level, though the height of the atmosphere is more than $100\,km$

(c) Hydrostatic pressure is a scalar quantity even though pressure is force divided by area.

Answer:

(a) The blood pressure in humans is greater at the feet than at the brain:

Explanation:

The pressure of a liquid is given by the relation:

$$p = hpg$$

Where,

$p =$ pressure

$h =$ Height of the liquid column

$p =$ Density of the liquid

$g =$ Acceleration due to the gravity

It can be inferred that pressure is directly proportional to height. Hence, the blood pressure in human vessels depends on the height of the blood column in the body. The height of the blood column is more at the feet than it is at the brain. Hence, the blood pressure at the feet is more than it is at the brain.

(b) Atmospheric pressure at a height of about 6 km decreases to nearly half of its value at the sea level, though the height of the atmosphere is more than $100\,km$:

Explanation:

Density of air is the maximum near the sea level. Density of air decreases with increase in height from the surface. At a height of about $6\,km$, density decreases to nearly half of its value at the sea level. Atmospheric pressure is proportional to density. Hence, at a height of 6 km from the surface, it decreases to nearly half of its value at the sea level.

(c) Hydrostatic pressure is a scalar quantity even though pressure is force divided by area:

Explanation:

When force is applied on a liquid, the pressure in the liquid is transmitted in all directions. Hence, hydrostatic pressure does not have a fixed direction and it is a scalar physical quantity.

Question 10.2:

Explain why

(a) The angle of contact of mercury with glass is obtuse, while that of water with glass is acute.

(b) Water on a clean glass surface tends to spread out while mercury on the same surface tends to form drops. (Put differently, water wets glass while mercury does not.)

(c) Surface tension of a liquid is independent of the area of the surface

(d) Water with detergent dissolved in it should have small angles of contact.

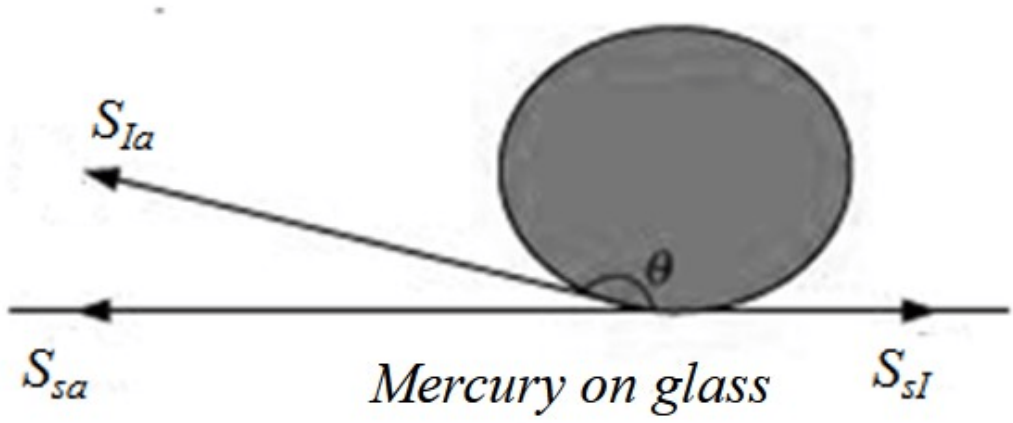
(e) Water with detergent dissolved in it should have small angles of contact.

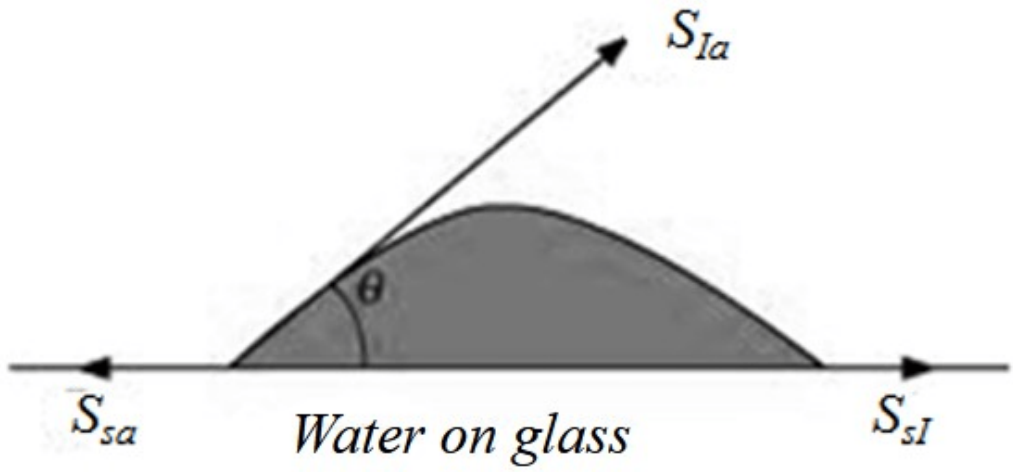
Answer:

(a) The angle of contact of mercury with glass is obtuse, while that of water with glass is acute:

Explanation:

The angle between the tangent to the liquid surface at the point of contact and the surface inside the liquid is called the angle of contact (θ), as shown in the given figure:





S_{la}, S_{sa}, and S_{sl} are the respective interfacial tensions between the liquid-air, solid-air, and solid-liquid interfaces. At the line of contact, the surface forces between the three media must be in equilibrium, i.e.. ,

$$\cos\theta = \frac{S_{sa} - S_{sl}}{S_{la}}$$

The angle of contact θ , is obtuse if $S_{sa} < S_{la}$ (as in the case of mercury on glass) . This angle is acute if $S_{sl} < S_{la}$ (as in the case of water on glass) .

(b) Water on a clean glass surface tends to spread out while mercury on the same surface tends to form drops. (Put differently, water wets glass while mercury does not.) :

Explanation:

Mercury molecules (which make an obtuse angle with glass) have a strong force of attraction between themselves and a weak force of attraction toward solids. Hence, they tend to form drops. On the other hand, water molecules make acute angles with glass. They have a weak force of attraction between themselves and a strong force of attraction toward solids. Hence, they tend to spread out.

(c) Surface tension of a liquid is independent of the area of the surface:

Explanation:

Surface tension is the force acting per unit length at the interface between the plane of a liquid and any other surface. This force is independent of the area of the liquid surface. Hence, surface tension is also independent of the area of the liquid surface.

(d) Water with detergent dissolved in it should have small angles of contact:

Explanation:

Water with detergent dissolved in it has small angles of contact (θ). This is because for a small , there is a fast capillary rise of the detergent in the cloth. The capillary rise of a liquid is directly proportional to the cosine of the angle of contact $(\theta$) . If θ is small, then $\cos\theta$ will be large and the rise of the detergent water in the cloth will be fast.

(e) Water with detergent dissolved in it should have small angles of contact:

Explanation:

A liquid tends to acquire the minimum surface area because of the presence of surface tension. The surface area of a sphere is the minimum for a given volume. Hence, under no external forces, liquid drops always take spherical shape.