

UNIT



PROPERTIES OF MATTER

PROBLEMS

- 7.1 A wooden block measuring 40 cm x 10cm x 5 cm has a mass of 850 g. find the density of the wood.
- Given Data

Volume of wooden block = $v = 40 \text{ cm } x 10 \text{ cm } x 5 \text{ cm} = 2000 \text{ cm}^3 = 2 \text{ x } 10^{-3} \text{ m}^3$ Mass of wooden block = m = 850 g = 0.85 kg

Required

Density of wooden block = d = ?

Solution

As we know that

By putting the values, we have

Density =
$$\frac{0.85}{2 \times 10^{-3}}$$

Density =
$$0.425 \times 10^3 \text{ kg m}^{-3}$$

Density = 425 kg m^{-3}

OR Density =
$$425 \text{ kg m}^{-3}$$

Result

Density of wooden block = $d = 425 \text{ kgm}^{-3}$

How much would be the volume of the ice formed by freezing 1 liter of water? 7.2 (LHR 2014)

Given Data

Volume of water =
$$V_1 = 1$$
 litre

Required

Volume of ice on freezing = V_2 = ?

Solution

As we know that

$$\frac{\text{Volume of ice}}{\text{volume of water}} = \frac{\text{density of water}}{\text{density of ice}}$$

volume of water density of ice

volume of ice =
$$(\frac{\text{density of water}}{\text{density of ice}})$$
 x volume of water

Putting values, we have

Volume of ice = $(1000/920) \times 1$

Volume of ice = 1.09 litres

Result

So

Volume of ice on freezing = V_2 = 1.09 litres

- 7.3 (i) Calculate the volume of the following objects.
 - (i) An iron sphere of mass 5 kg, the density of iron is 8200 kgm⁻³.
 - (ii) 200 g of lead shot having density 11300 kgm⁻³.
 - (iii) A gold bar of mass 0.2 kg. the density of gold is 19300 kgm⁻³
- An iron sphere of mass 5 kg, the density of iron is 8200 kgm⁻³. (i)

Required

Volume of iron sphere = V = ?

Solution

As we know that

$$Density = \frac{Mass}{Volume}$$

$$Volume = \frac{Mass}{Density}$$

By putting the values, we have

Volume =
$$\frac{5}{8200}$$

Volume = 0.00069 m³
Volume = 6.9 x 10⁻⁴ m³

Result

Volume of iron sphere = $V = 6.9 \times 10^{-4} \text{ m}^3$

7.3 (ii) 200 g of lead shot having density 11300 kgm⁻³.

Given Data

OR

Mass of lead shot =
$$m = 200 \text{ g} = 0.2 \text{ kg}$$

Density of lead = $d = 11300 \text{ kgm}^{-3}$

Required

Volume of lead shot
$$= v = ?$$

Solution

As we know that

$$Density = \frac{Mass}{Volume}$$

$$Volume = \frac{Mass}{Density}$$

By putting the values, we have

Volume =
$$\frac{0.2}{11300}$$

Volume = 0.000017699 m³
Volume = 1.77 x 10⁻⁵ m³

OR Result

Volume of lead shot = $v = 1.77 \times 10^{-5} \text{ m}^3$

7.3 (iii) A gold bar of mass 0.2 kg. the density of gold is 19300 kgm⁻³. (LHR 2016)

Given Data

Mass of gold bar =
$$m = 0.2 \text{ kg}$$

Density of gold = $d = 19300 \text{ kgm}^{-3}$

Required

Volume of gold bar =
$$v = ?$$

Solution

As we know that

$$Density = \frac{Mass}{Volume}$$

$$Volume = \frac{Mass}{Density}$$

By putting the values, we have

$$Volume = \frac{0.2}{19300}$$

Volume =
$$0.00001036 \text{ m}^3$$

OR Volume = $1.04 \times 10^{-5} \text{ m}^3$

Result

Volume of gold bar = $v = 1.04 \times 10^{-5} \text{ m}^3$

7.4 The density of air is 1.3 kgm⁻³. Find the mass of air in room measuring 8 m x 5 m x 4 m. (GRW 2016)

Given Data

Density of air =
$$d = 1.3 \text{ kgm}^{-3}$$

Volume of air = $v = 8 \text{ m x } 5 \text{ m x } 4 \text{ m} = 160 \text{ m}^{3}$

Required

Mass of air
$$= m = ?$$

Solution

As we know that

$$Density = \frac{Mass}{Volume}$$

$$Mass = 1.3 \times 160$$

$$Mass = 208 \text{ kg}$$

Result

Mass of air = m = 208 kg

7.5 A student passes her palm by her thumb with a force of 75 N. how much would be the pressure under her thumb having contact area 1.5 cm²?

Given Data

Force exerted by student =
$$F = 75 \text{ N}$$

Contact area = $A = 1.5 \text{ cm}^2 = 1.5 \times 10^{-4} \text{ m}^2$

Required

Pressure under the thumb = P = ?

Solution

As we know that

$$P = \frac{F}{A}$$

By putting the values, we have

$$P = \frac{75}{1.5 \times 10^{-4}}$$

$$P = 50 \times 10^{4} \text{ Nm}^{-2}$$

$$P = 5 \times 10^{5} \text{ Nm}^{-2}$$

Result

Pressure under the thumb = $P = 5 \times 10^5 \text{ Nm}^{-2}$

7.6 The head of the pin is a square of side 10 mm. find the pressure on it due to a force of 20 N. (GRW 2014)

Given Data

Force applied = F = 20 N
Side of head of pin = L = 10 mm =
$$10 \times 10^{-3}$$
 m
Area of head of pin = A = L x L = 10×10^{-3} m x 10×10^{-3} m
= 100×10^{-6} m² = 1×10^{-4} m²

Required

Pressure exerted by head of pin = P = ?

Solution

As we know that

$$P = \frac{20}{1 \times 10^{-4}}$$

$$P = 20 \times 10^{4} \text{ Nm}^{-2}$$

$$P = 2 \times 10^{5} \text{ Nm}^{-2}$$

Result

Pressure exerted by head of pin = $P = 2 \times 10^5 \text{ Nm}^{-2}$

- 7.7 A uniform rectangular block of wood 20 cm x 7.5 cm x 7.5 cm and of mass 1000 g stands on a horizontal surface with its longest edge vertical. Find
 - (i) The pressure exerted by the block on the surface
 - (ii) Density of the wood

Given Data

Mass of wooden block = m = 1000 g = 1 kg

Volume of wooden block = $V = 20 \text{ cm } \times 7.5 \text{ cm } \times 7.5 \text{ cm}$

$$= 0.001125 \text{ m}^3 \text{ or } 1.125 \text{ x } 10^{-3}$$

Area of wooden block = A = 7.5 cm x 7.5 cm

$$= 0.005625 \text{ m}^2 \text{ or } 5.625 \text{ x } 10^{-3} \text{ m}^2$$

Required

- (i) The pressure exerted by the block on the surface = P = ?
- (ii) Density of wood = d =?

Solution

As we know that

$$V = L \times W \times H$$

By putting the values, we have

$$V = 20 \text{ cm } \times 7.5 \text{ cm} \times 7.5 \text{ cm} = 1125 \text{ cm}^3 = 0.001125 \text{ m}^3$$

Density =
$$\frac{\text{Mass}}{\text{Volume}}$$

By putting the values, we have

Density =
$$\frac{1}{0.001125}$$

Density = 888 89 kgm⁻³ =

Density =
$$888.89 \text{ kgm}^{-3} = 889 \text{ kgm}^{-3}$$

As we know that

$$P = \frac{F}{A}$$

By putting the values, we have

$$P = \frac{10}{0.005625}$$

$$P = 1778 \text{ Nm}^{-2}$$

Result

- (i) The pressure exerted by the block on the surface = $P = 1778 \text{ Nm}^{-2}$
- (ii) Density of wood = $d = 889 \text{ kgm}^{-3}$
- 7.8 A cube of glass of 5 cm side and mass 306 g, has a cavity inside it. If the density of the glass is 2.55 gcm⁻³. Find the volume of the cavity.

Given Data

Length of side of glass cube = L = 5 cm

Volume of glass cube =
$$v = L^3 = (5 \text{ cm})^3 = 125 \text{ cm}^3$$

= $125 \times 10^{-6} \text{ m}^3 = 1.25 \times 10^{-4} \text{ m}^3$

Mass of cube = $m = 306 g = 0.306 kg = 3.06 x 10^{-1} kg$

Density of glass =
$$d = 2.25 \text{ gcm}^{-3} = 2.55 \times 10^3 \text{kg m}^{-3}$$

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Required

Volume of cavity inside the glass cube = V = ?

Solution

 $= 1.25 \times 10^{-4} \text{ m}^3$ Volume without cavity

Volume with cavity = mass/density

=
$$(3.06 \times 10^{-1})/(2.55 \times 10^{3})$$

= $1.20 \times 10^{-4} \text{ m}^{3}$

Volume of cavity = volume without cavity - volume with cavity

= volume without cavity – volum
=
$$1.25 \times 10^{-4} \text{ m}^3 - 1.20 \times 10^{-4} \text{ m}^3$$

= $0.05 \times 10^{-4} \text{ m}^3$
= $5 \times 10^{-6} \text{ m}^3 \text{ or } 5 \text{ cm}^3$

$$= 0.05 \times 10^{-4} \text{ m}^3$$

= $5 \times 10^{-6} \text{ m}^3 \text{ or } 5 \text{ cm}^3$

Result

Volume of cavity inside the glass cube = $v = 5 \text{ cm}^3$

An object has weight 18 N in air. Its weight is found to be 11.4 N when immersed in 7.9 water. Calculate its density. Can you guess the material of the object? (GRW 2014)

Given Data

Weight of object in air = $w_1 = 18 \text{ N}$

Weight of object in water = $w_2 = 11.4 \text{ N}$

Density of water = $\rho_{\rm w} = 1000 \text{ kgm}^{-3}$

Gravitational acceleration = $g = 10 \text{ ms}^{-2}$

Weight of equal volume of water = $w = w_1 - w_2 = 18 N - 11.4 N = 6.6 N$

Required

Density of material = $D_m = ?$

Name of material = ?

Solution

As we know that

$$\frac{\mathbf{D}}{\mathbf{\rho}} = \frac{\mathbf{W}_1}{\mathbf{W}}$$

By putting the value, we have

$$\frac{D}{1000} = \frac{18}{6.6}$$

$$D = \frac{18000}{6.6}$$

D = 2727 Kgm

Result

Density of material = $D_m = 2727 \text{ Kgm}^{-3}$

As we know that density of aluminum is approximately equal to the density found in the numerical. So, the material is aluminum.

- A solid block of wood of density 0.6 gcm⁻³ weighs 3.06 N in air. Determine, 7.10
 - (i) Volume of the block
 - (ii) The volume of block immersed when placed freely in liquid of density 0.9 gcm-3.

Given Data

Density of wooden block $= d = 0.6 \text{ gcm}^{-3}$ Weight of the wooden block = w = 3.06 N

 $= d_1 = 0.9 \text{ gcm}^{-3}$ Density of liquid

Required

Volume of the wooden block = V_1 = ?

Volume of block when immersed in liquid = $V_2 = ?$

Solution

As we know that

Volume = mass/ density

$$V_1 = 0.306/(0.6 \times 10^3)$$
 = 0.51 x 10⁻³ m³ or 510cm³

As we also know that

Weight=
$$10 \times \text{volume x density}$$

 $3.06 = 10 \times \text{volume x } 0.9 \times 10^3$

Volume =
$$3.06/(9 \times 10^3)$$

$$V_2 = 0.00034 \text{ m}^3 \text{ or } 34 \text{ cm}^3$$

Result

Volume of the wooden block = $V_1 = 510 \text{ cm}^3$

Volume of block when immersed in liquid = $V_2 = 34 \text{ cm}^3$

7.11 The diameter of the piston of hydraulic press is 30 cm. How much force is required a car weighing 20000 N on its piston, if the diameter of the piston of the pump is 3 cm. (GRW 2016)

Given Data

Diameter of the piston of hydraulic press = D = 30 cm = 0.3 m

Diameter of the piston of pump = d = 3 cm = 0.03 m

Weight of the car lifted by hydraulic press = $w = F_2 = 20000 \text{ N}$

Required

Force applied on piston of pump = F_1 = ?

Solution

As we know that

$$A = \frac{\pi D^2}{4}$$

Larger piston (i)

By putting the values, we have

$$A = \frac{3.14 \times (3 \times 10^{-1})^2}{4}$$

$$A = \frac{3.14 \times 9 \times 10^{-2}}{4}$$

$$A = \frac{28.26 \times 10^{-2}}{4}$$

$$A = 7.065 \times 10^{-2} \text{ m}^2$$

(ii) Smaller piston

By putting the value, we have

$$a = \frac{3.14 \times (3 \times 10^{-2})^2}{4}$$

$$3.14 \times 9 \times 10^{-4}$$

$$a = \frac{3.14 \times 9 \times 10^{-4}}{4}$$

$$a = \frac{28.26 \times 10^{-4}}{4}$$

$$a = 7.065 \times 10^{-4} \text{ m}^2$$

From Pascal's law, we have

$$\frac{\mathbf{F}_1}{\mathbf{a}} = \frac{\mathbf{F}_2}{\mathbf{A}}$$

By putting the values, we have

$$\frac{F_1}{7.065 \times 10^{-4}} = \frac{20000}{7.065 \times 10^{-2}}$$

$$F_1 = \frac{20000 \times 7.065 \times 10^{-4}}{7.065 \times 10^{-2}}$$

$$F_{_{\! 1}} = \frac{20000}{100}$$

$$F_1 = 200 \text{ N}$$

Result

a

Force applied on piston of pump = $F_1 = 200 \text{ N}$

7.12 A steel wire of cross-sectional area 2 x 10⁻⁵ m² is stretched through 2 mm by a force of 4000 N. Find the young's modulus of the wire. The length of the wire is 2m.

Given Data

Length of the wire = L_o = 2 m Area of steel wire = A = 2 x 10^{-5} m² Increase in length of wire = ΔL = 2 mm = 2 x 10^{-3} m Force applied = F = 4000 N

Required

Young's modulus of wire = Y = ?

Solution

As we know that

$$Y = \frac{F \times L}{A \times \Delta L}$$

By putting the values, we have

$$Y = \frac{4000 \times 2}{2 \times 10^{-5} \times 2 \times 10^{-3}}$$

$$Y = \frac{2000}{10^{-5} \times 10^{-3}}$$

$$Y = 2000 \times 10^{8} \text{ Nm}^{-2} = 2 \times 10^{3} \times 10^{8} \text{ Nm}^{-2}$$

$$Y = 2 \times 10^{11} \text{ Nm}^{-2}$$

Result

Young's modulus of wire = $Y = 2 \times 10^{11} \text{ Nm}^{-2}$

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