Chapter 9: The Amazing World of Solutes, Solvents, and Solutions

Exercises — Keep the Curiosity Alive

Q1 State whether the statements given below are True [T] or False [F]. Correct the false statement(s).
(i) Oxygen gas is more soluble in hot water rather than in cold water.
(ii) A mixture of sand and water is a solution.
(iii) The amount of space occupied by any object is called its mass.
(iv) An unsaturated solution has more solute dissolved than a saturated solution.
(v) The presence of different gases in the atmosphere is also a uniform mixture.

SOLUTION

(i) FALSE.
Correction: Oxygen gas is more soluble in cold water than in hot water. The solubility of gases in liquids decreases as temperature increases.

(ii) FALSE.
Correction: A mixture of sand and water is NOT a solution. Sand does not dissolve in water; the components are not uniformly distributed, making it a non-uniform (heterogeneous) mixture.

(iii) FALSE.
Correction: The amount of space occupied by any object is called its volume, not its mass. Mass is the quantity of matter present in an object.

(iv) FALSE.
Correction: A saturated solution has the maximum amount of solute dissolved at a given temperature. An unsaturated solution has LESS solute dissolved than a saturated solution — it can still dissolve more.

(v) TRUE.
The atmosphere is a mixture of gases (nitrogen, oxygen, carbon dioxide, etc.) that are uniformly distributed throughout, forming a uniform (homogeneous) mixture — i.e., a solution of gases.

Answer: (i) F — oxygen is more soluble in cold water; (ii) F — sand and water is a non-uniform mixture, not a solution; (iii) F — space occupied is volume, not mass; (iv) F — saturated solution has MORE solute; (v) T

Q2 Fill in the blanks.
(i) The volume of a solid can be measured by the method of displacement, where the solid is _____ in water and the _____ in water level is measured.
(ii) The maximum amount of _____ dissolved in _____ at a particular temperature is called solubility at that temperature.
(iii) Generally, the density _____ with increase in temperature.
(iv) The solution in which glucose has completely dissolved in water, and no more glucose can dissolve at a given temperature, is called a _____ solution of glucose.

SOLUTION

(i) The volume of a solid can be measured by the method of displacement, where the solid is immersed (submerged) in water and the rise in water level is measured.
The volume of the displaced water equals the volume of the solid.

(ii) The maximum amount of solute dissolved in solvent (or solution) at a particular temperature is called solubility at that temperature.

(iii) Generally, the density decreases with increase in temperature.
As temperature rises, particles spread apart → volume increases while mass stays the same → density (= mass/volume) decreases.

(iv) The solution in which glucose has completely dissolved in water, and no more glucose can dissolve at a given temperature, is called a saturated solution of glucose.

Answer: (i) immersed / submerged; rise; (ii) solute; solvent; (iii) decreases; (iv) saturated

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Q3 You pour oil into a glass containing some water. The oil floats on top. What does this tell you?
(i) Oil is denser than water
(ii) Water is denser than oil
(iii) Oil and water have the same density
(iv) Oil dissolves in water

SOLUTION

When oil is poured into water, it floats on top of the water.
A substance floats on a liquid when its density is less than the density of that

liquid.
Therefore, oil is less dense than water, which means water is denser than oil.
Option (i) is incorrect — if oil were denser it would sink.
Option (iii) is incorrect — same density would mean oil mixes uniformly or neither floats nor sinks distinctly.
Option (iv) is incorrect — oil and water do not mix (they are immiscible); oil floats as a separate layer.
The correct answer is option (ii): Water is denser than oil.

Answer: (ii) Water is denser than oil

Q4 A stone sculpture weighs 225 g and has a volume of 90 cm^3. Calculate its density and predict whether it will float or sink in water.

SOLUTION

Given: Mass = 225 g, Volume = 90 cm^3
Density = Mass ÷ Volume
Density = 225 g ÷ 90 cm^3 = 2.5 g/cm^3

The density of water is 1 g/cm^3.
Since the density of the stone (2.5 g/cm^3) is greater than the density of water (1 g/cm^3), the stone sculpture will sink in water.

Answer: Density = 2.5 g/cm^3; the stone sculpture will sink in water (denser than water)

Q5 Which one of the following is the most appropriate statement, and why are the other statements not appropriate?
(i) A saturated solution can still dissolve more solute at a given temperature.
(ii) An unsaturated solution has dissolved the maximum amount of solute possible at a given temperature.
(iii) No more solute can be dissolved into the saturated solution at that temperature.
(iv) A saturated solution forms only at high temperatures.

SOLUTION

The correct and most appropriate statement is (iii): No more solute can be dissolved into the saturated solution at that temperature.
By definition, a saturated solution is one in which the maximum amount of solute has already been dissolved at a given temperature — no additional solute can

dissolve.

Why the other statements are NOT appropriate:

Statement (i) is incorrect: A saturated solution CANNOT dissolve more solute at that temperature. If it could, it would be an unsaturated solution.

Statement (ii) is incorrect: It is the SATURATED solution (not the unsaturated solution) that has dissolved the maximum amount of solute. An unsaturated solution can still dissolve more solute.

Statement (iv) is incorrect: A saturated solution can form at any temperature, not just high temperatures. The solubility value differs with temperature, but saturation can be reached at any temperature by adding enough solute.

Answer: (iii) is correct — a saturated solution has already dissolved the maximum possible solute at that temperature and no more can dissolve

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Q6 You have a bottle with a volume of 2 litres. You pour 500 mL of water into it. How much more water can the bottle hold?

SOLUTION

Total volume of bottle = 2 litres = 2000 mL
Volume of water already poured = 500 mL
Remaining capacity = 2000 mL − 500 mL = 1500 mL
1500 mL = 1.5 litres

Answer: The bottle can hold 1500 mL (1.5 litres) more water

Q7 An object has a mass of 400 g and a volume of 40 cm^3. What is its density?

SOLUTION

Given: Mass = 400 g, Volume = 40 cm^3
Density = Mass ÷ Volume
Density = 400 g ÷ 40 cm^3 = 10 g/cm^3

Answer: Density = 10 g/cm^3

Q8 Analyse Fig. 9.25a and 9.25b. Why does the unpeeled orange float, while the peeled one sinks? Explain.

SOLUTION

Fig. 9.25 shows: (a) an unpeeled orange floating in water, and (b) a peeled orange sinking in water.

An unpeeled orange floats because:
The peel (rind) of an orange is thick, spongy, and contains many tiny air pockets. These air pockets reduce the overall density of the orange with its peel.
The combined density of the orange flesh + peel + trapped air is less than the density of water (1 g/cm³), so the unpeeled orange floats.

A peeled orange sinks because:
When the peel is removed, the air pockets in the rind are gone. The orange flesh alone is denser than the peel-with-air combination.
The density of the orange flesh is greater than the density of water (1 g/cm³), so the peeled orange sinks.

This demonstrates that density — not just mass — determines whether an object floats or sinks. Changing the volume (by removing the buoyant peel) changes the overall density of the object.

Answer: The unpeeled orange floats because its thick, air-filled peel lowers its overall density below 1 g/cm³. Removing the peel eliminates the trapped air, making the flesh denser than water, so it sinks.

Q9 Object A has a mass of 200 g and a volume of 40 cm³. Object B has a mass of 240 g and a volume of 60 cm³. Which object is denser?

SOLUTION

Density of Object A = Mass ÷ Volume = 200 g ÷ 40 cm³ = 5.0 g/cm³
Density of Object B = Mass ÷ Volume = 240 g ÷ 60 cm³ = 4.0 g/cm³

Comparing: Density of A (5.0 g/cm³) > Density of B (4.0 g/cm³)
Therefore, Object A is denser.

Answer: Object A is denser (density = 5.0 g/cm³ vs Object B's 4.0 g/cm³)

Q10 Reema has a piece of modeling clay that weighs 120 g. She first moulds it into a compact cube that has a volume of 60 cm³. Later, she flattens it into a thin sheet. Predict what will happen to its density.

SOLUTION

When the clay is a compact cube:
Mass = 120 g, Volume = 60 cm³
Density = 120 g ÷ 60 cm³ = 2.0 g/cm³

When the clay is flattened into a thin sheet:
Modeling clay is an incompressible solid — flattening it does not add or remove any material.
Mass remains the same = 120 g
Volume remains the same = 60 cm³ (the clay just changes shape, not the amount of matter or the space it occupies)
Density = 120 g ÷ 60 cm³ = 2.0 g/cm³

The density does NOT change.
Density depends on the nature of the material (mass and volume), not its shape. Reshaping the clay changes neither its mass nor its volume, so the density stays the same.

Answer: Density remains unchanged at 2.0 g/cm³; reshaping clay does not change its mass or volume

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Q11 A block of iron has a mass of 600 g and a density of 7.9 g/cm³. What is its volume?

SOLUTION

Given: Mass = 600 g, Density = 7.9 g/cm³
Density = Mass ÷ Volume
Therefore: Volume = Mass ÷ Density
Volume = 600 g ÷ 7.9 g/cm³
Volume ≈ 75.95 cm³

Answer: Volume ≈ 75.95 cm³

Q12 You are provided with an experimental setup as shown in Fig. 9.26a and 9.26b. On keeping the test tube (Fig 9.26b) in a beaker containing hot water (~70 °C), the water level in the glass tube rises. How does it affect the density?

SOLUTION

The setup (Fig. 9.26): A test tube containing water is connected to a glass tube. When the test tube is placed in a beaker of hot water (~70 °C), the water inside the test tube is heated.

What happens: The water in the test tube expands on heating, causing the water level in the glass tube to rise.

Effect on density:
When water is heated, its particles gain energy and move farther apart, causing the volume to increase.
The mass of the water remains unchanged (no water is added or removed).
Since Density = Mass ÷ Volume, and volume increases while mass stays the same:
Density = same mass ÷ larger volume → Density decreases.

Conclusion: Heating the water causes its volume to expand, which decreases its density. This is consistent with the general principle that the density of a substance decreases with an increase in temperature.

Answer: Heating expands the water's volume while mass stays constant, so density decreases (Density = Mass/Volume)