01 Matter, Mixtures and Separation

Set A **Answer key**

A From the lesson

19 MARKS

1 **C** air [1]

Air is nitrogen, oxygen, carbon dioxide and other gases that are not chemically combined, and its make-up varies.

Water and carbon dioxide are compounds. Oxygen is an element.

2 **C** it stays constant [1]

The energy goes into overcoming the forces of attraction between the particles, not into raising the temperature.

The temperature rises again only after all the liquid has boiled.

3 **C** helium [1]

Helium has the smallest mass, so its particles move fastest and diffuse fastest.

Chlorine, carbon dioxide and oxygen are all heavier, so they diffuse more slowly.

4 **B** crystallisation [1]

Crystallisation is gentler. It heats only to a saturated solution, cools it, and gives a pure solid.

Evaporation to dryness would heat the solute until it decomposes. Simple distillation collects the solvent, not the solid. Sieving separates solids by particle size.

5 **B** 4.0 cm [1]

$$R_f = \frac{\text{distance moved by the spot}}{\text{distance moved by the solvent front}}$$

Distance moved by the spot = 0.40 × 10.0 cm = 4.0 cm

6 **(a)** Salt is the solute and water is the solvent. [1]

(b) Its solvent is water. [1]

7 **(a)** A mixture: the water and carbon dioxide are not chemically combined, and the amount of carbon dioxide can vary. [1]

(b) Argon (single atoms), nitrogen, N_2 (molecules), carbon dioxide, CO_2 (compound). **[1]**

8 The particles gain energy and overcome the forces of attraction between them, so they move far apart, quickly and randomly.

In the gas the particles are far apart, so it takes up much more space than the closely packed solid. **[2]**

9 In a warmer kitchen the particles have more kinetic energy, so they move faster and diffuse faster. **[1]**

10 **(a)** Any two of evaporation, crystallisation, simple distillation, fractional distillation and sublimation. **[1]**

(b) By the physical property in which the components differ, such as particle size, solubility, or melting and boiling points. **[1]**

11 Graphite does not dissolve in the solvent, so the line stays put. Ink would dissolve, run up the paper and its colours would confuse the result. **[1]**

12 **(a)** No. The spot and the solvent front both move further in the longer run, in the same proportion, so the ratio stays the same. **[1]**

(b) The R_f value of a substance changes with the solvent. **[1]**

13 **(a)** P is a mixture: a pure substance boils at one fixed temperature. **[1]**

(b) Chromatography (a pure substance gives one spot) and measuring its melting point (a pure substance melts at a fixed temperature). **[1]**

B Practice

17 MARKS

14 **D** white solid that melts from 56 °C to 58 °C **[1]**

A mixture melts over a range of temperatures. A pure substance, element or compound, melts at one temperature.

The white solid melts from 56 °C to 58 °C, so it is a mixture. The green powder breaks down into simpler substances on heating, so it is a compound. Nothing in A or C shows a mixture.

15

A one [1]

Only statement 1 is correct: an element holds one type of atom.

A compound has properties different from those of its elements (2), its formation usually involves a large energy change (3), and a mixture has no fixed ratio (4).

16

C When heated strongly, a brown solid and a yellow gas are produced. [1]

Strong heating breaks the substance down into two simpler substances. An element cannot be broken down into simpler substances by chemical methods, so the substance is a compound.

A fixed boiling point only shows that it is pure. Dissolving does not break it down. Forming oxides means it reacts with oxygen, which an element can do.

17

A Energy is gained when X changes from liquid to gas. [1]

Energy is absorbed to overcome the forces of attraction between the particles when a liquid changes to a gas.

A molecule has the same mass in every state. Sublimation is solid to gas, not liquid to gas. Particles in a liquid slide past one another, while vibrating about fixed positions describes a solid.

18

C gas Q at 30 °C [1]

A heavier gas diffuses more slowly, and a lower temperature gives slower particles. Gas Q is the heavier gas and 30 °C is the lower temperature.

So the slowest rate is gas Q at 30 °C.

19

C The molecules lose energy and move closer together. [1]

When steam condenses, the molecules lose energy, move more slowly and come closer together to form a liquid.

The molecules do not change size, and they do not break up into atoms in a change of state.

20

B The carbon dioxide particles become far apart. [1]

0 °C is above the sublimation temperature of −78 °C, so the solid carbon dioxide turns straight into a gas, in which the particles are far apart. The particles do not change size, and they take in energy from the surroundings as the solid sublimes.

21

D their miscibility [1]

Immiscible liquids form layers and are separated with a separating funnel. Miscible liquids with different boiling points are separated by distillation.

So the method depends on whether the liquids mix. Colour, density and melting point do not decide it.

22 **D** A substance that remains in the heated flask after distillation is called a residue. [1]

In distillation the solvent is vaporised and collected, and the solid left in the flask is the residue.

The filtrate is the liquid that passes through the filter paper, not the solid. A saturated solution is one in which no more solute can dissolve. A solution is a mixture, not a compound.

23 **A** distillation, sublimation, evaporation [1]

Water is obtained from sodium chloride solution by distillation, because the solvent has a lower boiling point than the solute.

Iodine sublimes on heating and nickel does not, so sublimation gives solid iodine. Solid sodium chloride is obtained from its solution by evaporating the water.

Filtration separates an insoluble solid from a liquid, so it cannot separate dissolved sodium chloride. Crystallisation does not give iodine from nickel.

24 **A** argon [1]

At −190 °C only the substances that boil above −190 °C are liquids: argon and oxygen. Nitrogen is still a gas and carbon dioxide is a solid.

As the temperature rises, the liquid with the lower boiling point boils first, so argon (−186 °C) turns into a gas before oxygen (−183 °C).

25 **D** The R_f value is a ratio of the distance travelled by a component to the solvent front. [1]

R_f is the distance moved by the substance divided by the distance moved by the solvent front.

The first statement is wrong because R_f depends on the solvent, so a value is only fixed for one substance in one solvent. Locating agents are for colourless substances, not coloured inks. The start line must be above the solvent level, or it would dissolve into the solvent.

26 **A** Ponceau 4R [1]

R_f = distance moved by the spot ÷ distance moved by the solvent front. Ponceau 4R gives 42 ÷ 60 = 0.70, carmoisine 45 ÷ 74 = 0.61, fast red 27 ÷ 67 = 0.40 and erythrosine 17 ÷ 58 = 0.29.

The more soluble a colour is in the solvent, the further it travels with the solvent, so the most soluble colour has the largest R_f value: Ponceau 4R.

27 **C** measure its melting point [1]

A pure substance has a specific melting point. A mixture melts over a range of temperatures, so the melting point shows whether the powder is pure.

Burning it, a solubility test and testing conductivity do not show how many substances are present.

28 **B** measure its boiling point [1]

A pure liquid boils at one specific temperature under fixed conditions. A mixture boils over a range, so the boiling point shows whether the liquid is pure ethanol.

Burning, reacting with ethanoic acid and testing with litmus paper do not show whether other substances are present.

29 **A** a drug for curing diseases [1]

Impurities in a drug can harm the patient, so a drug must be pure.

Airplane bodies are made from aluminium alloys, petrol is a mixture of hydrocarbons, and tap water contains dissolved substances that are safe to drink.

30 **B** crystallisation, 125 °C [1]

X melts at about 120 °C, so it is a solid at room temperature. A solid is purified by crystallisation.

Impurities lower the melting point, so pure X melts above 120 °C, at 125 °C.