K18 Separating Mixtures and Solutions

AQA AQA KS3 Science - Chemistry · Calculator allowed · about 75 minutes

Name: ______________________________ Date: ____ / ____ / ______

Answer ALL questions. Show all your working.

1 Name the substance in a solution that is dissolved and the substance that does the dissolving. Example: sugar dissolved in water.

(1)

2 A student adds small scoops of salt to 100 g of water at 20 degrees C until no more salt dissolves and extra salt stays as grains on the bottom. State what is meant by a saturated solution, and use this experiment to give one sentence that shows the solution is saturated.

(2)

3 Priya mixes sand and salt and then adds water so the salt dissolves. Which method should she use first to separate the sand from the salt solution? Give a short reason for your choice.

(2)

4 Describe how you would obtain dry salt crystals from the salt solution left after filtration. Give two steps in order.

(3)

5 A student performs simple distillation to separate pure water from seawater. Describe two differences between evaporation and simple distillation in how they separate mixtures.

(4)

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6 Chromatography is used to separate the different dyes in a black ink pen. Explain the role of the solvent in paper chromatography.

(3)

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7 A student tests solubility by adding 20 g of a solid to 100 g of water at 20 degrees C. After stirring, 5 g of solid remains undissolved. Calculate the solubility of the solid in g per 100 g water at 20 degrees C.

(4)

8 A chromatography experiment uses a strip of paper. The start line is drawn at 2.0 cm from the bottom. The solvent front moves to 12.0 cm from the bottom. A blue spot originally at 2.0 cm travels to 7.0 cm. Calculate the Rf value of the blue dye. Then suggest one practical reason why using the same solvent and same paper is important when comparing Rf values between different students.

(a) Calculate the Rf value of the blue dye. Rf = distance moved by dye / distance moved by solvent front. **(2)**

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(b) Suggest one practical reason why using the same solvent and same paper is important when comparing Rf values between different students. **(3)**

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9 You are given a mixture of sand, salt, and methylated spirits (a liquid that does not mix with water). Describe a clear plan to separate and collect each component as pure as possible. Explain your choices and any steps you would take to make the method fair, safe and practical. You may draw a simple labelled diagram in your answer if it helps. Your answer will be marked for the quality of scientific explanation and the clarity of your method.

(6)

10 An experiment compares the solubility of potassium nitrate at two temperatures. A student dissolves 30 g of potassium nitrate in 100 g of water at 25 degrees C and finds it all dissolves. At 5 degrees C the student dissolves 30 g in 100 g water and 12 g remains undissolved. Use the data to answer the parts.

(a) Calculate the solubility of potassium nitrate at 5 degrees C in g per 100 g water. **(2)**

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(b) Give one conclusion about how temperature affects the solubility of potassium nitrate, using the data. **(2)**

(c) Name one experimental improvement the student could make to reduce random error when measuring how much solid dissolves. **(2)**

11 A student uses filtration to separate a mixture of charcoal fines and salt solution. After filtering, the student notices the filtrate is slightly cloudy. The student suspects fine charcoal particles passed through the filter. Answer the parts below.

(a) Give two possible mistakes the student could have made that would allow charcoal to pass through the filter. **(2)**

(b) Suggest two improvements the student could make to obtain a clear filtrate. **(3)**

(c) If the student wanted to obtain pure salt from the clear filtrate, outline the main steps they should follow after obtaining the clear solution. (Max 3 steps.) **(3)**

12 A student is given a mixture composed of 10 g of sugar, 10 g of sand and 20 g of an oily liquid that does not mix with water. The student plans to separate and weigh each component. The student follows these steps and records the mass obtained for each component at the end: 1) Add 50 g of water, stir and allow to settle. 2) Use a separating funnel and drain the lower aqueous layer into a beaker, leaving the oily layer in the funnel. 3) Filter the aqueous layer to remove any sand and then evaporate the water to obtain sugar crystals. The student reports the following masses after drying: oily liquid 19.0 g, sand 9.2 g, sugar 9.0 g. Use the data to answer the parts.

(a) Calculate the total mass recovered by the student and compare it to the original total mass of the mixture. Show your working and state the difference in grams. **(4)**

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(b) Suggest three plausible reasons, related to technique or apparatus, that could explain the loss of 2.8 g during the separation and collection. Give brief explanations for each reason. **(6)**

(c) The teacher suggests an improved method to reduce loss: rinse the separating funnel and filter paper with small amounts of solvent or water and include the rinsings with the correct fraction, and dry samples thoroughly before weighing. Explain how rinsing and careful drying would reduce the mass loss or measurement error. Give two separate points. **(6)**

Mark scheme · K18 Separating Mixtures and Solutions

Question 1

- **B1** solute and solvent, in either order, cao
- Answer: **solute; solvent**

Question 2

- **M1** definition that no more solute will dissolve at that temperature or solution contains the maximum amount of solute for that temperature
- **A1** reference to the experiment such as "extra salt stays undissolved on the bottom" or "adding more salt does not dissolve" cao
- Answer: **A saturated solution contains the maximum amount of solute that can dissolve at that temperature; in the experiment the extra salt stays undissolved on the bottom so the solution is saturated.**

Question 3

- **M1** filtration named
- **A1** reason that sand is insoluble and will be trapped by the filter leaving the salt solution cao
- Answer: **Filtration; sand is insoluble and will be left on the filter while the salt passes into the solution**

Question 4

- **M1** evaporate or gently heat the salt solution to remove most of the water / concentrate the solution
- **M1** leave to cool or allow remaining water to evaporate so crystals form
- **A1** mention collecting, scraping or drying the crystals (eg remove and dry crystals) cao
- Answer: **Gently heat the salt solution to evaporate water until crystals start to form; then leave to cool and dry and collect the dry salt crystals**

Question 5

- **M1** evaporation removes solvent by heating until solvent evaporates leaving solute behind
- **M1** simple distillation collects vapour which is then cooled and condensed into a separate container
- **A1** state that evaporation does not collect the liquid while distillation does (collects liquid) cao
- **A1** state that distillation gives a purer collected liquid because vapour is condensed leaving non-volatile impurities behind or mention control of temperature cao
- Answer: **Evaporation turns water into vapour and leaves the salt behind without collecting the water; simple distillation condenses the vapour to collect pure water in another container, giving a purer collected liquid.**

Question 6

- **M1** solvent moves up the paper carrying the dye mixture
- **M1** different dyes dissolve to different extents or travel at different speeds in the solvent
- **A1** so components separate because of different solubility or different attraction to the paper and solvent cao
- Answer: **The solvent moves up the paper carrying the dyes; different dyes dissolve differently and travel at different speeds, so they separate on the paper**

Question 7

- **M1** correct subtraction to find dissolved amount 20 - 5 = 15 g
- **M1** recognise solubility is dissolved mass per 100 g water
- **A1** 15 g per 100 g water cao
- **B1** unit stated as g per 100 g water or g/100 g, cao
- Answer: **15 g per 100 g water**

Question 8

- (a) **M1** correct distances: dye moved = 7.0 - 2.0 = 5.0 cm and solvent moved = 12.0 - 2.0 = 10.0 cm
- (a) **A1** Rf = 5.0 / 10.0 = 0.50 cao
- (a) Answer: **0.50**
- (b) **M1** state that different solvents or paper can change how far dyes travel
- (b) **M1** link to comparing results eg so Rf values are comparable between students
- (b) **A1** give a practical example such as solvent strength or absorbency affecting distance travelled cao
- (b) Answer: **Different solvents or paper change how far dyes travel, so using the same solvent and paper makes Rf values comparable; for example a stronger solvent would carry dyes further.**

Question 9

- **Level 3** (5-6): Detailed method with correct sequence to separate all three components, clear scientific explanation of why each step works, and consideration of fairness, safety and practicality. Uses correct separation ideas such as decanting, filtration, separating funnel or use of a solvent, and includes ways to dry and collect solids.
- **Level 2** (3-4): Method separates most components with some correct reasons. May include one missing detail or minor inaccuracy in sequence or in explanation of how techniques separate components.
- **Level 1** (0-2): Simple or incomplete method with little explanation. May name techniques but not explain why they work or how to collect pure samples.
- **Indicative content:**
  - Use a separating funnel or careful decanting to remove the methylated spirits because it is immiscible with water and will form a separate layer if water is added; collect the spirit layer into a clean container.
  - Add water to the remaining solid mixture so the salt dissolves but sand remains insoluble; stir and then filter to separate sand from the salt solution.
  - Evaporate or gently heat the salt solution to crystallise and collect dry salt; dry the sand and the methylated spirits container appropriately.
  - Mention safety: methylated spirits are flammable so work away from flames and use a fume cupboard or well ventilated area, wear goggles and gloves.
  - Discuss fairness and purity: use clean apparatus, avoid cross contamination by using separate containers, repeat filtration if needed, and allow time to dry to obtain pure solids.

Question 10

- (a) **M1** calculate dissolved amount 30 - 12 = 18 g
- (a) **A1** 18 g per 100 g water cao
- (a) Answer: **18 g per 100 g water**
- (b) **M1** state that solubility increases with temperature or solubility at 25 degrees C is greater than at 5 degrees C
- (b) **A1** use data to support statement eg 30 g dissolves at 25 degrees C but only 18 g dissolves at 5 degrees C cao
- (b) Answer: **Solubility increases as temperature increases; 30 g dissolves at 25 degrees C but only 18 g dissolves at 5 degrees C.**
- (c) **M1** suggestion such as repeat the experiment and take an average, use more accurate balance, ensure constant temperature with a water bath, or use same stirring time
- (c) **A1** brief explanation of how this reduces error eg repeats reduce random variation or water bath keeps temperature constant
- (c) Answer: **Repeat the experiment and take the average, or use a water bath to keep temperature constant to reduce random error.**

Question 11

- (a) **B1** filter paper folded incorrectly or wrong pore size (eg too large)
- (a) **B1** filter not wetted/secured so mixture bypassed the paper or pouring too quickly causing particles to be pushed through
- (a) Answer: **Possible mistakes: using filter paper with pores too large or folding/setting the paper incorrectly; pouring too quickly so particles pass through or not wetting the paper so it does not seal.**
- (b) **M1** use finer filter paper or a filter funnel with smaller pores
- (b) **M1** pour slowly and in small portions, or pre-wet the filter paper to create a seal
- (b) **A1** mention alternate methods such as decanting before filtration or using centrifuging or using multiple filtration steps to remove fine particles
- (b) Answer: **Use finer filter paper and pour slowly in small portions, pre-wetting the paper so it seals; alternatively decant and re-filter or use centrifuging to remove fine particles.**
- (c) **M1** evaporate or gently heat the filtrate to concentrate it
- (c) **M1** leave to cool so crystals form
- (c) **A1** collect and dry the crystals or scrape and dry the crystals (eg remove and dry crystals) cao
- (c) Answer: **Gently evaporate the filtrate to concentrate it, leave to cool so salt crystals form, then collect and dry the crystals.**

Question 12

- (a) **M1** correct addition of recovered masses 19.0 + 9.2 + 9.0 = 37.2 g
- (a) **M1** correct statement of original total mass 10 + 10 + 20 = 40 g
- (a) **A1** calculate difference 40 - 37.2 = 2.8 g cao
- (a) **A1** state that recovered mass is 37.2 g which is 2.8 g less than original
- (a) Answer: **Total recovered 37.2 g; original mass 40 g; difference 2.8 g (less recovered).**
- (b) **M1** loss could be due to incomplete transfer of oily liquid from separating funnel (eg some left on walls), with brief explanation
- (b) **M1** loss of sugar during filtration or crystallisation (eg some sugar remained dissolved in water or stuck to filter paper), with brief explanation
- (b) **M1** sand lost during transfers or stuck to glassware, with brief explanation
- (b) **M1** evaporation losses when drying crystals (splashing or carry-over) or incomplete drying leading to underestimation, with brief explanation
- (b) **M1** weighing error such as balance not tared or sample not cooled before weighing, with brief explanation
- (b) **M1** contamination or mixture of layers causing some mass to be unassigned, with brief explanation
- (b) Answer: **Possible causes: oily liquid left on funnel walls; some sugar remained dissolved or stuck to filter paper; sand lost during transfers; evaporation losses or incomplete drying; balance or weighing procedure errors; or contamination between layers.**
- (c) **M1** rinsing recovers material stuck to glassware or filter paper and returns it to the correct fraction
- (c) **A1** explain that rinsing increases recovered mass because residues are washed into the correct container instead of being left behind
- (c) **M1** careful drying ensures that water or solvent is removed before weighing
- (c) **A1** explain that drying avoids measuring extra mass from solvent or underestimating mass when wet, improving accuracy
- (c) **M1** mention practical step such as using a warm oven or desiccator or leaving to dry to constant mass
- (c) **A1** link to how this reduces random or systematic error in the final mass measurement
- (c) Answer: **Rinsing washes residues from the funnel and filter paper into the correct collection vessel so less sample is left behind, increasing recovered mass. Careful drying removes water or solvent so the measured mass is of the substance only; drying to constant mass avoids systematic under- or overestimation.**