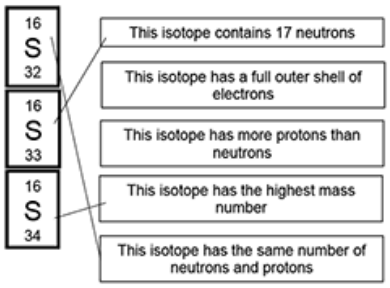
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			(Formulation) B ✓ B has highest melting point / **ORA** / B is solid at the highest temperature ✓	2 (2 x AO 3.2a)	**MP2 is dependent on MP1** **ALLOW** idea that B has the highest temperature before it changes state **Examiner's Comments** Most candidates correctly selected formulation B, with many then able to explain their choice in terms of melting point to gain 2 marks. Lower attaining candidates focused their answers on comparing the shapes of the graphs, for example the steepness of the lines or the times taken for the lines to plateau, without understanding that this represented the solid melting.
			Total	**2**	
2	a		The measured volume will be greater than the actual volume. ☐ The measured volume will be smaller than the actual volume. ☑ ✓ The measured volume will be the same as the actual volume. ☐	1 (AO 3.2b)	**Examiner's Comments** 'The measured volume will be greater than the actual volume' was a commonly chosen distractor.
	b	i	**First check the answer on answer line** **If answer = 24.0 (cm^3) award 1 mark** Average titre = $\frac{24.1 + 23.9 + 24.0}{3}$ = 24.0 (cm^3) ✓	1 (AO 2.2)	**ALLOW** 24 (cm^3) **ALLOW** Average titre = $\frac{24.1 + 24.0}{2}$ = 24.05(cm^3) **ALLOW** Average titre = $\frac{23.9 + 24.0}{2}$ = 23.95(cm^3) **Examiner's Comments** Lower attaining candidates calculated the average of all 4 results, including the anomalous result in their calculation.

		ii	**First check the answer on answer line** **If answer = 4.7 / 4.70 / 4.704 / 4.71 / 4.7088 (g/dm^3) award 5 marks** Moles of $KOH = \frac{0.100 \times 24.0}{1000}$ / 0.100 x 0.024 / 0.0024 ✓ Moles of $H_2SO_4 = \frac{0.0024}{2}$ / 0.0012 ✓ Concentration of $H_2SO_4 = \frac{0.0012}{0.025} = 0.048$ (mol/dm^3) ✓ M_r of H_2SO_4 = 98.0 / 98.1 ✓ Concentration of H_2SO_4 in g/dm^3 = 98 × 0.048 = 4.70 (g/dm^3) **or** Concentration of H_2SO_4 in g/dm^3 = 98.1 × 0.048 = 4.71 (g/dm^3) ✓ **OR for MP3, 4 & 5:** Mr of H_2SO_4 = 98.0 / 98.1 ✓ Mass of H_2SO_4 = 98.0 × 0.0012 = 0.1176 g **or** Mass of H_2SO_4 = 98.1 × 0.0012 = 0.1177 g ✓ Concentration of H_2SO_4 in g/dm^3 = 0.1176 ÷ 0.025 =4.70 (g/dm^3) **or** Concentration of H_2SO_4 in g/dm^3 = 0.1177 ÷ 0.025 = 4.71 (g/dm^3)	5 (5 × AO 2.2)	**ALLOW ECF** from average titre in part **(i)** **ALLOW ECF** from moles of KOH unit not needed **ALLOW ECF** from moles of alkali i.e., concentration $= \frac{\text{moles}}{0.025}$ / $\frac{\text{moles x 1000}}{25}$ **ALLOW ECF** from concentration of H_2SO_4 **ALLOW ECF** from moles of H_2SO_4 **ALLOW ECF** from mass of H_2SO_4 Answer is 4.7138 (g/dm^3) if answer for **(b)(i)** is 24.05 cm^3 or 4.6942 (g/dm^3) if answer for **(b)(i)** is 23.95 cm^3 **Examiner's Comments** Around a quarter of candidates were given all 5 marks. Higher attaining candidates were able to calculate the concentration of sulfuric acid in g/dm^3. Error carried forward was given from an incorrect titre in part (b) (i). **Assessment for learning** Examiners use **bold type** to draw the candidates' attention to key aspects of a question. Despite the emboldening of '**in g/dm^3**' in this question, many candidates calculated the concentration in mol/dm^3. Exemplar 3

					 This response gained full marks for this titration calculation. The candidate has clearly set out their working out, making it easy for the examiner to follow. The candidate has calculated the moles of potassium hydroxide. They have appreciated the mole ratio and correctly calculated the moles of sulfuric acid, going on to use this to calculate the concentration of the acid. The candidate has then calculated the relative molecular mass of sulfuric acid and used this to convert the concentration in mol/dm^3 to g/dm^3.
			Total	**7**	
3	a		Idea of using filtration to separate the sand from the water and dissolved salt ✓ Idea of using distillation to collect the water from the salt solution ✓ Idea that the salt is left in the flask (after removal of the water by distillation) ✓ Correct choice of apparatus for at least one of the 3 stages of the method ✓	4 (4 × AO 3.3a)	Marks can be awarded from labelled diagrams **DO NOT ALLOW** stages in incorrect order **ALLOW** idea of salt remaining after water is evaporated **Examiner's Comments** Most candidates were able to describe the separation of sand, water and salt using filtration, distillation, and crystallisation. Less successful candidates missed out the distillation step and wrote about filtration followed by crystallisation. **Assessment for learning**

					Candidates should be encouraged to include **labelled** diagrams in questions that ask them to describe an experimental method. Many candidates scored the majority, if not all, of the marks in this question from labelled diagrams. **OCR support** Our Candidate Exemplars show how this can be used to good effect and is a great way of showing students how to make the most of this skill.
	b	i		2 (2 × AO 2.1)	All three correct = 2 marks Two correct = 1 mark **Examiner's Comments** Most candidates correctly matched the three isotopes to their descriptions.
		ii	**First check the answer on answer line** **If answer = 121.3 award 2 marks** 33 + (4 × 16) + 24.3 ✓ = 121.3 ✓	2 (2 × AO 2.2)	**Examiner's Comments** Most candidates correctly calculated the relative formula mass of magnesium sulfate. The most common incorrect response was 24.3 + 33 + 16 = 73.3.
		iii	Solvent / mobile phase ✓	1 (AO 3.3b)	**IGNORE** use a different liquid **IGNORE** change the concentration of the solvent **DO NOT ALLOW** (change) the stationary phase **Examiner's Comments** Many candidates correctly stated the need to change the solvent.

					The most common incorrect responses were: • use gas chromatography • melt the magnesium sulfate • increase the concentration of the solvent or use more solvent • change the stationary phase • add water.
	•	iv	Strong electrostatic attraction (between oppositely charged ions) / strong forces between oppositely charged ions / strong ionic bonds ✓ Lots of energy is required to overcome the forces / bonds ✓	2 (2 × AO 2.1)	**DO NOT ALLOW** references to intermolecular forces, covalent bonds or metallic bonds – scores 0 for question **Examiner's Comments** Successful responses to this question described the strong electrostatic attraction between oppositely charged ions, which needs lots of energy to overcome. Less successful responses referred to intermolecular forces, even after identifying the bonding in magnesium sulfate as ionic. **Assessment for learning** Candidates should be encouraged to use correct terminology. Many candidates attempted to explain the high melting point of magnesium sulfate in terms of covalent bonds or intermolecular forces. The term intermolecular forces appeared to be used by candidates without understanding of what they are or what type of structure possesses them.
			Total	**11**	
4			D	1 (AO 2.2)	
			Total	**1**	
5			A	1 (AO 2.2)	

			Total	**1**	
6			C	1 (AO 2.1)	
			Total	**1**	
7			B	1 (AO 1.2)	
			Total	**1**	
8	a	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.73 / 0.75 / 0.74 award 3 marks** R_f = distance moved by dye / distance moved by solvent ✓ **BUT** R_f = 4.4 ÷ 6 / Rf = 4.5 ÷ 6 / Rf = 4.45 ÷ 6 ✓ ✓ **THEN** R_f = 0.73 / Rf = 0.75 / Rf = 0.74 (2 significant figures) ✓	3 (1×AO1.1) (2 ×AO2.1)	R_f calculation scores MP1 and 2 **ALLOW** ECF for sig fig mark **Examiner's Comments** Many candidates gained 3 marks on this question. The most common error was R_f = distance moved by solvent ÷ distance moved by dye. **Assessment for learning** Centres should remind candidates that they should measure to the centre of the spot on a chromatogram.
		ii	(Cake) 1 and (cake) 3 ✓ Idea that the spots in the dyes from cakes 1 and 3 match / cakes 1 and 3 both contain blue and yellow colours / idea that blue and yellow spots in cakes 1 and 3 have the same R_f values / idea that the dye in cake 2 contains different substances ✓	2(2 ×AO3.2b)	Second marking point is dependent on choice of cakes 1 and 3 **ALLOW** cakes 1 and 3 have the same substances in them **Examiner's Comments** Good responses identified cake 1 and cake 3, appreciating that the blue and yellow spots in these cakes have the same R_f values.
	b	i	Formulation ✓	1(AO1.1)	**Examiner's Comments** The definition or meaning of a formulation was not well known. Examiners saw a wide range of incorrect responses including, most frequently, compound, alloy, polymer,

					solution, equal mixture and impure mixture.
		ii	Alloy ✓	1(AO1.1)	**Examiner's Comments** Most candidates identified brass as an alloy. The most common incorrect response was allotrope
	c		(Use a different) solvent / mobile phase ✓	1(AO3.3b)	**ALLOW** (use a different) stationary phase **Examiner's Comments** Many candidates did not appreciate the need to change the solvent to separate the blue and yellow spots. Common incorrect responses described spreading the blue and yellow spots along the baseline to improve the experiment. Other suggestions included increasing the length of the paper, using more solvent, leaving the experiment for a longer time, or using more dye.
			Total	**9**	
9			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3.92 (g) award 5 marks** M_r of H_2SO_4 = 98.1 **AND** $(NH_4)_2SO_4$ = 132.1 ✓ Theoretical yield of $(NH_4)_2SO_4$ = $\frac{4.22 \times 100 / 5.275}{80}$ /5.28 ✓ Mass of H_2SO_4 = $5.275 \times \frac{98.1}{132.1}$ / $5.28 \times \frac{98.1}{132.1}$ ✓ = 3.917 / 3.921 ✓ **BUT** 3.917 / 3.921 without working out ✓ ✓ To 3 **sig figs** = 3.92 (g) ✓	5 (4 ×AO2.2) (1 ×AO1.2)	**ALLOW** ECF from incorrect M_r **ALLOW** ECF from incorrect theoretical yield eg Mass of H_2SO_4 = $\frac{4.22 \times 98.1}{132.1}$ ✓ = 3.13385 ✓ **BUT** 3.13385 without working out ✓ ✓ **ALLOW** ECF for sig fig mark **Examiner's Comments** Good responses to this question calculated the theoretical yield of ammonium sulfate as 5.275g, and hence the mass of sulfuric acid used as 3.92g. A significant number of candidates correctly worked out the theoretical yield but then continued their

					calculation using 4.22g as the theoretical yield. Many candidates scored 2 marks, usually for the 2 correct M_r values and an answer to 3 significant figures. **Assessment for learning** Appendix 5e of the specification lists the mathematical skills that will be assessed within the context of relevant chemistry. Skill M2a requires candidates to use an appropriate number of significant figures. Incorrect rounding to 3 significant figures, giving 3.917, was a common error.
			Total	**5**	
10			B ✓	1(AO2.2)	
			Total	**1**	
11			C ✓	1(AO2.1)	
			Total	**1**	
12			A ✓	1(AO2.1)	
			Total	**1**	
13			C ✓	1(AO1.2)	
			Total	**1**	