OCR GCSE GATEWAY CHEMISTRY A · J248

CHEMISTRY



MARK SCHEME

C2.1 PURITY AND SEPARATING MIXTURES

SCORE	PERCENTAGE
/213	%

STEMUP

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Question			Answer/Indicative content	Marks	Guidance
1			B	1	
			Total	**1**	
2			Slow evaporation of solution / heat solution over a steam bath (1)	1	
			Total	**1**	
3			B	1	
			Total	**1**	
4			C	1	
			Total	**1**	
5			A	1	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
6	a		**Please refer to point 10 of the marking instructions of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** **Suggestion would enable pure samples of all three components to be obtained in the correct sequence with clear explanations of why the methods work.** *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** **Suggestion would enable pure samples of two of the components of the mixture to be obtained with an attempt at an explanation.** *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** **Suggestion would enable a pure sample of one of the components to be obtained.** *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** *No response or no response worthy of credit.*	6	**AO1.2: Knowledge of process of fractional distillation** • Use fractional distillation to separate substance **A** from substance **B**. • Substance **B** will come off first as it has lowest boiling point. • Stronger forces between molecules in substance **A** / ora. **AO2.2: Apply knowledge of process of fractional distillation** • Fractional distillation works as substances **A** and **B** have different boiling points. • As substance **C** is insoluble in water. • Because there are differing forces of attraction between the molecules. **AO3.3a: Analyse information in the table to develop experimental procedure** • Heat mixture to boil off substances **A** and **B** leaving pure **C**. • Filter mixture to remove substance **C**. • Substance **C** can be washed with water and dried.
	b		measure its melting point or boiling point (1) if pure melting point or boiling point will be sharp / if impure melting point is lowered / if impure boiling point is elevated (1)	2	
			Total	**8**	
7			D	1	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
8			A	1	
			Total	**1**	
9			B	1	
			Total	**1**	
10			A	1	
			Total	**1**	
11			C	1	
			Total	**1**	
12			A	1	
			Total	**1**	
13			D	1	
			Total	**1**	
14			negative electrode / cathode – copper deposited (1) positive electrode / anode – anode dissolves / copper ions formed (1)	2	
			Total	**2**	
15	a		During this reaction, the oxidising agent is **oxygen** and the reducing agent is **magnesium** (1)	1	
	b		$2Mg(s)$ (1) + $O_2(g)$ (1) $\longrightarrow$ $2MgO(s)$	2	
			Total	**8**	

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Question			Answer/Indicative content	Marks	Guidance
16	a		Level 3 Describes two stages of extracting drug from plant material AND Explains why the drug is impure using both melting point and chromatography data. Quality of communication does not impede communication of science at this level. (5-6 marks) Level 2 Answer describes one stage of extracting drug from plant material AND explains why the drug is impure using either melting point or chromatography data OR Answer describes two stages of extracting drug from plant material. OR Explains why the drug is impure using both melting point and chromatography data. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) Level 1 Describes one stage of extracting drug from plant material OR Explains why the drug is impure using either melting point or chromatography data. Quality of communication impedes communication of the science at this level. (1 – 2 marks) Level 0 Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to C Indicative scientific points for extraction may include: • Crushing (plant material) • Boiling (with a solvent) • Dissolving (with a solvent) / solvent extraction • Chromatography • Crystallisation • Evaporation • Filtration Indicative scientific points for analysis may include: • Drug is impure • Chromatography shows that there are (at least) two substances (so not pure) • Melting point is below that of the pure sample so not pure • Melting point is a range so not pure Use the L1, L2, L3 annotations in Scoris, do not use ticks <u>Examiner's Comments</u> This question was about pharmaceutical drugs. The six mark question was a common question with the higher tier examination paper and candidates found it very challenging. Most candidates were not able to use the melting point or chromatography data to explain why the sample was impure. Candidates did not appreciate that the two spots on the chromatography paper indicated two compounds. In terms of describing how the drug is extracted from a plant most candidates gave the name of a process but were not able to give an accurate description of what happened with the process. A significant proportion of the candidates made no

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Question			Answer/Indicative content	Marks	Guidance
					attempt to answer the question.
	b		any two from idea that the drug must be as pure as possible (1) idea that the drug must have no side effects / needs to be safe to use / not addictive (1) idea that the drug must have been extensively trialled / idea that the drug does what it is supposed to do (1)	2	Examiner's Comments This question was about pharmaceutical drugs. Candidates often appreciated that the drug must be tested to avoid side-effects. Better answers suggested that the drug had to be tested to see that it actually worked. Very few candidates mentioned the need to get the drug as pure as possible.
			Total	8	
17			(2 x 23) + 12 + (3 x 16) (1)	1	mark is for the working out and **not** for the final answer **allow** 23 + 23 + 12 + 16 + 16 + 16 etc. Examiner's Comments This question was about the thermal decomposition of sodium hydrogencarbonate. Most candidates were able to show how to calculate the relative formula mass of sodium hydrogencarbonate.
			Total	1	

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>18</td><td>a</td><td></td><td><table><tr><th>Alloy</th><th>Metallic element</th></tr><tr><td>amalgam</td><td>(copper)</td></tr><tr><td>bronze</td><td>mercury</td></tr><tr><td>solder</td><td></td></tr></table>(2)</td><td>2</td><td>All four correct (2)

Two or three correct (1)

Ignore any extra metals or alloys included in the table

<u>Examiner's Comments</u>

This question was about metals and alloys.

Candidates were rarely able to classify the four materials into alloys and metallic elements. Often candidates managed to get two correct but often one of the alloys was classified as an element. Some candidates put the same material is both columns.</td></tr>
<tr><td></td><td>b</td><td></td><td>duralumin (no mark)

low density (1)

high strength / strong (1)</td><td>2</td><td>allow steel because it has the highest strength / steel because it is strong for one mark

<u>Examiner's Comments</u>

This question was about metals and alloys.

Most candidates chose steel as the best material to make an aeroplane quoting its high strength as their reason. Candidates rarely appreciated the importance of both low density and strength and so seldom gave duralumin as the answer.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
19	a		Level 3] Describes two stages of extracting drug from plant material AND Explains why the drug is impure using both melting point and chromatography data. Quality of communication does not impede communication of science at this level. (5-6 marks) [Level 2] Describes one stage of extracting drug from plant material AND explains why the drug is impure using either melting point or chromatography data OR Describes two stages of extracting drug from plant material OR Explains why the drug is impure using both melting point and chromatography data. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) [Level 1] Describes one stage of extracting drug from plant material OR Explains why the drug is impure using either melting point or chromatography data. Quality of communication impedes communication of the science at this level. (1 – 2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to C Indicative scientific points for extraction may include: • Crushing (plant material) • Boiling (with a solvent) • Dissolving (with a solvent) / solvent extraction • Chromatography • Crystallisation • Evaporation • Filtration Indicative scientific points for analysis may include: • Drug is impure • Chromatography shows that there are (at least) two substances (so not pure) • Melting point is below that of the pure sample so not pure • Melting point is a range so not pure Use the L1, L2, L3 annotations in RM Assessor; do not use ticks Examiner's Comments This question focused on pharmaceutical drugs. This 6 mark question focused on how drugs are obtained from plants was targeted up to grade C. Candidates were also required to draw conclusions about the purity of a drug from melting point and chromatography data. At the simplest level, candidates who described one stage in extracting the drug from plant material, or drew a conclusion using one piece of data, scored Level 1. Many candidates gained credit at Level 2 by describing two stages of the drug extraction. A description of two stages of the drug extraction and an explanation of why the drug is impure

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Question			Answer/Indicative content	Marks	Guidance
					using both melting point and chromatography data was required to gain credit at Level 3. Of the two test results, the melting point was discussed correctly more frequently than the chromatography. A common misconception was that the drug was pure because the melting point was close to the pure sample.
	b		**any two from:** idea that takes a (very) long time to get results (1) idea that need to test on humans which has ethical issues (1) idea the side effects may take a long time to show (1) idea that strict safety laws have to be met (1)	2	**allow** idea that many tests need to be carried out (in developing a drug) (1) **allow** idea that animal testing has ethical issues (1) **allow** idea that difficult to find human volunteers to test drugs (1) **ignore** references to cost / need for skilled workers <u>Examiner's Comments</u> This question focused on pharmaceutical drugs. Good responses to this question described ideas such as the length of time to get results and that testing on humans or animals has ethical issues. When candidates did not gain credit it was often because they referred to cost and the need for skilled workers, as have been answers in previous exam papers to slightly different drug related questions. Many also commented on the testing on animals being banned or against the law rather than referring to it being unethical. The idea that drugs may react differently on animals to humans was also a common answer which did not gain credit.
			Total	8	

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>20</td><td></td><td></td><td>
<table>
<tr><th>Alloy</th><th>Metals in the alloy</th></tr>
<tr><td>amalgam</td><td>mercury</td></tr>
<tr><td>brass</td><td>copper and zinc</td></tr>
<tr><td>solder</td><td>lead and tin</td></tr>
</table>
</td><td>2</td><td>all correct (2)
one or two correct (1)

for amalgam, allow mercury and zinc / silver / copper / tin

<u>Examiner's Comments</u>

This question was about alloys.

Examiners saw a wide range of incorrect responses in this question.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
21	a		$4Al + 3O_2 \rightarrow 2Al_2O_3$ formulae (1) balancing - mark is conditional on correct formulae (1)	2	**allow** correct multiples e.g. $2Al + {}^3/_2O_2 \rightarrow Al_2O_3$ **allow** = or → instead of → **not** 'and' or & instead of + **allow** one mark for correct balanced equation with minor errors of case, subscript and superscript e.g. $4AL + 3O^2 \rightarrow 2Al_2o_3$ (1) Examiner's Comments This question was about alloys. Many candidates were able to write the correct balanced symbol equation for the reaction of aluminium with oxygen to make aluminium oxide. One mark was awarded for the correct reactants and products and 1 mark for the correct balancing. The balancing mark was dependent on the correct formulae, but 1 mark was allowed for a balanced equation with a minor error in subscripts or formulae. When candidates did not gain marks it was often because they tried to balance the equation by writing Al_2 or Al_23O_2.

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>b</td><td>i</td><td>
<table>
<tr><th>Alloy</th><th>Advantages</th><th>Disadvantages</th></tr>
<tr><td>A</td><td>low density / high strength</td><td>high cost</td></tr>
<tr><td>B</td><td>high strength</td><td>high density</td></tr>
<tr><td>C</td><td>high strength / low cost</td><td>high density</td></tr>
<tr><td>D</td><td>low density / low cost</td><td>low strength</td></tr>
</table>
all eight cells in table correct (3)
</td><td>3</td><td>five, six or seven correct (2)

three or four correct (1)

allow AW eg cheap / expensive / strong / weak / dense / lightweight
ignore light / heavy

ignore medium cost in relation to B
ignore answers which merely quote numbers from the table

<u>Examiner's Comments</u>

This question was about alloys.

Most candidates successfully evaluated the advantages and disadvantages of the four alloys for making aeroplane wings in part (i). Marks were lost most commonly for writing ‘heavy’ instead of high density, or putting high density in the advantages boxes / low density in the disadvantages boxes.</td></tr>
<tr><td></td><td></td><td>ii</td><td>A (1)</td><td>1</td><td><u>Examiner's Comments</u>

This question was about alloys.

In part (ii) C was a common incorrect choice.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>6</td><td></td></tr>
<tr><td>22</td><td></td><td></td><td>bitumen (1)</td><td>1</td><td>allow phonetic spelling

Examiner's Comments

Many candidates could interpret the data in the table.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
23	a		46 (1)	1	**ignore** units **Examiner's Comments** Most candidates could correctly calculate the relative formula mass of ethanol.
	b		280 (g) (1)	1	unit **not** needed **ignore** incorrect units **Examiner's Comments** Just over half of all candidates could correctly work out the mass of carbon monoxide needed for the reaction.
	c		atom economy = $\frac{60}{60+18}$ / $\frac{60}{46+32}$ / $\frac{60}{78}$ (1) **but** atom economy = $\frac{60}{60+18} \times 100$ / $\frac{60}{46+32} \times 100$ / $\frac{60}{78} \times 100$ (2)	2	**allow** atom economy formula in words for one mark i.e. atom economy = $\frac{\text{total Mr of desired products}}{\text{total Mr of all products}} \times 100$ (1) or atom economy = $\frac{\text{total Mr of desired products}}{\text{total Mr of all reactants}} \times 100$ (1) **Examiner's Comments** Just over half of all candidates could correctly work out the mass of carbon monoxide needed for the reaction.
	d		percentage yield = $\frac{9.5}{9.8}$ (1) **but** percentage yield = $\frac{9.5}{9.8} \times 100$ (2)	2	**allow** percentage yield formula in words for one mark e.g. percentage yield = $\frac{\text{actual yield}}{\text{predicted yield}} \times 100$ or percentage yield = $\frac{\text{am}}{\text{pm}} \times 100$ **Examiner's Comments** Although better answered than part (d), a significant number of candidates omitted the question. Better candidates showed a good understanding of the ideas involved, scoring both marks.

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Question			Answer/Indicative content	Marks	Guidance
			Total	6	
24	a		198 (1)	1	**ignore** any unit given Examiner's Comments Almost two thirds of candidates scored this mark. '111' was seen which takes no account of the number of each type of atom.
	b	i	0.33 (1)	1	Examiner's Comments Again two thirds of candidates scored the mark.
		ii	33 (1)	1	**allow** ecf from (i) **allow** 32.32 or 32.3 (1) Examiner's Comments This part allowed for error carried forward. A number of candidates worked out the percentage using the molar mass of K_2FeO_4 and the relative atomic mass of oxygen. Full credit was given for this approach with the answer being 32.32%.
	c		C_2H_5 (1)	1	**allow** any order of symbols **not** C^2H^5 / C2H5 / or use of lower case H Examiner's Comments The concept of empirical formula is not well understood except by better candidates. Many candidates gave numerical answers, calculating molar masses.
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
25			insoluble materials – filtration and / or sedimentation (1) microbes – chlorination (1)	2	answer must be linked to insoluble solids and microbes **allow** sieve for insoluble materials (1) **allow** add chlorine (1) If no marks scored **allow** filter it or chlorination (1) Examiner's Comments Better candidates frequently scored both marks correctly referring to filtration and the use of chlorine. Weaker candidates thought that heating the water would bring about the necessary purification.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
26			**Level 3** **Candidate applies knowledge to predict more than one correct observation** **AND** **names both of the products** **AND** **predicts a correct reaction time for rubidium.** Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) **Level 2** **Candidate applies knowledge to predict more than one correct observation** **AND** **EITHER names one of the products** **OR** **predicts a correct reaction time for rubidium.** Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) **Level 1** **Candidate applies knowledge to predict one observation** **OR** **the name of one product** **OR** **predicts a correct reaction time for rubidium.** Quality of written communication impedes communication of the science at this level. (1 – 2 marks) **Level 0** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to C.** **Indicative scientific points may include:** **Observations** • melts • moves across the surface (of the water) • catches fire or explodes or sparks • gas given off • alkaline solution made **Names of Products** • hydrogen • rubidium hydroxide **Reaction Time** • any time less than 7 seconds **Use the L1, L2, L3 annotations in Scoris; do not use ticks.** **Examiner's Comments** Most candidates could predict at least two observations, with many offering far more. Better candidates talked about how the reactivity of the elements increases as Group 1 is descended and hence predicted reaction times of less than 7 seconds. Far fewer candidates named the products even with the hint that a gas was given off that burns with a 'pop'. It was rare to see rubidium hydroxide mentioned.
			Total	**6**	

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>27</td><td>a</td><td></td><td>239 (1)</td><td>1</td><td><u>?Examiner's Comments</u>??

Many candidates could calculate the molar mass as 239 g/mol.</td></tr>
<tr><td></td><td>b</td><td></td><td>C_2H_5 (1)</td><td>1</td><td>allow any order of symbols

not C^2H^5 / C2H5 / or use of lower case H

<u>?Examiner's Comments</u>??

Candidates often deduced the correct empirical formula as C_2H_5 although some candidates gave the molecular formula and others worked out the molar mass.</td></tr>
<tr><td></td><td>c</td><td></td><td>FIRST LOOK AT THE ANSWER
IF ANSWER = Fe_2O_3 AWARD 3 MARKS

<table><tr><td>symbols</td><td>Fe</td><td>O</td></tr><tr><td>mole ratio</td><td>$\frac{70}{56}$ or 1.25</td><td>$\frac{30}{16}$ or 1.875</td></tr><tr><td>simplest mole ratio</td><td>$\frac{1.25}{1.25}$ or 1</td><td>$\frac{1.875}{1.25}$ or 1.5</td></tr></table>
mole ratio (1)

simplest mole ratio (1)

empirical formula is Fe_2O_3 (1)</td><td>3</td><td>If fraction is the wrong way around = 0 marks for the question

If divide by atomic number = 0 marks for the question

If just use ratio of masses = 0 for the question

allow ecf from mole ratio

allow ecf from simplest ratio

allow $FeO_{1.5}$ = 2 marks for the question

<u>?Examiner's Comments</u>??

Candidates found this empirical formula calculation very challenging. Even candidates who calculated the mole ratio often rounded the ratio incorrectly to end up with FeO_2 or stated the formula was $FeO_{1.5}$. Common misconceptions included using the mass ratio rather than the mole ratio or using atomic number to calculate the mole ratio rather than the relative atomic mass. A significant proportion of candidates left this question blank.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>5</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
28	a		72 (1)	1	unit **not** needed **ignore** any unit given **Examiner's Comments** Many candidates could calculate the molar mass of pentane as 72 g/mol.
	b		C_4H_6 / H_6C_4 (1)	1	**not** if superscripts used for the numbers **Examiner's Comments** Although many candidates gave the molecular formula as C_4H_6, some gave partial structural formulae instead.
	c		C_2H_2 **and** C_6H_6 (1)	1	**both** needed if no answer on answer line **allow** other ways of indicating the correct answer e.g. circling, ticking or underlining **Examiner's Comments** A significant proportion of candidates chose the two correct hydrocarbons.

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Question			Answer/Indicative content	Marks	Guidance
	d		Mole ratio C : H is 0.1 : 0.4 (1) Empirical formula is CH_4 / H_4C(1)	2	LOOK AT THE ANSWER FIRST IF CH^4 / H^4C AWARD 2 MARKS **allow** moles of C = 0.1 and moles of hydrogen = 0.4 **allow** moles of C = 1.2 / 12 and moles of hydrogen = 0.4/1 **allow** C_1H_4 **allow** full marks despite any working out for correct empirical formula **Examiner's Comments** Candidates found this empirical formula calculation very challenging and only the best candidates were able to get the answer CH_4. Typically candidates did show their working out for this question and this often showed up their misconceptions. One misconception was that candidates used the atomic number rather than the relative atomic mass to calculate the mole ratio of carbon to hydrogen. Other candidates did not use the mole ratio at all and used a mass ratio instead getting an answer of C_3H. A significant proportion of the candidates did not attempt this question.
			Total	**5**	
29			melting point of sodium – any value between 90 and 130 (1) atomic radius of rubidium – any value between 0.250 and 0.280 (1)	2	**Examiner's Comments** Many candidates could use the data provided to estimate the melting point of sodium and the atomic radius of rubidium. Candidates found the melting point of sodium less demanding than the atomic radius. Some candidates missed out this question possibly because they did not see the gaps in the table.
			Total	**2**	

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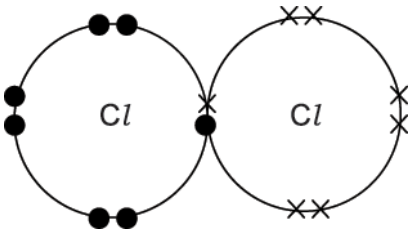
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Question			Answer/Indicative content	Marks	Guidance
30	a		(add up number of electrons) and this is the atomic number (and check on periodic table) (1)	1	**allow** has 20 electrons and on periodic table element number 20 is calcium **allow** element is in Group 2 and Period 4 it has 20 electrons on its own is **not** sufficient **Examiner's Comments** The best answers appreciated that the electronic structure could be used to determine both the group number and the period number of an element. Other candidates realised that the number of electrons indicated the atomic number of the element. It was not sufficient just to mention that a calcium atom contains 20 electrons.

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Question			Answer/Indicative content	Marks	Guidance
	b		one shared pair of electrons between the chlorine atoms (1) rest of outer shells correct (1)	2	**allow** electrons to be all crosses or all dots  **ignore** inner shell electrons even if incorrect **do not allow** diagams with charges / diagrams with double bonds = 0 marks **Examiner's Comments** Many candidates appreciated that there was a shared pair of electrons but some candidates did not draw any more electrons. Even though the required candidates to only draw the outer shell electrons a significant proportion of candidates did draw the inner shell electrons. The mark scheme ignored any inner shell electrons even if they were incorrect. Candidates must be careful to ensure that the electrons are clearly shown as being shared when they are part of a covalent bond.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
31	a		72 (1)	1	unit **not** needed **Examiner's Comments** Just over half of candidates gave the correct answer of 72 in this question. Others either omitted the question or added up the numbers incorrectly.
	b		C_4H_6 / H_6C_4 (1)	1	**not** if superscripts used for the numbers **Examiner's Comments** About two thirds of candidates correctly gave the molecular formula of butyne as C_4H_6.
	c		C_2H_2 **and** C_6H_6 (1)	1	**both** needed if no answer on answer line **allow** other ways of indicating the correct answer e.g. circling, ticking or underlining **Examiner's Comments** Just under half of candidates understood what was meant by an empirical formula and gave C_2H_2 and C_6H_6. Incorrect answers frequently involved methane, CH4 and ethene, C_2H_4.
	d		75% (1)	1	**Examiner's Comments** About half of candidates correctly calculated the percentage by mass of carbon in methanev as 75%. Some candidates calculated the percentage of hydrogen as 25% and failed to score.
			Total	**4**	

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>32</td><td></td><td></td><td><table><tr><th></th><th>Number of atoms</th></tr><tr><td>nitrogen</td><td>2</td></tr><tr><td>hydrogen</td><td>8</td></tr><tr><td>sulfur</td><td>1</td></tr><tr><td>oxygen</td><td>4</td></tr></table></td><td>1</td><td>Examiner's Comments

Most candidates were successful in deducing the number of each type of element in the formula for ammonium sulphate. Candidates who did not gain credit usually either gave the relative atomic mass of each element or calculated the mass of the element in the formula.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
33			Level 3 (5–6 marks) Comprehensively explains the process of fractional distillation in terms of molecular size, intermolecular forces and boiling points AND Applies knowledge of temperature gradient in fractionating tower to correctly list the fractions in the order they 'exit' the tower. Quality of written communication does not impede communication of the science at this level. Level 2 (3–4 marks) Attempts to explain the process of fractional distillation in terms of molecular size and / or intermolecular forces and boiling points AND Applies knowledge of temperature gradient in fractionating tower to list the fractions in the order they 'exit' the tower. Quality of written communication partly impedes communication of the science at this level. Level 1 (1–2 marks) Describes the process of fractional distillation, but answer may be simplistic and lacking in detail OR lists the fractions in the correct order. Quality of written communication impedes communication of the science at this level. Level 0 (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted at grades up to A*. Indicative scientific points at levels 2 and 3 may include: • smaller molecules, eg LPG / petrol / paraffin, have weaker or fewer intermolecular forces / ora • smaller molecules have lower boiling points with weaker or fewer intermolecular forces / ora • during boiling the weak intermolecular forces break but covalent bonds within the molecule do not. Indicative scientific points at Level 1 may include: • crude oil is heated • fractionating column has temperature gradient (cold at top and hot at bottom) • order of fractions, from top, is: LPG petrol paraffin heating oil fuel oils bitumen Use the L1, L2, L3 annotations in scoris; do not use ticks. Examiner's Comments This 6 mark question was targeted at all grades up to, and including, grade A* and discriminated well. The question required candidates to analyse the data in order to list the fractions in the positions that they 'exit' the fractionating column and then to explain how fractional distillation separates crude oil into fractions. At level 3 (5-6 marks) all aspects of the question needed to be addressed and candidates were required to explain the process of fractional

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Question			Answer/Indicative content	Marks	Guidance
					distillation in terms of molecular size, intermolecular forces and boiling points. Some candidates continue to confuse fractional distillation and cracking.
			Total	6	
34		i	Idea that impurities may be dangerous or toxic / if not pure difficult to measure the exact dose	1	**allow** so only safe chemicals are included / no other ingredients can damage the body / avoid side-effects (from impurities) Examiner's Comments Candidates often referred to the idea of side effects and only a small proportion of candidates appreciated that it is difficult to get the correct dosage if the drug is impure.
		ii	chromatography / melting point / boiling point (1)	1	**allow** any form of chromatography **allow** any form of spectroscopy **allow** titration / volumetric analysis Examiner's Comments Candidates found this very challenging and often referred to testing with animals or human volunteers rather than the required chemical tests such as melting point or chromatography. Many candidates did not attempt this part.
			Total	2	
35			mining / dug out of the ground / solution mining / (drill into the salt layer and) pump water down (1)	1	**accept** dissolve the salt in water Examiner's Comments The idea of solution mining was not well known and many candidates just referred to drilling or digging for salt.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
36			fractional distillation (1) compounds have different boiling points (1)	2	**allow** any other way of indicating the correct answer such as a tick or a circle but answer line takes precedence this marking point is **dependent** on the correct method of separation **allow** lower boiling point gets to top **allow** according to its boiling point **allow** any reference that indicates different boiling points ?Examiner's Comments?? Those candidates who selected fractional distillation often gave the correct explanation in terms of different boiling points. All the other processes except polymerisation were chosen by candidates, and in particular cracking was a popular choice.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
37			Level 3 (5-6 marks) Candidates correctly calculate the percentage yield and describe some reasons why the yield in this reaction is less than 100%. Quality of written communication does not impede communication of the science at this level. Level 2 (3-4 marks) Candidates correctly calculate the percentage yield OR describe some reasons why the yield in this reaction is less than 100%. Quality of written communication partly impedes communication of the science at this level. Level 1 (1-2 marks) Candidates suggest a reason why the yield is less than 100% in this reaction OR attempt to calculate the % yield e.g. 3/4. Quality of written communication impedes communication of the science at this level. Level 0 (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted at grades up to C. Indicative scientific points may include: • percentage yield is 75% • $\text{percentage yield} = \frac{actual}{predicted} \times 100$ reasons why yield is not 100% include: • loss in filtering solution of magnesium sulfate • some product / solution may bubble over the side of beaker • some solid / solution may be lost in evaporation • loss in transferring solutions / solids • not all reactants react to make product. Use the L1, L2, L3 annotations in scoris, do not use ticks. Examiner's Comments Many candidates were able to calculate the percentage yield as 75% and score 4 marks.
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
38			**Level 3 (5–6 marks)** Describes how ethanol is made from glucose including how ethanol is separated from the reaction mixture. Quality of written communication does not impede communication of the science at this level. **Level 2 (3–4 marks)** States that fermentation needs yeast or enzymes **and** describe a condition needed for fermentation **OR** describe partly how ethanol is made from glucose including mention of use of yeast and distillation Quality of written communication partly impedes communication of the science at this level. **Level 1 (1–2 marks)** States that fermentation needs yeast or enzymes or catalyst. **OR** gives one condition Quality of written communication impedes communication of the science at this level. **Level 0 (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.	6	**This question is targeted at grades up to C** **Indicative scientific points at Level 3 should include:** • use of distillation to obtain pure alcohol. **Indicative scientific points at Levels 1 and 2 may include:** • water required • temperature 25 - 50°C / warm / body temperature • absence of oxygen • reaction catalysed by (enzymes) in yeast. **Indicative scientific points at Level 1 may include:** • yeast needed • enzyme such as zymase needed. • any condition from the list above • distillation to get pure alcohol **Examiner's Comments** Very few candidates were able to describe how ethanol is made by fermentation of glucose. In previous years, fermentation experiments were often carried out by candidates. The need for yeast was not well known, and a number of candidates only scored at all as they stated that a catalyst was needed. The only condition which appeared to be well known was the temperature required. Only a very few knew that the ethanol was extracted by distillation.
			Total	**6**	

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Question			Answer/Indicative content	Marks	Guidance
39			40 (g/mol) (1)	1	**ignore** any unit given **Examiner's Comments** These calculations were almost all completed correctly by the candidates.
			Total	1	
40			idea that hydocarbons have different boiling points (1) **and any two from:** larger molecules or longer chains have higher boiling points / ora (1) larger molecules or longer chains have stronger intermolecular forces / ora (1) idea that stronger intermolecular forces results in higher boiling point / ora (1)	3	**allow** hexadecane for larg**er** molecules or hexane for small**er** molecules throughout the question **ignore** melting points **allow** molecules with higher mass have higher boiling points / ora (1) **allow** larger molecules or longer chains have more intermolecular forces / ora (1) **allow** idea that stronger intermolecular forces results in more energy needed (to boil) / ora (1) Examiner's Comments Good responses to this question appreciated that hydrocarbons have different boiling points and explained that larger molecules have stronger intermolecular forces, and hence higher boiling points. Candidates who failed to gain credit often referred to melting points or focused on where the fraction was going to exit the fractionating column.
			Total	3	
41			B ✓	1(AO1.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
42			C ✓	1(AO1.2)	
			Total	1	
43			B ✓	1(AO2.2)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
44	a		Low density **and** idea that aircraft is lightweight / isn't too heavy to fly / less weight to carry / AW ✓ High strength **and** idea that aircraft is less likely to be damaged ✓	2(AO3.2b)	**DO NOT ALLOW** light / lighter for low density but **ALLOW** so aircraft is light or lighter **Answers must give property and explanation for marks** **BUT ALLOW** 1 mark for low density and high strength / strongest if no or only one explanation given Examiner's Comments This question required candidates to identify and explain the properties that make alloy **C** the best choice for making an aircraft. Lower ability candidates often simply stated the properties (low density and high strength) without explaining why these properties were important. When reasons were stated they were often trivial e.g. 'low density because it would be good for the aircraft'. A common misconception was that high melting point was a key property.
	b	i	(Percentage of lithium =) (2 ÷ 10) x 100 = 20(%) ✓	1(AO3.1a)	Examiner's Comments Most candidates correctly calculated the percentage of lithium atoms at 20%.
		ii	Idea that alloy B is only 2.2% lithium / Idea that alloy B is 2.2% lithium but the diagram has 20% lithium / Idea that the % of lithium in the alloy is much smaller than in the diagram / there should be 100 aluminium atoms (and 2 lithium atoms) ✓	1(AO3.2a)	**ALLOW** ECF from incorrect percentage in (c)(i) **ALLOW** should be more Al atoms / 17.8% too large **IGNORE** references to the relative sizes of the atoms Examiner's Comments Good responses to this question identified that the percentage of lithium in the alloy is much smaller than in the diagram.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
45		i	Methanol ✓ (because it has the) lowest boiling point ✓	2(AO3.2b)	IGNORE (because it has the) lowest melting point Examiner's Comments Most candidates correctly identified that methanol will be distilled first as it has the lowest boiling point.
		ii	Particles (are close together in a liquid and) move further apart in a gas ✓	1(AO1.1)	Answer must be comparative ALLOW idea that arrangement of particles becomes less regular or more random IGNORE the idea that movement increases Examiner's Comments Many candidates described the arrangement of the particles in the gaseous state without any comparison with the liquid state, which was required to gain the mark.
		iii	Particles move more quickly (in all directions) in a gas ✓	1(AO1.1)	Answer must be comparative IGNORE particles have more (kinetic) energy IGNORE the idea that movement increases Examiner's Comments As in (ii), many candidates described the movement of the particles in the gaseous state without any comparison with the liquid state.

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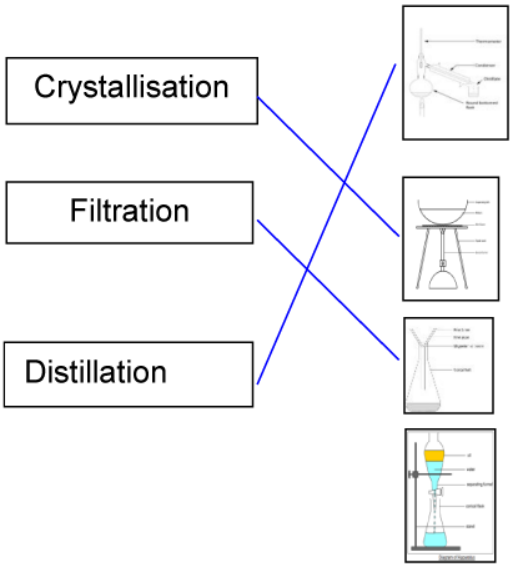
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Question			Answer/Indicative content	Marks	Guidance
		iv	Fractionating column ✓ Large surface area ✓	2(AO3.3b) (AO1.2)	**ALLOW** fractional (distillation) column **IGNORE** distillation / fractional distiller Examiner's Comments This question required candidates to identify the use of a fractionating column and then explain that this would provide a large surface area. Candidates who stated the name of the process (fractional distillation), rather than the piece of equipment as required by the question, did not gain credit. Only the most able candidates were able to explain why a fractionating column is used.
			Total	**6**	
46			B	1 (AO 2.2)	Examiner's Comments Many candidates added the relative masses of one of each atom and answered A.
			Total	**1**	
47			C	1 (AO 2.1)	Examiner's Comments D was the most common incorrect response.
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
48	a		 **If more than one line drawn to apparatus DO NOT award the mark.**	3 (AO1.2)	
	b		Use a magnet ✓	1 (AO2.2)	**ALLOW** dissolve sulfur in solvent/xylene **and** filter **ALLOW** sieve Examiner's Comments Candidates found this very difficult with filtration and crystallisation being the most common incorrect responses.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
49		i	900 (^{0}C) ✓	1 (AO3.3a)	Examiner's Comments A small but significant number of candidates gave 500°C
		ii	(compound X) consists of one type of particle/one compound/element/substance	1 (AO1.1)	ALLOW no other substance mixed with it Examiner's Comments The most common incorrect response was the compound containing just one element.
		iii	A pure substance melts at a specific temperature / the line is horizontal / has a single melting temperature ✓	1 (AO2.1)	ALLOW A mixture melts over a range of temperatures / the line would not be horizontal IGNORE boiling point Examiner's Comments Many candidates either did not use the graph to inform their answer or described areas of positive gradient. High melting point was the most common incorrect response, others included: one line and time for melting,
			Total	3	

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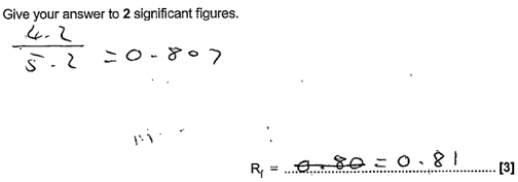
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Question			Answer/Indicative content	Marks	Guidance
50	a	i	Red and Yellow ✓	1 (AO3.1a)	**BOTH** needed for the mark Examiner's Comments Identifying red or yellow rather than both was common, some candidates responded 1849, the date of the paint using all pure dyes.
		ii	Y ✓ All paints are soluble (in Y) / ORA ✓	2 (AO3.1b) (AO3.2b)	**ALLOW** dissolves all 3 colours / forms (clear) solutions Examiner's Comments Many candidates chose Y but did not give a creditworthy explanation of their choice. Both X and Y were chosen quite often with solid or clear solvents being a reason for choice.

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Question			Answer/Indicative content	Marks	Guidance
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.79 award 3 marks R_f = 41(mm) ÷ 52(mm) / 4.1(cm) ÷ 5.2(cm) ✓ = 0.788 ……✓ = 0.79 (2 sig figs) ✓	3 (AO2.2 ×2) (AO1.2)	Examiner's Comments Few candidates measured the distances correctly. Most used their values correctly to calculate a value for R_f and gave the value to 2 significant figures. Some candidates gave an incorrect answer with no working and so working marks could not be given. A small number omitted the question. Exemplar 5  Give your answer to 2 significant figures. 4.2 / 5.2 = 0.807 R_f = 0.80 = 0.81 [3] The candidate has measured the solvent front correctly but not the spot distance so has not gained marking point one. However, because the candidate has clearly shown their working for the division sum and the correct evaluation, they can gain credit for marking point 2. They have then rounded this value correctly to 2 significant figures and therefore score marking point 3. Had the candidate only written 0.81 in the answer space with no working they would have scored 0.
	b		No (no mark) All the sample paints match the paint in the 1973 painting / chromatogram is the same as the 1973 chromatogram ✓	1 (AO3.2b)	ALLOW The blue paint was different in 1849 / blue paint has different R_f to the blue paint used in 1849 / blue paint pure in 1849 / blue paint not pure in sample/it doesn't match 1849 Examiner's Comments Many candidates appreciated that the laboratory was incorrect but struggled to explain why. A significant number thought the chromatogram matched the paint from 1849.
			Total	7	

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Question			Answer/Indicative content	Marks	Guidance
51	a		Low density **and** idea that aircraft is lightweight / isn't too heavy to fly / less weight to carry / AW ✓ High strength **and** idea that aircraft is less likely to be damaged ✓	2 (AO3.2b)	**DO NOT ALLOW** light / lighter for low density but **ALLOW** so aircraft is light or lighter **Answers must give property and explanation for marks** **BUT ALLOW** 1 mark for low density and high strength / strong**est** if no or only one explanation given Examiner's Comments Many candidates discussed the properties without applying them to the specific use of making an aircraft.
	b	i	(Percentage of lithium =) (2 ÷ 10) × 100 = 20(%) ✓	1 (AO3.1a)	Examiner's Comments Many calculated the percentage correctly. Incorrect responses included 25%, 2% and 80%.
		ii	Idea that alloy B is only 2.2% lithium / Idea that alloy B is 2.2% lithium but the diagram has 20% lithium / Idea that the % of lithium in the alloy is much smaller than in the diagram / there should be 100 aluminium atoms (and 2 lithium atoms) ✓	1 (AO3.2a)	**ALLOW** ECF from incorrect percentage in (c)(i) **ALLOW** should be more Al atoms / 17.8% too large **IGNORE** references to the relative sizes of the atoms Examiner's Comments Higher ability candidates compared their answer to the amount quoted in the table. Many discussed the relative sizes of the atoms, the small numbers in the diagram, the structure or properties of an alloy or omitted the question.
			Total	**4**	
52			D	1 (AO1.2)	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
53			B	1 (AO2.1)	
			Total	**1**	
54			B	1 (AO2.1)	
			Total	**1**	
55	a	i	A **AND** D ✓	1 (AO3.1a)	
		ii	**Any two from:** Conducts electricity in molten state ✓ Does not conduct electricity in solid state ✓ High melting point ✓	2 (AO3.2b)	ALLOW dissolve in water
	b	i	Add water (and stir) ✓ Filtration ✓ **B** collects on filter paper ✓	3 (AO3.3a 1.2 3.3a)	
		ii	Distillation **OR** evaporation **OR** heating ✓ Removes water **OR** dries C **OR** removes some water and leave to crystalise ✓	2 (AO1.2 3.3a)	**ALLOW** boiling
			Total	**8**	

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Question			Answer/Indicative content	Marks	Guidance
56			*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** Correctly names the acid and the base used in the neutralisation reaction. **AND** Method can be followed to make a pure, dry sample of potassium chloride. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Correctly names the acid and the base used in the neutralisation reaction. **OR** Method can be followed to make a salt sample. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Method includes adding acid to base. **OR** Correctly names either the acid or the base used in the neutralisation reaction. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	6 (AO1.1 ×2 2.2 ×2 3.3a ×2)	**AO1.1 Demonstrates knowledge and understanding of neutralisation reactions** • base neutralises the acid • acid + base → salt + water • potassium chloride is a salt • potassium chloride is neutral **AO2.1 Application of knowledge and understanding related to making a salt by neutralisation** • acid used is hydrochloric acid • base used is potassium hydroxide / potassium oxide / potassium carbonate • pH paper / pH probe is used to show solution made is neutral **AO3.3 Analyse of information and ideas to develop experimental procedures** • pH probe will not contaminate the solution • evaporate some of the water to form crystals • leave the crystals to dry / dry crystals in an oven

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Question			Answer/Indicative content	Marks	Guidance
			Total	6	
57	a		Ink dissolves in solvent ✓	1 (AO1.1)	**ALLOW** Pencil will not dissolve in solvent **ALLOW** so it doesn't move (with the solvent) / doesn't mix with the spots / solvent / colours in ink don't separate / ink has colours in it / ink would run
	b		Circle / dot drawn on start line in diagram ✓	1 (AO2.2)	
	c		A ✓	1 (AO3.2a)	
	d		**FIRST CHECK ANSWER ON ANSWER LINE** **If answer = 0.62 award 3 marks** 3.7/6 ✓ = 0.61666…… ✓ = 0.62 (2 sig. figs) ✓	3 (AO2 × 2.2 1.2)	**ALLOW** 3.7 ± 0.1
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
58	a	i	Condenser ✓	1 (AO1.2)	
		ii	Distillation ✓	1 (AO1.1)	**DO NOT ALLOW** fractional
		iii	Add thermometer ✓ Water goes in at the bottom (of condenser) **OR** water comes out at the top (of condenser) ✓	2 (AO2 × 3.3b)	**ALLOW** take out the funnel
	b		Mass of M_3 = 164 – (31 + 16 × 4) = 69 ✓ Mass of **M** = 69/3 = 23 ✓ **M** = sodium **OR** Na ✓	3 (AO2.2)	**ALLOW** metal closest to calculated **M** by **ECF**
			Total	**7**	
59			C ✓	1 (AO 2.2)	
			Total	**1**	
60			B ✓	1 (AO2.2)	
			Total	**1**	
61			D ✓	1 (AO1.1)	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
62	a	i	FIRST CHECK ANSWER ON ANSWER LINE If answer = 0.62 award 3 marks R_f = distance travelled by substance / distance travelled by solvent = 37/60 ✓ = 0.61666…. ✓ = 0.62 (2 significant figures) ✓	3 (AO1.1) (AO2.2) (AO1.2)	**ALLOW** ECF for use of correct calculation from incorrect measurements **ALLOW** 0.59 – 0.67 **ALLOW** ECF for sig fig mark
		ii	A and B	1 (AO3.2a)	Both needed for the mark
		iii	Idea that D forms weak(er) bonds with the mobile phase than C / Idea that D forms strong(er) bonds with stationary phase than C / D is less polar than C / ORA ✓	1 (AO2.1)	**ALLOW** C is more soluble (in the solvent) than D / ORA
	b	i	Similarity: Both have stationary and mobile phases / both use silica in the stationary phase ✓ Difference: Thin-layer uses liquid for mobile phase / gas chromatography use gas for mobile phase ✓	2 (AO2 × 1.1)	**ALLOW** the mobile phases are different states
		ii	Thin-layer chromatography is used to separate solids / gas chromatography is used to separate gases (in a gas mixture) ✓	1 (AO2.1)	**ALLOW** idea that the tomato sauce is a liquid or not a gas
			Total	**8**	

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Question			Answer/Indicative content	Marks	Guidance
63			FIRST CHECK ANSWER ON ANSWER LINE If answer = 373 (tonnes) award 4 marks M_r $CaCO_3$ = 100.1 and M_r CaO = 56.1 ✓ 209 g of calcium oxide = $\frac{100.1}{56.1} \times 209$ = 372.9215686 (g) ✓ = 373 (g) (3 significant figures) ✓	4 (AO3 × 2.2) (AO1.2)	Need both relative formula masses for 1 mark DO NOT ALLOW 100 or 56 ALLOW ECF from incorrect RFMs ALLOW ECF ALLOW ECF for sig fig mark
			Total	4	
64		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 120 (tonnes) award 3 marks M_r of NH_3 = 17 AND M_r of NH_4NO_3 = 80 ✓ Mass of ammonium nitrate = $\frac{80}{17}$ x 25.5 / 1.5 x 80 ✓ = 120 (tonnes) ✓	3 (AO2.1)	ALLOW ECF from incorrect RMMs
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 10(g) award 2 marks Actual mass = $\frac{80 \times 12.5}{100}$ ✓ = 10 (g) ✓	2 (AO1.2) (AO2.2)	ALLOW % yield = (am ÷ pm) x 100 OR 80 = (am ÷ 12.5) x 100 for 1 mark if no other mark awarded
			Total	5	

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Question			Answer/Indicative content	Marks	Guidance
65		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 120 (tonnes) award 3 marks M_r of NH_3 = 17 **AND** M_r of NH_4NO_3 = 80 ✓ Mass of ammonium nitrate = $\frac{80}{17}$ × 25.5 / 1.5 × 80 ✓ = 120 (tonnes) ✓	3 (AO2.1)	**ALLOW** ECF from incorrect RMMs
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 10(g) award 2 marks Actual mass $= \frac{80 \times 12.5}{100}$ ✓ = 10 (g) ✓	2 (AO1.2) (AO2.2)	**ALLOW** % yield = (am ÷ pm) × 100 **OR** 80 = (am ÷ 12.5) × 100 for 1 mark if no other mark awarded
			Total	5	

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