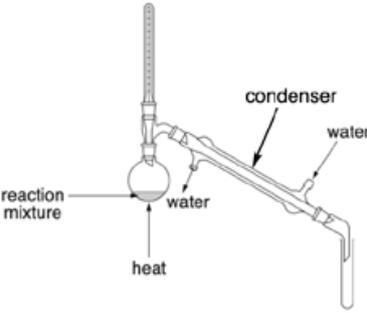


Mark scheme

Question	Answer/Indicative content	Marks	Guidance
1	 <p>Workable set up</p> <ul style="list-style-type: none"> • Flask with 'horizontal' OR 'angled down' condenser ✓ • NOT a sealed system for collection vessel • NOT open at the top above flask <p>Key labels for distillation set up</p> <ul style="list-style-type: none"> • Water in at bottom and out at top • AND condenser label ✓ 	2	<p>DO NOT ALLOW ANY MARKS FOR A REFLUX SET UP</p> <p>IGNORE</p> <ul style="list-style-type: none"> • no heat <i>question about apparatus</i> • no thermometer <i>istopper is fine</i> <p>Examiner's Comments</p> <p>The presentation of many candidates' diagrams in questions such as this one requires improvement.</p> <p>The mark scheme was generous, requiring to first see that a candidate knew what distillation is.</p> <p>A first mark was given for a set up comprising a flask connected to a roughly horizontal condenser.</p> <p>There had to be no gap above the condenser and the overall set up could not be a closed system.</p> <p>A second mark was given for minimal labels: condenser and correct direction of water flow.</p> <p>Nearly half the candidates received no marks for their diagram with only just over a quarter being given both marks.</p> <p>Typical errors included:</p> <ul style="list-style-type: none"> • a reflux set up • open above the flask • a closed system • water flowing the wrong way • the condenser labelled as condensation tube, cooling tube, cooling funnel, distiller, etc. <p>Less successful responses showed a conical flask, beaker or test tube being heated.</p> <p>The best advice is to spend some time instructing students how to draw diagrams and to label the apparatus using the accepted scientific names. Students increasingly appear to be finding these questions challenging.</p>

				 <p style="text-align: center;">Assessment for learning</p> <p>Practise the drawing of common organic apparatus as part of the practical work carried out for the practical endorsement.</p>
			Total	2
2	a	<p>Idea that reflux is used to prevent loss by evaporation ✓</p> <p>e.g. prevents reaction mixture boiling dry e.g. prevents loss of (volatile) compounds / products / reactants e.g. prevent methanol escaping</p>	1	<p>IGNORE responses related to rate of reaction IGNORE responses related to ensuring complete reaction</p> <p>DO NOT ALLOW reference to incorrect reaction e.g. oxidation, combustion (flammability)</p> <p><u>Examiner's Comments</u></p> <p>An unfamiliar question that proved challenging with only around a fifth of candidates obtaining the mark for correctly suggesting that reflux would prevent loss of volatile compounds. Many candidates suggested that reflux ensures the reaction goes to completion but here this was insufficient as esterification is an equilibrium reaction and additional information in (b)(i) indicates that there is unreacted compound G present.</p> <p>It was necessary to focus on the purpose for reflux rather than other ways of heating a reaction, such as the energy needed to break bonds or speed up the rate of reaction. Some less successful responses linked to oxidation reactions, presumably as they understand the importance of either reflux or distillation in this context. For example, 'reflux is required for complete oxidation' or 'if distillation had been used an aldehyde would have been formed'.</p>
	b	<p>Steps must be given in correct order:</p> <p>Step 1 (Add to) separating funnel ✓ (Use of) bottom layer (containing H / organic) ✓</p> <p>Step 2 Dry with an <u>anhydrous salt</u> OR Dry with MgSO₄ /magnesium sulfate OR CaCl₂ /calcium chloride ✓</p>	4	<p>Mark each step in order but then don't mark any further if response refers to purification of a solid e.g. dissolve in minimum amount of hot solvent, evaporate off water to allow solid to crystallise</p> <p>IGNORE use of carbonate (to remove excess acid) OR (saturated) NaCl ALLOW (remove) aqueous layer on the top ALLOW description that aqueous layer can be determined by adding water and seeing which layer increases in size IGNORE distillation OR filtration prior to step 1 OR step 2</p> <p>ALLOW 'to remove water' instead of 'dry' IGNORE any other named salt, e.g. 'an anhydrous salt e.g. CaCO₃' is acceptable IGNORE filtration to remove anhydrous salt after step 2</p> <p>ALLOW temperature range of 220-224°C for distillation</p>

	<p>Step 3 (Re)Distil at 222 °C ✓</p>	<p>DO NOT ALLOW if forms a solid product</p> <p><u>Examiner' Comments</u></p> <p>Many candidates identified the need to describe the isolation and purification of a liquid in response to this question. Some struggled to remember the name of the apparatus required i.e. 'separating funnel' but could describe the separation of layers. The best responses used the density data provided to explain that the lower layer would contain compound H. A few gained a mark for a description of the addition of water to identify the correct layer to discard. In generally, candidates only have experience of the organic layer being less dense in their practical work which was reflected in their responses. The use of an anhydrous salt to dry the organic layer was well-known, but many candidates gave vague answers such as 'add anhydrous salt' failing to justify why the salt was needed. Many recognised the need to purify the resultant liquid by distillation, but not all linked to the boiling point of compound H to secure this final mark. Some who didn't dry with an anhydrous salt said to heat to 100°C to remove water.</p> <p>Approximately a third of candidates gained no marks here. Candidates thought that compound H would form crystals so described recrystallisation rather than a method to purify an organic liquid. Other responses attempted to merge both methods together.</p> <p> OCR support</p> <p>The method to purify an organic liquid was poorly understood by many candidates. Many of the candidates answered this question using techniques to purify an organic solid which is covered in the second year of A Level, rather than an organic liquid which is covered in the first year. It is important to spend time comparing both methods and helping candidates identify when each method is required.</p> <p>OCR have produced a range of practice exam questions linked to the purification of an organic liquid (PAG5). These can be found on Teach Cambridge.</p> <p>Exemplar 2</p>
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				<p>Pour the mixture into a separating funnel. Add some inorganic inorganic fluid to work out which layer is which as the organic part (H) will stay the same size. Then let out the inorganic layer leaving just the organic layer. The compound H should be at the top before separating as it has density 1.174 g cm^{-3} which is low. Distill the organic layer that remains after separating to find get a pure compound. Heat it in a capillary tube and check its. You could also instead recrystallise it by dissolving in the minimum amount of hot solvent and then allow it to cool and filter it under reduced pressure using a buchner flask and cold solvent.</p> <p>This candidate scored 1 mark for this response for the use of a 'separating funnel'. They have attempted to use the density information but have incorrectly identified that the density of H as being low which would make it the top layer. Candidates needed to know that the density of water is 1 g cm^{-3} to be able to make a correct comparison. There is no addition of an anhydrous salt to dry the organic layer. They have recognised the need to distil but have not given the correct temperature at which to collect the pure compound. However, if they had given the boiling point for distillation no mark would have been given as they would lose this final mark for describing the purification of a solid. It was very common to see responses which described the purification of a solid, often in addition to that of a liquid.</p>	
			Total	5	
3			D	1	<p><u>Examiner's Comments</u></p> <p>Most correctly identified the colour of the precipitate as yellow, D. The most common incorrect response was brown, A, possibly linking to the colour of iodine.</p>
			Total	1	
4			C	1	<p><u>Examiner's Comments</u></p> <p>The majority of candidates were able to correctly identify the two functional groups and the correct corresponding test i.e. alkene using bromine water and primary alcohol using 2,4-dinitrophenylhydrazine. The most common incorrect response was B.</p>
			Total	1	
5			D	1	

				<p><u>Examiner's Comments</u></p> <p>Most were able to correctly calculate the moles of alcohol using the mass and M_r provided and then multiply by $24 \text{ dm}^3 \text{ mol}^{-1}$ to give the correct answer D. All other distractors were seen as incorrect responses from calculations involving the incorrect molar ratio.</p>	
			Total	1	
6		D		1	<p><u>Examiner's Comments</u></p> <p>Many candidates wrote the functional groups on the structure shown on their scripts, which reflects good exam technique. Most correctly identified that the compound contains ketone and carboxylic acid functional groups (D). This was an excellent discriminator.</p>
			Total	1	
7		D		1 (AO 2.7)	<p><u>Examiner's Comments</u></p> <p>Candidates find it difficult to identify an intermediate within a synthesis and less than half selected the correct option, D.</p>
			Total	1	
8		<p>Level 3 (5-6 marks) Diagram showing reflux with most labels AND A CORRECT calculation of the % yield of 1-bromobutane AND A detailed description of most purification steps.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3-4 marks) Diagram showing reflux with some labels AND Calculates the % yield of 1-bromobutane with some errors OR</p>	<p>6 (AO2. 8 × 2) (AO3. 3 × 4)</p>	<p>Indicative scientific points may include:</p> <p>Diagram Diagram draw with condenser above flask Labels including</p> <ul style="list-style-type: none"> condenser water in at bottom and out at top pear-shaped or round-bottom flask <p><u>Calculation of % yield of 1-bromobutane</u></p> <ul style="list-style-type: none"> $n(\text{butan-1-ol}) = \frac{9.25}{74.0} = 0.125 \text{ (mol)}$ mass 1-bromobutane = $6.10 \times 1.268 = 7.7348 \text{ g}$ $n(1\text{-bromobutane}) = \frac{7.7348}{136.9} = 0.0565 \text{ (mol)}$ % yield = $\frac{0.0565}{0.125} \times 100 = 45.2\%$ <p>ALLOW 45.2 ± 0.2 for small slip/rounding NOTE Use of 6.1 g (omission of density)</p> <ul style="list-style-type: none"> $n(1\text{-bromobutane}) = \frac{6.10}{136.9} = 0.044558... \text{ (mol)}$ % yield = $\frac{0.044558...}{0.125} \times 100 = 35.6\%$ <p><u>Purification</u></p>	

	<p>Diagram showing reflux with most labels AND describes some purification steps, with some detail OR Calculates the % yield of 1-bromobutane with some errors AND describes some purification steps, with some detail <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1-2 marks) Diagram showing reflux OR Attempts to calculate the % yield of 1-bromobutane OR Describes few purification steps. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks No response or no response worthy of credit.</p>		<ul style="list-style-type: none"> In separating funnel, organic layer is on bottom Drying with an anhydrous salt by formula or name, e.g. MgSO_4, Na_2SO_4, CaCl_2 Redistil at 102°C <p>Examples of detail in bold (NOT INCLUSIVE) NOTE: 'Use a separating funnel', dry, and 'redistil' on their own are NOT detailed descriptions</p> <p>Examiner's Comments This question was assessed by level of response (LoR). Candidates were required to describe key features in a procedure to prepare a pure organic liquid, including a labelled diagram for reflux, a calculation of the percentage yield and the procedural steps for purification. Levels were determined using these three features. Marks within a level were determined by communication. This question discriminated extremely well.</p> <p>Level 3 candidates would draw a clear diagram with all key items labelled and the set up being capable of being used safely. The percentage yield calculation would be correct, producing a percentage yield close to 45.2%. The steps for the purification: use of a separating funnel, drying and redistillation would be described in the correct order and with some detail.</p> <p>Level 2 candidates would have obtained some of the features required for Level 3 but there would be some key omissions or errors. The diagram may have been drawn clearly but labelling may have been incomplete or a thermometer with bung may have been inserted into the top of the condenser, a very hazardous arrangement. The calculation would be attempted but with some errors, such as omitting to use the density, or using a mixture of moles and masses. The purification steps may have been described but in the wrong order. Purification steps would be incomplete, perhaps only including distillation.</p> <p>Level 1 candidates often drew a diagram resembling a tube above a flask, with water often flowing in the wrong direction. The percentage yield may have been a simple mass ratio with no moles being used.</p> <p>A significant number of candidates described the purification steps for an organic solid, including recrystallisation. The preparation of an organic liquid is a key practical procedure that will have been experienced by students during their A Level studies (PAG 5). The overall standard of drawing diagrams was poor, an area that needs improvement.</p>
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Total			6	
9	i	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 8.07 g award 3 marks CARE: Intermediate rounding may give 8.06 g which is acceptable for 3 marks</p> <p>----- -----</p> <p>$n(2\text{-bromobutane})$</p> $= \frac{10.0}{136.9} = 0.073(0)\dots (\text{mol}) \checkmark$ <p>$n(\text{CH}_3\text{CH}_2\text{CHOHCH}_3)$</p> $= 0.0730\dots \times \frac{100}{67.0} = 0.109 (\text{mol}) \checkmark$ <p>mass $\text{CH}_3\text{CH}_2\text{CHOHCH}_3$ $= 0.109 \times 74.0 = 8.07 \text{ g}$ \checkmark</p> <p>3 SF required</p>	<p>3 (AO 2.4 × 3)</p>	<p>ALLOW ECF throughout</p> <p>IGNORE trailing zeroes in intermediate working, e.g. 0.073 for 0.0730</p> <p>ALLOW 3 SF or more, correctly rounded</p> <p>Calculator: 0.7304601899</p> <p>Calculator: 0.1089552239</p> <p>ALLOW alternative method mass</p> <ul style="list-style-type: none"> Theoretical mass of 2-bromobutane $= 100 \times \frac{10.0}{67.0} = 14.9\dots (\text{g})$ <p>Calculator: 14.925373</p> <ul style="list-style-type: none"> Theoretical $n(\text{CH}_3\text{CH}_2\text{CHBrCH}_3)$ $= \frac{14.923373}{136.9} = 0.1902 (\text{mol})$ <ul style="list-style-type: none"> Mass of $\text{CH}_3\text{CH}_2\text{CHOHCH}_3$ $= 0.109 \times 74.0 = 8.07 \text{ g} \checkmark$ <p>Common Errors for 2 marks 5.41 g (no % yield) 3.62 g (inverted yield)</p> <p><u>Examiner's Comments</u></p> <p>The most common errors were omitting the yield or inverting the yield, as given on mark scheme, resulting in 2 marks. Clear working was vital here to help marks to be given even if the final answer was incorrect. Many candidates did not gain the final mark due to incorrect significant figures. As with other multi-step calculations, rounding of intermediate values could also cause marks to be lost.</p>
	ii	<p>Separating funnel (to separate aqueous and organic layers) \checkmark</p> <p>Dry organic layer with anhydrous salt \checkmark</p>	<p>3 (AO 3.3 × 3)</p>	<p>ALLOW Use a drying agent ALLOW appropriate example of an anhydrous salt e.g. MgSO_4, CaCl_2</p>

			Distil and collect fraction at 91°C ✓	<u>Examiner's Comments</u> This question was not answered well with over half the candidates failing to score any marks. While some candidates seemed familiar with the techniques required, describing the process to separate the layers, they often struggled to name the separating funnel. Common approaches were to attempt to 'filter' the layers or to use heat (via evaporation or distillation) to drive off the water. Some attempted to use Na ₂ CO ₃ or NaOH to dry the organic layer – perhaps confusing neutralisation of any remaining acid. Although distillation appeared frequently many did not give the temperature so did not gain marks. The order of the procedure was also not always clear with distillation before using a drying agent. Some described attempts to crystallise the organic layer. The range of answers suggests students may need more practical experience with separating organic liquids.
			Total	6