Question	Answer	Marks	Guidance
1 a	(purification processes) do not remove dissolved or soluble substances (1)	1	**allow** they are soluble / they are dissolved
b	large energy requirement (1) expensive (1)	2	**allow** heat for energy **allow** high cost of equipment **allow** issues related to scaling up / needs lots of water (1) **ignore** takes a long time
c	Pete is right about **A** but wrong about **B** (no mark) **A** contains copper (ions) because it gives a blue (ppt) with sodium hydroxide (1) **A** contains sulfate (ions) because it gives a white (ppt) with barium chloride (1) **B** contains iron(III) (ions) because it gives a brown (ppt) with sodium hydroxide (1) **B** does **not** contain sulfate (ions) as it does **not** give a white (ppt) with barium chloride (1)	4	**allow** Pete is wrong **not** Pete is wrong about **A** for marks about **A** **not** Peter is correct for **B** for marks about **B** copper sulfate goes blue with sodium hydroxide is **not** sufficient copper sulfate goes white with barium chloride is **not** sufficient iron(III) sulfate goes brown with sodium hydroxide is not sufficient **B** is not iron(III) sulfate because it does not go white with barium chloride is not sufficient **allow B** does not contain sulfate as it does not give a ppt **allow A** and **B** both cannot be sulfates since they do not both go white with barium chloride (2)
	Total	**7**	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>5 a</td><td>239 (1)</td><td>1</td><td></td></tr>
<tr><td>b</td><td>FIRST LOOK AT THE ANSWER
IF ANSWER = 33% AWARD 2 MARKS

0.33 g (1)

33 (%) (1)</td><td>2</td><td>

allow ecf from wrong mass</td></tr>
<tr><td>c</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</td></tr>
<tr><td>d</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

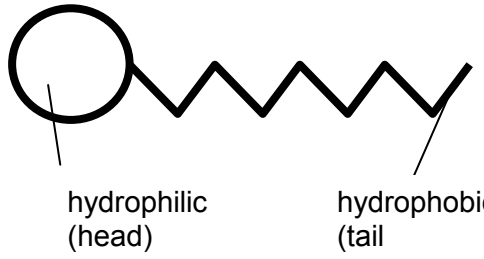
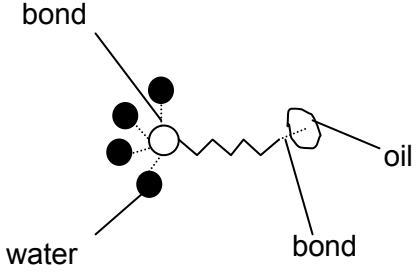
If divide by atomic number = 0 marks for the question

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</td></tr>
<tr><td></td><td>Total</td><td>7</td><td></td></tr>
</table>

Question	Answer	Marks	Guidance
2 a i	hydrophilic (head) **and** hydrophobic (tail) (1)	1	 **allow** polar (head) and non-polar (tail) (1) **allow** ionic (head) and hydrocarbon (tail) (1) **ignore** water loving and water hating
a ii	hydrophobic end or tail is attracted to oil / hydrophobic end or tail forms intermolecular forces with oil / hydrophobic end or tail bonds to oil (1) hydrophilic end or head is attracted to water / hydrophilic end or head forms intermolecular forces with water / hydrophilic end or head bonds to water (1)	2	**if no other marks awarded allow** tail is surrounded by oil molecules and the head by water molecules **allow** sticks to or attached or joined or combines with as alternative to 'bonds', **but** the hydrophobic end goes into oil is **not** sufficient **ignore** hydrophilic head loves water / hydrophobic tail loves oil **ignore** ideas of repelling water / oil **all** marks can be awarded from a **labelled** diagram but to get two marks must clearly show bonding to rather than surrounded by  **allow** ecf from (a)(i) for 1 mark e.g. hydrophobic head bonds to oil and hydrophilic tail bonds to water, if labels the wrong way round in (a)(i)

Question	Answer	Marks	Guidance
b	protein (molecules) (1) **permanently** change shape / **irreversible** change of shape (1)	2	**allow** polypeptide (molecules) (1) **ignore** enzymes **allow** proteins become cross-linked (2) **allow** molecular structure changes permanently (1) **allow** one mark for denaturing if no other mark awarded
	Total	**5**	

Question	Answer	Marks	Guidance
3 a	absorbs or takes in energy (in the light) (1) (then) releases or emits energy (in the dark) (1)	2	**allow** stores energy from light in the day (1) **allow** light instead of energy **not** reference to radioactive emissions
b	reacts with oxygen / it is oxidised (1)	1	
	Total	**3**	

Question			Answer	Marks	Guidance
4	(a)		**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.**

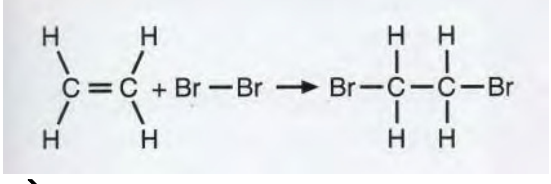
Question			Answer	Marks	Guidance
	(b)		$C_3H_8 + 3½O_2 \rightarrow 3CO + 4H_2O$ formulae (1) balancing (1)	2	**allow** any correct multiple, including fractions **allow** = / ⇌ instead of → **not** and / & balancing mark is dependent on the correct formula **but** **allow** 1 mark for a balanced equation with minor errors of case, subscripts, superscripts, etc eg $C_3H_8 + 3½O2 \rightarrow 3CO + 4H2O$
			Total	**8**	

Question			Answer	Marks	Guidance
5	(a)		nonane (1) largest temperature change / greatest temperature rise – dependent on correct choice of hydrocarbon (1)	2	**second mark is dependent on first mark** **allow** nonane (1) because the temperature rise is 27 (1) but only if all of the temperature changes are calculated **not** highest temperature obtained **allow** nonane (1) because it is the largest molecule (1)
	(b)		29 (1)	1	
			Total	**3**	

Question			Answer	Marks	Guidance
6	(a)		$\frac{34}{267}$ x 100 (1)	1	**allow** $\frac{34}{(233+34)}$ x100 **/** $\frac{34}{(98+169)}$ x 100 the mark is for the working out and not the answer
	(b)		$\frac{18}{20} \times 100$ / $\frac{18}{20}$ (1) 90 (1)	2	**allow** $\frac{am}{pm} \times 100$ for one mark if answer incorrect **allow** full marks for 90(%) with no working out
	(c)		because the atom economy is low / lots of atoms are wasted in the reaction (1)	1	**allow** lots of waste made / produces waste products / produces barium sulfate which is not used **not** reference to percentage yield
			Total	**4**	

Question	Answer	Marks	Guidance
7 a	no undesired products made / no waste products made / all the atoms that react end up in the product / only **one** product made (1)	1	**not** the same number of atoms on each side of the equation
b i	idea that 164g of sodium ethanoate makes 120g of ethanoic acid / idea that 82g of sodium ethanoate makes 60g of ethanoic acid (1) **but** mass is 6 (2)	2	units **not** needed
b ii	$\frac{(2\times 60)}{(2\times 60)+142}\times 100$ **or** $\frac{120}{262}\times 100$ **or** $\frac{(2\times 60)}{(2\times 82)+98}\times 100$ **or** $\frac{120}{164+98}\times 100$ (1) **but** 45.8% (2)	2	**allow** full marks for correct answer despite working out **allow** 46% (2)
c i	46 % (2) but 46.2 / 46.15 / 46.154 (1)	2	answer must have **two** sig figs for two marks **allow** one mark for $\frac{2.4}{5.2}\times 100$
ii	waste a lot of starting material / wastes reactants (1)	1	**ignore** waste products **ignore** just 'a lot of waste' **ignore** wastes lots of resources
	Total	**8**	

Question			Answer	Marks	Guidance
8	(a)		**any two from:** all the readily extractable resources will be used up in the future (1) will have to find replacements / AW (1) idea of not enough fuel to power vehicles or homes / make electricity / make chemicals (1) conflict between making petrochemicals and fuels (1) UK dependent on oil and gas from politically unstable countries / AW (1)	2	**allow** (all) it / oil / coal / fossil fuels will run out / be used up (1) **allow** crude oil will have to be extracted from more inaccessible areas (1) **allow** crude oil will become very expensive / may lead to rationing / may lead to conflicts (1)
	(b)		bitumen (1)	1	**allow** phonetic spelling
	(c)	(i)	C_4H_{10} (1)	1	**not** C4H10 / C^4H^{10} **allow** $H_{10}C_4$
		(ii)	propane and butane contain carbon and hydrogen (atoms) (1) only (1) has (carbon to carbon) single bonds **only** / contains single (covalent) bonds **only** (1)	3	**not** is a mixture of carbon and hydrogen (only) **not** contains carbon and hydrogen molecules Only must be linked to first marking point and is not independent **allow** has no (carbon to carbon) double bonds (1) **allow** they are saturated compounds (1) **allow** has general formula C_nH_{2n+2} (1) **ignore** has the maximum amount of hydrogen atoms
			Total	**7**	

Question			answer	Marks	Guidance
9	(a)		contains single (covalent) bonds **only** / AW (1)	1	**allow** does not have a double bond **allow** fits the general formula C_nH_{2n+2} **ignore** reference to saturation
	(b)		ethene		**allow** C_2H_4 / correct displayed formula / ethylene
	(c)		$C_2H_4O_2$	1	**allow** symbols in any order **ignore** CH_3COOH **not** C2H4O2 / $C_2H^4O_2$/ $C^2H^4O^2$
	(d)		$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$	1	**allow** correct equation using displayed formulae or mixture of molecular, correct structural and correct displayed formulae  **allow = for →** **not and & for +**
			Total	**4**	

Question			Answer	Marks	Guidance
10	(a)		petrol (1)	1	**allow** $C_5 – C_{10}$ (1)
	(b)		**any two from** oil slicks (1) idea of damage to wildlife (1) damage to beaches (1)	2	 **allow** oil leaks/oil spills (1) **allow** named wildlife eg kills sea birds / fish (1) **allow** destroys habitats (1) **allow** harms tourist trade (1) **allow** damage to the local economy or fishing industry (1) **ignore** risk of explosion
	(c)	(i)	percentage made is less than the percentage needed ora (1)	1	**allow** only 5% is produced when 22% is needed (1)
		(ii)	idea that cracking converts large (hydrocarbon) molecules into smaller (more useful) ones or petrol (1) **and** **any one condition from** catalyst / high temperature (1)	2	**allow** correct references to just hydrocarbons or (hydrocarbon) chains **allow** hydrocarbon molecules are split or hydrocarbon molecules are broken down **allow** breaks named large fractions into named smaller fractions eg breaks bitumen down into petrol (1) **ignore** references to pressure **allow** heat it (1)
			Total	**6**	