

Mark Scheme (Results)

Summer 2016

Pearson Edexcel International GCSE  
in Chemistry (4CH0) Paper 1CR

Pearson Edexcel International in Science  
Double Award (4SC0) Paper 1CR

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Publications Code 4CHO\_1CR\_1606\_MS

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## General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the **candidate's response is not worthy of credit according to the mark scheme.**
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the **mark scheme to a candidate's response, the team leader must be consulted.**
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question number	Answer	Notes	Marks
1 a	atomic number	Accept proton number Accept number of protons	1
b	(relative) atomic mass	Reject mass number	1
c	i electrons ii electrons iii protons AND neutrons iv protons AND electrons v neutrons	Names can be in either order Names can be in either order	1 1 1 1 1

Question number	Answer	Notes	Marks												
2 a	<table border="1"> <thead> <tr> <th data-bbox="383 309 824 480">Change of state</th> <th data-bbox="824 309 1028 480">State symbol before change</th> <th data-bbox="1028 309 1229 480">State symbol after change</th> </tr> </thead> <tbody> <tr> <td data-bbox="383 480 824 571">Water boils in a kettle</td> <td data-bbox="824 480 1028 571"><b>l</b></td> <td data-bbox="1028 480 1229 571"><b>g</b></td> </tr> <tr> <td data-bbox="383 571 824 662">Ethene is converted to poly(ethene)</td> <td data-bbox="824 571 1028 662"><b>g</b></td> <td data-bbox="1028 571 1229 662"><b>s</b></td> </tr> <tr> <td data-bbox="383 662 824 753">Crystals of iodine sublime on heating</td> <td data-bbox="824 662 1028 753"><b>s</b></td> <td data-bbox="1028 662 1229 753"><b>g</b></td> </tr> </tbody> </table>	Change of state	State symbol before change	State symbol after change	Water boils in a kettle	<b>l</b>	<b>g</b>	Ethene is converted to poly(ethene)	<b>g</b>	<b>s</b>	Crystals of iodine sublime on heating	<b>s</b>	<b>g</b>	<p>M1 l AND g in first row</p> <p>M2 g AND s in second row</p> <p>M3 s AND g in third row</p> <p>Accept upper case letters, eg S in place of s</p> <p>Accept words, eg liquid in place of l</p> <p>Accept answers in brackets</p>	3
Change of state	State symbol before change	State symbol after change													
Water boils in a kettle	<b>l</b>	<b>g</b>													
Ethene is converted to poly(ethene)	<b>g</b>	<b>s</b>													
Crystals of iodine sublime on heating	<b>s</b>	<b>g</b>													
b	$\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$	<p>Award 1 mark for s and g correct</p> <p>Award 1 mark for other 3 correct</p> <p>Accept upper case</p> <p>Reject words</p>	2												
c	s / solid	Accept upper case S in place of s	1												

<b>Question number</b>	<b>Answer</b>	<b>Notes</b>	<b>Marks</b>
3 a	D / simple distillation		1
b	C / fractional distillation		1
c	B / filtration		1
d	A / crystallisation		1

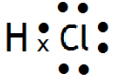
Question number	Answer		Notes	Marks								
4 a	C (green)			1								
b	value in range 120 - 250		If range given, it must be wholly within 120 - 250	1								
c	(colour) dark(er) grey / black		Do not accept grey alone Reject any other colour given with black eg blue/black Ignore just darker than iodine	2								
	(state) solid		Accept correct state symbol									
d	C (outer electrons)			1								
e	<table border="1"> <thead> <tr> <th data-bbox="336 1080 723 1155">Incorrect word</th> <th data-bbox="723 1080 1245 1155">Correct word</th> </tr> </thead> <tbody> <tr> <td data-bbox="336 1155 723 1230">positive</td> <td data-bbox="723 1155 1245 1230">negative</td> </tr> <tr> <td data-bbox="336 1230 723 1305">potassium</td> <td data-bbox="723 1230 1245 1305">sodium</td> </tr> <tr> <td data-bbox="336 1305 723 1380">reducing</td> <td data-bbox="723 1305 1245 1380">oxidising</td> </tr> </tbody> </table>	Incorrect word	Correct word	positive	negative	potassium	sodium	reducing	oxidising		<p>one mark for each correct row</p> <p>Accept minor variations and alternatives and extra words eg for negative, accept negatively / minus eg for oxidising, accept oxidation / electron acceptor /oxidating Accept potassium bromide and sodium bromide Accept K for potassium and Na for sodium</p>	3
Incorrect word	Correct word											
positive	negative											
potassium	sodium											
reducing	oxidising											

Question number	Answer	Notes	Marks
5 a i	to prevent spots/them dissolving/mixing (in the solvent) / OWTTE	Accept substance(s)/pigment(s)/dye(s) for spots Ignore references to diffusion/absorption Ignore references to spots smudging/running Accept spots would be washed off/away Ignore water for solvent	1
ii	Any two from: M1 evaporation /loss of solvent / OWTTE M2 risk of fire M3 fumes may be toxic/poisonous	Accept water for solvent Ignore gas escaping Ignore it is flammable only Ignore harmful/dangerous Ignore references to substances entering tank/spillage Ignore references to reaction with air	2



b	<p>M1 cross in box A (chlorophyll is <b>not</b> present in carrots, sweet potatoes or tomatoes)</p> <p>M2 cross in box C (both beta-carotene and lycopene are present in sweet potatoes)</p> <p>M3 cross in box E (Both carrots and tomatoes contain a pigment <b>other than</b> beta-carotene, chlorophyll and lycopene)</p>	<p>If more than three answers given mark on list principle: eg four answers given with 3 correct and 1 incorrect scores 2 marks eg all five answers given so 3 correct and 2 incorrect scores 1 mark</p>	3
c	<p>M1 (distance between start line and solvent front) = 6(.0)</p> <p>M2 correct evaluation of <math>R_f</math> value <math>1.3/6.0 = 0.22</math></p>	<p>Accept answer to 1 or more dp, eg 0.2, 0.217,  Accept 0.216recurring Reject 0.216  correct answer with no working scores 2  M2 CQ on M1</p>	2
d	(there is a substance in sweet potatoes that) does not dissolve/is insoluble (in the solvent)	<p>Ignore mix Ignore water for solvent Reject not very soluble/partially soluble</p>	1

Question number	Answer	Notes	Marks
6 a	covalent	Ignore references to polar bonding and electron sharing	1
b	<p>M1 weak forces (of attraction) between molecules / weak intermolecular forces</p> <p>M2 (therefore) little (thermal/heat) <u>energy</u> required to overcome the forces / separate the molecules</p>	<p>Accept bonds for forces for both M1 and M2 Reject atoms for both M1 and M2</p> <p>Accept particles for molecules Accept correctly named IMF eg van der Waals'</p> <p>Ignore more easily separated / easier to break</p> <p>if any reference to/implication of breaking covalent or ionic bonds scores 0/2</p> <p>M1 and M2 indep</p>	2
c	<p>M1 (strong) attraction between bonding/shared pair of electrons</p> <p>M2 (and) nuclei of (both atoms)</p> <p><b>OR</b></p> <p>M1 bonding/shared pair of electrons M2 (strongly) attracted to nuclei (of both atoms)</p>	<p>Do not award M2 if reference to only one nucleus</p> <p>Do not award M2 if reference to only one nucleus</p>	2

d		<p>M1 for 2 electrons shared between one H and one Cl</p> <p>M2 rest of molecule fully correct</p> <p>M2 DEP on M1</p> <p>Accept any combination of dots and crosses Ignore inner shells of electrons in chlorine</p> <p>if overlapping touching/circles are used both electrons must be within the overlapping/touching area</p> <p>symbols do not need to be shown if overlapping touching /circles are used</p>	2
e	<p>M1 (effervescence) due to hydrogen (gas)</p> <p>M2 solution A is acidic / contains H<sup>+</sup> / contains hydrochloric acid</p> <p>M3 solution B is not acidic / does not contain H<sup>+</sup> / does not contain hydrochloric acid</p>	<p>Accept hydrogen chloride/HCl does not ionise/dissociate</p> <p>If only reference to HCl ionises/dissociates allow max one mark for M2 and M3, ie reference to either H<sup>+</sup> or acid(ic) needed to score both marks</p> <p>Ignore the bonds between H and Cl are not broken (when HCl dissolved) in methylbenzene</p> <p>Do not award M3 if any reference to methylbenzene reacting or dissociating</p>	3

Question number	Answer	Notes	Marks
7 a	M1 (they/all) contain hydrogen and carbon (atoms)  M2 only	Accept H and C Accept particles/elements in place of atoms Reject ions/molecules/compounds in place of atoms Reject element instead of they/all Reject H <sub>2</sub> Reject mixture  Accept words with other meaning (eg solely/exclusively) M2 DEP on reference to hydrogen and carbon even if M1 not awarded	2
b	double bond	Accept multiple in place of double Accept contain C=C Ignore references to single bonds	1
c	A		1
d	B and E and F	All three correct scores 2 marks Two correct scores 1 mark  If more than three answers given lose one mark for each error eg BCEF scores 1 mark	2
e	because it has no double bond(s) / has only single bonds / is saturated	Accept because only unsaturated compounds decolourise bromine water Accept because only alkenes decolourise bromine water <b>Accept because it's not an alkene</b> <b>Accept because it's not unsaturated</b> <b>Accept because it's a (cyclo)alkane</b>	1

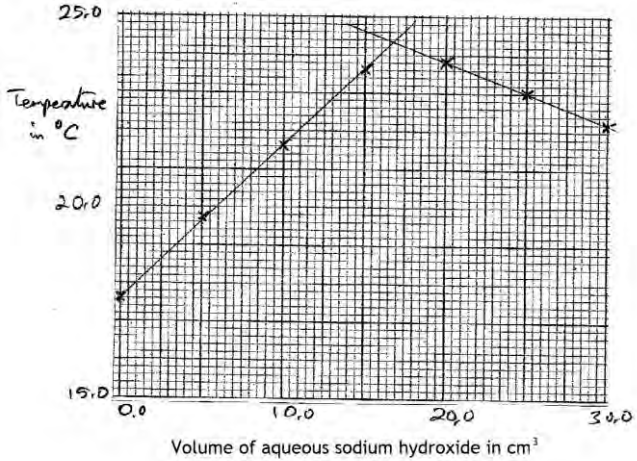
Question number	Answer	Notes	Marks									
7 f i	<p>M1 for setting out calculation</p> <table style="margin-left: 40px;"> <tr> <td style="text-align: center;">C</td> <td style="text-align: center;">H</td> <td style="text-align: center;">Br</td> </tr> <tr> <td style="text-align: center;"><u>22.2</u></td> <td style="text-align: center;"><u>3.7</u></td> <td style="text-align: center;"><u>74.1</u></td> </tr> <tr> <td style="text-align: center;">12</td> <td style="text-align: center;">1</td> <td style="text-align: center;">80</td> </tr> </table> <p>If division upside down or division by one or more atomic numbers, then 0/3</p> <p>M2 for obtaining ratio Accept any number of sig figs except one Allow 0.92</p> <p>M3 for whole number ratio M3 DEP on M2</p> <p style="margin-left: 40px;">2 : 4 : 1</p> <p>allow alternative method:</p> <p>M1 calculation of <math>M_r C_2H_4Br = 108</math></p> <p>M2 expression for % of <u>each</u> element eg C: <math>24/108 \times 100</math></p> <p>M3 evaluation to show these equal 22.2%, 3.7%, 74.1%</p>	C	H	Br	<u>22.2</u>	<u>3.7</u>	<u>74.1</u>	12	1	80		3
C	H	Br										
<u>22.2</u>	<u>3.7</u>	<u>74.1</u>										
12	1	80										
ii	<p>M1 <math>((2 \times 12) + (4 \times 1) + (1 \times 80) =) 108</math></p> <p>M2 <math>(216 \div 108 = 2)</math> (so molecular formula is) <math>C_4H_8Br_2</math></p>	correct answer with no working scores 2	2									

Question number	Answer	Notes	Marks
8 a i	$2\text{NdF}_3 + 3\text{Ca} \rightarrow 2\text{Nd} + 3\text{CaF}_2$	Accept fractions and multiples	1
	ii calcium fluoride AND neodymium fluoride (in either order)	Accept formulae	1
	iii ionic	Accept electrovalent Ignore giant Ignore electron transfer Reject covalent bonding/ intermolecular forces	1
	iv $\text{Nd}_2\text{O}_3$	penalise incorrect use of symbols and subscripts	1

b	<p>M1 (neodymium ions in) layers/rows/planes/sheets/OWTTE</p> <p>M2 slide/slip (over each other)</p> <p>M3 delocalised electrons OR sea of electrons</p> <p>M4 (can) flow/travel/move (through structure) / are mobile (when voltage/pd is applied)</p>	<p>Accept atoms/cations/particles for ions Reject molecules</p> <p>Allow OWTTE, eg flow/shift/roll/move</p> <p>M2 DEP on mention of <b>EITHER</b> layers or equivalent <b>OR</b> mention of ions or equivalent</p> <p>Do not award M2 if molecules/protons/electrons/nuclei in place of ions etc</p> <p>If reference to ionic bonding / covalent bonding / molecules / intermolecular forces, no marks</p> <p>Not just electrons Ignore free electrons</p> <p>Ignore carry charge M4 DEP on M3 or near miss</p>	4
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Question number	Answer	Notes	Marks
9 a	(polystyrene is an) insulator / prevents/reduces heat loss	Accept is a poor conductor (of heat) Accept keeps heat in <b>Accept doesn't conduct (heat)</b> as well (as glass) Ignore does not heat up Ignore references to accuracy/safety/breakages Reject to keep the temperature constant	1
b	M1 (after) 19.4(0) M2 (before) 15.9(0) M3 3.5(0)	If readings are correct but in the wrong order, award 1 mark for M1 and M2  M3 CQ on (M1 – M2)	3



<p>c i</p>		<p>M1+M2 all seven points plotted to nearest gridline Deduct 1 mark for each error</p> <p>M3 best fit straight line through first 4 points drawn with aid of a ruler</p> <p>M4 best fit straight line through last 3 points drawn with aid of a ruler</p> <p>No penalty if lines do not cross or if the two straight lines are joined by a curve</p> <p><b>values correctly read from candidate's graph</b> Do not award these marks if lines do not cross or if curve drawn</p>	<p>4</p>
<p>ii</p>	<p>M1 (temperature)</p> <p>M2 (volume)</p>	<p>temperature to <math>\pm 0.1</math> °C</p> <p>volume to <math>\pm 0.25</math> cm<sup>3</sup></p> <p>If values correct but in wrong places allow 1/2</p>	<p>2</p>

Question number	Answer	Notes	Marks
9 d	M1 mass = 47.7 (g) M2 temperature change = 5.8 (°C) M3 (47.7 × 4.2 × 5.8 =) 1200 (J)	Accept 1160, 1162, 1161.97, 1161.972 Reject 1161.9 M3 CQ on M1 and M2 answer correct to two or more sig fig  Correct final answer with or without working scores 3 marks Accept answer in kJ if unit included Ignore sign	3

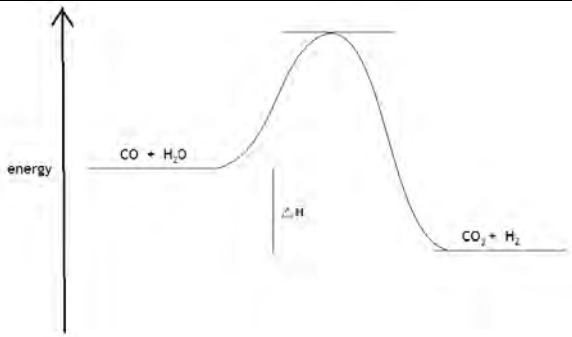
Question number	Answer	Notes	Marks
10 a i	<p>M1 <math>n(\text{Na}_2\text{S}_2\text{O}_3) = \frac{0.300 \times 20}{1000}</math> OR 0.006(0) mol (= <math>n(\text{SO}_2)</math>)</p> <p>M2 <math>M_r</math> of <math>\text{SO}_2 = 32 + (2 \times 16)</math> OR 64</p> <p>M3 mass of <math>\text{SO}_2 = (0.006 \times 64) = 0.38</math> (g)</p>	<p>Mark CQ throughout Accept any number of sig fig Correct final answer with or without marking scores 3 marks</p>	3
ii	<p>M1 mass of <math>\text{SO}_2</math> in 1 dm<sup>3</sup> = <math>\frac{0.38(4) \times 1000}{50}</math>  = 7.6(8) (g)</p> <p>M2 this is less than 100 so no <math>\text{SO}_2</math> will escape</p> <p><b>OR</b></p> <p>M1 volume of solvent is 50cm<sup>3</sup> which would dissolve (100/20) = 5(g)</p> <p>M2 0.384(g) is less than 5(g) so no <math>\text{SO}_2</math> would escape</p>	<p>M1 CQ on M3 in ai</p> <p>Accept any number of sig fig</p> <p>If candidate value for M1 is greater than 100, award M2 for opposite argument If no answer to M1 then M2 cannot be awarded</p> <p>If answers based on volume of solvent = 20cm<sup>3</sup> eg 20cm<sup>3</sup> which would dissolve (100/50) = 2(g) 0.384(g) is less than 2(g) so no <math>\text{SO}_2</math> would escape worth 1 mark</p>	

b	as the (hydrochloric) acid/HCl is added	<p>Allow (immediately) after (all) the acid/HCl added</p> <p>Ignore when the solutions are mixed</p>	1
c	<p>i timer started too late / stopped too early</p> <p>OR</p> <p>thermometer (scale) read incorrectly / timer read incorrectly</p> <p>ii 19.5 (s)</p>	<p>Allow misread/incorrectly recorded the temperature/time</p> <p>Accept range 19-20</p>	1

Question number	Answer	Notes	Marks
10 d i	<p>M1 times are (very) short</p> <p>M2 heat loss greater</p>	<p>Accept reaction happens too/very/so quickly (so hard to time accurately/precisely)            Ignore reaction is quicker            Ignore hard(er) to measure rate            Allow human reaction time becomes significant            Allow references to shorter times producing greater percentage (measurement) uncertainties/errors</p> <p>Accept heat loss occurs more quickly            Accept difficult to maintain a higher temperature/keep temperature constant            Ignore references to evaporation occurring</p>	2
ii	<p>M1 more collisions/particles have energy equal to/greater than the activation energy</p> <p>M2 (therefore there are) more successful collisions (per second)</p>	<p>Ignore particles have more (kinetic) energy            Ignore harder/more vigorous collisions            Ignore references to speed of particles</p> <p>if state activation energy is lowered scores 0/2            references to concentration scores 0/2</p>	2

e	<p>Any three from</p> <p>M1 concentration of the (hydrochloric/nitric) acid</p> <p>M2 volume of the (hydrochloric/nitric) acid</p> <p>M3 volume of sodium thiosulfate</p> <p>M4 temperature</p>	<p>Allow amount for volume</p> <p>If neither M2 or M3 scored allow 1 mark for total volume of the mixture OR depth of liquid in the flask</p> <p>Ignore reference to volume of water Ignore references to size of flask/same apparatus Ignore references to distance of eye from flask/the X/references to timing</p> <p>3</p>
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Question number	Answer	Notes	Marks
11 a	$\text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3\text{H}_2$	Accept fractions and multiples	1
b i	M1 (increased pressure) has no effect (on yield) M2 because equal numbers of (gas) moles/molecules on each side	Ignore no effect on other factors eg equilibrium (position) Do not award M2 if M1 is incorrect	2
ii	M1 (at higher temperature equilibrium position shifts to left so yield of hydrogen) decreases M2 because (forward) reaction is exothermic	Accept because backward reaction is endothermic Accept because reaction moves in the endothermic direction  <b>Ignore references to Le Chatelier's principle</b> eg increase in temperature favours the endothermic reaction  Do not award M2 if M1 is incorrect	2

c	i		<p>M1 for <math>\text{CO}_2 + \text{H}_2</math> / products below <math>\text{CO} + \text{H}_2\text{O}</math></p> <p>M2 for approximately vertical line/arrow with <math>\Delta H</math> symbol/enthalpy change/<math>-41\text{kJ/mol}</math> between reactants and products</p> <p>M2 CO on M1 unless if products above the activation energy</p>	2
	ii	no effect / OWTTE		1
	iii	<p>M1 provides alternative pathway / route / OWTTE</p> <p>M2 with lower activation energy</p>	<p>Accept words such as another / different in place of alternative, but not just route</p> <p>Accept lowers the activation energy Accept less energy needed to start the reaction</p> <p>Reject (catalyst) provides energy for M1 and M2 Ignore references to providing surface for reaction</p>	2



Question number	Answer	Notes	Marks
11 d	<p>M1 identifying reaction 3 or reaction 4</p> <p>M2 a correct explanation for either eg in reaction 3, there is gain of hydrogen  in reaction 4, there is gain of oxygen</p>	<p>Ignore reactions 5 and 6</p> <p>Accept increase in oxidation number of H / changes from 0 to (+)1 Accept decrease in oxidation number of N / changes from 0 to -3 Ignore references to gain/loss of electrons</p> <p>Accept decrease in oxidation number of O/ changes from 0 to -2 Accept increase in oxidation number of N / changes from -3 to (+)2 Ignore references to gain/loss of electrons</p> <p>Ignore other explanations</p> <p>Allow:</p> <p>Identifying both Reaction 3 and 4 <u>only</u> for 2 marks Ignore any explanations</p>	2

e	<p>M1 <math>n(\text{NH}_3) = \frac{34 \times 1000}{17} = 2000 \text{ (mol)}</math></p> <p>M2 <math>M_r(\text{NH}_4\text{NO}_3) = 80</math></p> <p>M3 mass <math>(\text{NH}_4\text{NO}_3) = 80 \times 2000 = 160\,000 \text{ g} / 160 \text{ kg}</math></p> <p><b>OR</b></p> <p>M1 <math>M_r(\text{NH}_4\text{NO}_3) = 80</math></p> <p>M2 (so) 17 (kg <math>\text{NH}_3</math>) gives 80 (kg <math>\text{NH}_4\text{NO}_3</math>)</p> <p>M3 (so) 34 (kg <math>\text{NH}_3</math>) gives <math>\frac{80}{17} \times 34 = 160 \text{ kg}</math> / 160 000 g</p>	<p>Correct final answer with or without working scores 3 marks</p> <p>Do not award M3 if unit missing or incorrect</p> <p>Mark CQ throughout</p> <p>3</p>
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Question number	Answer	Notes	Marks
12 a	i fuel oil		1
	ii fuel oil		1
	iii gasoline		1
b	i alumina / silica	Accept aluminosilicates/zeolites Accept aluminium oxide/silicon dioxide/silicon oxide/silicon (IV) oxide  Accept correct formulae	1
	ii M1 for correct formula - C <sub>4</sub> H <sub>8</sub>	Accept C <sub>4</sub> H <sub>8</sub> + C <sub>4</sub> H <sub>8</sub> for 2 marks	
	M2 for correct coefficient - 2	Award 1 mark for 4C <sub>2</sub> H <sub>4</sub>  Award 1 mark for C <sub>8</sub> H <sub>16</sub>  Award 1 mark for two alkenes which have a total of 8C and 16H eg C <sub>3</sub> H <sub>6</sub> + C <sub>5</sub> H <sub>10</sub>	2

iii	M1	over/greater supply of long-chain hydrocarbons/molecules/ heavy/heavier fractions / OWTTE	Accept long chain hydrocarbons/molecules heavy/heavier fractions are of less use (as fuels)	3
	M2	high demand/more use for short-chain/small hydrocarbons/ light/lighter fractions / OWTTE	Accept answers in terms of petrol / fuel (for cars)  Short chain hydrocarbon molecules are more useful/in greater demand than long chain hydrocarbons/molecules scores M1 and M2	
	M3	Alkenes used to make polymers	Accept specific alkene and product eg ethene to make poly(ethene)/ethanol/alcohol	
c	M1	forms sulfur dioxide (when burned)		2
	M2	which causes specified problem for environment OR specified problem for humans	eg acid rain / damages trees / kills fish  eg toxic / respiratory irritant / triggers asthma attacks Ignore harmful gas	

Question number	Answer	Notes	Marks
12 d	$  \begin{array}{cccc}  \text{H} & \text{H} & \text{H} & \text{H} \\    &   &   &   \\  \text{---C} & \text{---C} & \text{---C} & \text{---C} \text{---} \\    &   &   &   \\  \text{H} & \text{CH}_3 & \text{H} & \text{CH}_3  \end{array}  $	<p>M1 for only <u>two</u> (of the four) carbon atoms both with two H  eg -CH<sub>2</sub>-CH<sub>2</sub>-CH<sub>2</sub>-CH<sub>2</sub>- scores 0</p> <p>M2 for (the other) <u>two</u> carbon atoms each with one H and one CH<sub>3</sub>  No M2 if methyl groups on 1st + 2nd, or on 3rd + 4th carbons in chain</p> <p>Do not penalise bonds to H of CH<sub>3</sub></p> <p>Max 1 if chain extended correctly</p> <p>Ignore brackets and n</p> <p>each carbon must have four bonds  eg -CH<sub>2</sub>-CH-CH-CH<sub>2</sub>- scores 0</p> <p>if terminal Hs added max 1</p> <p>0/2 if any double bonds shown</p>	2

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