

Mark Scheme (Results) Summer 2007

GCE

GCE Chemistry Nuffield (6252) Paper 01

General Guidance on Marking

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge.

Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the mark scheme

The mark scheme gives you:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

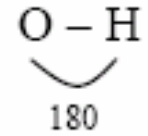
Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

- 1 / means that the responses are alternatives and either answer should receive full credit.
- 2 () means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
- 3 [] words inside square brackets are instructions or guidance for examiners.
- 4 Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is essential to the answer.
- 5 ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

	EXPECTED ANSWER			ACCEPT	REJECT	MARK
1	(a)	(i)	$\text{Br}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons 2\text{H}^+(\text{aq}) + \text{Br}^-(\text{aq}) + \text{BrO}^-(\text{aq})$ formulae (1) balancing (ignore state symbols) (1)	$\rightleftharpoons \text{H}^+(\text{aq}) + \text{Br}^-(\text{aq}) + \text{HBrO}(\text{aq}) / \text{BrOH}$ $\text{H}^+(\text{aq}) + \text{BrO}^-(\text{aq}) + \text{HBr}(\text{aq})$ If $\text{HBr} + \text{HBrO}$, H^+ must be crossed out		(2)
		(ii)	reaction is reversible/equilibrium (reaction) can go backward and forward/can go both ways/occurs in both directions	Reversible		(1)
		(iii)	<u>bromine</u> has been both oxidised and reduced (1) ↑ must mention bromine (Br/Br_2 for first mark) from 0 to +1 and -1 (1)	Br oxidation number both increased and decreased / goes up and down	Bromine goes to +1 and -1 must show from 0 Arguments based on OILRIG Incorrect identification of ox/red i.e. ox is 0 → -1	(2)
		(iv)	$\text{Cl}_2(\text{g}) + 2\text{Br}^-(\text{aq}) \rightarrow 2\text{Cl}^-(\text{aq}) + \text{Br}_2(\text{aq})$ formulae (1) balancing and state symbols (1) second mark dependent on first unless correct but non ionic equation given $\text{Cl}_2(\text{g}) + 2\text{KBr}(\text{aq}) \rightarrow 2\text{KCl}(\text{aq}) + \text{Br}_2(\text{aq})$	$\text{Br}_2(\text{l})$ multiples	$\text{Cl}_2(\text{aq})$ $\text{Br}_2(\text{g})$ $\text{Br}^2(\text{aq})$	(2)
	(b)	(i)	Sulphur from +4 to +6 / +4 to 6 + / 4 to 6 (1) Bromine from 0 to -1 (1) Accept name or symbol (S or Br or Br_2)	Oxidation and reduction transposed but correct numbers 1 (out of 2) Elements correctly identified but incorrect numbers 1 (out of 2) sulfur, sulphur, sulfer		(2)

	EXPECTED ANSWER		ACCEPT	REJECT	MARK
	(ii)	$\text{Br}_2 + 2\text{H}_2\text{O} + \text{SO}_2 \rightarrow 4\text{H}^+ + 2\text{Br}^- + \text{SO}_4^{2-}$	Accept multiples		(1)
(c)		Add silver nitrate (solution) / AgNO_3 (1) creme/cream precipitate/solid both words needed (1) 2 nd mark dependent on 1 st unless Ag^+ given as reagent	off-white pale yellow	react with Ag^+ / fluorine /alkene / H_2SO_4 and misty fumes yellow	(2)
(d)	(i)	Chlorine/ Cl_2	HBr/hydrogen bromide/hydrobromic acid		(1)
	(ii)	(fractionally) distil (as the three substances have different boiling points) (1) add a drying agent e.g. anhydrous calcium chloride (1) must give named drying agent (either order) OR solvent extraction/e.g. add a liquid hydrocarbon (1) (fractionally) distil (1) (either order) Distil, then solvent extract then distil (2)	any neutral drying agent anhydrous sodium sulphate anhydrous magnesium sulphate silica gel	anhydrous copper sulphate calcium carbonate conc H_2SO_4 KOH Heat under reflux Steam distillation	(2)
					(Total 15 marks)

	EXPECTED ANSWER		ACCEPT	REJECT	MARK
2	(a)	ANY TWO Coal (crude) oil/petroleum (natural) gas/CH ₄ / methane	Wood peat		(1)
	(b)	543 (K) 543° 543 Kelvin 543 in Kelvin			(1)
	(c)	(i) $ \begin{array}{c} \text{H} \\ \vdots \\ \text{H} \vdash \text{C} : \quad \text{: O} \vdash \text{H} \\ \vdots \\ \text{H} \end{array} $ ↑ check 2 lone pairs on oxygen	showing all electrons can be all dots or all crosses	Ethanol or any other alcohol	(1)
		(ii) $ \begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{O}-\text{H} \\ \\ \text{H} \end{array} $ (0) HCH or HCO = 109.5° (1) HOC = 104.5° (1)	TE from (c)(i) if ethanol etc If angle shown on diagram, must bridge two bonds 109° 102.5 - 106.5		(2)
	(d)	(i) higher pressure / temperature will increase rate of reaction OR higher pressure will increase production of methanol (as less moles of gas on the RHS)	Higher pressure faster reaction higher temperature faster reaction higher pressure greater yield	no catalyst used so cheaper	(1)

		EXPECTED ANSWER	ACCEPT	REJECT	MARK
	(ii)	<p>Any three from:</p> <p>lower temperature increases yield / because reaction exothermic (1)</p> <p>lower temperature costs less, (less energy used) (1)</p> <p>lower pressure costs less, (pipes thinner/less energy needed to pressurise plant) (1)</p> <p>catalyst speeds up reaction (1) /allows a lower temperature to be used</p>	<p>Can gain 2 marks if both ideas of temperature and pressure put together in same advantage</p> <p>catalyst allows a lower pressure to be used</p>	<p>Lower temp/pressure easier to achieve</p>	(3)
(e)	(i)	ethane C ₂ H ₆	<p>CH₃.CH₃ CH₃-CH₃</p> <pre> H H H - C - C - H H H </pre>	Ethene, methane	(1)
	(ii)	van de(r) Waals/Walls Van Der Waals London forces/temporary dipole-dipole/induced dipole-dipole		VDW vdw Dipoles permanent dipoles Fluctuating/flickering dipoles	(1)
	(iii)	methanol because there are hydrogen bonds between the methanol molecules	Allow ethanol Dipole-dipole interaction	Stronger intermolecular forces	(1)
	(iv)	<pre> H H H H - C - O - H - O - C - H H H H </pre> <p>correct atoms involved in hydrogen bonds (1) bond angle 180° and correctly indicated (1) second mark dependant on first</p>	<p>Allow ethanol</p> <p>Drawing does NOT have to be at 180°</p>	 <p>NO TE from (e) (iii) if alkane selected</p>	(2)

EXPECTED ANSWER			ACCEPT	REJECT	MARK
(f)	(i)	$\text{CH}_4\text{O}/\text{CH}_3\text{OH}(\text{l})/(\text{g}) + 1\frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})/(\text{g})$ formulae (1) balancing and state symbols (1)	Multiples 1 missing state symbol for oxygen, carbon dioxide or water	$\text{CH}_3\text{OH}(\text{aq})$	(2)
	(ii)	burns with a cleaner flame/no sulphur/ greater proportion of hydrogen to carbon/ available from a variety of sources other than petroleum/ less likelihood of incomplete combustion/only CO_2 and not CO etc any one	Wood is a renewable resource	Less CO_2 given off ignites more easily not as polluting no impurities in methanol A renewable energy source cheaper to produce less oxygen needed to burn it	(1)
					(Total 17 marks)

	EXPECTED ANSWER			ACCEPT	REJECT	MARK
3	(a)	(i)	A and/or propene	prop-1-ene	A and any other letter	(1)
		(ii)	B C and D (any order) 3 correct for 2 marks 2 correct for 1 mark 1 letter, correct or incorrect 0 eg B 2 letters both correct 1 BC 2 letters 1 correct 1 wrong 0 BE 3 letters, all correct 2 BCD 3 letters, 2 correct 1 wrong 1 BCE 3 letters, 1 correct 2 wrong 0 ABE 4 letters, 3 correct 1 wrong 1 BCDE 4 letters, 2 correct 2 wrong 0 ABDE 5 letters 0 ABCDE			(2)
	(b)	(i)	2-bromopropane 2 (-) bromo (-) propane 2 Bromo Propane 2, bromopropane		Bromopropane bromo-2-propane 2-bromopropene	(1)
		(ii)	poly(propene) or polypropene	Polly(propene) Polypropylene	Poly porpene polypropene	(1)
	(c)	(i)	potassium/sodium hydroxide (1) (concentrated) ethanol(ic)/alcoholic AND heat/reflux	KOH/NaOH	Alkali on its own Any mention of water/aqueous/ pressure (-1)	(2)
		(ii)	Elimination (reaction)		Any qualification of elimination e.g nucleophilic electrophilic cracking	(1)

	EXPECTED ANSWER			ACCEPT	REJECT	MARK
	(d)	(i)	$\text{Cl}_2 \rightarrow 2\text{Cl}^\bullet$ Ignore state symbols		Not 2 Cl(g) $\text{Cl}_2 \rightarrow 2\text{Cl}$	(1)
		(ii)	$\text{C}_3\text{H}_8 + \text{Cl}_2 \rightarrow \text{C}_3\text{H}_7\text{Cl} + \text{HCl}$ Ignore state symbols		$2\text{Cl}^\bullet +$ $\text{C}_3\text{H}_8 \rightarrow \text{C}_3\text{H}_7\text{Cl} + \text{HCl}$	(1)
		(iii)	2 (,) 3 (-)dimethyl butane (1) Ignore punctuation Reaction between two $\text{CH}_3 - \text{CH} - \text{CH}_3$ (1) dot must be shown on central carbon atom Termination (1)	$\text{C}_3\text{H}_7^\bullet + \text{C}_3\text{H}_7^\bullet \rightarrow \text{C}_6\text{H}_{14}$ Chain termination	2,3 methylbutane $\text{CH}_3\text{CHCH}_3^\bullet$	(3)
(Total 13 marks)						
4	(a)	(i)	(same) <u>number</u> of protons and electrons (86)	React in the same way Same atomic number and same electron arrangement		(1)
		(ii)	unstable/radioactive		Decay by emitting α particles /all gases / similar reactions	(1)
	(b)	(Only decay product which) is a gas (so can escape from the ground)			Soluble in water so travels long distances	(1)
	(c)	van der Waals forces between radon atoms and hydrogen bonds between water molecules (1) therefore on mixing unable to break strong hydrogen bonds as no new strong bonds can be formed (1)		Radon cannot form hydrogen bonds with water (1 out of 2)		(2)
	(d)	(i)	$3/24 \times 6 \times 10^{23} = 7.5 \times 10^{22}$	0.75×10^{23}	Incorrect units e.g. dm^3	(1)
		(ii)	$3\,000 / 7.5 \times 10^{22} \times 100\%$ $= 4 \times 10^{-18}$ TE from (d) (i)	0.4×10^{-17} etc	4^{-18}	(1)

	EXPECTED ANSWER	ACCEPT	REJECT	MARK
(e)	<p>Examiners will need to consider each answer for (i) key points and (ii) style and use of English. Candidates should have recorded their word total at the end of their answer, and this should be checked.</p> <p>up to 105 words: no penalty 106 - 115 words: -1 116 - 125 words: -2 126 - 135 words: -3 and at a rate of -1 penalty for every 5 words excess thereafter, up to a maximum penalty equal to the number of key points included by the answer.</p> <p>Note that words appearing in the title to the summary do not count in the word total. Normally hyphenated words, eg α-radiation, uranium-238, X-rays, γ-rays, radon-induced = 1 word. 1000-2000 = 3 words Numbers and chemical formulae count as one word. The question does not ask for equations in the summary, but if included they should be counted in the word total. Sub headings do not count in the word total.</p>			

		<p>Quality of written communication</p> <p>This should be impression marked on a scale 2 - 1 - 0, and the mark out of 2 should be recorded in the body of the script at the end of the answer. This mark can not be lost as a result of a word penalty.</p> <p>Candidates are expected to:</p> <ul style="list-style-type: none"> •show clarity of expression; •construct and present coherent argument; •demonstrate effective use of grammar, punctuation and spelling. <p>The aspects to be considered are:</p> <ul style="list-style-type: none"> • use of technical terms; the answer should convey a correct understanding by the writer of the technical terms used in the passage which are involved in the key points. • articulate expression; the answer should be well-organised in clear, concise English, without ambiguity. It should read fluently, with the links between key points in the original maintained. • legible handwriting; the reader should be able to read the answer without difficulty at normal reading pace, with only the occasional difficulty with a word. • points must be in a logical order. <p>Good style and use of English, with only infrequent minor faults, no use of formulae (2) Frequent minor or a few major faults in style and use of English (1) Very poor style and use of English (0)</p> <p>NB: The quality of written communication mark cannot be lost through word penalties.</p>	(2 marks)
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