GCE
AS and A Level

Chemistry

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 2:
Specimen mark scheme

Version 1.1

Version 1.1: 07/07

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Chemistry 2420

CHEM2 Chemistry In Action

Mark Scheme

Specimen Paper

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. The specimen assessment materials are provided to give centres a reasonable idea of the general shape and character of the planned question papers and mark schemes in advance of the first operational exams.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question 1

(a) The enthalpy change when 1 mol of a compound (1)
is completely burnt in oxygen (1)
under standard conditions, or 298K and 100kPA (1)

(b) (i) $C_2H_6 + 3\frac{1}{2}O_2 \rightarrow 2CO_2 + 3H_2O$ (1)

(ii) $\Delta H = 2 \times \Delta H_f^{\ominus}(CO_2) + 3 \times \Delta H_f^{\ominus}(H_2O) - \Delta H_f^{\ominus}(C_2H_6)$ (1)
$= -788 - 858 - (-85)$ (1)
$= -1561$ kJ mol^{-1} (1)

(c) moles methane $= \frac{0.10}{16} = 6.25 \times 10^{-3}$ (1)

kJ evolved $= 6.25 \times 10^{-3} \times 890 = 5.56$ (1)

5.56×10^3 joules $= (mc)\Delta T$ (1)

$\Delta T = \frac{5.56 \times 10^3}{120} = 46.4$ K (1)

Question 2

(a) Peak lower (1)

and moved to right (1)

start at the origin and curve crosses once only (1)

(b) (i) (Rate of reaction) <u>increases</u> (1)

(At a higher temperature) <u>more molecules/particles</u> (1)

have the minimum energy needed to react/have activation energy/have successful collisions (1)
Mark CE if incorrect effect given

(ii) (Rate of reaction) <u>increases</u> (1)

lowers activation energy (1)

so that more molecules are able to react (1)
Mark CE if incorrect effect given

Question 3

(a) Low temperature

Reaction is exothermic (1)

Low T reduces effect of heat evolved

<u>or</u> heat evolved opposes the change in temperature (1)

High pressure

3 mol gas → 1 mol gas (1)

High p favours fewer moles by lowering p

<u>or</u> forward reaction reduces volume and lowers p (1)

(b) High T gives a low yield (1)

<u>but</u> Low T gives a low rate ∴compromise (1)

increases reaction rate/catalyst surface contact (1)

Question 4

(a) Gain of electrons (1)

(b) (i) (+)5 or V or N^{5+} (1)

(+)4 or IV or N^{4+} (1)

(+)2 or II or N^{2+} (1)

(ii) Reduction (1)

$4H^+ + NO_3^- + 3e^{(-)} \rightarrow NO + 2H_2O$ (1)

(iii) $2H^+ + NO_3^- + e^{(-)} \rightarrow NO_2 + H_2O$ (1)

(iv) $Cu + 4H^+ + 2\ NO_3^- \rightarrow Cu^{2+} + 2H_2O + 2NO_2$

species (1)

balanced (1)

If electrons included, **mark CE if these are not balanced**

Question 5

(a)	(i)	$2CuCO_3 + C \rightarrow 2Cu + 3CO_2$	(1)
	(ii)	Charcoal /carbon /C	(1)
(b)	(i)	Iron is more reactive / iron ore needs much more heat to extract the iron	(1)
		Carbon monoxide	(1)
(c)		*stage 1:* $TiO_2 + 2C + Cl_2 \rightarrow TiCl_4 + 2CO$	(2)
		($C + Cl_2$ in incorrect equation gains 1 mark)	
		allow equations with $+ C \rightarrow CO_2$	
		stage 2: $\underline{TiCl_4} + 4Na$ (*or 2Mg*) $\rightarrow 4NaCl$ (*or $2MgCl_2$*) $+ Ti$	(2)
		(Na or Mg in unbalanced equation gains 1 mark)	
(d)		*Extraction*: form metal oxide *Or metal oxide implied*	(1)
		reduce **or** react with suitable reducing agent *Consequential on formation of metal oxide*	(1)
		Pollution problems: SO_2 **(1)** or oxides of S <u>not</u> SO_3 alone *(allow any sensible and correct reducing agent identified)*	(1)
		any mention of acid rain or H_2SO_4 or erosion caused by acid rain or correct problem due to acid rain	(1)

Question 6

(a) *Trend*: increases (1)

Wrong trend CE=0 and in (b)

Reason: More electron shells (1)

OR implies more shell / sub-shells / levels

(b) *Trend*: decreases (1)

Explanation: Metallic bonds weaker (1)

OR weaker attraction between ions (or nuclei) & delocalised electrons

Atoms (ions) larger (1)

This mark is only scored if previous mark given**. CE if mention molecules, intermolecular forces ionic bonding**

(c) *Trend*: increases (1)

Equation for magnesium: $Mg + H_2O \rightarrow MgO + H_2$ (1)

Equation for strontium: $Sr + 2\ H_2O \rightarrow Sr(OH)_2 + H_2$ (1)

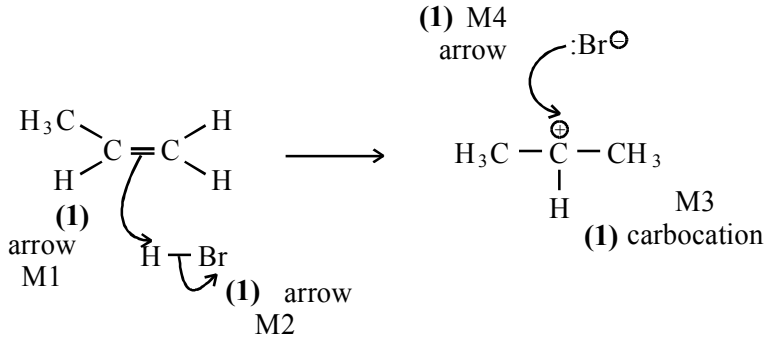
(d) *Formula*: $BaSO_4$ (1)

Use: Test for sulfate ion (1)

OR Pigment, for x-rays, barium meal, paint

Question 7

(a) (i)



(4)

If wrong carbocation, lose structure mark
If wrong alkene, lose structure mark
Can still score ¾ i.e. penalise M3
Penalise M2 if polarity included incorrectly
no bond between H and Br
bond is shown as ⸺ or ⸺

(ii) $CH_3CH_2\overset{\oplus}{C}H_2$ **(1)** (1)

credit secondary carbocation here if primary carbocation has been used in (i)

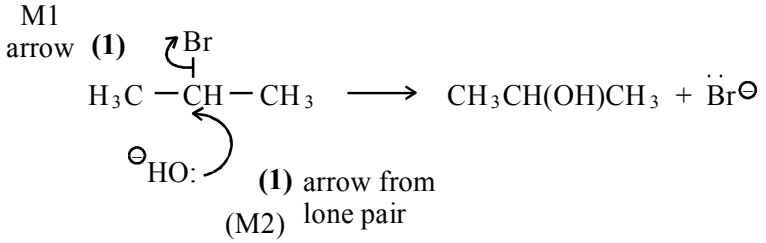
Ignore attack on this carbocation by $\ddot{Br}^{\ominus}$

(b) (i) *Structure*: $H_3C-CH(OH)-CH_3$ **(1)** [insist on C — OH bond] (1)

Name: propan-2-ol (1)
Not 2-hydroxypropane

(ii) *Name of mechanism*: nucleophilic substitution **(both words)** (1)
(NOT S_N1 or S_N2)

Mechanism:



(2)

penalise incorrect polarity on C-Br (M1)

Credit the arrows even if incorrect haloalkane

If S_N1, both marks possible

(c) (i) elimination (1)

(ii) base (1)
OR proton acceptor
NOT nucleophile

Question 8

Mark Range	The marking scheme for this part of the question includes an overall assessment for the Quality of Written Communication (QWC). There are no discrete marks for the assessment of QWC but the candidates' QWC in this answer will be one of the criteria used to assign a level and award the marks for this part of the question **Descriptor** an answer will be expected to meet most of the criteria in the level descriptor
4-5	- claims supported by an appropriate range of evidence - good use of information or ideas about chemistry, going beyond those given in the question - argument well structured with minimal repetition or irrelevant points - accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling
2-3	- claims partially supported by evidence - good use of information or ideas about chemistry given in the question but limited beyond this - the argument shows some attempt at structure - the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling
0-1	- valid points but not clearly linked to an argument structure - limited use of information or ideas about chemistry - unstructured - errors in spelling, punctuation and grammar or lack of fluency

(a)	Kills bacteria / prevents bacterial diseases		QWC	(1)
	Chlorine is a toxic substance			(1)
	$Cl_2 + H_2O \rightarrow HCl + HClO$			(1)
(b)	$Cl_2(aq)$ to $Br^-(aq)$;	yellow-orange or yellow-red or yellow-brown solution	QWC	(1)
		$2Br^- + Cl_2 \rightarrow 2Cl^- + Br_2$ or molecular equation		(1)
	$Cl_2(aq)$ to $I^-(aq)$;	brown/black solution formed or black/brown/grey ppt/solid	QWC	(1)
		$2I^- + Cl_2 \rightarrow 2Cl^- + I_2$ **or molecular equation**		(1)
(c)	Bromide:-	Brown/orange fumes		(1)

	Bromine produced	(1)
	Sulphur dioxide produced	(1)
Iodide:-	Purple fumes or black/brown/grey solid QWC or smell of bad eggs	(1)
	Iodine produced	(1)
	SO_2, S, H_2S produced (one mark each)	(3)
Half-equations	$2Br^- \rightarrow Br_2 + 2e^-$ OR $2I^- \rightarrow I_2 + 2e^-$	(1)
	$H_2SO_4 + 2e^- + 2H^+ \rightarrow SO_2 + 4H_2O$ OR $H_2SO_4 + 6e^- + 6H^+ \rightarrow S + 4H_2O$ OR $H_2SO_4 + 8e^- + 8H^+ \rightarrow H_2S + 4H_2O$	(1)
Overall equation	Any correct equation based on half-equations QWC	(1)

Question 9

(a) Allow 1 mark each for any correctly drawn primary, secondary and tertiary alcohol of molecular formula C_4H_8O (3)

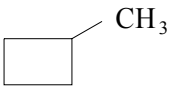
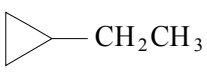
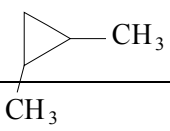
Tertiary alcohol cannot be oxidised (1)

(b) Region 1500–400 cm^{-1} (1)

exact match to spectrum of known compound (1)

(c)

A	**B**
$CH_3CH_2CH_2OH$ or $CH_3CH(OH)CH_3$ **(1)**	$CH_3CH_2–O–CH_3$ **(1)**

C	**D**
one alkene e.g.	one cycloalkane e.g.
$CH_2= CH\ CH_2CH_2CH_3$	 
$CH_3– CH = CH – CH_2CH_3$	
$(CH_3)_2C = CHCH_3$	 
$H_2C = C(CH_3)CH_2CH_3$	

(1) etc **(1)** (6)

E	**F**
CH_3CH_2CHO **(1)**	CH_3COCH_3 **(1)**