



**Cambridge International Examinations**  
Cambridge International General Certificate of Secondary Education

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**CHEMISTRY**

**0620/41**

Paper 4 Theory (Extended)

**May/June 2016**

MARK SCHEME

Maximum Mark: 80

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**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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### Abbreviations used in the Mark Scheme

- ; separates marking points
- / separates alternatives within a marking point
- **OR** gives alternative marking point
- **R** reject
- **I** ignore mark as if this material was not present
- **A** accept (a less than ideal answer which should be marked correct)
- **COND** indicates mark is conditional on previous marking point
- owtte or words to that effect (accept other ways of expressing the same idea)
- max indicates the maximum number of marks that can be awarded
- ecf credit a correct statement that follows a previous wrong response
- ( ) the word / phrase in brackets is not required, but sets the context
- ora or reverse argument

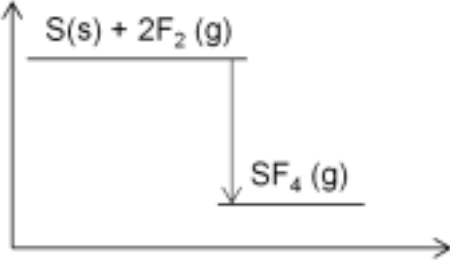
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Question	Answer	Marks																
1(a)	<table border="1"> <thead> <tr> <th>particle</th> <th>relative mass</th> <th>relative charge</th> </tr> </thead> <tbody> <tr> <td>proton</td> <td>1</td> <td>+1</td> </tr> <tr> <td>neutron</td> <td>1</td> <td>nil</td> </tr> <tr> <td>electron</td> <td>1/1840</td> <td>-1</td> </tr> </tbody> </table>	particle	relative mass	relative charge	proton	1	+1	neutron	1	nil	electron	1/1840	-1	3				
particle	relative mass	relative charge																
proton	1	+1																
neutron	1	nil																
electron	1/1840	-1																
1(b)(i)	<p><b>M1</b> <u>atom(s)</u> of the same element;</p> <p><b>M2</b> with different number of neutrons;</p>	2 1 1																
1(b)(ii)	<p><b>M1</b> (both have) the same number of electrons;</p> <p><b>M2</b> in the outer shell;</p>	2 1 1																
1(c)	<table border="1"> <thead> <tr> <th>particle</th> <th>number of protons</th> <th>number of neutrons</th> <th>number of electrons</th> </tr> </thead> <tbody> <tr> <td><math>{}^7_3\text{Li}</math></td> <td>3</td> <td>4</td> <td>3</td> </tr> <tr> <td><math>{}^{34}_{16}\text{S}^{2-}</math></td> <td>16</td> <td>18</td> <td>18</td> </tr> <tr> <td><math>{}^{41}_{19}\text{K}^+</math></td> <td>19</td> <td>22</td> <td>18</td> </tr> </tbody> </table>	particle	number of protons	number of neutrons	number of electrons	${}^7_3\text{Li}$	3	4	3	${}^{34}_{16}\text{S}^{2-}$	16	18	18	${}^{41}_{19}\text{K}^+$	19	22	18	5
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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
2(a)	number of moles of NaNO <sub>3</sub> used: $3.40/85 = 0.04(00)$ (mol) <b>OR</b> $4.(00) \times 10^{-2}$ (mol);  number of moles of O <sub>2</sub> formed: $0.04/2 = 0.02(00)$ (mol) <b>OR</b> $2.(00) \times 10^{-2}$ (mol);  volume of O <sub>2</sub> formed: $0.02 \times 24 = 0.48$ (dm <sup>3</sup> );	<b>3</b>
2(b)(i)	(a substance which is) a proton/H <sup>+</sup> /hydrogen ion acceptor;	<b>1</b>
2(b)(ii)	$\text{Mg(s)} + 2\text{H}_2\text{O(l)} \rightarrow \text{Mg(OH)}_2\text{(aq)} + \text{H}_2\text{(g)}$ Mg(OH) <sub>2</sub> ; rest of equation;	<b>2</b>
2(c)	<b>M1</b> add a <i>named</i> acid, e.g. HCl <b>and</b> a named alkali, e.g. NaOH; <b>M2</b> Al <sub>2</sub> O <sub>3</sub> will react with/neutralises both reagents; <b>M3</b> and so it will dissolve into the reagent/form a solution;	1 1 1
2(d)(i)	covalent;	<b>1</b>
2(d)(ii)	any 2 from: high melting point/high boiling point; poor conductor (of electricity); hard; insoluble;	<b>2</b>
2(e)(i)	<b>M1</b> (electrostatic) <u>attraction</u> ; <b>M2</b> between <u>oppositely charged ions</u> ;	1 1
2(e)(ii)	Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> ;	<b>1</b>

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Question	Answer	Marks
2(f)(i)	 <p><b>M1</b> exothermic mark: horizontal product energy line at lower energy than that of reactant energy line;  <b>M2</b> label of product mark: SF<sub>4</sub>;  <b>M3</b> correct direction of vertical heat of reaction arrow: arrow must start level with reactant energy and finish level with product energy <b>and</b> must have only <b>one</b> (correct) arrow-head;</p>	3 1 1 1
2(f)(ii)	<p><b>M1</b> bond energy of 2F<sub>2</sub>: 2 × F–F = 2 × 160 = 320 (kJ/mol);  <b>M2</b> bond energy of all bonds in SF<sub>4</sub>: 780 + 320 = 1100 (kJ/mol);  <b>M3</b> calculated bond energy of SF<sub>4</sub> divided by 4: 1100/4 = 275 (kJ/mol);</p>	3 1 1 1
2(g)(i)	kills bacteria;	1
2(g)(ii)	name of compound: cobalt(II) chloride; from: blue; to: pink;	3 1 1 1
2(h)(i)	it has a complete outer shell/a full outer shell/8 electrons in the outer shell;	1
2(h)(ii)	(in) lamps;	1

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
3(a)	$1 \text{ Na}_2\text{S}_2\text{O}_3$ $2 \text{ H}_2\text{O}$ $3 \text{ HCl}$ <b>OR</b> $1 \text{ HCl}$ $2 \text{ H}_2\text{O}$ $3 \text{ Na}_2\text{S}_2\text{O}_3$ <b>OR</b> $1 \text{ H}_2\text{O}$ $2 \text{ Na}_2\text{S}_2\text{O}_3$ $3 \text{ HCl}$ <b>OR</b> $1 \text{ H}_2\text{O}$ $2 \text{ HCl}$ $3 \text{ Na}_2\text{S}_2\text{O}_3$ ;	<b>1</b>
3(b)(i)	<b>M1</b> volumes 40 : 10 : 10; <b>M2</b> time = 14;	<b>2</b> 1 1
3(b)(ii)	<b>M1</b> more particles per unit volume/particles are closer together; <b>M2</b> increases the rate of collisions/there are more collisions per unit time;	<b>2</b> 1 1
3(c)	<b>M1</b> particles gain more energy <b>and</b> move faster; <b>M2</b> increasing rate of collisions/more collisions per unit time; <b>M3</b> higher proportion of particles have sufficient energy to react/collisions have sufficient energy to react/are above the activation energy;	<b>3</b> 1 1 1

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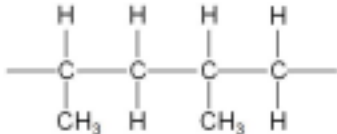
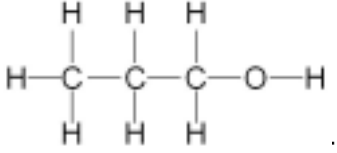
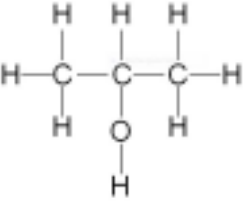
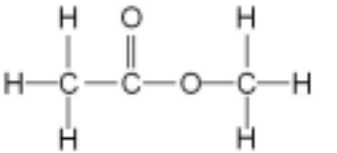
<b>Question</b>	<b>Answer</b>	<b>Marks</b>
4(a)(i)	reduction <b>and</b> (the $\text{Cu}^{2+}$ ion/copper ions) is gaining electrons/is decreasing in oxidation number;	<b>1</b>
4(a)(ii)	formation of $\text{Cu}^{2+}$ /copper ions at the anode happens at the same rate as; removal of $\text{Cu}^{2+}$ /copper ions at the cathode ora;	1 1 <b>2</b>
4(b)	replace (anode of) copper with nickel; replace electrolyte with nickel(II) sulfate/ $\text{NiSO}_4$ ;	1 1 <b>2</b>
4(c)	(good) catalysts; variable oxidation numbers; form coloured compounds/coloured ions;	1 1 1 <b>3</b>

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
5(a)	(sulfur-containing) fossil fuels;	<b>1</b>
5(b)	<b>M1</b> vanadium pentoxide/vanadium(V) oxide/ $V_2O_5$ (catalyst); <b>M2</b> 1–5 atmospheres (units required); <b>M3</b> 450 °C (units required); <b>M4</b> $2SO_2 + O_2 \rightarrow 2SO_3$ ; <b>M5</b> equilibrium/reversible reaction;	<b>5</b> 1 1 1 1 1
5(c)	$H_2S_2O_7$ ;	<b>1</b>
5(d)(i)	3 correct (2 marks) 2 correct (1 mark)  bubbles/ effervescence/ fizzing; dissolves/ disappears/ <i>forms</i> a solution; blue (solution);	<b>2</b>
5(d)(ii)	carbon dioxide and water and copper(II) sulfate;	<b>1</b>
5(e)(i)	carbon;	<b>1</b>
5(e)(ii)	dehydration;	<b>1</b>



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Question	Answer	Marks
6(a)	fractional distillation; cracking;	2 1 1
6(b)(i)	addition;	1
6(b)(ii)	CH <sub>2</sub> ;	1
6(b)(iii)	 <p><b>M1</b> chain of 4 carbon atoms with single bonds and continuation bonds; <b>M2</b> correctly positioned CH<sub>3</sub> side chains;</p>	2
6(c)	 ;  ;	2
6(d)(i)	(concentrated) sulfuric acid;	1
6(d)(ii)	methyl ethanoate;	1
6(d)(iii)	 <p><b>M1</b> ester link; <b>M2</b> rest of molecule;</p>	2
6(d)(iv)	terylene;	1