Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2016**

MARK SCHEME

Maximum Mark: 80

Published

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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

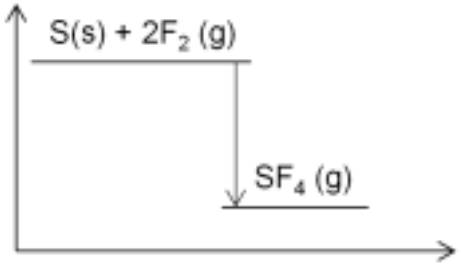
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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><td>particle</td><td>relative mass</td><td>relative charge</td></tr>
<tr><td>proton</td><td>1</td><td>+1</td></tr>
<tr><td>neutron</td><td>1</td><td>nil</td></tr>
<tr><td>electron</td><td>1 / 1840</td><td>–1</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>1(b)(i)</td><td>M1 <u>atom(s)</u> of the same element;
M2 with different number of neutrons;</td><td>2
1
1</td></tr>
<tr><td>1(b)(ii)</td><td>M1 (both have) the same number of electrons;
M2 in the outer shell;</td><td>2
1
1</td></tr>
<tr><td>1(c)</td><td>
<table>
<tr><td>particle</td><td>number of protons</td><td>number of neutrons</td><td>number of electrons</td></tr>
<tr><td>$^{7}_{3}Li$</td><td>3</td><td>4</td><td>3</td></tr>
<tr><td>$^{34}_{16}S^{2-}$</td><td>16</td><td>18</td><td>18</td></tr>
<tr><td>$^{41}_{19}K^{+}$</td><td>19</td><td>22</td><td>18</td></tr>
</table>
</td><td>5</td></tr>
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Question	Answer	Marks
2(a)	number of moles of $NaNO_3$ used: 3.40 / 85 = 0.04(00) (mol) **OR** 4.(00) × 10^{-2} (mol); number of moles of O_2 formed: 0.04 / 2 = 0.02(00) (mol) **OR** 2.(00) × 10^{-2} (mol); volume of O_2 formed: 0.02 × 24 = 0.48 (dm^3);	**3**
2(b)(i)	(a substance which is) a proton / H^+ / hydrogen ion acceptor;	**1**
2(b)(ii)	$Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$ $Mg(OH)_2$; rest of equation;	**2**
2(c)	**M1** add a *named* acid, e.g. HC*l* **and** a named alkali, e.g. NaOH; **M2** Al_2O_3 will react with / neutralises both reagents; **M3** and so it will dissolve into the reagent / form a solution;	**3** 1 1 1
2(d)(i)	covalent;	**1**
2(d)(ii)	any 2 from: high melting point / high boiling point; poor conductor (of electricity); hard; insoluble;	**2**
2(e)(i)	**M1** (electrostatic) attraction; **M2** between oppositely charged ions;	**2** 1 1
2(e)(ii)	$Ca_3(PO_4)_2$;	**1**

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Question	Answer	Marks
2(f)(i)	 **M1** *exothermic mark*: horizontal product energy line at lower energy than that of reactant energy line; **M2** *label of product mark*: SF_4; **M3** *correct direction of vertical heat of reaction arrow*: arrow must start level with reactant energy and finish level with product energy **and** must have only **one** (correct) arrow-head;	**3** 1 1 1
2(f)(ii)	**M1** *bond energy of $2F_2$*: 2 × F–F = 2 × 160 = 320 (kJ/mol); **M2** *bond energy of all bonds in SF_4*: 780 + 320 = 1100 (kJ/mol); **M3** *calculated bond energy of SF_4 divided by 4*: 1100/4 = 275 (kJ/mol);	**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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Question	Answer	Marks
3(a)	1 $Na_2S_2O_3$ 2 H_2O 3 HCl **OR** 1 HCl 2 H_2O 3 $Na_2S_2O_3$ **OR** 1 H_2O 2 $Na_2S_2O_3$ 3 HCl **OR** 1 H_2O 2 HCl 3 $Na_2S_2O_3$;	**1**
3(b)(i)	**M1** volumes 40 : 10 : 10; **M2** time = 14;	**2** 1 1
3(b)(ii)	**M1** more particles per unit volume / particles are closer together; **M2** increases the rate of collisions / there are more collisions per unit time;	**2** 1 1
3(c)	**M1** particles gain more energy **and** move fast**er**; **M2** increasing rate of collisions / more collisions per unit time; **M3** higher proportion of particles have sufficient energy to react / collisions have sufficient energy to react / are above the activation energy;	**3** 1 1 1

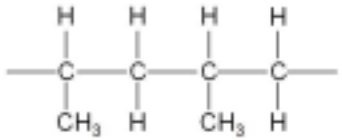
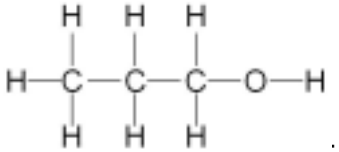
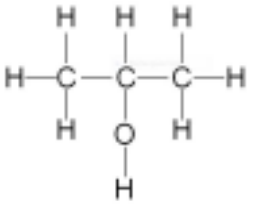
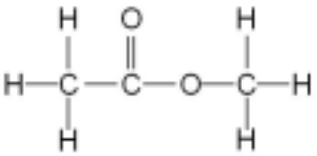
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Question	Answer	Marks
4(a)(i)	reduction **and** (the Cu^{2+} ion / copper ions) is gaining electrons / is decreasing in oxidation number;	**1**
4(a)(ii)	formation of Cu^{2+} / copper ions at the anode happens at the same rate as; removal of Cu^{2+} / copper ions at the cathode ora;	**2** 1 1
4(b)	replace (anode of) copper with nickel; replace electrolyte with nickel(II) sulfate / $NiSO_4$;	**2** 1 1
4(c)	(good) catalysts; variable oxidation numbers; form coloured compounds / coloured ions;	**3** 1 1 1

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

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Question	Answer	Marks
6(a)	fractional distillation; cracking;	**2** 1 1
6(b)(i)	addition;	**1**
6(b)(ii)	CH_2;	**1**
6(b)(iii)	 **M1** chain of 4 carbon atoms with single bonds and continuation bonds; **M2** correctly positioned CH_3 side chains;	**2**
6(c)	 ;  ;	**2**
6(d)(i)	(concentrated) sulfuric acid;	**1**
6(d)(ii)	methyl ethanoate;	**1**
6(d)(iii)	 **M1** ester link; **M2** rest of molecule;	**2**
6(d)(iv)	terylene;	**1**

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