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

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.

Cambridge will not enter into discussions about these mark schemes.

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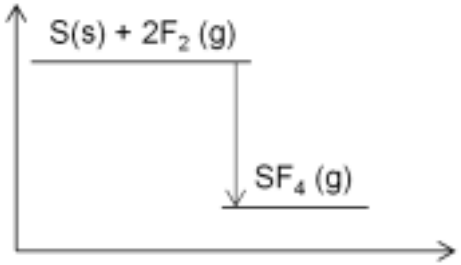
Abbreviations used in the Mark Scheme

- ; 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

Question	Answer	Marks
1(a)	<table><tr><th>particle</th><th>relative mass</th><th>relative charge</th></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>	3
1(b)(i)	**M1** atom(s) of the same element; **M2** with different number of neutrons;	**2** 1 1
1(b)(ii)	**M1** (both have) the same number of electrons; **M2** in the outer shell;	**2** 1 1
1(c)	<table><tr><th>particle</th><th>number of protons</th><th>number of neutrons</th><th>number of electrons</th></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>	**5**

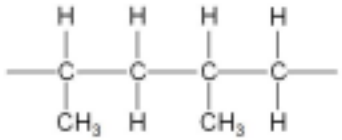
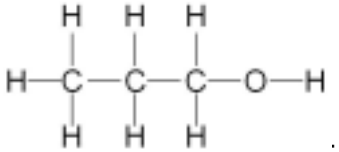
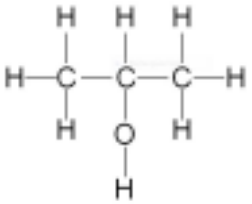
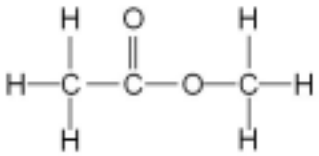
Question	Answer	Marks
2(a)	number of moles of $NaNO_3$ used: 3.40 / 85 = 0.04(00) (mol) **OR** 4.(00) × 10^{-2} (mol); number of moles of O_2 formed: 0.04 / 2 = 0.02(00) (mol) **OR** 2.(00) × 10^{-2} (mol); volume of O_2 formed: 0.02 × 24 = 0.48 (dm^3);	**3**
2(b)(i)	(a substance which is) a proton / 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. HCl **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**

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**

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

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

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**

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**