

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

Cambridge International General Certificate of Secondary Education

**MARK SCHEME for the February/March 2016 series****0620 CHEMISTRY****0620/42**

Paper 4 (Extended Theory), maximum raw mark 80

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.

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<b>Page 2</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge IGCSE – February/March 2016</b>	<b>0620</b>	<b>42</b>

**Abbreviations used in the Mark Scheme**

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

<b>Page 3</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge IGCSE – February/March 2016</b>	<b>0620</b>	<b>42</b>

<b>Question</b>	<b>Answer</b>	<b>Marks</b>									
1(a)	B = 17; C = 18; D = 2,8; 2 <sup>-</sup> /2 <sup>-</sup> ;	<b>4</b>									
1(b)	Substance that cannot be broken down into anything simpler / substance that cannot be broken down (by chemical means) / substance containing <b>atoms</b> with the same atomic number or proton number;	<b>1</b>									
1(c)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>number of protons</th> <th>number of neutrons</th> <th>number of electrons</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">31</td> <td style="text-align: center;">38</td> <td style="text-align: center;">31</td> </tr> <tr> <td style="text-align: center;">31</td> <td style="text-align: center;">40</td> <td style="text-align: center;">31</td> </tr> </tbody> </table> <p><b>M1</b> column one; <b>M2</b> column two; <b>M3</b> column three;</p>	number of protons	number of neutrons	number of electrons	31	38	31	31	40	31	<b>3</b>
number of protons	number of neutrons	number of electrons									
31	38	31									
31	40	31									

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
2(a)	1;	<b>1</b>
2(b)	conducts electricity or heat / malleable / ductile / sonorous / shiny;	<b>1</b>
2(c)	any two from: <ul style="list-style-type: none"> <li>• (low) melting point / (low) boiling point;</li> <li>• hardness / softness / rubidium can be cut easily;</li> <li>• strength;</li> <li>• (low) density;</li> </ul>	<b>2</b>

<b>Page 4</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge IGCSE – February/March 2016</b>	<b>0620</b>	<b>42</b>

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
2(d)(i)	any two from: <ul style="list-style-type: none"> <li>• bubbles / effervescence / fizzing;</li> <li>• flame / sparks / ignites;</li> <li>• movement;</li> <li>• dissolves / forms a solution / disappears / gets smaller;</li> <li>• floats;</li> <li>• rubidium melts / rubidium forms a ball;</li> <li>• explosion;</li> </ul>	<b>2</b>
2(d)(ii)	yellow;	<b>1</b>
2(d)(iii)	$2\text{Rb} + 2\text{H}_2\text{O} \rightarrow 2\text{RbOH} + \text{H}_2$ formula of RbOH; whole equation completely correct;	<b>2</b>
2(d)(iv)	caesium → rubidium → potassium → sodium → lithium / Cs → Rb → K → Na → Li;	<b>1</b>
2(d)(v)	goggles / glasses / gloves / safety screen / stand at safe distance / tongs / open space;	<b>1</b>
2(e)	$\text{Rb}_3\text{PO}_4$ ;	<b>1</b>

<b>Question</b>	<b>Answer</b>	<b>Marks</b>								
3(a)	<table border="1" style="width: 100%;"> <tr> <td style="width: 50%; text-align: center;"><math>\text{CO}_2</math>;</td> <td style="width: 50%;"></td> </tr> <tr> <td></td> <td style="text-align: center;">solid;</td> </tr> <tr> <td></td> <td style="text-align: center;">poor conductor / non-conductor;</td> </tr> <tr> <td style="text-align: center;">simple molecular / simple (covalent);</td> <td></td> </tr> </table>	$\text{CO}_2$ ;			solid;		poor conductor / non-conductor;	simple molecular / simple (covalent);		<b>4</b>
$\text{CO}_2$ ;										
	solid;									
	poor conductor / non-conductor;									
simple molecular / simple (covalent);										
3(b)(i)	covalent;	<b>1</b>								

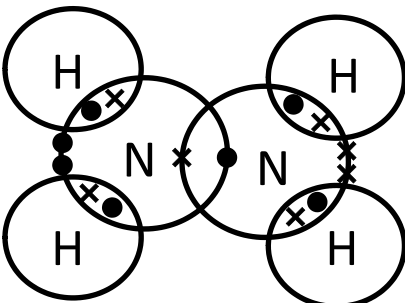
<b>Page 5</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge IGCSE – February/March 2016</b>	<b>0620</b>	<b>42</b>

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
3(b)(ii)	all bonds are (very) strong or bonds; <b>or</b> bonds need a lot of energy or heat to break; <b>or</b> (there are) no weak bonds/no (weak) intermolecular forces;	<b>1</b>
3(b)(iii)	weak forces between molecules; <b>or</b> weak intermolecular forces or weak van der Waals' forces; <b>or</b> low amount of energy needed to break intermolecular/van der Waals' forces;	<b>1</b>
3(b)(iv)	no (moving) ions/no mobile or moving electrons/all electrons used in bonding/ made of uncharged molecules;	<b>1</b>
3(c)	$2\text{NaOH} + \text{CO}_2 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$ <b>or</b> $\text{NaOH} + \text{CO}_2 \rightarrow \text{NaHCO}_3$  formula of $\text{Na}_2\text{CO}_3$ / $\text{NaHCO}_3$ ; whole equation correct;	<b>2</b>
3(d)(i)	(complete) combustion/burning;	<b>1</b>
3(d)(ii)	photosynthesis;	<b>1</b>
3(d)(iii)	respiration;	<b>1</b>

<b>Page 6</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge IGCSE – February/March 2016</b>	<b>0620</b>	<b>42</b>

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
4(a)	<b>M1</b> (substance that) speeds up a reaction / increases the rate of a reaction; <b>M2</b> any one from: unchanged (chemically at the end) / not used up; lowers activation energy;	<b>2</b>
4(b)(i)	at the start / initially / $t = 0$ ;	<b>1</b>
4(b)(ii)	catalyst should be powdered / increase surface area (of catalyst) / decrease particle size (of catalyst); <b>or</b> increase temperature / heat / warm;	<b>1</b>
4(c)(i)	0.002 (mol);	<b>1</b>
4(c)(ii)	0.001 (mol);	<b>1</b>
4(c)(iii)	0.024 (dm <sup>3</sup> );	<b>1</b>
4(c)(iv)	no change / no effect;	<b>1</b>
4(c)(v)	0.048 (dm <sup>3</sup> );	<b>1</b>
4(d)	same mass / amount of / moles / 1.0 g of catalyst; same temperature; same volume <b>and</b> concentration of hydrogen peroxide / 20 cm <sup>3</sup> of 0.1 mol / dm <sup>3</sup> of hydrogen peroxide or reactant;	<b>3</b>

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – February/March 2016	0620	42

Question	Answer	Marks
5(a)(i)	pressure in range 150–300 atmospheres/atm; temperature in range 370–470 °C; iron (catalyst); balanced equation: $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$ ; equilibrium/reversible;	5
5(a)(ii)	manufacture of fertilisers/nylon/nitric acid/cleaning agent(allow oven cleaner)/hair dye/urea/refrigeration/explosives;	1
5(b)	 <p><b>M1</b> all shared electrons correct (5 bonds); <b>M2</b> exactly two non-bonding electrons on each N and no additional non-bonding electrons;</p>	2
5(c)(i)	proton/ $\text{H}^+$ acceptor;	1
5(c)(ii)	$(\text{N}_2\text{H}_4 + \text{H}_2\text{O}) \rightarrow \text{N}_2\text{H}_5^+ + \text{OH}^-$ ; or $(\text{N}_2\text{H}_4) + 2\text{H}_2\text{O} \rightarrow \text{N}_2\text{H}_6^{2+} + 2\text{OH}^-$ ;	1
5(d)(i)	acid rain/effect of acid rain/(photochemical) smog/(producing) low level ozone;	1
5(d)(ii)	<b>M1</b> nitrogen and oxygen (from the air) react/combine or word equation; <b>M2</b> at high temperature/spark/very hot;	2

<b>Page 8</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge IGCSE – February/March 2016</b>	<b>0620</b>	<b>42</b>

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
6(a)	S <sub>2</sub> <sup>2-</sup> ; <b>or</b> S <sup>-</sup> ;	<b>1</b>
6(b)	test conductivity; gold conducts / ora; <b>or</b> malleability / hit with a hammer; gold malleable / only gold produces ringing sound / ora; <b>or</b> density; gold denser / ora; <b>or</b> add acid / any named / formula of acid; gold does not react (ignore products with pyrites) / ora; <b>or</b> heat (both strongly) in air / oxygen; iron pyrite reacts (ignore products); <b>or</b> melting point; gold lower / ora; <b>or</b> heat with a more reactive metal than iron; gold does not react / ora;	<b>2</b>
6(c)(i)	4FeS <sub>2</sub> + 11O <sub>2</sub> → 2Fe <sub>2</sub> O <sub>3</sub> + 8SO <sub>2</sub>  all formulae; balancing;	<b>2</b>



<b>Page 9</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge IGCSE – February/March 2016</b>	<b>0620</b>	<b>42</b>

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
6(c)(ii)	bleaching (in the manufacture of) wood pulp (for paper or straw or wool or cotton)/(food) preservative or killing bacteria in food or wine / fumigant / refrigerant / tanning(leather);	<b>1</b>

<b>Question</b>	<b>Answer</b>	<b>Marks</b>				
7(a)(i)	compound containing carbon and hydrogen only;	<b>1</b>				
7(a)(ii)	$C_nH_{2n+2}$ ; $C_nH_{2n}$ ;	<b>2</b>				
7(b)(i)	mol C = 54.54 / 12 or 4.5(45) <b>and</b> mol H = 9.09 / 1 or 9.09 <b>and</b> mol O = 36.37 / 16 or 2.27; $C_2H_4O$ ;	<b>2</b>				
7(b)(ii)	$M_r$ of $C_2H_4O$ = 44; $88 / 44 = 2$ therefore $C_4H_8O_2$ ;	<b>2</b>				
7(c)	<table border="1" style="width: 100%; text-align: center;"> <tr> <td>methyl ethanoate;</td> <td>ethyl methanoate;</td> </tr> <tr> <td><math>CH_3COOCH_3</math>;</td> <td><math>HCOOC_2H_5</math>;</td> </tr> </table>	methyl ethanoate;	ethyl methanoate;	$CH_3COOCH_3$ ;	$HCOOC_2H_5$ ;	<b>4</b>
methyl ethanoate;	ethyl methanoate;					
$CH_3COOCH_3$ ;	$HCOOC_2H_5$ ;					
7(d)	methyl propanoate;	<b>1</b>				
7(e)(i)	condensation;	<b>1</b>				
7(e)(ii)	water / $H_2O$ ;	<b>1</b>				
7(e)(iii)	dicarboxylic acid or diacyl chloride; diol;	<b>2</b>				