



Oxford Cambridge and RSA

# **Cambridge Technicals Applied Science**

## **Unit 1: Science Fundamentals**

Level 3 Cambridge Technical in Applied Science  
**05847 - 05849/05874/05879**

## **Mark Scheme for January 2020**

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

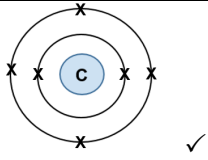
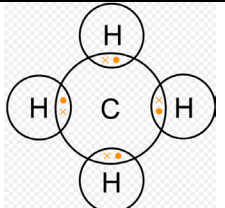
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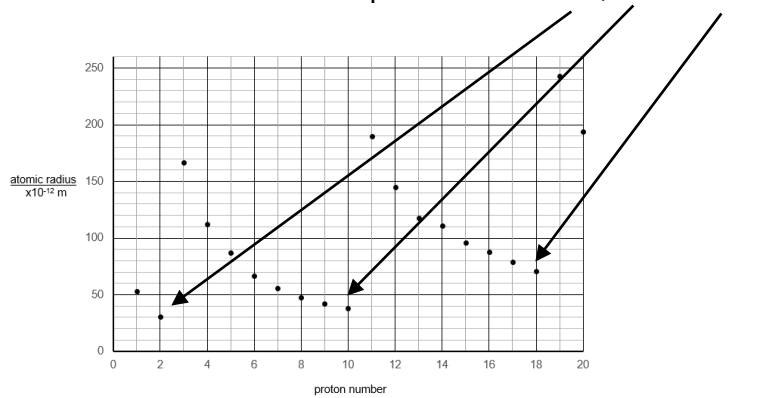
Annotations available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
<b>BOD</b>	Benefit of doubt given
<b>CON</b>	Contradiction
<b>RE</b>	Rounding error
<b>SF</b>	Error in number of significant figures
<b>ECF</b>	Error carried forward
<b>L1</b>	Level 1
<b>L2</b>	Level 2
<b>L3</b>	Level 3
<b>NBOD</b>	Benefit of doubt not given
<b>SEEN</b>	Noted but no credit given
<b>I</b>	Ignore

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

<b>Annotation</b>	<b>Meaning</b>
/	alternative and acceptable answers for the same marking point
<b>DO NOT ALLOW</b>	Answers which are not worthy of credit
<b>IGNORE</b>	Statements which are irrelevant
<b>ALLOW</b>	Answers that can be accepted
( )	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
<b>ECF</b>	Error carried forward
<b>AW</b>	Alternative wording
<b>ORA</b>	Or reverse argument

Question		Answer	Marks	Guidance
1	(a)		1	<p><b>ALLOW</b> any configuration of electrons only if 4 on outer and 2 on inner shells.</p> <p><b>ALLOW</b> • or e = x</p>
	(b)	7 ✓	1	
	(c)	<p>positive and negative charges ✓</p> <p>equal numbers of protons and electrons / 6 protons and 6 electrons ✓</p>	2	<p><b>ALLOW</b> charges of protons and electrons are balanced</p> <p><b>ALLOW</b> cancel each other out - if ref. to charge <b>but not</b> if ref. to named particles</p>
	(d) (i)	silicon ✓	1	
	(ii)	both have same number of electrons <b>in the outer shell</b> ✓	1	<b>ALLOW</b> same number of valence electrons / same chemical properties
	(iii)	<p>(proton number/ atomic number increases so) <b>more electrons</b> ✓</p> <p>number of electrons per shell is limited/full ✓</p>	2	<p><b>IGNORE</b> reactivity</p> <p><b>IGNORE</b> ref. to number of electrons</p>
	(e) (i)	<p>four H around C ✓</p> <p>one pair of electrons at each bond ✓</p>	2	 <p><b>MUST</b> show source of electrons at each bond eg. •/x, •/e, x/e, on/within the overlap</p> <p><b>IGNORE</b> responses shown in the inner shell</p> <p>EXTRA electrons on shell = <b>CON</b> for mp2</p>

Question	Answer	Marks	Guidance
(ii)	covalent ✓	1	
(f) (i)	circles around the dots with proton numbers 2, 10 and 18 ✓ 	1	All three correct circles = 1 mark
(ii)	atomic radius decreases across each period ✓  atomic radius increases down each group ✓	2	<b>ALLOW</b> decreases within any set of data only with correct ref. to both atomic radius AND proton number  <b>ALLOW</b> increases across any set of data only with correct ref. to both atomic radius AND proton number
(iii)	<b>EITHER</b>  decrease across a period is due to increasing protons/atomic numbers exerting <b>greater attraction</b> for electrons  <b>OR</b>  increase down a group is due to increasing electron shells down the group <b>shielding</b> the outer electrons from the <b>attractive force</b> of the nucleus ✓	1	Candidates must make it clear which trend they are explaining  <b>ALLOW</b> correct ref. to numbers in <b>Fig.1.2</b> = across a period  <b>ALLOW</b> correct ref. to numbers in <b>Fig. 1.2</b> = down a group
<b>Total</b>		<b>15</b>	

Question			Answer	Marks	Guidance
2	(a)	(i)	ammonium ✓ amino acids ✓ protein ✓	3	One mark for each correct response via sentence completion.
		(ii)	<b>Any four from:</b> the number of algae (blooms) increase ✓  the number of fish decreases ✓  <b>gradual</b> increase in algae bloom numbers / <b>steep</b> decline in fish numbers ✓  fish numbers drop from 100 to 0 ✓  fish numbers are 0 at approximately 120 m (down river) ✓  steep decline in fish numbers within the first 20 m ✓  algae bloom numbers increase from 10 to approximately 48 ✓	4	<b>ALLOW</b> negative correlation between numbers of algae blooms and fish.  <b>MAX. 3</b> = response refers <b>ONLY</b> to fish <b>OR</b> algae  <b>ALLOW</b> any correct ref. to data values for fish or algae – up to a <b>MAX.</b> of 2 sets of data
		(iii)	decreased light intensity ✓	1	
	(b)	(i)	polluted/contaminated/nitrate-containing water / food / diet ✓	1	OWTTE
		(ii)	oxidation is loss of electrons ✓  $\text{Fe}^{2+}$ is oxidised / loses an electron to become $\text{Fe}^{3+}$ ✓  reduction is gain of electrons ✓  $\text{NO}_2^-$ is reduced / loses oxygen / gains an electron ✓	4	<b>ALLOW</b> Fe/Iron = $\text{Fe}^{2+}$  <b>ALLOW</b> nitrate = $\text{NO}_2^-$ .

Question			Answer	Marks	Guidance
		(iii)	Fe <sup>2+</sup> <b>binds/bonds</b> with the oxygen molecules ✓ (transported) around body / in RBCs ✓	2	<b>ALLOW</b> iron/Fe = Fe <sup>2+</sup>
			<b>Total</b>	<b>15</b>	



Question		Answer	Marks	Guidance
3	(a)	epithelial ✓	1	
	(b)	<p><b>Fig. 3.1a</b> one cell thick / one layer / flattened in shape / thin layer / simple / squamous ✓</p> <p><b>increases</b> absorption/diffusion of substances ✓</p> <p><b>Fig. 3.1b</b> several layers / thick layer / striated ✓</p> <p>acts as a barrier/ <b>increases</b> protection (around the body surface, internal organs and blood vessels) ✓</p>	4	<p><b>IGNORE</b> refs. to location</p> <p><b>ALLOW</b> detail/example of protection e.g. against pathogens</p>
	(c) (i)	cytoplasm ✓	1	<b>ALLOW</b> cytosol / protoplasm
	(ii)	<p>provides shape / support / structure to the cell / cytoskeleton / contains organelles/named organelle ✓</p> <p>site of chemical reactions / contains chemicals / transports chemicals ✓</p>	2	<p>OWTTE</p> <p><b>ALLOW</b> cytoplasmic streaming / cyclosis</p>
	(iii)	<p>Colloidal mixture</p> <p>Description</p> <p style="text-align: right;">✓✓</p>	2	

Question		Answer	Marks	Guidance																					
(d)	(i)	<p><b>eukaryotic</b> DNA is a double helix / as chromatin/chromosomes / in a nucleus/mitochondrion ✓</p> <p><b>prokaryotic</b> DNA as a circular ring/loop/plasmid / in the cytoplasm / not stored in a nucleus or a nuclear envelope/membrane ✓</p>	2	OWTTE																					
	(ii)	<table border="1"> <thead> <tr> <th>Molecule</th> <th>DNA</th> <th>RNA</th> </tr> </thead> <tbody> <tr> <td>Adenine</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>Deoxyribose</td> <td>✓</td> <td>✗</td> </tr> <tr> <td>Cytosine</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>Guanine</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>Phosphate</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>Thymine</td> <td>✓</td> <td>✗</td> </tr> </tbody> </table> <p style="text-align: right;">✓✓</p>	Molecule	DNA	RNA	Adenine	✓	✓	Deoxyribose	✓	✗	Cytosine	✓	✓	Guanine	✓	✓	Phosphate	✓	✓	Thymine	✓	✗	2	<p>Mark as <b>rows</b></p> <p>All 6 correct responses = 2 marks 4 or 5 correct responses = 1 mark 3 or fewer correct responses = 0 marks</p> <p><b>MUST</b> show ticks or crosses</p>
Molecule	DNA	RNA																							
Adenine	✓	✓																							
Deoxyribose	✓	✗																							
Cytosine	✓	✓																							
Guanine	✓	✓																							
Phosphate	✓	✓																							
Thymine	✓	✗																							
	(iii)	<p><b>Any two from:</b> RNA is only a <b>single</b> strand molecule / DNA is a <b>double</b> strand molecule ✓</p> <p>RNA size/shape allows it to pass through (nuclear pores) / DNA size/shape does not allow it to pass through (nuclear pores) ✓</p> <p>DNA is held in position by <b>proteins/histones/amino acids</b> / RNA is not held in position by <b>proteins/histones/amino acids</b> ✓</p>	2	<p><b>ALLOW</b> held/not held <b>as</b> chromatin</p> <p><b>IGNORE</b> is fixed if unqualified</p>																					
		<b>Total</b>	<b>16</b>																						

Question			Answer	Marks	Guidance						
4	(a)	(i)	<p>same molecular formula ✓</p> <p>different structural/display formulae / structure / arrangement / contain carbons with four different groups attached ✓</p> <p>molecular formula for both is <math>C_6H_{12}O_6</math> / <math>C=O</math> is at the end of molecule in glucose but not in fructose ✓</p>	3	<p><b>DO NOT ALLOW</b> empirical formula  <b>ALLOW</b> chemical formula  <b>IGNORE</b> unqualified formula</p> <p><b>ALLOW</b> fructose is an aldehyde but glucose is a ketone</p>						
		(ii)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Sugar molecule</th> <th>Number of asymmetric carbon atoms</th> </tr> </thead> <tbody> <tr> <td>D-fructose</td> <td>3</td> </tr> <tr> <td>D-glucose</td> <td>4</td> </tr> </tbody> </table> <p style="text-align: right;">✓✓</p>	Sugar molecule	Number of asymmetric carbon atoms	D-fructose	3	D-glucose	4	2	One mark for each number
Sugar molecule	Number of asymmetric carbon atoms										
D-fructose	3										
D-glucose	4										
		(iii)	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; width: 30%;">Sugar molecule</th> <th style="text-align: left; width: 70%;">Functional group</th> </tr> </thead> <tbody> <tr> <td style="vertical-align: top; padding: 10px;"> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 10px;">D-fructose</div> <div style="border: 1px solid black; padding: 5px; width: fit-content;">D-glucose</div> </td> <td style="vertical-align: top; padding: 10px;"> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Aldehyde</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Alkyne</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Carboxylic acid</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Ester</div> <div style="border: 1px solid black; padding: 5px; width: fit-content;">Ketone</div> </td> </tr> </tbody> </table> <p style="text-align: right;">✓✓</p>	Sugar molecule	Functional group	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 10px;">D-fructose</div> <div style="border: 1px solid black; padding: 5px; width: fit-content;">D-glucose</div>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Aldehyde</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Alkyne</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Carboxylic acid</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Ester</div> <div style="border: 1px solid black; padding: 5px; width: fit-content;">Ketone</div>	2	One mark for each correct link		
Sugar molecule	Functional group										
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 10px;">D-fructose</div> <div style="border: 1px solid black; padding: 5px; width: fit-content;">D-glucose</div>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Aldehyde</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Alkyne</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Carboxylic acid</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-bottom: 5px;">Ester</div> <div style="border: 1px solid black; padding: 5px; width: fit-content;">Ketone</div>										
	(b)		addition ✓	1							

Question		Answer	Marks	Guidance															
	(c)	(i)	disaccharide ✓	1 <b>DO NOT ALLOW</b> double sugar <b>ALLOW</b> maltose <b>IGNORE</b> dimer															
		(ii)	H <sub>2</sub> O ✓	1 <b>DO NOT ALLOW</b> water <b>ALLOW</b> H-O-H															
	(d)		<table border="1"> <thead> <tr> <th>Feature</th> <th>Glycogen</th> <th>Polypeptide</th> </tr> </thead> <tbody> <tr> <td>Type of monomer</td> <td>glucose/sugar</td> <td>amino acid</td> </tr> <tr> <td>Type of bond between the monomers</td> <td>glycosidic</td> <td>peptide</td> </tr> <tr> <td>Atoms present</td> <td>C, H and O</td> <td>C, H, O and N</td> </tr> <tr> <td>Function in the body</td> <td>Energy/glucose/sugar store</td> <td>Enzymes, carrier proteins, structural role, protein</td> </tr> </tbody> </table> <p style="text-align: right;">✓✓✓✓</p>	Feature	Glycogen	Polypeptide	Type of monomer	glucose/sugar	amino acid	Type of bond between the monomers	glycosidic	peptide	Atoms present	C, H and O	C, H, O and N	Function in the body	Energy/glucose/sugar store	Enzymes, carrier proteins, structural role, protein	4 One mark for each correct row.  <b>IGNORE</b> carbohydrate (for glycogen)  <b>IGNORE</b> references to sulphur
Feature	Glycogen	Polypeptide																	
Type of monomer	glucose/sugar	amino acid																	
Type of bond between the monomers	glycosidic	peptide																	
Atoms present	C, H and O	C, H, O and N																	
Function in the body	Energy/glucose/sugar store	Enzymes, carrier proteins, structural role, protein																	
	(e)	(i)	$  \begin{array}{cccccc}  & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\  &   &   &   &   &   &   \\  - & \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{C} - \\  &   &   &   &   &   &   \\  & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H}  \end{array}  $ <p style="text-align: right;">✓✓</p>	2 1 mark for correct number of carbons (6) and hydrogens (12) 1 mark showing all single bonds <b>AND</b> no atom on either end of structure  <b>IGNORE</b> brackets/use of <i>n</i>															

Question			Answer	Marks	Guidance
		(ii)	glycogen/carbohydrate contains <b>oxygen/OH</b> but polyethene does not ✓	<b>1</b>	<b>ALLOW</b> glycogen consists of carbon, hydrogen and oxygen whilst polyethene only consists of carbon and hydrogen <b>IGNORE</b> synthetic/organic / ref. to energy/glucose
			<b>Total</b>	<b>17</b>	

Question			Answer	Marks	Guidance
5	(a)	(i)	H <sub>2</sub> O <sub>2</sub> ✓	1	
		(ii)	metabolism of amino acids ✓	1	
	(b)		water ✓	1	
	(c)		<p><b>Any three from:</b></p> <p>particles in a liquid have more <b>space</b> between them than those in a solid / particles in a solid are close / packed together ✓</p> <p>particles in a solid do not <b>move</b> as much as particles in a liquid <b>OR</b> particles in a solid can only vibrate ✓</p> <p>particles in a solid do not have as much <b>energy</b> as particles in a liquid ✓</p> <p>particles in a solid do not <b>collide</b> with sufficient energy (to break the bonds in the hydrogen peroxide molecules) ✓</p> <p>greater <b>force</b> between particles/molecules in solid ✓</p>	3	<p>OWTTE</p> <p><b>ALLOW</b> molecules = particles <b>IGNORE</b> atoms</p> <p><b>ALLOW</b> solid needs more energy to be decomposed/broken down</p> <p><b>DO NOT ALLOW</b> pressure</p>

Question	Answer	Marks	Guidance
(d)	<p><b>[Level 3]</b> Candidate shows a high level of understanding of enzyme-catalysed reactions and gives a good description of the graph. (5 – 6 marks)</p> <p><b>[Level 2]</b> Candidate shows a detailed understanding of enzyme-catalysed reactions and gives a partial description of the graph. (3 – 4 marks)</p> <p><b>[Level 1]</b> Candidate shows a basic understanding of enzyme-catalysed reactions <b>OR</b> gives a limited description of the graph. (1 – 2 marks)</p> <p><b>[Level 0]</b> Candidate includes fewer than two valid points. (0 marks)</p>	6	<p>Valid scientific points</p> <p><b>Description</b></p> <ul style="list-style-type: none"> <li>• Relatively slow increase in volume of oxygen produced between 5 – 15oC</li> <li>• The volume of oxygen produced increases with temperature to a maximum temperature (up to 36-38oC)</li> <li>• Peak oxygen production at 36-38oC</li> <li>• The volume of oxygen produced decreases with temperature after the maximum (36-38oC)</li> </ul> <p><b>Explanation</b> Rate of reaction:</p> <ul style="list-style-type: none"> <li>• Increases because the hydrogen peroxide particles have more kinetic energy/ more molecules have energy greater than the activation energy</li> <li>• Increases because there are more frequent collisions between the hydrogen peroxide particles and the liver enzymes</li> <li>• Enzymes/catalysts reduce the activation energy</li> <li>• Speed up the rate of reactions, if qualified</li> <li>• Decreases because the active site of the liver enzymes becomes denatured/deformed</li> <li>• Decreases hydrogen peroxide particles no longer fit into the active site</li> </ul>
	<b>Total</b>	<b>12</b>	

Question		Answer	Marks	Guidance
6	(a)	<p><b>Any two from:</b></p> <p><b>property</b> for one material with ref. to either strength or toughness ✓</p> <p><b>comparison</b> between two or more materials ✓</p> <p><b>quantitative</b> comparison (using approximate data on axes) between two or more materials, with ref. to strength or toughness ✓</p>	3	
	(b)	<p>fracture when a small force is applied ✓</p> <p>absorb little energy before breaking ✓</p> <p>suddenly snap (without stretching or bending) when a force is applied ✓</p>	3	<p><b>ALLOW</b> break easily / fragile / weak / not malleable / low tensile strength</p> <p><b>IGNORE</b> ref. to elasticity</p> <p><b>ALLOW</b> not tough</p> <p><b>ALLOW</b> not ductile/plastic</p> <p><b>IGNORE</b> ref. to unqualified deformation</p>
		<b>Total</b>	<b>6</b>	



Question		Answer	Marks	Guidance
7	(a)	<b>FIRST CHECK ANSWER ON ANSWER LINE</b> <b>If answer = 1.0 (W) award 2 marks</b>  $5.0 \times 0.2 \checkmark$  $= 1.0 \text{ (W)} \checkmark$	2	<b>ALLOW</b> answer is 1 = 2 marks
	(b) (i)	<b>FIRST CHECK ANSWER ON ANSWER LINE</b> <b>If answer = 0.12 (V) award 2 marks</b>  $0.2 \times 0.6 \checkmark$  $= 0.1(2) \text{ (V)} \checkmark$	2	<b>ALLOW</b> answer is .12 = 2 marks
	(ii)	$(0.12 \times 0.2 = ) 0.02(4) \text{ (W)} \checkmark$	1	<b>ecf</b> from b(i)
	(iii)	$(1.0 - 0.024 = ) 0.976 \text{ (W)} \checkmark$	1	<b>ALLOW</b> 0.98 <b>ecf</b> from b(ii)
	(c) (i)	power supplied = $5.0 \times 1.3 = 6.5 \text{ (W)} \checkmark$	1	<b>ALLOW</b> 7 if correct calculation shown
	(ii)	p.d. = $1.3 \times 0.6 = 0.78 \text{ (V)} \checkmark$ power dissipated = $0.78 \times 1.3 = 1.01(4) \text{ (W)} \checkmark$	2	
<b>Total</b>			<b>9</b>	

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