

# **Cambridge Technicals Applied Science**

## **Unit 2: Laboratory techniques**

Level 3 Cambridge Technical in Applied Science  
**05847 – 05849, 05874 & 05879**

## **Mark Scheme for January 2023**

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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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## MARKING INSTRUCTIONS

### PREPARATION FOR MARKING















#### TRADITIONAL

Before the Standardisation meeting you must mark at least 10 scripts from several centres. For this preliminary marking you should use **pencil** and follow the **mark scheme**. Bring these **marked scripts** to the meeting.

#### MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the traditional 40% Batch 1 and 100% Batch 2 deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or by email.
5. Work crossed out:
  - a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
  - . if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.
6. Always check the pages (and additional lined pages if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add an annotation to confirm that the work has been seen.
7. There is a NR (No Response) option. Award NR (No Response)
  - if there is nothing written at all in the answer space
  - OR if there is a comment which does not in anyway relate to the question (e.g. 'can't do', 'don't know')
  - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the questionNote: Award 0 marks - for an attempt that earns no credit (including copying out the question)
8. Assistant Examiners will email a brief report on the performance of candidates to your Team Leader (Supervisor) by the end of the marking period. Your report should contain notes on particular strength displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

## 9. Annotations available in RM Assessor


Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore

10. 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

11. **Subject-specific marking instructions**

Question			Answer	Marks	Guidance								
1	(a)	(i)	biased      random      representative <u>whole</u> ✓	1									
		(ii)	<table border="1"> <tr> <td>All the people in the village would be in the sample</td> <td>✓</td> </tr> <tr> <td>Over 100 people would be in the sample</td> <td></td> </tr> <tr> <td>There are more men than women in the village</td> <td></td> </tr> <tr> <td>There would be a range of men women and children in the sample</td> <td></td> </tr> </table> <p style="text-align: right;">✓</p>	All the people in the village would be in the sample	✓	Over 100 people would be in the sample		There are more men than women in the village		There would be a range of men women and children in the sample		1	
All the people in the village would be in the sample	✓												
Over 100 people would be in the sample													
There are more men than women in the village													
There would be a range of men women and children in the sample													
	(b)	(i)	biased <u>random</u> <u>representative</u> whole ✓	1	Both required for mark								
		(ii)	<table border="1"> <tr> <td>Anika did not choose the selection herself</td> <td>✓</td> </tr> <tr> <td>Half of the people in the village would be in the sample</td> <td></td> </tr> <tr> <td>Over 100 people would in the sample</td> <td></td> </tr> <tr> <td>There would be a range of men, women and children in the sample</td> <td>✓</td> </tr> </table> <p style="text-align: right;">✓</p>	Anika did not choose the selection herself	✓	Half of the people in the village would be in the sample		Over 100 people would in the sample		There would be a range of men, women and children in the sample	✓	1	Both required for mark
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There would be a range of men, women and children in the sample	✓												
	(c)		(reliability) increases / becomes more reliable ✓	1	OWTTE <b>IGNORE</b> more accurate/precise/data/less data								
	(d)	(i)	Reference to (the needle being) sharp/cuts ✓	1	<b>ALLOW</b> correct reference to the low risk of the cheek swab.								

Question		Answer	Marks	Guidance
	(ii)	Less training required / quick(er) / patients can take their own sample / cheap(er) ✓	1	<b>ALLOW</b> idea that people are nervous of needles <b>DO NOT ALLOW</b> get results faster <b>IGNORE</b> easier <b>IGNORE</b> health and safety
	(iii)	Pathogens (in mouth) ✓	1	<b>ALLOW</b> named pathogen <b>IGNORE</b> contamination <b>IGNORE</b> health hazard <b>IGNORE</b> (getting) an infection
	(iv)	Mosquitos / malaria ✓	1	<b>ALLOW</b> any sensible answer relating to working in Ghana e.g. <u>The disease</u> /heat stroke/high temperatures
(e)	(i)		1	<b>IGNORE</b> labels
	(ii)	In the following order: Autoclaving/waste operator ✓ Written waste operator ✓	2	Both required for second mark
(f)	(i)	17.6 (%) ✓	1	<b>ALLOW</b> 18 (%) <b>DO NOT ALLOW</b> incorrect rounding

Question		Answer	Marks	Guidance
	(ii)	<b>Any one from</b> ✓ <ul style="list-style-type: none"><li>• sample size is very small / only 125 out of 28 million (people) tested</li><li>• people living in the same village may be closely-related / share the same combination of genes / there may be inbreeding</li><li>• (sickle cell disease may be) unequally distributed across Ghana / the village could be a 'hot spot' for this disease</li></ul>	1	
		<b>Total</b>	<b>14</b>	



Question		Answer	Marks	Guidance
2	(a)	<p>PCR</p> <p>To amplify specific sequences of nucleic acid</p> <p>To purify sequences of nucleic acid</p> <p>Gel electrophoresis</p> <p>To extract nucleic acid from cells</p> <p>To separate nucleic acid according to size</p> <p style="text-align: right;">✓✓</p>	2	
	(b)	<p>Polymerase ✓</p> <p>nucleotides ✓</p>	2	
	(c)	<p>Denaturation</p> <p>Primers bind to specific complementary sequence</p> <p>Annealing</p> <p>Double stranded DNA separated into single strands</p> <p>Elongation</p> <p>Nucleotide monomers assembled into a DNA strand</p> <p style="text-align: right;">✓✓</p>	2	<p>3 correct = 2 marks</p> <p>1 or 2 correct = 1 mark</p>
	(d)	<p><math>(2^{30} = ) 1 \times 10^9</math> ✓</p>	1	<p><b>ALLOW</b> 1000000000</p> <p><b>DO NOT ALLOW</b> other responses if not to 1 sig. fig.</p>
	(e)	<p><b>Any two from</b> ✓✓</p> <ul style="list-style-type: none"> <li>The enzymes are not denatured (by higher temperatures)</li> <li>So additional enzymes do not need to be added each cycle</li> <li>PCR generates heat</li> </ul>	2	<p><b>IGNORE</b> damaged</p>

Question		Answer	Marks	Guidance
(f)	(i)	<div style="display: flex; flex-wrap: wrap; justify-content: space-around;"> <div style="border: 1px solid black; padding: 2px; margin: 2px;">positive</div> <div style="border: 1px solid black; padding: 2px; margin: 2px;">anode</div> <div style="border: 1px solid black; padding: 2px; margin: 2px;">neutral</div> <div style="border: 1px solid black; padding: 2px; margin: 2px;">cathode</div> <div style="border: 1px solid black; padding: 2px; margin: 2px;">negative</div> <div style="border: 1px solid black; padding: 2px; margin: 2px;">dynode</div> <div style="border: 1px solid black; padding: 2px; margin: 2px;">dipole</div> <div style="border: 1px solid black; padding: 2px; margin: 2px;">cestode</div> </div> <p style="text-align: right;">✓</p>	1	
	(ii)	In the following (decreasing) order: 489bp 404bp 331bp 242bp 110bp ✓	1	
	(iii)	348(bp) Allow any value between 404 and 331(bp) ✓	1	<b>ecf</b> from (h) (ii) any value between the marker above and marker below the fragment.
(g)		(short DNA fragments) are less dense / gel gives much less resistance (to short DNA fragments) ✓	1	OWTTE <b>ALLOW</b> lower mass = less dense = less heavy <b>IGNORE</b> they are smaller/less weight
		<b>Total</b>	<b>13</b>	

Question			Answer	Marks	Guidance
3	(a)	(i)	Measure (out 10 cm <sup>3</sup> of the concentrated acid) using a <b>10 cm<sup>3</sup> pipette.</b> ✓ Transfer to a <b>1 dm<sup>3</sup> volumetric flask</b> ✓ make up to the mark with distilled water. ✓	3	<b>ALLOW</b> If no other marks awarded 1 mark max for naming pipette <b>and</b> volumetric flask
		(ii)	B✓	1	
		(iii)	Methyl orange ✓  The pH range matches the range of rapid pH change <b>OR</b> the pH range matches the pH of the vertical section of the pH curve <b>OR</b> The equivalence point is within the pH range ✓	2	<b>ecf</b> from (b)(ii) for selection of sketch A or C. If A: any of the indicators If C: any except methyl orange
		(iv)	burette conical flask✓	1	2 correct = 1 mark <b>IGNORE</b> any volumes
		(v)	<b>FIRST CHECK ANSWER ON ANSWER LINE</b> <b>If answer = 0.161 (mol dm<sup>-3</sup>) award 3 marks</b>  <ul style="list-style-type: none"> <li>• <math>n\text{HCl} = \frac{16.1 \times 0.1}{1000}</math> ✓</li> <li>• n ammonia in 10 cm<sup>3</sup> = 0.00161 mol ✓</li> <li>• Concentration of ammonia = <math>\frac{0.00161 \times 1000}{10}</math>  = 0.161 mol dm<sup>-3</sup> ✓</li> </ul>	3	<b>ecf</b> for 1 mark <b>max.</b>
	(b)	(i)	Autotitrators use a (pH) electrode (to measure the pH) ✓	1	<b>ALLOW</b> <u>pH</u> probe

Question		Answer	Marks	Guidance												
	(ii)	<table border="1"> <tr> <td>It is not necessary to make up accurate standard solutions</td> <td></td> </tr> <tr> <td>Less titrant is used</td> <td>✓</td> </tr> <tr> <td>Results can be exported electronically to another device</td> <td>✓</td> </tr> <tr> <td>Smaller sample is required</td> <td>✓</td> </tr> <tr> <td>The equipment is cheaper</td> <td></td> </tr> <tr> <td>The results are more accurate</td> <td>✓</td> </tr> </table> <p style="text-align: right;">✓✓✓</p>	It is not necessary to make up accurate standard solutions		Less titrant is used	✓	Results can be exported electronically to another device	✓	Smaller sample is required	✓	The equipment is cheaper		The results are more accurate	✓	3	3 or 4 correct = 3 marks 2 correct = 2 marks 1 correct = 1 mark
It is not necessary to make up accurate standard solutions																
Less titrant is used	✓															
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Smaller sample is required	✓															
The equipment is cheaper																
The results are more accurate	✓															
	(iii)	<p><b>FIRST CHECK ANSWER ON ANSWER LINE</b> <b>If answer = 250 (mg) award 3 marks</b></p> <p>No. moles <i>mefloquine</i> in 100 cm<sup>3</sup> = 0.0066 ÷ 10 = 0.00066 ✓ Mass <i>mefloquine</i> = 0.00066 × 378 = 0.24948 g ✓ = 250 (mg) ✓</p>	3	<p><b>MUST</b> be 3 sf for 3 marks</p> <p><b>ALLOW</b> 249 (mg) for two marks</p> <p><b>ALLOW</b> 2.49(48)(mg) for one mark</p>												
		<b>Total</b>	<b>17</b>													

Question			Answer	Marks	Guidance
4	(a)	(i)	30 OR 36 ✓ mm ✓	2	<b>ALLOW +/- 1</b> <b>ALLOW</b> correct answers expressed via other units  Second mark dependant on first mark point
		(ii)	30/300,000 = 0.0001 (mm) OR 36 / 300,000 = 0.00012 (mm) ✓	1	<b>ALLOW</b> = $0.1 \times 10^{-4}$ / $1.2 \times 10^{-4}$ (mm) <b>ecf</b> from (a) <b>DO NO ALLOW incorrect rounding</b>
		(iii)	A single line length 30 mm drawn on <b>Fig 4.1</b> ✓	1	<b>ALLOW</b> +/- 1mm
		(iv)	(Protein) spikes on surface ✓	1	
		(v)	Nucleus	1	
		(vi)	<b>Advantage</b> Can see how cells move/change over time ✓  <b>Explanation</b> Because cells are viable/living when they are viewed ✓	2	<b>ALLOW</b> Cheap/Portable /Colour/Less training  <b>ALLOW</b> explanation that matches Advantage
		(vii)	<b>Any two from</b> ✓✓ <ul style="list-style-type: none"> <li>• HIV particles are too small (to be seen)</li> <li>• (smaller than) <math>\frac{1}{2}</math> wavelength of (visible) light</li> <li>• light microscopes lack the resolution/magnification needed</li> </ul>	2	



Question		Answer	Marks	Guidance
5	(a)	<p><b>[Level 3]</b> Candidate shows a high level of understanding of the principles of AES, <b>and</b> analyses the data in detail <b>and</b> correctly identifies the two cations.</p> <p style="text-align: right;"><i>(5 - 6 marks)</i></p> <p><b>[Level 2]</b> Candidate shows an understanding of the principles of AES <b>and</b> attempts to analyse the data, <b>and</b> correctly identifies the two cations.</p> <p style="text-align: right;"><i>(3 – 4 marks)</i></p> <p><b>[Level 1]</b> Candidate shows a basic understanding of the principles of AES <b>and</b> attempts to analyse the data <b>or</b> correctly identifies the two cations.</p> <p style="text-align: right;"><i>(1 – 2 marks)</i></p> <p><b>[Level 0]</b> Candidate response includes <b>fewer than two</b> valid points.</p> <p style="text-align: right;"><i>(0 marks)</i></p> <p style="text-align: right;">✓✓✓✓✓✓</p>	6	<p><b>Indicative content may include:</b></p> <p><b>AES Principles</b></p> <ul style="list-style-type: none"> <li>Metals in sample are <b>excited</b> by flame, plasma arc or spark.</li> <li>The emitted light is passed through a spectroscope to produce <b>a line emission spectrum</b>.</li> <li>Each element produces a <b>unique</b> spectrum.</li> </ul> <p><b>Analysis</b></p> <ul style="list-style-type: none"> <li>The sample contains two cations, <b>Li<sup>+</sup> and K<sup>+</sup></b></li> <li>The unknown spectrum has an orange line at 610 nm corresponding to the spectrum of Li, and several lines corresponding to the spectrum of K</li> </ul> <p><b>Detail</b></p> <ul style="list-style-type: none"> <li>The idea that a line spectrum consists of emitted light with <b>specific</b> wavelengths.</li> <li>The <b>absence of certain lines</b> in the unknown salt spectrum: no lines corresponding to Na (eg no yellow line at 600 nm) or Ca (eg no red lines at 650 nm or green line at 560 nm).</li> <li>The unknown salt spectrum has <b>specific lines corresponding to K</b> e.g. yellow lines at 590, green lines at 540 and blue lines at 510 nm</li> </ul>

Question		Answer	Marks	Guidance
	(b) (i)	In the following order Charged ✓ Low ✓ High ✓	3	
	(ii)	G ✓	1	
	(iii)	D ✓	1	
	(iv)	A ✓	1	
	(v)	Proteins absorb UV light ✓	1	
	(vi)	<b>Any two from</b> ✓ ✓ <ul style="list-style-type: none"> <li>• Analysis of amino acids</li> <li>• Determination of base composition of nucleic acids</li> <li>• Water purification / analysis</li> <li>• Quality control</li> </ul>	2	<b>ALLOW</b> other realistic answers
		<b>Total</b>	<b>15</b>	



Question			Answer	Marks	Guidance
6	(a)	(i)	<p><b>Equipment or material to be sterilised</b></p> <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; width: 150px;">Hard surfaces inside the work area</div> <div style="border: 1px solid black; padding: 5px; width: 150px;">Filtering through a sterile membrane filter</div> </div> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="border: 1px solid black; padding: 5px; width: 150px;">Glassware</div> <div style="border: 1px solid black; padding: 5px; width: 150px;">Autoclaving</div> </div> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="border: 1px solid black; padding: 5px; width: 150px;">Protein growth factors to add to the animal cell culture medium</div> <div style="border: 1px solid black; padding: 5px; width: 150px;">Refrigeration</div> </div> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="border: 1px solid black; padding: 5px; width: 150px;"></div> <div style="border: 1px solid black; padding: 5px; width: 150px;">Wiping with bactericidal solution</div> </div> <p style="text-align: right;">✓✓✓</p>	3	
	ba	(ii)	<p>Prevent airborne <b>contamination</b> of the tissue/cell culture (by other bacteria or fungi) ✓</p> <p>Prevent Kareem/him being contaminated/infected by the bacteria ✓</p>	2	<b>IGNORE</b> contamination unqualified
	ba	(iii)	<p>(The bacterial cultures) are less likely to be contaminated by other bacteria/microorganisms from <b>Kareem's skin</b> ✓</p>	1	OWTTE <b>IGNORE</b> contamination unqualified
		(iv)	<p><b>Any two from</b> ✓✓</p> <ul style="list-style-type: none"> <li>• preparation of medical test kits</li> <li>• pharmaceutical production of drugs/medicines</li> <li>• surgical procedures</li> <li>• (animal/plant) tissue cultures / organoids</li> <li>• Cell culture</li> </ul>	2	

Question		Answer	Marks	Guidance												
	(b)	(i)	1													
		<table border="1"> <tr><td>To avoid killing the inoculum</td><td></td></tr> <tr><td>To check for contamination</td><td></td></tr> <tr><td>To obtain clones of bacteria</td><td></td></tr> <tr><td>To prevent aerosols containing bacteria</td><td></td></tr> <tr><td>To sterilise the inoculating loop</td><td>✓</td></tr> <tr><td>To test for lithium ions</td><td></td></tr> </table> <p style="text-align: right;">✓</p>			To avoid killing the inoculum		To check for contamination		To obtain clones of bacteria		To prevent aerosols containing bacteria		To sterilise the inoculating loop	✓	To test for lithium ions	
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Question		Answer	Marks	Guidance
	(c)	<p><b>Any two from:</b></p> <p><b>Single</b> bacterial cells have been discharged from the inoculating loop and formed individual colonies ✓</p> <p>the <b>inoculating loop</b> has lost most of the bacteria towards the end of the streak ✓</p> <p>(The individual colonies are formed by) <b>contaminants</b> / other bacteria/fungi ✓</p>	2	
		<b>Total</b>	<b>13</b>	

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