

**Cambridge Technicals
Applied Science**

Unit 2: Laboratory techniques

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

Mark Scheme for January 2024

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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).

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

11. **Subject-specific marking instructions**

Question			Answer	Marks	Guidance
1	(a)	(i)	(blood could contain) biological agent/pathogen/virus ✓	1	ALLOW bacteria/named biological agent/named pathogen IGNORE infection/contamination/disease
		(ii)	Gloves✓	1	ALLOW goggles IGNORE face mask
		(iii)	<ul style="list-style-type: none"> • Hazard: something that can cause harm✓ • Risk: type of harm (possible due to a hazard) / the chance of a person being harmed by the hazard ✓ 	2	OWTTE
	(b)	(i)	<p>Any two from:</p> <ul style="list-style-type: none"> • Date (sample taken) • Sampler • Where the sample was taken • What the sample was • Unique reference number ✓✓ 	2	<p>IGNORE time taken</p> <p>ALLOW hazard symbol</p> <p>DO NOT ALLOW name of patient/person</p>
		(ii)	<p>Any two from:</p> <ul style="list-style-type: none"> • Prevent samples from being lost • Prevent samples from being mixed up • Prevent samples from being tampered with ✓✓ 	2	<p>IGNORE answers relating to contamination</p> <p>IGNORE Leaks/spills</p>

Question	Answer	Marks	Guidance						
	(iii) Prevent the sample from degrading/decomposing ✓ To ensure that the quality of the forensic evidence is accurate/reliable ✓	2	ALLOW Keep the sample fresh/preserve the sample IGNORE prevent contamination IGNORE prevent bacteria growing						
(c)	(i) <table border="0" style="margin-left: 20px;"> <tr> <td style="border: 1px solid black; padding: 5px;">Concentrated hydrochloric acid</td> <td style="border: 1px solid black; padding: 5px;">Flammables cupboard</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">Ethanol</td> <td style="border: 1px solid black; padding: 5px;">Toxic chemicals locker</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">Cyanide</td> <td style="border: 1px solid black; padding: 5px;">Corrosives cupboard</td> </tr> </table> ✓✓	Concentrated hydrochloric acid	Flammables cupboard	Ethanol	Toxic chemicals locker	Cyanide	Corrosives cupboard	2	3 correct = 2 marks 1 or 2 correct = 1 mark
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	(ii) <table border="0" style="margin-left: 20px;"> <tr> <td style="border: 1px solid black; padding: 5px;">A shattered beaker</td> <td style="border: 1px solid black; padding: 5px;">Pour down a designated sink</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">The sample swabs</td> <td style="border: 1px solid black; padding: 5px;">Place in a broken glassware box</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">1 M Hydrochloric acid</td> <td style="border: 1px solid black; padding: 5px;">Place in an autoclave</td> </tr> </table> ✓✓	A shattered beaker	Pour down a designated sink	The sample swabs	Place in a broken glassware box	1 M Hydrochloric acid	Place in an autoclave	2	3 correct = 2 marks 1 or 2 correct = 1 mark
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	Total	14							

Question			Answer	Marks	Guidance												
2	(a)	(i)	High performance/pressure ✓ liquid chromatography ✓	2													
		(ii)	A: pump B: sample injector C: HPLC column D: detector ✓✓✓	3	3 or 4 correct = 3 marks 2 correct = 2 marks 1 correct = 1 mark												
	(b)	(i)	An estimate between 6 and 7 (mins) ✓	1													
		(ii)	8 (different) peaks ✓	1													
		(iii)	The area of peak E ✓ Relative to the total area under all the peaks ✓	2													
		(iv)	Produce a calibration graph (of area vs concentration / mass) ✓ Interpolate the area of E (in Fig 2.1) ✓ OR Use standard/known concentration of digoxin to get area ✓ Compare to area of peak E ✓	2													
	(c)	(i)	Mass spectrometry ✓	1													
		(ii)	<table border="1"> <thead> <tr> <th></th> <th>Order</th> </tr> </thead> <tbody> <tr> <td>fragmentation</td> <td>2</td> </tr> <tr> <td>ionisation</td> <td>1</td> </tr> <tr> <td>detection</td> <td>5</td> </tr> <tr> <td>deflection</td> <td>4</td> </tr> <tr> <td>acceleration</td> <td>3</td> </tr> </tbody> </table> ✓✓		Order	fragmentation	2	ionisation	1	detection	5	deflection	4	acceleration	3	2	3 or 4 correct = 2 marks 2 correct = 1 mark
	Order																
fragmentation	2																
ionisation	1																
detection	5																
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acceleration	3																
		(iii)	800	1													
			Total	15													


Question			Answer	Marks	Guidance
3	(a)	(i)	$(1000 \div 12.05) \times 0.1 = 8.3 \text{ (cm}^3\text{)}$. ✓	1	ALLOW 8.2987....cm ³ ALLOW 8.29 DO NOT ALLOW 8 alone
		(ii)	1. 10 cm³ graduated pipette ✓ 2. 1 dm³ volumetric flask ✓	2	If given 1dm ³ measuring cylinder check answer to ai
	(b)	(i)*	<p>[Level 3] Candidate shows a high level of understanding by giving a good description AND most explanations of the method to ensure that the end point of a titration and volume of titrant are determined accurately. <i>(5 – 6 marks)</i></p> <p>[Level 2] Candidate shows understanding by giving a fair description of the method to ensure that the end point of a titration and volume of titrant are determined accurately AND some explanations. <i>(3 – 4 marks)</i></p> <p>[Level 1] Candidate shows basic understanding by giving a fair description of the method to ensure that the end point of a titration and volume of titrant are determined accurately but with few explanations. <i>(1 – 2 marks)</i></p> <p>[Level 0] Candidate response includes fewer than two valid points. <i>(0 marks)</i></p> <p>✓✓✓✓✓✓</p>	6	<p>Indicative points may include:</p> <p>Description</p> <ul style="list-style-type: none"> • use a one- mark 25cm³ pipette for diluted drain cleaner • wash glassware appropriately (burette with water, then HCl; pipette with water and then diluted drain cleaner; flask with water only) • use a named indicator: methyl orange, phenol phthalein or bromothymol blue • do a rough reading initially • do accurate repeats until titres are concordant • add the titrant dropwise near the <u>endpoint</u> • swirl flask between additions of acid • put flask on white tile <p>Explanation</p> <ul style="list-style-type: none"> • pipette: to ensure exactly 25.0 cm³ volume of drain cleaner • washing: to ensure no excess concentration or volumes/no contaminants • indicator: to show a visible end point • rough titration: so that the approximate amount of titrant is determined (quickly) • dropwise addition of acid: so that a single drop changes the colour of the indicator to ensure volume of acid added at the endpoint is accurate. • swirling: to ensure thorough mixing of solutions • concordant titres: to verify concentration • white tile: to see end point clearly

Question		Answer	Marks	Guidance
(b)	(ii)	<p>Table values 32.60, 32.30, 32.55, 32.40 ✓</p> <p>Explanation Concordant titres are 32.30 and 32.40/titre 1 and titre 3 (within 0.1 cm³) ✓</p> <p>Mean titre is the average of the concordant titres (= 32.35 cm³) / add concordant titres together and divide by 2 ✓</p>	3	<p>Four correct values in table = 1 mark</p> <p>Ecf from their calculations in the table DO NOT ALLOW rough titre</p> <p>Ecf from their chosen titres</p>
(c)	(i)	$n \text{ HCl} = 32.35 \times 0.1 \times 10^{-3} = 3.235 \times 10^{-3} \checkmark$	1	ecf from mean titre calculated in (b) ALLOW answers not in standard form/0.003235
	(ii)	$n \text{ NaOH in } 25.0 \text{ cm}^3 = 3.235 \times 10^{-3} \checkmark$	1	ecf – ALLOW same answer as c(i) ALLOW answers not in standard form
	(iii)	$n \text{ NaOH in } 1 \text{ dm}^3 = \frac{3.235 \times 10^{-3} \times 1000}{25} = 0.1294 \checkmark$	1	ecf c(ii) x 1000/25
	(iv)	<p>C NaOH in undiluted drain cleaner = $0.1294 \times 5 = 0.647 \text{ mol dm}^{-3} \checkmark$</p> <p>C NaOH in g dm⁻³ = $0.647 \times 40 = 25.9 \text{ g dm}^{-3}$ (3 sf required) ✓</p>	2	c(iii) x 5 ecf final answer must be 3sf
		Total	17	

Question			Answer	Marks	Guidance	
4	(a)	(i)	Higher /greater ✓	1		
		(ii)	Transducer / probe ✓	1		
		(iii)	To direct the ultrasound into the patient and receive the reflected ultrasound from the patient	✓	1	
			To direct the ultrasound into the patient's abdomen			
To produce the ultrasound image						
To receive the reflected ultrasound from the patient						
		(iv)	(ultrasound) gel ✓	1	ALLOW coupling medium ALLOW lubricating gel must be ultrasound gel if named	
(b)	(i)	E ✓		1		
	(ii)	Nervous (tissue) / brain ✓		1	IGNORE embryo	
(c)	(i)	High ✓ electromagnetic ✓		2	ALLOW only responses in the correct order.	
	(ii)	(X-ray) generator ✓		1	ALLOW X-ray tube IGNORE X-ray machine	
		(iii)	To detect the X rays that leave the patient		1	
			To produce X-rays and direct them to the patient	✓		
			To produce X-rays and detect the X-rays that leave the patient			
			To reflect X-rays			

Question		Answer	Marks	Guidance								
	(iv)	(X-ray) detector / charged couple device/CCD / photographic plate/film ✓	1									
	(v)	<table border="1"> <tr> <td>To detect the X rays that leave the patient</td> <td>✓</td> </tr> <tr> <td>To generate the X-ray image</td> <td></td> </tr> <tr> <td>To produce X-rays and direct them to the patient</td> <td></td> </tr> <tr> <td>To produce X-rays and to detect the X-rays that leave the patient</td> <td></td> </tr> </table>	To detect the X rays that leave the patient	✓	To generate the X-ray image		To produce X-rays and direct them to the patient		To produce X-rays and to detect the X-rays that leave the patient		1	
To detect the X rays that leave the patient	✓											
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To produce X-rays and direct them to the patient												
To produce X-rays and to detect the X-rays that leave the patient												
	(d)	<ul style="list-style-type: none"> • Ultrasound is non-ionising ✓ • So is less harmful to the patient/foetus/embryo ✓ 	2	<p>ORA</p> <p>ALLOW ultrasound is not high energy</p> <p>IGNORE references to moving images</p>								
		Total	14									

Question			Answer	Marks	Guidance												
5	(a)	(i)	<table border="1"> <thead> <tr> <th>Step</th> <th>Order</th> </tr> </thead> <tbody> <tr> <td>add a few drops of aqueous sodium hydroxide</td> <td>3</td> </tr> <tr> <td>add aqueous sodium hydroxide until it is in excess and record the result.</td> <td>5</td> </tr> <tr> <td>dissolve a small quantity of the unknown solid in water.</td> <td>1</td> </tr> <tr> <td>place about 5cm³ of the solution into a test tube.</td> <td>2</td> </tr> <tr> <td>record the colour of any precipitate that is formed.</td> <td>4</td> </tr> </tbody> </table>	Step	Order	add a few drops of aqueous sodium hydroxide	3	add aqueous sodium hydroxide until it is in excess and record the result.	5	dissolve a small quantity of the unknown solid in water.	1	place about 5cm ³ of the solution into a test tube.	2	record the colour of any precipitate that is formed.	4	2	4 correct = 2 marks 2 or 3 correct = 1 mark 1 or 0 correct = 0 marks
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✓ ✓																	
(ii)	Compound X Potassium ✓ Iodide ✓ Compound Y Iron(II) ✓ Sulfate ✓	4	1 mark for correct cation, 1 mark for correct anion DO NOT ALLOW iodine DO NOT ALLOW iron for iron (II) ALLOW correct formulae														
(iii)	Add (dilute nitric) acid ✓ Bubbles/fizzing/effervescence/gas produced ✓	2	ALLOW (dilute) hydrochloric acid or sulfuric acid. IGNORE limewater turns milky														
(iv)	CO_3^- CO^{2-} CO_2^{3-} CO_3^{2-} ✓	1															
(b)	(i)	serial dilution ✓	1														

Question	Answer	Marks	Guidance
	(ii) <ul style="list-style-type: none"> • Evidence of interpolation of the graph ✓ • (Concentration of cadmium in the milk) $7.8 \mu\text{g dm}^{-3}$ ✓ • (The milk is safe to drink) because the concentration of cadmium is less than $10 \mu\text{g dm}^{-3}$ ✓ 	3	ALLOW between 7.5 -7.9 OWTTE Can only get third mark if evidence from graph or concentration given ECF from interpolation on graph/concentration found
	(iii) <div style="text-align: center; margin: 10px 0;">  </div> <p style="text-align: center;">Li⁺ AND Mg²⁺ required ✓</p>	1	Both required for 1 mark
	Total	14	

Question		Answer	Marks	Guidance															
6	(a)	Autoclaving the eggs	1																
		Irradiating the eggs with gamma rays																	
		Wiping the egg with a disinfectant			✓														
(b)	(i)	(HEPA) filtration ✓	1	Air filters															
		(ii) Leave a (nutrient) agar plate open to the air (for a set period of time). ✓ Count the number of colonies that grow ✓	2																
		(iii) Any three from goggles ✓ (face) mask ✓ coverall / laboratory coat ✓ gloves ✓	3	ALLOW <u>safety</u> glasses															
		(iv) Prevent (the workers from) contaminating the eggs ✓	1	IGNORE cross contamination unqualified															
	(c)	<table border="1"> <thead> <tr> <th>Feature</th> <th>TEM</th> <th>SEM</th> </tr> </thead> <tbody> <tr> <td>Electrons are reflected off the surface of the virus.</td> <td></td> <td>✓</td> </tr> <tr> <td>The image produced is two dimensional.</td> <td>✓</td> <td></td> </tr> <tr> <td>Maximum magnification can be up to x 50 million.</td> <td>✓</td> <td></td> </tr> <tr> <td>A typical resolution of 0.4nm is achieved.</td> <td></td> <td>✓</td> </tr> </tbody> </table> <p style="text-align: right;">✓✓✓</p>	Feature	TEM	SEM	Electrons are reflected off the surface of the virus.		✓	The image produced is two dimensional.	✓		Maximum magnification can be up to x 50 million.	✓		A typical resolution of 0.4nm is achieved.		✓	3	4 correct ticks = 3 marks 3 correct ticks = 2 marks 1 or 2 correct ticks = 1 mark
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A typical resolution of 0.4nm is achieved.		✓																	

Question		Answer	Marks	Guidance
	(d)	<p>Any two from:</p> <ul style="list-style-type: none"> all virus particles are contained within the bioreactor virus particles can be deactivated / sterilised without removing them from the bioreactor virus particles can be moved / processed without exposing employees <p style="text-align: right;">✓ ✓</p>	2	<p>IGNORE lower risk of contamination/cross contamination</p> <p>IGNORE virus is sealed in bioreactor</p> <p>ALLOW employees don't come in contact with/get infected by the virus</p>
	(e)	<p>Any three from:</p> <ul style="list-style-type: none"> cell / tissue culture preparation of medical test kits microbiology surgical procedures <p style="text-align: right;">✓ ✓ ✓</p>	3	<p>DISCUSS alternate answers at SSU</p> <p>ALLOW plant/cauliflower cloning</p> <p>ALLOW genetic transformation/ producing recombinant cells</p>
		Total	16	

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