# Cambridge Technicals

# Applied Science

## Unit 2: Laboratory techniques

Level 3 Cambridge Technical in Applied Science

**05847 – 05849, 05874 & 05879**

# Mark Scheme for June 2024

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

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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.

# 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 question

   Note: 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**

**INTRODUCTION**

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 1 | (a) | (i) | **Any two from:** ✓✓<br>• implementation/ensure health, safety and welfare, if reasonably practical<br>• health and safety applies to all employees<br>• safety equipment provided and maintained<br>• apply safety protocols in the workplace<br>• making 'assessments of risk' to the health and safety of its workforce, and to act upon risks they identify<br>• appointing competent persons to oversee workplace health and safety<br>• providing workers with information and training on occupational health and safety<br>• operating a written health and safety policy.<br><br>any valid response from the Health and Safety act | 2 | **OWTTE**<br><br>**ALLOW** provide PPE<br><br>**ALLOW** risk to assessment / take preventative measures<br><br>**IGNORE** roles of employees |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| | | (ii) | **[Level 3]** Candidate shows a high level of understanding by giving a good description of the differences between hazard and risk **AND** identifies a range of risks **AND** how the risks can be minimised.<br><br>***(5 - 6 marks)***<br><br>**[Level 2]** Candidate shows understanding by giving some description of the differences between hazard and risk **AND** identifies some risks **AND** how the risks can be minimised.<br>***(3 – 4 marks)***<br><br>**[Level 1]** Candidate shows basic understanding by giving some description of the differences between hazard and risk, **OR** names some risks **OR** how the risks can be minimised.<br>***(1 – 2 marks)***<br><br>**[Level 0]** Candidate response includes **fewer than two** valid points.<br>***(0 marks)***<br><br>✓✓✓✓✓✓ | 6 | Indicative content may include:<br><br>**Hazards and risks**<br>Hazard is what could cause harm or injury<br>Hazard is related to the chemical or task involved<br>Hazards are fixed<br>Risk is the potential for/example of harm by the activity<br>Risk can change according to how the hazard is used e.g. quantities, frequency of use etc.<br><br>**Chemical laboratory risks**<br>Chemical burns<br>Ingestion of toxic substances<br>Inhalation of toxic substances<br>Cuts from broken glassware<br>Fire and explosion<br><br>**Ways to minimise risks**<br>Availability of fire safety equipment<br>Named PPE<br>Adequate ventilation<br>Use of fume hoods<br>Risk assessments<br>Protocols and procedures<br>First aid kits<br>First aiders / first aid training<br><br>**ALLOW** other appropriate hazards and risks |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| | **(b)** | | **Any two from:** ✓✓<br>• Sweep up / clear away the glassware<br>• Place broken glassware in a suitable container / receptacle/sharps bin | 2 | **OWTTE**<br><br>**ALLOW** signage<br>**IGNORE** report it<br><br>**IGNORE** PPE<br>**IGNORE** answers related to what might be in glass |
| | **(c)** | **(i)** |  <br>✓ | 1 | |
| | | **(ii)** | **Any three from:**<br>Date of disposal<br>Material disposed<br>Quantity/volume disposed<br>Who disposed it<br>How/where it was disposed ✓✓✓ | 3 | **OWTTE**<br>**IGNORE** time<br>**ALLOW** name (of material)<br><br>**IGNORE** check if material is a hazard<br>**IGNORE** description of hazard or risk |
| | | | **Total** | **14** | |

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2</td><td>(a)</td><td></td><td>Thin layer chromatography ✓</td><td>1</td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td>Any two from:<br><br>Separation (of pigments/lines) is clearer ✓<br>More/other pigments/lines can be seen ✓<br>(Uniform progress of solvent leads to) flat pigments/lines✓</td><td>2</td><td>ALLOW responses in any order<br><br>IGNORE clearer pigments/lines<br>IGNORE accuracy<br>IGNORE advantages that cannot be seen</td></tr>
<tr><td></td><td>(c)</td><td></td><td>(Distance travelled by solvent =) 60(mm) or 6.0(cm) ✓<br><br>(Distance travelled by chlorophyll a) = 21(mm) or 2.1 (cm) ✓<br><br>Rf value = 21 ÷ 60 OR 2.1 ÷ 6.0<br><br>= 0.35. ✓</td><td>3</td><td>ALLOW +/- 1mm<br>ALLOW +/- 1mm<br><br>ECF if is clear they have divided distance travelled by substance by distance travelled by solvent</td></tr>
<tr><td></td><td>(d)</td><td></td><td><table>
<tr><td>Chlorophyll a has a greater affinity for the stationary phase in paper chromatography</td><td></td></tr>
<tr><td>Chlorophyll a has a lower affinity for the stationary phase in paper chromatography</td><td>✓</td></tr>
<tr><td>The chlorophyll a is different in the two chromatograms</td><td></td></tr>
<tr><td>In TLC the solvent runs faster than paper chromatography</td><td></td></tr>
<tr><td>Paper chromatography uses a lid</td><td></td></tr>
</table></td><td>1</td><td></td></tr>
</table>

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| | (e) | | **Any two from:**<br>The pigment bands are straighter / parallel in TLC ✓<br>Better separation ✓<br>The lines are thinner ✓<br>So the measurements taken are more accurate ✓ | 2 | **ORA**<br>**IGNORE** accuracy alone<br>**IGNORE** clearer<br>**IGNORE** results are more accurate<br>**IGNORE** comments about origin |
| | (f) | (i) | A: carrier gas ✓<br>B: sample ✓<br>C: column ✓<br>D: detector ✓ | 4 | **ALLOW** gas cylinder<br>**IGNORE** injection/syringe/solution<br>**IGNORE** analyser |
| | | (ii) | **Any two from:**<br>GC: offers improved separation. ✓<br>Greater sensitivity. ✓<br>Tells you how much of each component is present. ✓ | 2 | **OWTTE**<br>**IGNORE** accuracy/speed<br>**ALLOW** more precise |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| | | **(iii)** | Mass Spectrometer can identify each compound/components✓<br>**AND**<br>**Any one from:** ✓<br>MS tells you the relative formula mass / Mr of each compound.<br>**OR** The spectrum of each compound can be compared to reference spectra to find a match.<br>**OR** The peaks in the spectrum of each compound tells you the structure of the compound. | 2 | **ALLOW** relative molecular mass |
| | | | **Total** | **17** | |

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3</td><td>(a)</td><td>(i)</td><td>Three marks max: ✓✓✓<br><br>1. <u>volumetric</u> flask<br>2. <u>conical</u> flask<br>3. one mark pipette/ bulb pipette<br>4. measuring cylinder<br>5. burette<br>6. beaker</td><td>3</td><td>ALLOW response only in the correct order<br>6 correct = 3 marks<br>4 or 5 correct = 2 marks<br>2 or 3 correct = 1 mark<br>1 correct = 0 marks<br><br>ALLOW pipette for number 3.<br>DO NOT ALLOW graduated pipette for number 3.<br><br>ALLOW measuring beaker for number 6</td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><th>Acidic conditions</th><th>Basic conditions</th><th></th></tr><tr><td>Yellow</td><td>Blue</td><td></td></tr><tr><td>Colourless</td><td>Pink</td><td></td></tr><tr><td>Red</td><td>Yellow</td><td>✓</td></tr><tr><td>Pink</td><td>Colourless</td><td></td></tr></table></td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(iii)</td><td>strong acid - weak base titration ✓<br>The indicator changes colour within the range of rapid pH change ✓</td><td>2</td><td>IGNORE accuracy<br>ALLOW the pH range of the indicator is within the range of rapid pH change/clear colour change at end point</td></tr>
<tr><td></td><td>(b)</td><td></td><td>(pH) electrode / by measuring pH ✓</td><td>1</td><td>ALLOW pH probe/ pH meter</td></tr>
</table>

| | | | | | |
|---|---|---|---|---|---|
| | **(c)** | **(i)** | (No. moles HC*l* = ) $\frac{0.1 \times 3.62}{1000}$ = 0.000362 **OR** 3.62 x $10^{-4}$ mol ✓ | 1 | **ALLOW** 3.6x$10^{-4}$ |
| | | **(ii)** | (No moles $NH_3$ in 10 $cm^3$ )= 0.000362 **OR** 3.62 x $10^{-4}$ mol (ie the SAME as **c(i)** ) ✓<br><br>(Concentration of $NH_3$) = $\frac{0.000362 \times 1000}{10}$ = 0.0362 ✓ | 2 | **ALLOW ecf from c(i)** |
| | | **(iii)** | Dilution factor = 250 ÷ 5 = 50 ✓<br><br>Concentration of $NH_3$ in undiluted solution = 0.0362 (or answer to cii) x 50= 1.81 (mol $dm^{-3}$) ✓ | 2 | **IGNORE** units<br><br>**ALLOW ecf from answer to c(ii)**<br>**ALLOW** 1.8 |
| | | **(iv)** | **First check the answer line. If answer is % $NH_3$ = 3.077 award 2 marks**<br><br>Mass $NH_3$ in 1 $dm^3$ = 1.81 (or answer to ciii) x 17 = 30.77 g ✓<br><br>% $NH_3$ = 30.77 ÷ 10 = 3.077 ✓ | 2 | **ALLOW ecf** using answer to **(c)(iii)**<br><br>**ALLOW** 3.08 **OR** 3.1 |

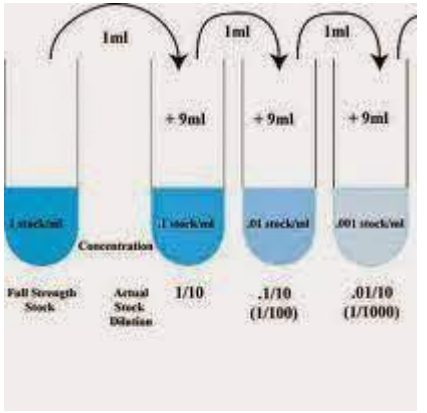
| | | | | | |
|---|---|---|---|---|---|
| | | **(d)** | **Any two from:** ✓✓<br>• (Equivalence point detection is based on sensor readings) not the opinion of the user / objective rather than subjective<br>• (Very small additions of titrant are added automatically so The accuracy of the titre) does not depend on the skill of the user<br>• The results are more likely to be reproducible/consistent | 2 | **IGNORE** human error<br><br>**IGNORE** No need for indicator |
| | | **(e)** | The colour change of an indicator would be difficult to see. ✓ | 1 | **OWTTE** |
| | | | **Total** | **17** | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 4 | (a) | (i) | Stage ✓ | 1 | **ALLOW** sample table<br>**IGNORE** platform |
| | | (ii) | Provide a light source / illuminate the sample | 1 | **OWTTE** |
| | | (iii) | **Any three from:**<br>Fine focus ✓<br>Coarse focus ✓<br>Coarse focus – to bring the specimen into near or approximate focus ✓<br>Fine focus – to sharpen the image ✓ | 3 | **ALLOW** idea of depending on size of specimen<br>**ALLOW** higher resolution |
| | | (iv) | Multiple/sequential magnifications ✓<br><br>Range of field of views ✓ | 2 | **ALLOW** used to focus in or magnify structures in more detail<br>**ALLOW** higher resolution<br><br>**ALLOW** Answers related to ease of getting the focus |
| | (b) | (i) | (The appearance of) the fibre in Fig 4.2 is, the same / similar to cashmere in Fig 4.1. ✓ | 1 | **OWTTE** |
| | | (ii) | (Diameter = 20 +/- 2 μm =) 0.02 +/- 0.002 (mm) ✓ | 1 | **ALLOW** any number between 0.018 – 0.022 |
| | | (iii) | E **AND** F ✓ | 1 | |
| | | (iv) | **First check the answer line. If answer is magnification = 250 +/- 10 (x) award 3 marks**<br><br>Diameter of cashmere on image = 5 mm ✓<br>Magnification = image diameter ÷ actual diameter ✓<br>= 5 ÷ 0.02 (or answer to bii) = 250 +/- 10 ✓ | 3 | **ALLOW** +/- 0.5mm ECF from bii |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| | **(c)** | **(i)** | **Any one from:** ✓<br>• Higher magnification<br>• Higher resolution | 1 | **ALLOW** objects/artefacts seen in more detail<br>**IGNORE** 3D |
| | | **(ii)** | Light microscopy can reveal the colour of the fibres ✓ | 1 | |
| | | | **Total** | **15** | |

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>5</td><td>(a)</td><td></td><td>
<table>
<tr><th>Features</th><th>IC</th><th>AES</th></tr>
<tr><td>Can detect anions and cations</td><td>✓</td><td></td></tr>
<tr><td>Can detect very low concentrations</td><td>✓</td><td>✓</td></tr>
<tr><td>Can determine concentrations of solutions</td><td>✓</td><td>✓</td></tr>
<tr><td>Uses a flame as a heat source</td><td></td><td>✓</td></tr>
</table>
</td><td>2</td><td>1 mark for each correct column</td></tr>
<tr><td></td><td>(b)</td><td></td><td>Three marks max: ✓✓✓<br>In the following order:<br>Absorbed<br>Eluent<br>Higher<br>Detected</td><td>3</td><td>4 correct = 3 marks<br>3 correct = 2 marks<br>1 or 2 correct = 1 mark</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>Chloride AND sulfate✓</td><td>1</td><td>ALLOW 2 AND 5</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Fluoride ✓<br>It has the greatest peak area ✓</td><td>2</td><td>ALLOW 1<br>ALLOW highest peak / largest spike</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>Interpolation clearly shown on graph ✓<br><br>0.83 (μg $cm^{-3}$) AND within range ✓</td><td>2</td><td><br><br>+/- 0.01 Both required for mark 2</td></tr>
<tr><td></td><td>(d)</td><td></td><td>Any two from:<br>Protein purification<br>Nucleotide sequencing<br>Amino acid analysis<br>Quality control<br>Water purification ✓✓</td><td>2</td><td>ALLOW any other valid use of IC<br>IGNORE identification of ions</td></tr>
</table>

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| | **(e)** | | Each metal has a unique spectrum ✓<br>The metal can be identified by comparison with reference spectra ✓ | 2 | **ALLOW** unique wavelength |
| | | | **Total** | **14** | |

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><td></td><td>Autoclaving</td><td>Dry heat</td><td>Flaming</td></tr>
<tr><td>Agar for the agar plates</td><td>✓</td><td></td><td></td></tr>
<tr><td>Glass pipettes</td><td></td><td>✓</td><td></td></tr>
<tr><td>Sterile buffer solution</td><td>✓</td><td></td><td></td></tr>
</table>
</td><td>3</td><td>1 mark for each correct row</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Add 1 $cm^3$ of 1x sample solution to 9 $cm^3$ of sterile buffer solution (and mix well to make 1/10 dilution) ✓<br><br>Repeat with 1/10 dilution to make 1/100 dilution ✓<br><br>Repeat with 1/100 dilution to make 1/1000 dilution ✓</td><td>3</td><td>ALLOW any appropriate measurements<br>ALLOW a suitable diagram e.g.<br> 
</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>To check that none of the bacterial growth comes from the buffer solution ✓</td><td>1</td><td>IGNORE unqualified references to controls/contamination<br>ALLOW so no unwanted bacteria<br>IGNORE remove bacteria</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>(The solution is not diluted enough so) individual colonies cannot be seen ✓</td><td>1</td><td>OWTTE<br>ALLOW too many bacterial colonies growing on the plate/colonies are too close</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>There are only a few colonies in the 1/1000 dilution, (so less accurate than 1/100 dilution) ✓</td><td>1</td><td>ORA</td></tr>
</table>

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>First check the answer line. If answer = 21200 award 3 marks<br>No. of colonies in 0.5 $cm^3$ = (53 x 100) = 5300 ✓<br>No. of colonies in 50 $cm^3$ = (5300 x 100) = 530000 ✓<br>No. of colonies in 1 g = 530000 ÷ 25 = 21200 (or 2.12 x $10^4$) ✓</td><td>3</td><td>ecf throughout</td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><td>The number of colonies in the food is less than the allowed maximum number</td><td>✓</td></tr><tr><td>The number of colonies in the food is the same as the allowed maximum number</td><td></td></tr><tr><td>The number of colonies in the food is more than the maximum allowed number</td><td></td></tr></table></td><td>1</td><td>ALLOW ecf using answer to (c)(i)</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>13</td><td></td></tr>
</table>

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