

# **Chemistry A**

General Certificate of Secondary Education

Unit **A173/02**: Module C7 (Higher Tier)

## **Mark Scheme for June 2013**

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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

Used in the detailed Mark Scheme:

| Annotation          | Meaning   |
|---------------------|---|
| /                   | alternative and acceptable answers for the same marking point |
| (1)                 | separates marking points                                      |
| <b>not/reject</b>   | answers which are not worthy of credit                        |
| <b>ignore</b>       | statements which are irrelevant - applies to neutral answers  |
| <b>allow/accept</b> | answers that can be accepted                                  |
| (words)             | words which are not essential to gain credit                  |
| <u>words</u>        | underlined words must be present in answer to score a mark    |
| ecf                 | error carried forward   |
| AW/owtte            | credit alternative wording / or words to that effect          |
| ORA                 | or reverse argument   |

Available in scoris to annotate scripts:

|   |   |
|---|---|
|  | correct response  |
|  | incorrect response  |
| <b>BOD</b>  | benefit of doubt  |
| <b>NBOD</b>   | no benefit of doubt   |
| <b>ECF</b>  | error carried forward   |
| <b>0</b> , <b>L1</b> , <b>L2</b> , <b>L3</b>                                      | indicate level awarded for a question marked by level of response |
| <b>A</b>  | information omitted   |
| <b>CON</b>  | contradiction   |
| <b>R</b>  | reject  |

|   |   |
|---|---|
|  | indicate uncertainty or ambiguity                         |
|  | draw attention to particular part of candidate's response |

**Subject-specific Marking Instructions**

- a. Accept any clear, unambiguous response (including mis-spellings of scientific terms if they are *phonetically* correct, but always check the guidance column for exclusions).
- b. Crossed out answers should be considered only if no other response has been made. When marking crossed out responses, accept correct answers which are clear and unambiguous.

*e.g. for a one-mark question where ticks in the third and fourth boxes are required for the mark:*

|   |
|---|
|   |
|   |
| ☑ |
| ☑ |
|   |

*This would be worth  
1 mark.*

|   |
|---|
|   |
|   |
| ü |
| ☑ |
|   |

*This would be worth  
0 marks.*

|   |
|---|
| ☑ |
| ☑ |
| ü |
| ü |
|   |

*This would be worth  
1 mark.*

- c. The list principle:  
If a list of responses greater than the number requested is given, work through the list from the beginning. Award one mark for each correct response, ignore any neutral response, and deduct one mark for any incorrect response, e.g. one which has an error of science. If the number of incorrect responses is equal to or greater than the number of correct responses, no marks are awarded. A neutral response is correct but irrelevant to the question.

d. Marking method for tick-box questions:

If there is a set of boxes, some of which should be ticked and others left empty, then judge the entire set of boxes. If there is at least one tick, ignore crosses and other markings. If there are no ticks, accept clear, unambiguous indications, e.g. shading or crosses. Credit should be given according to the instructions given in the guidance column for the question. If more boxes are ticked than there are correct answers, then deduct one mark for each additional tick. Candidates cannot score less than zero marks.

e.g. if a question requires candidates to identify cities in England:

|             |                          |
|-------------|--------------------------|
| Edinburgh   | <input type="checkbox"/> |
| Manchester  | <input type="checkbox"/> |
| Paris       | <input type="checkbox"/> |
| Southampton | <input type="checkbox"/> |

the second and fourth boxes should have ticks (or other clear indication of choice) and the first and third should be blank (or have indication of choice crossed out).

|               |          |          |          |          |          |          |          |          |          |           |
|---------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
| Edinburgh     |          |          | ü        |          |          | ü        | ü        | ü        | ü        |           |
| Manchester    | ü        | x        | ü        | ü        | ü        |          |          |          | ü        |           |
| Paris         |          |          |          | ü        | ü        |          | ü        | ü        | ü        |           |
| Southampton   | ü        | x        |          | ü        |          | ü        | ü        |          | ü        |           |
| <b>Score:</b> | <b>2</b> | <b>2</b> | <b>1</b> | <b>1</b> | <b>1</b> | <b>1</b> | <b>0</b> | <b>0</b> | <b>0</b> | <b>NR</b> |

e. For answers marked by levels of response:

- i. **Read through the whole answer from start to finish**
- ii. **Decide the level that best fits** the answer – match the quality of the answer to the closest level descriptor
- iii. **To determine the mark within the level**, consider the following:

| Descriptor                           | Award mark                   |
|--------------------------------------|------------------------------|
| A good match to the level descriptor | The higher mark in the level |
| Just matches the level descriptor    | The lower mark in the level  |

iv. Use the **L1**, **L2**, **L3** annotations in Scoris to show your decision; do not use ticks.

Quality of Written Communication skills assessed in 6-mark extended writing questions include:

- appropriate use of correct scientific terms
- spelling, punctuation and grammar
- developing a structured, persuasive argument
- selecting and using evidence to support an argument
- considering different sides of a debate in a balanced way
- logical sequencing.

| Question     |         | Answer   | Marks    | Guidance  |
|--------------|---------|--|----------|---|
| 1            | (a)     | catalyst / speed up reaction / increase rate of reaction   | 1        | <b>allow</b> to lower activation energy / to provide an alternative route for the reaction<br><b>ignore</b> reference to getting rid of water   |
|              | (b) (i) | condenser  | 1        | <b>allow</b> Liebig condenser / reflux condenser  |
|              | (ii)    | reflux / refluxing   | 1        | <b>do not allow</b> condensation / distillation   |
|              | (c) (i) | $C_3H_7OH + C_4H_9COOH \xrightarrow{a} C_4H_9COOC_3H_7 + H_2O$<br><b>or</b><br>$CH_3(CH_2)_2OH + CH_3(CH_2)_3COOH \xrightarrow{a} CH_3(CH_2)_3COO(CH_2)_2CH_3 + H_2O$<br><b>or</b><br>$C_3H_8O + C_5H_{10}O_2 \xrightarrow{a} C_8H_{16}O_2 + H_2O$ | 1        | <b>allow</b> reactants in either order and products in either order<br><b>allow</b> O <sub>2</sub> for OO in formulae<br><b>ignore</b> state symbols even if incorrect<br><b>allow</b> multiples that balance |
|              | (ii)    | flavouring / add pineapple flavour   | 1        | <b>ignore</b> vague answers eg add to food<br><b>allow</b> fragrances eg perfume/deodorant/air freshener  |
| <b>Total</b> |         |  | <b>5</b> |   |



| Question |     | Answer   | Marks | Guidance  |
|----------|-----|--|-------|---|
| 2        | (a) | <p><b>Level 3 (5–6 marks)</b><br/>Answer uses idea of equilibrium position between phases to explain why some chemicals move quicker than others. Quality of written communication does not impede communication of the science at this level.</p> <p><b>Level 2 (3–4 marks)</b><br/>Answer partially explains why some chemicals move quicker than others. Quality of written communication partly impedes communication of the science at this level.</p> <p><b>Level 1 (1–2 marks)</b><br/>Answer includes idea that some chemicals move quicker than others with little or no explanation. Quality of written communication impedes communication of the science at this level.</p> <p><b>Level 0 (0 marks)</b><br/>Insufficient or irrelevant science. Answer not worthy of credit.</p> | 6     | <p><b>This question is targeted at grades up to A*</b></p> <p><b>Indicative scientific points may include:</b></p> <ul style="list-style-type: none"> <li>• solvent is mobile phase</li> <li>• (water in) paper is stationary phase</li> <li>• chemicals are attracted to (water in) paper</li> <li>• chemicals are attracted to solvent</li> <li>• an equilibrium is established for each chemical in solvent and in paper</li> <li>• for each chemical there is distribution/partition between solvent and paper</li> <li>• solvent moves up paper</li> <li>• different chemicals move up paper at different rates</li> <li>• the more the chemical is attracted to the solvent the quicker it moves up the paper / ora</li> <li>• the more the chemical is towards the solvent side of the equilibrium the quicker it moves up the paper / ora.</li> </ul> <p><b>accept</b> dissolve in/spend more time in instead of attracted to</p> <p><b>do not accept</b> ideas of chemicals reacting with solvent/paper/phases</p> <p><b>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</b></p> |

| Question     |     |      | Answer  | Marks     | Guidance   |
|--------------|-----|------|---|-----------|--|
| 2            | (b) | (i)  | $R_f = 4.2/5.6$ (1)<br>$= 0.75$ (1)<br><br>[ for braille scripts only:<br>$R_f = 4/6$ (1)<br>$= 0.66$ (1) ]   | 2         | both marks for correct answer without working<br><b>allow</b> (use of 4.0 / 4.4 or between in calculation giving)<br>answer of 0.71 / 0.79 or between for one mark only<br><b>allow</b> answers with more than two figures after decimal point<br><b>do not credit</b> 5.6/4.2                   |
|              |     | (ii) | <i>'method' mark</i><br>compare measured dye chemical $R_f$ with<br>published/reference $R_f$ values of banned dye chemicals /<br>run known samples of banned dye chemicals on a<br>chromatogram and calculate $R_f$ values for comparison (1)<br><br><i>'use of results' mark</i><br>if measured dye chemical $R_f$ is same as $R_f$ of a banned<br>dye chemical the soft drink contains a banned dye<br>chemical / the same chemical will always have the same<br>$R_f$ value (1) | 2         | allow only one mark for idea of running banned dye<br>chemicals and soft drink dye chemicals on same<br>chromatogram and comparing distances travelled<br><br><b>ignore</b> idea that same chemical always travels same<br>distance unless made clear that this is under identical<br>conditions |
| <b>Total</b> |     |      |   | <b>10</b> |  |

| Question |     |      | Answer   | Marks | Guidance  |
|----------|-----|------|--|-------|---|
| 3        | (a) | (i)  | <p><b>Level 3 (5–6 marks)</b><br/>Answer uses ideas of equilibrium and rate to explain the compromise choices of both temperature and pressure and why a catalyst is used. Quality of written communication does not impede communication of the science at this level.</p> <p><b>Level 2 (3–4 marks)</b><br/>Answer gives a good explanation for either temperature or pressure or a partial explanation of both. May write about yield rather than equilibrium. Quality of written communication partly impedes communication of the science at this level.</p> <p><b>Level 1 (1–2 marks)</b><br/>Answer discusses the data but gives little or no explanation of the compromise conditions. Quality of written communication impedes communication of the science at this level.</p> <p><b>Level 0 (0 marks)</b><br/>Insufficient or irrelevant science. Answer not worthy of credit.</p> | 6     | <p><b>This question is targeted at grades up to A</b></p> <p><b>Indicative scientific points may include:</b></p> <ul style="list-style-type: none"> <li>• to be economically viable need to make as much ammonia as possible as quickly as possible</li> </ul> <p>temperature ideas</p> <ul style="list-style-type: none"> <li>• higher temperature shifts equilibrium to left</li> <li>• the higher the temperature the lower the yield</li> <li>• high temperature costs more to maintain</li> <li>• because forward reaction is exothermic / releases heat energy</li> <li>• at low temperature rate is too slow</li> <li>• compromise medium temperature eg about 450°C</li> </ul> <p>pressure ideas</p> <ul style="list-style-type: none"> <li>• higher pressure shifts equilibrium to right</li> <li>• the higher the pressure the higher the yield</li> <li>• because forward reaction decreases pressure / decreases number of molecules</li> <li>• higher the pressure the tougher the reaction vessel has to be so that it does not burst</li> <li>• higher pressure increases cost / risk of process</li> <li>• compromise medium pressure of 250 atmospheres.</li> </ul> <p>catalyst ideas</p> <ul style="list-style-type: none"> <li>• catalyst gives more product in same time</li> <li>• catalyst allows use of lower temperature for same rate</li> <li>• catalyst does not change yield/equilibrium position</li> </ul> <p><b>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</b></p> |
|          |     | (ii) | <p>tick in box 2 (1)</p> <p>tick in box 5 (1)</p>  | 2     |   |

| Question     |     |       | Answer   | Marks     | Guidance   |
|--------------|-----|-------|--|-----------|--|
| 3            | (b) | (i)   | 17   | 1         |  |
|              |     | (ii)  | $1.0 \times (2 \times 17) / 28$ (1)<br>= 1.2 (1)   | 2         | <b>allow</b> 1.21<br><b>ignore</b> additional figures beyond 3 sig fig if they would round down to 1.21<br><b>allow</b> ecf from (i)<br><b>allow</b> both marks for correct answer without working |
|              |     | (iii) | $(1.2 \times 95 / 100 = )$ 1.14  | 1         | <b>allow</b> 1.1<br><b>allow</b> ecf from (ii) (ie candidate's answer in (ii) x 0.95)  |
|              | (c) |       | fertiliser is washed into rivers causing pollution/eutrophication (1)<br>production of ammonia has increased / use of fertilisers has increased (1)<br><b>plus</b><br>a link from more ammonia/fertilisers to more pollution (1) | 3         | <b>allow</b> description of eutrophication   |
| <b>Total</b> |     |       |  | <b>15</b> |  |

| Question     |     | Answer  | Marks    | Guidance  |
|--------------|-----|---|----------|---|
| 4            | (a) | $(5 \times 411) + 348 + 358 + 459 = (1)$<br>3220 (1)  | 2        | <b>allow</b> both marks for correct answer without working  |
|              | (b) | $6 \times 459 = (1)$<br>2754 (1)  | 2        | <b>allow</b> both marks for correct answer without working  |
|              | (c) | 4714 in first box and 5950 in second box (1)<br>in third box (-) 1236 (1)   | 2        | <b>allow</b> ecf from (a) and (b)<br>give first mark for correct addition and transfer of both figures<br>second mark for correct subtraction of figures they have used<br><b>ignore</b> sign |
|              | (d) | <b>any two from</b><br>as number of bonds (between two carbon atoms)<br>increases bond length decreases (1)<br>as number of bonds (between two carbon atoms)<br>increases bond energy increases (1)<br>as bond energy increases bond length decreases (1) | 2        | ora throughout<br><b>ignore</b> references to strength or weakness of bonds<br><br><b>allow</b> triple bond has more energy than double which has<br>more energy than single                  |
| <b>Total</b> |     |   | <b>8</b> |   |

| Question     |     |       | Answer   | Marks     | Guidance   |
|--------------|-----|-------|--|-----------|--|
| 5            | (a) | (i)   | tick in box 2 (1)<br>tick in box 4 (1)   | 2         |  |
|              |     | (ii)  | make sure correct/exact amount of acid is added (to react with magnesium hydroxide) (1)<br>to show end point/when mixture neutral (by change of colour) (1)  | 2         |  |
|              | (b) | (i)   | 58   | 1         |  |
|              |     | (ii)  | $0.0151 \times 73.0$ (1)<br>$= 1.1$ (1)  | 2         | <b>allow</b> both marks for correct answer without working<br><b>ignore</b> additional figures after sig fig if they would round down to 1.1                             |
|              |     | (iii) | $58 \times 1.1/73$ (1)<br>$= 0.87$ (1)   | 2         | <b>allow</b> ecf from (i) and (ii) <b>ie (i) x (ii) / 73</b><br><b>allow</b> both marks for correct answer without working<br><b>allow</b> 0.9                           |
|              | (c) |       | batch A is OK because each tablet is within the allowed range (1)<br><br>batch B is unsatisfactory because the tablets contain less (than the minimum permitted amount) (1)<br><br>batch C is unsatisfactory because the tablets contain more (than the maximum permitted amount) (1)<br><br>batch D is unsatisfactory because some tablets contain more (than the maximum permitted amount) (1) | 4         | each answer must say indicate whether the batch is satisfactory or unsatisfactory and explain why<br><br><b>do not credit</b> calculation and use of average/mean values |
| <b>Total</b> |     |       |  | <b>13</b> |  |

| Question | Answer   | Marks | Guidance   |
|----------|--|-------|--|
| 6 (a)    | <p><b>Level 3 (5–6 marks)</b><br/>Answer deals fully with sustainability in terms of feedstock <b>and</b> another factor. Quality of written communication does not impede communication of the science at this level.</p> <p><b>Level 2 (3–4 marks)</b><br/>Answer deals fully with sustainability in terms feedstock <b>or</b> partially in terms of feedstock and another factor. Quality of written communication partly impedes communication of the science at this level.</p> <p><b>Level 1 (1–2 marks)</b><br/>Answer offers some explanation of sustainability. Quality of written communication impedes communication of the science at this level.</p> <p><b>Level 0 (0 marks)</b><br/>Insufficient or irrelevant science. Answer not worthy of credit.</p> | 6     | <p><b>This question is targeted at grades up to C</b></p> <p><b>Indicative scientific points may include:</b></p> <p>feedstock/raw materials</p> <ul style="list-style-type: none"> <li>• method 1 uses ethene from crude oil</li> <li>• natural gas/crude oil is finite</li> <li>• method 2 uses sugar</li> <li>• more sugar beet/cane can be grown</li> <li>• in terms of feedstock fermentation is more sustainable</li> </ul> <p>fuel/energy input</p> <ul style="list-style-type: none"> <li>• method 1 uses high temperature which needs a lot of fuel/energy</li> <li>• burning fuel releases pollutant gases</li> <li>• method 2 uses low temperature with uses little fuel</li> <li>• in terms of fuel needed fermentation is more sustainable</li> </ul> <p>equipment</p> <ul style="list-style-type: none"> <li>• method 1 is carried out at high pressure and so needs reaction vessel to withstand this/has safety issues</li> <li>• method 2 is carried out at normal/atmospheric pressure</li> <li>• making reaction vessel for method 1 uses more resources than making reaction vessel for 2</li> <li>• in terms of equipment fermentation more sustainable</li> </ul> <p>other ideas</p> <ul style="list-style-type: none"> <li>• method 1 has a better atom economy than method 2 and is therefore more sustainable in this aspect</li> <li>• method 2 releases carbon dioxide which is a greenhouse gas, but so does method 1 as fuel is burned</li> </ul> <p><b>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</b></p> |

| Question     |     | Answer                |         |        | Marks    | Guidance |   |
|--------------|-----|-----------------------|---------|--------|----------|----------|---|
| 6            | (b) |                       | ethanol | ethane | water    | 3        | one mark for each correct <b>column</b> |
|              |     | violent reaction      |         |        | ü        |          |   |
|              |     | slow reaction         | ü       |        |          |          |   |
|              |     | no reaction           |         | ü      |          |          |   |
|              |     | hydrogen made         | ü       |        | ü        |          |   |
|              |     | sodium ethoxide made  | ü       |        |          |          |   |
|              |     | sodium hydroxide made |         |        | ü        |          |   |
| <b>Total</b> |     |                       |         |        | <b>9</b> |          |   |



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