

# Commentary on candidate evidence

The candidate evidence has achieved the following marks for each question in this course component.

## Question 1(a)(ii)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response as they have not included a sign for the  $m_s$  quantum number.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect response as they have given an incorrect value for the  $l$  quantum number.

### Candidate 3

The candidate was awarded **1 mark**.

The candidate has given a correct response.

## Question 1(b)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response as they have not mentioned the special stability associated with a half-filled subshell.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect response as they have not mentioned the special stability associated with a half-filled subshell.

### Candidate 3

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. The candidate has not mentioned the special stability associated with a half-filled subshell.

### Candidate 4

The candidate was awarded **1 mark**.

The candidate has given a correct response.

### Candidate 5

The candidate was awarded **1 mark**.

The candidate has given a correct response.

### Candidate 6

The candidate was awarded **1 mark**.

The candidate has given a correct response.

## Question 2(a)

### Candidate 1

The candidate was awarded **1 mark**.

The candidate has given an incorrect numerical response but can be awarded up to 1 partial mark.

They have used the expression,  $\Delta G = \Delta H - T\Delta S$  and can be awarded 1 partial mark.

They have correctly calculated a value for  $\Delta H$  but their value for  $\Delta S$  is incorrect and cannot be awarded this partial mark. The candidate has substituted incorrectly into the expression and the units for  $\Delta H$  and  $\Delta S$  do not correspond, so cannot be awarded the final partial mark.

## Candidate 2

The candidate was awarded **2 marks**.

The candidate has given an incorrect numerical response but can be awarded up to 2 partial marks.

They have correctly calculated values for  $\Delta H$  and  $\Delta S$ , so can be awarded 1 partial mark.

They have correctly substituted these values into the expression,  $\Delta G = \Delta H - T\Delta S$ , and correctly predicted the reaction feasibility, so can be awarded a second partial mark.

Although the candidate has given incorrect units for  $\Delta S$  ( $\text{JK}^{-1}$  instead of  $\text{JK}^{-1} \text{mol}^{-1}$ ) and for  $\Delta G$  (Kj instead of  $\text{kJmol}^{-1}$ ) no penalty is applied as their final numerical answer is incorrect.

## Candidate 3

The candidate was awarded **2 marks**.

The candidate has given a partially correct response and can be awarded up to 2 partial marks.

They have a correctly calculated numerical answer, however they have incorrectly stated that the reaction is feasible. They have correctly calculated values for  $\Delta H$  and  $\Delta S$ , so can be awarded 1 partial mark. They have used and correctly substituted values into the expression  $\Delta G = \Delta H - T\Delta S$  and can be awarded a second partial mark.

## Candidate 4

The candidate was awarded **2 marks**.

The candidate has correctly calculated the temperature at which the reaction becomes feasible and can be awarded 2 marks. The candidate has not explained the range of values for T at which  $\Delta G$  is less than zero and cannot be awarded the third mark.

The candidate has given incorrect units for  $\Delta S$ , however no penalty is applied as general marking principle (i) states that a mark can only be deducted for incorrect units in the final answer.

## Candidate 5

The candidate was awarded **2 marks**.

The candidate has given an incomplete response. They have correctly calculated  $\Delta G$  however, they have not made a statement to say if the reaction is feasible or not. They have correctly calculated values for  $\Delta H$  and  $\Delta S$ , so can be awarded 1 partial mark. They have used and correctly substituted values into the expression  $\Delta G = \Delta H - T\Delta S$  and can be awarded a second partial mark.

## Candidate 6

The candidate was awarded **2 marks**.

The candidate has given an incorrect response, however they can be awarded up to 2 partial marks. They have correctly calculated  $\Delta G$  in J, however, they have incorrectly converted this into kJ giving an answer of 866 instead of 86.6. They have correctly calculated values for  $\Delta H$  and  $\Delta S$ , so can be awarded 1 partial mark. They have used and correctly substituted values into the expression  $\Delta G = \Delta H - T\Delta S$  and can be awarded a second partial mark.

## Question 2(b)

### Candidate 1

The candidate was awarded **1 mark**.

They have given an incorrect response but can be awarded 1 partial mark.

They have incorrectly calculated the numerical value and cannot be awarded the first mark. The candidate has multiplied an incorrect number of moles by the GFM of nitrogen monoxide. This means the units (g) are appropriate for their answer, so can be awarded the second mark.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has calculated an incorrect value for the mass of nitrogen monoxide having used 120 ppm, so the first mark cannot be awarded. The candidate's working (dividing by 1000) would result in this mass being in g not mg, so the mark for the unit cannot be awarded.

### Candidate 3

The candidate was awarded **0 marks**.

The candidate has calculated an incorrect value for the mass of nitrogen monoxide, so the first mark cannot be awarded. The candidate's working would result in this mass being in kg not g, so the mark for the unit cannot be awarded.

### Candidate 4

The candidate was awarded **1 mark**.

They have given an incorrect response but can be awarded 1 partial mark.

They have incorrectly calculated the numerical value and cannot be awarded the first mark.

The value they have calculated is within the range for the units they have provided (g), so can be awarded the second mark.

### Candidate 5

The candidate was awarded **1 mark**.

They have given a correct numerical response and can be awarded the first mark.

They have given incorrect units (ppm) and cannot be awarded the second mark.

### Candidate 6

The candidate was awarded **2 marks**.

The candidate has given a correct numerical response and can be awarded the first mark.

They have given correct units and can be awarded the second mark.

## Question 2(d)(i)(A) and (B)

### Candidate 1

The candidate was awarded **0 marks** for part (i)(A).

The candidate has given an incorrect response to part (i)(A).

The candidate was awarded **0 marks** for part (i)(B).

The candidate has given an incorrect follow through from their incorrect rate equation. The correct follow through should be  $9.88 \times 10^{-5}$ .

### Candidate 2

The candidate was awarded **0 marks** for part (i)(A).

The candidate has given an incorrect response to part (i)(A).

The candidate was awarded **0 marks** for part (i)(B).

The candidate has given an incorrect follow through from their incorrect rate equation. The correct follow through should be 0.0811.

### Candidate 3

The candidate was awarded **0 marks** for part (i)(A).

The candidate has given an incorrect response to part (i)(A) but can be awarded follow through for part (i)(B).

The candidate was awarded **1 mark** for part (i)(B).

The candidate has given a correct follow through from their incorrect rate equation.

### Candidate 4

The candidate was awarded **1 mark** for part (i)(A).

The candidate was awarded **0 marks** for part (i)(B).

The candidate has given an incorrect response. The candidate has shown correct working but has incorrectly rounded their final numerical answer. The candidate has given four significant figures in their answer; however, the correct four significant figure response should have been  $9.938 \times 10^{-3}$ .

## Candidate 5

The candidate was awarded **0 marks** for part (i)(A).

The candidate has given an incorrect response to part (i)(A). The candidate has used an incorrect symbol for rate but can be awarded follow through for part (i)(B).

The candidate was awarded **1 mark** for part (i)(B).

The candidate has given a correct response.

## Candidate 6

The candidate was awarded **1 mark** for part (i)(A).

The candidate was awarded **1 mark** for part (i)(B).

The candidate has given a correct response.

## Question 3(a)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incomplete response as they have not stated 'in solution'.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incomplete response as they have not stated 'in solution'.

### Candidate 3

The candidate was awarded **0 marks**.

The candidate has given an incorrect response as they have stated that 'ions do not fully dissociate' instead of the acid not fully dissociating.

### Candidate 4

This candidate was awarded **1 mark**.

The candidate has given a correct response.

## Question 3(b)(i)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has an incorrect equation as they have used the speed of light instead of the concentration of the acid for the variable  $c$ , so this partial mark cannot be awarded.

The candidate has incorrectly substituted the equation using an incorrect value (-0.57) for  $pK_a$ , so cannot be awarded this partial mark.

### Candidate 2

The candidate was awarded **1 mark**.

The candidate has given an incorrect response but can be awarded up to 1 partial mark.

The candidate has an incorrect equation. They have used a lower-case  $k$  instead of an upper case  $K$  for the  $pK_a$  variable, so this partial mark cannot be awarded.

The candidate has correctly substituted the equation using correct values for  $pK_a$  and  $c$ , so can be awarded 1 partial mark.

### Candidate 3

The candidate was awarded **1 mark**.

The candidate has given an incorrect response but can be awarded up to 1 partial mark.

The candidate has an incorrect equation. They have used a lower-case  $h$  instead of an upper case  $H$  for  $pH$ . Also, it is hard to determine if the letter  $K$  used in the  $pK_a$  variable is upper case as it has been written with the same height as the letter 'a'. Therefore, the first partial mark cannot be awarded.

The candidate has correctly substituted the equation using correct values for  $pK_a$  and  $c$ , so can be awarded 1 partial mark.

### Candidate 4

The candidate was awarded **2 marks**.

The candidate has given a correct response.

## Question 3(b)(ii)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has not calculated a mass of 75g present in 1 litre, so cannot be awarded the first partial mark option.

The candidate has incorrectly used percentage by mass of an element present in a chemical formula, so cannot be awarded the second partial mark option.

### Candidate 2

The candidate was awarded **1 mark**.

The candidate has given an incorrect final answer. They have incorrectly used percentage by mass of an element present in a chemical formula, so cannot be awarded the full 2-mark allocation.

The candidate has calculated a mass of 75g present in 1 litre, so can be awarded 1 partial mark.

### Candidate 3

The candidate was awarded **2 marks**.

The candidate has given a correct response.

## Question 4(b)(i)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response as they have not made any mention of different (types of) 'vibrations' or different 'atoms' (in the bonds).

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect response as 'functional groups' is not equivalent to different atoms in a bond.

### Candidate 3

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. They have restated much of the information given in the question and they have not made any mention of different (types of) 'vibrate/ stretch or bend'.

### Candidate 4

The candidate was awarded **1 mark**.

The candidate has given a correct response. They have stated that the bonds 'vibrate at various frequencies' which is acceptable as different (types of) vibrations.

### Candidate 5

The candidate was awarded **1 mark**.

The candidate has given a correct response. They have mentioned 'different strengths', 'different atoms make up different bonds', and 'vibrate differently'. Any one of these can be accepted for the mark to be awarded.

## Question 4(c)(iii)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. They have given a response that is confused with mass spectroscopy and have not described flipping or energy gaps between high and low states being different, so cannot be awarded either of the 2 marks.

### Candidate 2

The candidate was awarded **1 mark**.

The candidate has given an incorrect response.

They have given a response that refers to electrons rather than hydrogen nuclei, however they have said 'fall to ground state', so can be awarded the first mark. They have not mentioned energy gaps between high and low states being different, so cannot be awarded the second mark.

### Candidate 3

The candidate was awarded **1 mark**.

The candidate has stated that the (hydrogen nuclei) 'flip to higher energy and as they fall back to low', so the first mark has been awarded.

The candidate has made no reference to different energy emitted or different energy gaps between high and low states, so the second mark cannot be awarded.

### Candidate 4

The candidate was awarded **1 mark**.

The candidate has stated that the (hydrogen nuclei) 'drop back to their original level', so the first mark has been awarded.

The candidate has made no reference to different energy emitted or different energy gaps between high and low states, so the second mark cannot be awarded.

## Question 5(a)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. Their response indicates that the repulsion is from the ligands rather than from the electrons in the ligands, so the mark cannot be awarded.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. The response states that the repulsion is from the ligands rather than from the electrons in the ligands, so the mark cannot be awarded.

### Candidate 3

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. The candidate has not mentioned repulsion from electrons or lone pairs in the ligands, so the mark cannot be awarded.

### **Candidate 4**

The candidate was awarded **1 mark**.

The candidate has given a correct response.

## **Question 5(b)(ii)(A)**

### **Candidate 1**

The candidate was awarded **1 mark**.

The candidate has made a correct first statement, so the first mark can be awarded. The second statement made is a direct opposite of the first statement and is therefore not valid, so the second mark cannot be awarded.

### **Candidate 2**

The candidate was awarded **1 mark**.

The candidate has made a correct first statement, so the first mark can be awarded. The second statement is incorrect, so the second mark cannot be awarded.

### **Candidate 3**

The candidate was awarded **2 marks**.

The candidate has given two different valid conclusions.

### **Candidate 4**

The candidate was awarded **2 marks**.

The candidate has given two different valid conclusions.

## **Question 5(b)(ii)(B)**

### **Candidate 1**

The candidate was awarded **0 marks**.

The candidate has given an incorrect spelling of the fluoro ligand (flurido) and an incorrect metal ion name (cobide), so the mark cannot be awarded.

## Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect spelling of the fluorido ligand (flouro) and an incorrect metal ion name (colbate), so the mark cannot be awarded.

## Candidate 3

The candidate was awarded **0 marks**.

The candidate has given an incorrect spelling of the fluorido ligand (flurido), so the mark cannot be awarded.

## Candidate 4

The candidate was awarded **0 marks**.

The candidate has given an incorrect spelling of the fluorido ligand (fluro) and an incorrect metal ion name (cobolt), so the mark cannot be awarded.

## Candidate 5

The candidate was awarded **0 marks**.

The candidate has given an incorrect metal ion name (cobalate) and has overwritten the ligand name making it impossible to tell if this is fluoride or fluoride, so the mark cannot be awarded.

## Question 6(a)(i)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. The candidate has not circled enough of the chromophore for the minimum structure as they have not included the C=C bond or the carbonyl group at the upper left-hand side of the molecule.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. The candidate has not circled any part of either chromophore, so cannot be awarded the mark.

### Candidate 3

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. The candidate has not circled enough of the chromophore for the minimum structure as they have not included all of the C=C bond at the lower right-hand side of the molecule.

### Candidate 4

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. The candidate has included a section at the lower left-hand side of the molecule that is not part of the chromophore, so the mark cannot be awarded.

### Candidate 5

The candidate was awarded **1 mark**.

The candidate has given a correct response. The candidate has circled an acceptable structure for the chromophore. The candidate has selected a portion slightly smaller than that of the maximum structure as they have not included the CH<sub>2</sub> from the middle of the branch connecting the upper and lower parts of the molecule structure.

## Question 6(a)(ii)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incomplete response as they have not made a comparison, so the mark cannot be awarded.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect response as their last sentence 'Bonding is higher energy' is incorrect and is therefore a cancelling error, so the mark cannot be awarded.

### Candidate 3

The candidate was awarded **0 marks**.

The candidate has given an incorrect response, so the mark cannot be awarded.

## Candidate 4

The candidate was awarded **1 mark**.

The candidate has given a correct response.

## Question 6(b)(i)

### Candidate 1

The candidate was awarded **1 mark**.

The candidate has given a partially correct response. They have correctly stated that 'carbon-carbon double bonds cannot rotate freely', so can be awarded 1 mark. They have not stated that two different groups are attached to each carbon atom of the double bond, so cannot be awarded the second mark.

### Candidate 2

The candidate was awarded **1 mark**.

The candidate has given a partially correct response. They have correctly stated the presence of 'restricted rotation due to C=C', so can be awarded 1 mark. They have not stated that two different substituents are attached to each carbon atom of the double bond, so cannot be awarded the second mark.

### Candidate 3

The candidate was awarded **0 marks**.

The candidate has given an incorrect response as they have given descriptions of the terms 'cis' and 'trans', rather than explaining why geometric isomerism can exist in some compounds, so the mark cannot be awarded.

### Candidate 4

The candidate was awarded **1 mark**.

The candidate has given a partially correct response. They have correctly stated 'lack of rotation around the double bond', so can be awarded 1 mark. They have not stated that two different substituents are attached to each carbon atom of the double bond, so cannot be awarded the second mark.

## Candidate 5

The candidate was awarded **1 mark**.

The candidate has given a partially correct response. They have correctly stated 'C=C double bonds lack free rotation', so can be awarded 1 mark. They have not stated that two different substituents are attached to each carbon atom of the double bond, so cannot be awarded the second mark.

## Candidate 6

The candidate was awarded **2 marks**.

The candidate has given a correct response. They have correctly stated 'two different groups on each of the carbons' and 'restriction of rotation', so can be awarded both marks.

## Question 6(b)(ii)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. They have drawn a dotted line between two hydrogen atoms, so cannot be awarded the mark.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. They have drawn a dotted line between two hydrogen atoms, so cannot be awarded the mark.

### Candidate 3

The candidate was awarded **1 mark**.

The candidate has given a correct response.

## Question 6(c)(ii)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has used an incorrect formula ( $E = Lhf / \lambda$ ), so cannot be awarded a partial mark.

### Candidate 2

The candidate was awarded **1 mark**.

The candidate has given an incorrect response but can be awarded 1 partial mark as they have used a correct formula.

### Candidate 3

The candidate was awarded **1 mark**.

The candidate has given a correct numerical answer; however, they have given units which are incorrect. The candidate has used a lower-case j, so general marking principle (i) is applied. This penalty can only be applied once per question paper and only if general marking principle (h) has not already been applied.

### Candidate 4

The candidate was awarded **2 marks**.

The candidate has given a correct response.

## Question 7(a)(i)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has described heating to constant mass which is a cancelling error for both available marks.

## Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has not mentioned weighing or recording a mass, so cannot be awarded the first mark.

The candidate has not mentioned subtraction, so cannot be awarded the second mark.

## Candidate 3

The candidate was awarded **2 marks**.

The candidate has given a correct response.

The candidate has mentioned weighing and recording a mass, so can be awarded the first mark.

The candidate has mentioned subtraction 'difference between', so can be awarded the second mark.

## Question 7(a)(ii)

### Candidate 1

The candidate was awarded **1 mark**.

The candidate has given an incorrect response but can be awarded up to 1 partial mark.

The candidate has correctly obtained the concentration of manganese from the graph, so can be awarded 1 partial mark.

### Candidate 2

The candidate was awarded **1 mark**.

The candidate has made an error reading the concentration from the graph ( $c = 2.2 \times 10^{-4}$  instead of  $2.1 \times 10^{-4}$ ), so cannot be awarded 2 marks.

The candidate is awarded 1 partial mark for a correctly calculated mass of manganese(II) using an incorrectly determined permanganate concentration.

### Candidate 3

The candidate was awarded **1 mark**.

The candidate has given an incorrect response but can be awarded up to 1 partial mark.

The candidate has correctly obtained the concentration of manganese from the graph, so can be awarded 1 partial mark.

## Question 7(b)(ii)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has not calculated the correct number of moles of dichromate, so cannot be awarded this partial mark option.

The candidate has not applied the 1:6 mole ratio, so cannot be awarded this partial mark option.

The candidate has a calculated mass of iron from an incorrect calculated number of moles, however they have incorrectly carried out a unit conversion from kg to g, so cannot be awarded this partial mark option.

### Candidate 2

The candidate was awarded **2 marks**.

The candidate has given an incorrect response but can be awarded up to 2 partial marks.

The candidate has not calculated the correct number of moles of dichromate, so cannot be awarded this partial mark option.

The candidate has applied the 1:6 mole ratio, so can be awarded 1 partial mark.

The candidate has a calculated mass of iron from an incorrect calculated number of moles, so can be awarded a second partial mark.

### Candidate 3

The candidate was awarded **3 marks**.

The candidate has given a correct response.

## Question 7(b)(iii)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has not stated the direction of electron movement, so the first mark cannot be awarded. The candidate has given an incorrect colour of absorbed light, 'green' and an incorrect complementary colour, 'purple', so the second mark cannot be awarded.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has described the gap 'between' HOMO and LUMO and that 'electrons promoted to higher energy level', however, they have not indicated the direction of movement as being from HOMO to LUMO, so cannot be awarded the first mark.

The candidate has not mentioned the colour or wavelength of light absorbed or complementary colour, so cannot be awarded the second mark.

### Candidate 3

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has not indicated that electrons move from HOMO to LUMO, so cannot be awarded the first mark.

The candidate has not mentioned the colour or wavelength of light absorbed or complementary colour, so cannot be awarded the second mark.

## Candidate 4

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has described the gap 'between' HOMO and LUMO and that 'electrons are promoted to higher energy levels', however, they have not indicated the direction of movement as being from HOMO to LUMO, so cannot be awarded the first mark.

The candidate has mentioned 'a complementary colour', however, they have also said that electrons 'fall back to their original state' and 'emit a photon'. Both of these statements are cancelling errors, so cannot be awarded the second mark.

## Candidate 5

The candidate was awarded **1 mark**.

The candidate has given a partially correct response.

The candidate has correctly stated the direction of electron movement 'electron can move from HOMO to LUMO', so can be awarded the first mark.

The candidate has correctly identified yellow-green light being absorbed, however, they have also mentioned 'emitted', which is a cancelling error, so the second mark cannot be awarded.

## Candidate 6

The candidate was awarded **1 mark**.

The candidate has given an incomplete response.

The candidate has stated that electrons move from HOMO to LUMO, so can be awarded the first mark.

The candidate has mentioned 'complementary to the colour violet', however, they have also said that electrons 'drop back down to ground state' and 'release energy'. Both of these statements are cancelling errors, so cannot be awarded the second mark.

## Candidate 7

The candidate was awarded **1 mark**.

The candidate has given an incomplete response.

The candidate has correctly stated the direction of electron movement 'from lower energy levels to higher ones' and have identified these levels correctly as HOMO (lower) and LUMO (higher), so can be awarded the first mark.

They have not identified the light absorbed as yellow-green or as being complementary to violet, so cannot be awarded the second mark.

## Question 8(b)(i)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has used the term 'negative molecule', which is incorrect, so the mark cannot be awarded.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has used the term 'positive molecules', which is incorrect, so the mark cannot be awarded.

### Candidate 3

The candidate was awarded **0 marks**.

The candidate has given an incorrect response, so the mark cannot be awarded.

### Candidate 4

The candidate was awarded **0 marks**.

The candidate has used the term 'electron deficient molecule', which is incorrect, so the mark cannot be awarded.

### Candidate 5

The candidate was awarded **1 mark**.

The candidate has given a correct response.

## Candidate 6

The candidate was awarded **1 mark**.

The candidate has given a correct response.

## Question 8(b)(iii)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has drawn one full curly arrow, however, it originates from the incorrect oxygen atom and points to an incorrect destination atom, so the mark cannot be awarded.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has drawn four curly arrows. Although they have correctly placed one of the arrows (from the hydroxyl oxygen to the carbonyl carbon), there are three incorrectly placed. These additional arrows are cancelling errors as they do not relate to the nucleophilic attack step, so the mark cannot be awarded.

### Candidate 3

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has drawn one curly arrow originating from the correct oxygen atom, however it points to an incorrect destination (the bond between the carbon and the chlorine atoms instead of the carbon atom), so the mark cannot be awarded.

### Candidate 4

The candidate was awarded **1 mark**.

The candidate has given a correct response. The negative charge is ignored.

## Candidate 5

The candidate was awarded **1 mark**.

The candidate has given a correct response.

## Question 8(d)(ii)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has incorrectly calculated the theoretical yield from an incorrect GFM (78), so this partial mark cannot be awarded.

The candidate has calculated a correct number of moles of reactant but not of the product, so this partial mark cannot be awarded.

The candidate has incorrectly substituted into the percentage yield formula, so this partial mark cannot be awarded.

### Candidate 2

The candidate was awarded **1 mark**.

The candidate has given an incorrect response but can be awarded up to 1 partial mark.

The candidate has incorrectly calculated the theoretical yield using an incorrect GFM (78), so this partial mark cannot be awarded.

The candidate has calculated a correct number of moles of reactant (0.155) and product (0.101), so 1 partial mark can be awarded.

### Candidate 3

The candidate was awarded **1 mark**.

The candidate has given an incorrect response but can be awarded up to 1 partial mark.

The candidate has incorrectly calculated the theoretical yield as they have made a transcription error in the GFM of benzophenone (182 becomes 180), so this partial mark cannot be awarded.

The candidate has correctly calculated a percentage yield from incorrectly calculated values, so can be awarded 1 partial mark.

### **Candidate 4**

The candidate was awarded **2 marks**.

The candidate has given a correct response.

## **Question 10(a)**

### **Candidate 1**

The candidate was awarded **0 marks**.

The candidate has given an incomplete response.

The candidate has not stated that an antagonist prevents the natural compound from binding to a receptor in order to block the natural response, so the mark cannot be awarded.

### **Candidate 2**

The candidate was awarded **0 marks**.

The candidate has given an incomplete response.

The candidate has not mentioned the response that would result from this action, so the mark cannot be awarded.

### **Candidate 3**

The candidate was awarded **0 marks**.

The candidate has given an incorrect response. The candidate does not refer to the receptor and the use of the term 'neurotransmitter' is incorrect, so the mark cannot be awarded.

### **Candidate 4**

The candidate was awarded **1 mark**.

The candidate has given a correct response.

### **Candidate 5**

The candidate was awarded **1 mark**.

The candidate has given a correct response.

## Question 10(b)(ii)

### Candidate 1

The candidate was awarded **1 mark**.

The candidate has given an incorrect response but can be awarded up to 1 partial mark.

The candidate has incorrectly calculated a mass and number of moles of eucalyptol, so cannot be awarded either of these partial mark options.

The candidate has divided an incorrectly calculated number of moles by the correct volume (0.5), so can be awarded 1 partial mark.

### Candidate 2

The candidate was awarded **1 mark**.

The candidate has given an incorrect response but can be awarded up to 1 partial mark.

The candidate has an incorrectly calculated mass (460.5g) and an incorrectly calculated number of moles (2.99) of eucalyptol, so cannot be awarded either of these partial mark options.

The candidate has divided an incorrectly calculated number of moles by the correct volume (0.5), so can be awarded 1 partial mark.

### Candidate 3

The candidate was awarded **1 mark**.

The candidate has given an incorrect response but can be awarded up to 1 partial mark.

The candidate has an incorrectly calculated mass (5.42888165) and an incorrectly calculated number of moles (0.03525) of eucalyptol, so cannot be awarded either of these partial mark options.

The candidate has divided an incorrectly calculated number of moles by the correct volume (0.5), so can be awarded 1 partial mark.

### Candidate 4

The candidate was awarded **2 marks**.

The candidate has given a correct response.

## Question 11(b)(i)(A)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has not identified a separating funnel as the apparatus required; a burette is not acceptable, so cannot be awarded the first mark.

The candidate has not included leaving to separate in their method description, so cannot be awarded the second mark.

### Candidate 2

The candidate was awarded **1 mark**.

The candidate has given a partially correct response.

The candidate has identified a separating funnel as the apparatus required, so can be awarded the first mark.

The candidate has not included shaking or mixing in their method description, so cannot be awarded the second mark.

### Candidate 3

The candidate was awarded **1 mark**.

The candidate has given a partially correct response.

The candidate has identified a separating funnel as the apparatus required, so can be awarded the first mark.

The candidate has described adding caffeine to both layers, which is incorrect, so cannot be awarded the second mark.

### Candidate 4

The candidate was awarded **2 marks**.

The candidate has given a correct response.

## Question 11(b)(i)(B)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has given an incorrect expression for K. They have used a lower-case k and a round bracket on the lower line of the expression. They have also omitted (aq) from the bottom line. No partial marks can be awarded.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

The candidate has not given an expression for K, so this partial mark cannot be awarded.

The candidate has not calculated a concentration in dichloromethane, so this partial mark cannot be awarded.

The candidate has not calculated the concentration or mass remaining in (aq), so this partial mark cannot be awarded.

The candidate has not calculated a value for K from concentrations of caffeine, so cannot be awarded this partial mark.

### Candidate 3

The candidate was awarded **1 mark**.

The candidate has given an incorrect response but can be awarded 1 partial mark.

The candidate has not given an expression for K, so this partial mark cannot be awarded.

The candidate has not correctly calculated a concentration in dichloromethane (they have used the GFM of dichloromethane instead of caffeine), so this partial mark cannot be awarded.

The candidate has not correctly calculated the concentration or mass in (aq) (they have used 32 rather than 8.5), so this partial mark cannot be awarded.

The candidate has correctly calculated a value for K from incorrect concentrations of caffeine, so can be awarded 1 partial mark.

## Candidate 4

The candidate was awarded **2 marks**.

The candidate has given an incorrect response but can be awarded up to 2 partial marks.

The candidate has given correct expression for K, so can be awarded 1 partial mark.

The candidate has correctly calculated a concentration in dichloromethane, so can be awarded a second partial mark.

## Candidate 5

The candidate was awarded **2 marks**.

The candidate has given an incorrect response but can be awarded up to 2 partial marks.

The candidate has given a correct expression for K, so can be awarded 1 partial mark.

The candidate has correctly calculated a concentration in dichloromethane, so can be awarded a second partial mark.

## Candidate 6

The candidate was awarded **3 marks**.

The candidate has given a correct response.

## Q11(b)(ii)

### Candidate 1

The candidate was awarded **0 marks**.

The candidate has given an incorrect response.

### Candidate 2

The candidate was awarded **0 marks**.

The candidate has given an incomplete response.

The candidate has not said to use smaller volumes, so the mark cannot be awarded.

**Candidate 3**

The candidate was awarded **1 mark**.

The candidate has given a correct response.

**Candidate 4**

The candidate was awarded **1 mark**.

The candidate has given a correct response.