Commentary on candidate evidence

The candidate evidence has achieved the following marks for each section of the assignment.

Candidate 1

1 Aim

The candidate was awarded **1 out of 1 mark** because they have given an acceptable aim, 'To investigate the change that happens to the enthalpy of combustion of an alcohol when the chain of carbons is increased'.

2 Underlying chemistry

The candidate was awarded **1 out of 3 marks** because they have provided limited explanations at a level appropriate to Higher Chemistry.

The candidate has included correct chemistry relevant to the aim such as the definition of enthalpy of combustion.

They have also included a discussion of complete and incomplete combustion, however, this is National 4 and 5 content.

They have also given additional Higher Chemistry that refers to LDFs and hydrogen bonding, but this is not relevant to the experiment carried out in the investigation.

3 Data collection and handling

The candidate was awarded **2 out of 6 marks**. The marks were awarded as follows:

3(a)   **0 out of 1 mark** was awarded because the candidate has not provided any safety measures.

3(b)   **1 out of 1 mark** was awarded because sufficient raw data has been provided. The candidate has tested three alcohols and carried out a repeat for each.

3(c)   **0 out of 1 mark** was awarded because the raw experimental data provided on pages 4 and 5 is not tabulated, so no mark can be awarded.

Processed data (mean enthalpy of combustion) has been provided in a table (page 5). However, it is not sufficient to only tabulate processed data.

It is noted that the candidate has correctly given units of kJ mol^{-1} in the table, and units of kJ/mol in the final answer to the calculations. Both of these are acceptable.

In the intermediate step of the calculation the unit provided is kJ/mol and should be kJ. However, incorrect units are not penalised during intermediate steps in a calculation.

3(d)   **0 out of 1 mark** was awarded because the candidate has given the mean enthalpy of propanol with incorrect rounding (given as 1282.8 kJ/mol but should be 1282.9 kJ/mol since the unrounded value (not shown) would be -1282.85), so the mark cannot be awarded.

The candidate has shown correct calculations for all three alcohols using the relationship to calculate enthalpy (Eh=cmΔT). They have also scaled to 'kJ/mol'.

It should be noted that for the sample 'methanol 1', the mass of methanol burned is incorrectly shown as being divided by two, however, this calculation has not actually been carried out by the candidate and the final answer of 0.8 g is correct for the subtraction.

3(e)   **1 out of 1 mark** was awarded because the candidate has provided data relevant to the experiment from an internet source (extract from SQA data book, page 8). This is acceptable and a mark is awarded.

3(f)   **0 out of 1 mark** was awarded because the candidate has cited the full URL with date accessed at the source. However, a full URL with the source is not acceptable as a form of citation, so no mark is awarded.

4 Graphical presentation

The candidate was awarded **4 out of 4 marks**. The marks were awarded as follows:

4(a)   **1 out of 1 mark** was awarded because an appropriate format has been used (bar graph).

4(b)   **1 out of 1 mark** was awarded because a suitable scale has been provided on the y-axis.

4(c)   **1 out of 1 mark** was awarded because both axes have been given suitable labels and units.

4(d)   **1 out of 1 mark** was awarded because all three bars have been plotted accurately.

5 Analysis

The candidate was awarded **0 out of 1 mark** because they have only stated that the trend in the data for both sources agree. This is insufficient to be awarded a mark.

6 Conclusion

The candidate was awarded **0 out of 1 mark** because the conclusion given does not answer the aim.

The aim was to investigate the relationship between enthalpy of combustion and chain length. The candidate has not stated the number of carbons present in the alcohols investigated except for propan-1-ol. The candidate has given the structure for this alcohol as part of their underlying chemistry, and it can be seen to have three carbons. Since no link has been made between the carbon chain length and the name of the other two alcohols, this mark cannot be awarded.

7 Evaluation

The candidate was awarded **0 out of 3 marks** because they have not made any valid evaluative statements supported by appropriate justifications.

They have incorrectly associated the loss of heat with the reaction being exothermic, so the use of draught shields cannot be awarded a mark.

They have stated 'my values for combustion were not the same as the data booklet', however, there is no direction given and 'not the same' is insufficient.

The candidate's evaluative statement on the data 'my internet source's enthalpy of combustion was far more significant than what I calculated' has no direction and is ambiguous, so a mark cannot be awarded.

There is an attempt to evaluate the use of the data booklet. However, 'it is used by higher students and academic people' is not a suitable justification, so a mark cannot be awarded.

8 Structure

The candidate was awarded **1 out of 1 mark** because a suitable title and structure for the report has been given.

Overall

The candidate was awarded a total of **9 out of 20 marks**.

Candidate 2

1 Aim

The candidate was awarded **1 out of 1 mark** because they have given an acceptable aim, 'To investigate the effect of changing temperature on the rate of reaction oxalic acid and acidified of potassium permanganate.'

2 Underlying chemistry

The candidate was awarded **2 out of 3 marks** because the candidate has provided reasonable explanations at a level appropriate to Higher Chemistry.

They have included correct chemistry that is relevant to the aim such as collision theory and the effect of increased temperature on increased kinetic energy.

The candidate has also attempted to describe kinetic energy distribution.

3 Data collection and handling

The candidate was awarded **4 out of 6 marks**. The marks were awarded as follows:

3(a)   **0 out of 1 mark** was awarded because the candidate has not given the independent variable. The candidate has stated 'Heat the mixture to a specific temperature…', but they have not made any reference to repeating at different temperatures. The safety statement given would have been acceptable.

3(b)   **1 out of 1 mark** was awarded because sufficient raw data has been provided. The candidate has carried out the experiment at five temperatures and each experiment has been carried out three times. This is sufficient and the mark is awarded.

3(c)   **1 out of 1 mark** was awarded because raw data has been tabulated with correct headings and units given. The smaller c in '(°C)' in the table heading is accepted, and a mark is awarded.

3(d)   **1 out of 1 mark** was awarded because the candidate has provided a sample calculation using a correct chemical relationship and has correctly calculated and rounded all values.

Note that the candidate's written value for the relative rate at 25 °C has been accepted as being 0.005.

3(e)   **1 out of 1 mark** was awarded because the candidate has provided data relevant to the experiment from an internet source, so the mark is awarded.

3(f)   **0 out of 1 mark** was awarded because the candidate has not provided a reference for their source at the end of the report. They have also given the full

URL with date accessed beside the source, but this is not acceptable as a form of citation, so no mark is awarded.

4 Graphical presentation

The candidate was awarded **3 out of 4 marks**. The marks were awarded as follows:

4(a) **1 out of 1 mark** was awarded because an appropriate graph format has been used (scatter graph).

4(b) **1 out of 1 mark** was awarded because both axes of the graph have a suitable scale. The numbers on the x-axis are slightly offset from the markings on the axis, but this is accepted.

4(c) **1 out of 1 mark** was awarded because the candidate has correctly labelled both axes including units.

4(d) **0 out of 1 mark** was awarded because the candidate has plotted points accurately, but the line of best fit has not been correctly drawn, so no mark is awarded.

5 Analysis

The candidate was awarded **0 out of 1 mark** because the candidate has not identified a correct and valid relationship between their experimental data and the internet source. The candidate has stated that both sets of data 'show the same trend…'. This simple comparison of trends in data is insufficient, so no mark is awarded.

6 Conclusion

The candidate was awarded **1 out of 1 mark** because the candidate has given a valid conclusion that relates to the aim of the investigation. The generic temperature versus the rate graph provided as the internet source, is accepted to compare with the experimental results. The candidate has used the term 'proven by' to link both internet and experimental results, so a mark is awarded.

7 Evaluation

The candidate was awarded **0 out of 3 marks** because they have not made any valid evaluative statements supported by appropriate justifications.

The candidate has made some evaluative statements, however, these are not evidenced in the experimental results.

Repeating an experiment is standard practice and is a requirement for the 'Raw data' mark at section 3(b), so would not be awarded again here.

Modifications to the experiment suggested (use of pipettes or class A glassware) are not linked to experimental results. Stating that a change to procedure would 'help improve the accuracy' is not accepted unless linked directly to experimental results.

The internet source chosen by the candidate is accepted (section 3(c)) and shows the correct trend in the relationship between temperature and rate. No impact on the data would be evidenced if the second source used 'degrees' instead of 'Kelvins'.

8 Structure
The candidate was awarded **1 out of 1 mark** because a suitable title and structure for the report has been provided.

Overall
The candidate was awarded a total of **12 out of 20 marks**.

Candidate 3

1 Aim

The candidate was awarded **1 out of 1 mark** because the aim describes the purpose of the investigation, 'To investigate the mass of vitamin C in different brands of vitamin C tablets.'

2 Underlying chemistry

The candidate was awarded **2 out of 3 marks** because the candidate has provided reasonable explanations at a level appropriate to Higher Chemistry.

They have given correct chemistry relevant to their investigation including the structure and solubility of vitamin C, and the oxidation, reduction and redox equations for the reaction used in their experiment.

The candidate has also provided detail on intermolecular forces, however, the relevance of this in terms of the experiment is not explained.

3 Data collection and handling

The candidate was awarded **4 out of 6 marks**. The marks were awarded as follows:

3(a)   **0 out of 1 mark** was awarded because the candidate has not given the independent variable. The candidate states that they 'titrated iodine and vitamin C solution'. This suggests a single experiment and does not mention the independent variable – the three different brands of vitamin C tablets that were analysed.

3(b)   **1 out of 1 mark** was awarded because the candidate has provided sufficient raw data. Three vitamin C tablets have been analysed and titrations were repeated to concordancy. Repeating to concordancy is accepted as sufficient for Higher.

3(c)   **1 out of 1 mark** was awarded because the candidate has provided tables of raw data on pages 4, 5 and 6. All table headings and units given are correct.

3(d)   **0 out of 1 mark** was awarded because a sample calculation has not been provided. The candidate has listed the numbers used at each stage of the calculation however they have not shown the chemical relationships used (neither $n = c \times V$ nor $m = n \times GFM$ are shown) nor the relationships with substituted values, so the mark cannot be awarded.

3(e)   **1 out 1 mark** was awarded because the candidate has provided data relevant to the experiment from an internet source. Tables of manufacturers' nutritional data for each of the tablets analysed is given on pages 7 and 8.

3(f)   **1 out of 1 mark** was awarded because the candidate has provided three correct citations for each of the three internet sources, with a number linking each piece of data to the reference given on page 11. All three references at the end of the report are correct with full URLs and date accessed given.

Note that only one correct citation and full reference would be sufficient to obtain this mark.

4 Graphical presentation

The candidate was awarded **3 out of 4 marks**. The marks were awarded as follows:

4(a)   **1 out of 1 mark** was awarded because the candidate has used an appropriate graph format (bar chart).

4(b)   **1 out of 1 mark** was awarded because the axes of the bar chart have suitable scales. The graph has been shown with a compressed scale between 0 and 910 on the y-axis. The attempt at a compressed scale is accepted.

4(c)   **1 out of 1 mark** was awarded because the candidate has provided suitable labels and units on both axes.

4(d)   **0 out of 1 mark** was awarded because the bar for the Tesco tablet has not been accurately plotted. The bar should have been plotted at 1027.4 (mg) from the calculated value on page 5 but has been plotted at 1024.7 (mg). Therefore, the mark cannot be awarded.

5 Analysis

The candidate was awarded **1 out of 1 mark** because they have compared the data obtained from the experiment and their second source. They have calculated the differences between the values in these sources and they have commented on the variations in the difference.

The experimental value used in comparison of the Tesco tablet is the incorrect value plotted in their graph, rather than the value from their calculation. As the use of this number has been penalised as a plotting error at section 4(d), it is not further penalised here.

6 Conclusion

The candidate was awarded **0 out of 1 mark** because they have provided two values for the experimental Tesco data within their report, therefore the mass value given in the conclusion is not consistent with all the data in the report. The value given for the experimental Tesco data in the conclusion (1024.7 mg) is different from that given in the results section (1027.4 mg), so the conclusion mark cannot be awarded.

7 Evaluation

The candidate was awarded **0 out of 3 marks** because they have not made any valid evaluative statements supported by appropriate justifications.

They have identified that leaving the Vitamin Store tablet solution overnight could have resulted in oxidation of the vitamin C. However, the effect on the data for this tablet and the impact of making a 'fresh vitamin C solution' is not clearly explained, so a mark cannot be awarded.

They have suggested using a 'white tile' and to 'stir the mixture' to allow easier observation of the endpoint. Both suggestions are standard laboratory procedures for titration, so the mark cannot be awarded.

They have suggested the use of a 'colour detector sensor' to improve reliability in identifying the endpoint. As concordancy was obtained in the titration, the need for improvements in identifying the endpoint are not evidenced by the data, so the mark cannot be awarded.

The justification of the website reliability is not sufficient, so the mark cannot be awarded.

8 Structure

The candidate was awarded **1 out of 1 mark** because a suitable title and structure for the report has been provided.

Overall

The candidate was awarded a total of **12 out of 20 marks**.

Candidate 4

1 Aim

The candidate was awarded **1 out of 1 mark** because the aim describes the purpose of the investigation, 'To investigate the vitamin C concentration of several varieties of Tropicana fruit juices'.

2 Underlying chemistry

The candidate was awarded **3 out of 3 marks** because the candidate has provided good explanations at a level appropriate to Higher Chemistry and relevant to their investigation.

The relevant, correct chemistry includes the solubility of vitamin C, oxidation, reduction, redox (with equations), oxidising and reducing agents, description of preparing a standard solution and the titration carried out.

3 Data collection and handling

The candidate was awarded **5 out of 6 marks**. The marks were awarded as follows:

3(a)   **1 out of 1 mark** was awarded because the candidate has given a sufficiently brief summary.

The candidate has given the concentration of the iodine solution used. However, this is accepted as it has been provided in the context of the safety statement. The iodine concentration has been identified as 'low hazard' and wearing gloves is given as mitigation.

3(b)   **1 out of 1 mark** was awarded because the candidate has analysed three juices each titrated to concordancy. Repeating to concordancy is accepted as sufficient for Higher.

3(c)   **0 out of 1 mark** was awarded because the units given at the end of the calculations are incorrect. The calculations shown are for mass of vitamin C (the candidate has written 'm =…') but the units given at the end of each calculation is for concentration ('mg/100 cm^3').

The raw data has been tabulated with correct headings.

3(d)   **1 out of 1 mark** was awarded because the candidate has consistently used all three titre values (ignoring rough) to calculate average titre, which is accepted.

3(e)   **1 out of 1 mark** was awarded because the candidate has provided data from an internet source that is relevant to their experiment. These are tables of manufacturers' nutritional data for the juices analysed.

3(f)   **1 out of 1 mark** was awarded because the candidate has cited all three data sources and references have been given as footnotes at the bottom of pages 5 and 6.

The references for one and two are correct but the reference for three is missing the date accessed. However only one correct citation and reference is required.

4 Graphical presentation

The candidate was awarded **4 out of 4 marks**. The marks were awarded as follows:

4(a)   **1 out of 1 mark** was awarded because the candidate has used an appropriate graph format (bar chart).

4(b)   **1 out of 1 mark** was awarded because the candidate has provided a suitable scale on the y-axis.

4(c)   **1 out of 1 mark** was awarded because the candidate has used suitable labels and units for both axes.

4(d)   **1 out of 1 mark** was awarded because the candidate has plotted all three bars accurately.

5 Analysis

The candidate was awarded **0 out of 1 mark** because they have not made a valid comparison of their experimental data with the data from the internet source. They have calculated percentage differences between their experimental and internet data. However, the calculations on their own are not sufficient. They have made no analysis of this calculated data in terms of commentary on the relative values, so the mark cannot be awarded.

6 Conclusion

The candidate was awarded **0 out of 1 mark** because the conclusion only concerns the experimental data. The internet data shows a different trend, so contradicts the conclusion given.

7 Evaluation

The candidate was awarded **1 out of 3 marks** because they have made one valid evaluative statement supported by appropriate justification. The candidate has stated that the internet data is 'regulated… by UK government food and drink laws'. This is appropriate for this source, so 1 mark is awarded.

The candidate has given other evaluative statements that are not evidenced by the data.

The candidate has stated that the end point was 'hard to determine' however, concordancy was obtained, so this is not evidenced in the data and a mark cannot be awarded.

The statement about the standard of glassware used (class A and B) is not linked to any inaccuracies in the data, so a mark cannot be awarded.

8 Structure

The candidate was awarded **1 out of 1 mark** because a suitable title and structure for the report has been provided.

Overall

The candidate was awarded a total of **15 out of 20 marks**.

Candidate 5

1 Aim

The candidate was awarded **1 out of 1 mark** because they have given an acceptable aim, 'To determine which, out of 3 different vitamin C tablets has the greatest mass of vitamin C present in it'.

2 Underlying chemistry

The candidate was awarded **3 out of 3 marks** because the candidate has provided good explanations at a level appropriate to Higher Chemistry, that are relevant to their investigation.

The relevant, correct chemistry includes explanations of oxidation, reduction, and redox including ion-electron equations and an equation with full structural formulae. An explanation is given of changes in the oxygen to hydrogen ratio during oxidation. Mention is made of vitamin C as an antioxidant. A description of preparing a standard solution and of the titration carried out is included, and there is also a sample calculation.

3 Data collection and handling

The candidate was awarded **6 out of 6 marks**. The marks were awarded as follows:

3(a)   **1 out of 1 mark** was awarded because the summary provided is sufficiently brief and the safety statement is acceptable.

3(b)   **1 out of 1 mark** was awarded because the candidate has provided sufficient raw data using three different brands of vitamin C tablets. The candidate has repeated to concordancy. Repeating to concordancy is acceptable at Higher.

3(c)   **1 out of 1 mark** was awarded because the candidate has provided tables of raw data. All table headings and units given are correct.

3(d)   **1 out of 1 mark** was awarded because the candidate has correctly calculated all values using a correct chemical relationship. The candidate has also converted their calculated masses into mg.

3(e)   **1 out of 1 mark** was awarded because the candidate has provided data from an internet source that is relevant to their investigation.

3(f)   **1 out of 1 mark** was awarded because the candidate has provided three correctly cited sources in the body of the report using superscripted numbers and has referenced them correctly at the end of their report. They have also provided the date accessed for each with their references.

4 Graphical presentation

The candidate was awarded **4 out of 4 marks**. The marks were awarded as follows:

4(a)   **1 out of 1 mark** was awarded because the candidate has used an appropriate graph format (bar chart).

4(b)   **1 out of 1 mark** was awarded because the candidate has provided a suitable scale on the y-axis.

4(c)   **1 out of 1 mark** was awarded because both axes have correct labels and units.

4(d)   **1 out of 1 mark** was awarded because the candidate has plotted all bars accurately.

5 Analysis

The candidate was awarded **1 out of 1 mark** because they have compared the data obtained from the experiment and their second source in a table. They have calculated the differences between the values given by the internet sources and their experimental results as percentage decreases. They have also commented on the variations in the differences, stating that their results are all higher and that the Immune Support brand contained the greatest mass by both sources.

6 Conclusion

The candidate was awarded **1 out of 1 mark** because the conclusion answers the aim and is accepted.

7 Evaluation

The candidate was awarded **3 out of 3 marks** because they have made three valid evaluative statements supported by appropriate justifications.

The candidate has stated that the internet data 'must comply with all food standard regulations' and that it is 'verified by food scientists'. This is appropriate for this source, so 1 mark was awarded.

They have also stated that their results are 'significantly higher' in comparison to the internet source values because the tablets may have 'contained other compounds which could have reacted with the iodine solution'. This is an acceptable justification, so 1 mark was awarded.

The candidate has made a statement regarding increasing the volume of iodine solution used from 25 cm^3 to 50 cm^3. This would have the effect of increasing the titre volume of vitamin C solution with the candidate stating, 'this would have made my results more percise'. There is some evidence for this in the data as the

titrations of the two brands with the lower titre volumes are less precise, requiring more titrations to reach concordancy, so 1 mark was awarded. The loose spelling of precise by the candidate is accepted.

8 Structure

The candidate was awarded **1 out of 1 mark** because a suitable title and structure for the report has been provided.

Overall

The candidate was awarded a total of **20 out of 20 marks**.