

Commentary on candidate evidence

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

Candidate 1

1 Abstract

The candidate was awarded **1 out of 1 mark** because the abstract:

- ◆ comes before the underlying chemistry
- ◆ clearly states the aim of the project
- ◆ states the conclusion of the project which is consistent with the conclusion section and contains the values (which gives a range, including uncertainties, but the values also match with those recorded on page 9, in the results, and at the bottom of page 10)
- ◆ is brief

2 Underlying chemistry

The candidate was awarded **2 out of 3 marks** because there is a reasonable understanding demonstrated for how colour arises in TM complexes and the technique of colorimetry. This includes demonstrating the difference in energy levels based on the wavelength of light absorbed. There is also information and equations given for a redox titration, although this does not appear to have been used in the project.

The candidate could have given the d electron arrangement of Mn in MnO_4^- rather than for Mn atoms and the diagram that has been provided shows different numbers of electrons between the degenerate d orbitals and the split ones.

3 Data collection and handling

The candidate was awarded **3 out of 9 marks**. The marks were awarded as follows:

- 3(a) **0 out of 2 marks** were awarded because there is insufficient detail for another Advanced Higher Chemistry candidate to be able to repeat the procedure, so the first of these 2 marks were not awarded. The candidate has not included the concentrations used for phosphoric acid and acidified potassium periodate solutions. As there is only one procedure given and these concentrations have not been included elsewhere in the report, the second of these 2 marks were not awarded.

- 3(b) **0 out of 1 mark** was awarded because the safety measures listed have not been justified, for example, nitrile gloves worn because nitric acid is corrosive or the fume cupboard used as NO_2 is generated.
- 3(c) **1 out of 1 mark** was awarded because a modification has been carried out in the light of experience (the absorbance value did not lie within the calibration graph data and so the solutions were diluted). The underlying chemistry section mentioned a second procedure, however there are no recorded results for this, for example, initial burette readings. Therefore, the second procedure, on its own, would not be awarded 1 mark.
- 3(d) **1 out of 1 mark** was awarded because the results given provide evidence that the procedure for extraction of Mn has been carried out in duplicate. There are no duplicate results for the calibration graph but this is not required.
- 3(e) **0 out of 1 mark** was awarded because the apparatus list and the details given in the procedure do not demonstrate that the correct apparatus was chosen and used by the candidate to achieve the required levels of precision and accuracy. In the modification (on page 9) they have not stated what they have used to measure the 25cm^3 of the solution. The apparatus list only includes pipette once and does not indicate the size however pipettes are used on more than one occasion throughout the procedure.
- 3(f) **0 out of 1 mark** was awarded because all relevant raw data has been recorded, with balance readings recorded (balance was tared) and all absorbance values recorded, however, there is an inconsistency in the recording of the absorbance values on page 7 compared with page 9, so the mark cannot be awarded.
- 3(g) **1 out of 1 mark** was awarded because all numerical data are appropriately presented – all masses are recorded to two decimal places and raw absorbance values to three decimal places.
- 3(h) **0 out of 1 mark** was awarded because there is only one cited reference given (page 11) and the listed references do not include dates.

4 Data analysis

The candidate was awarded **3 out of 5 marks**. The marks were awarded as follows:

- 4(a) **2 out of 4 marks** were awarded because the analysis includes values calculated correctly using chemical relationships and analysis of the calibration graph. The graph does not allow for the accuracy of plotting or the extrapolation of concentration to be checked and so only 2 marks can be awarded for a better than limited analysis. The absorption 1 and 2 values for each piece are recorded incorrectly on page 7, but if followed

through from the results recorded on page 9, then the calculations are correct.

- 4(b) **1 out of 1 mark** was awarded because the final percentage values are given to two significant figures and this matches with the experimental measurement recorded to the lowest number of significant figures (all masses recorded to two significant figures). This is within the acceptable range of one fewer and two more than the raw data.

5 Conclusion

The candidate was awarded **1 out of 1 mark** because a valid conclusion has been stated that relates to the aim and is supported by the data.

6 Analysis

The candidate was awarded **1 out of 1 mark** because the data has been compared to an internet source and an appreciation shown that although the numbers are not identical, they do not vary by much.

7 Evaluation

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

- ◆ 2 marks were awarded for the quantitative treatment of uncertainties:
 - 1 mark was awarded for the list of uncertainty values associated with the measurements.
 - 1 mark was awarded for a correct calculation of the absolute error in the final value.

There is an error in the combining of uncertainties to calculate the relative error for piece 1 and so the second mark of the 3 available for the quantitative treatment was not awarded.

- ◆ 2 marks were awarded for the following evaluative statements and justifications:
 - Statement – ‘there was slightly less manganese’.
Justification – ‘there may have been a layer of plastic ... make it seem like there was slightly less manganese as the mass of the plastic was counted as the mass of aluminium can’.
 - Statement – ‘cut the piece up more’.
Justification – ‘nitric acid was evaporating before the can would dissolve’.

8 Structure

The candidate was awarded **1 out of 1 mark** because the report is clear and concise and has an informative title, contents page and page numbers. It is easy to follow.

Overall

The candidate was awarded a total of **16 out of 25 marks**.