



2009 Chemistry

Advanced Higher Investigation Report

Finalised Marking Instructions

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Advanced Higher Chemistry Investigation Report – 2009

Marking Scheme

This marking scheme should be used in accordance with ‘Advanced Higher Chemistry Guidance’ issued for use from September 2008.

General Points

No marks are awarded by the Centre and so all 25 of the available marks are based on the Report and since there is no visit to the Centre, the candidates have no opportunity to pick up extra marks.

Half marks must not be awarded in any category.

No comments or marks to be put on the Investigation Reports by markers under any circumstances.

Samples of Reports assessed by each marker will be verified and the Reports may be re-assessed if the candidate is borderline during the finalisation and/or appeals procedures.

The Report should be written in the past tense and the impersonal voice should be used. However this is only obligatory in Category 3 – Procedures. If the word “I” is used **once only** in Procedures, then accept this as a minor slip and do not penalise.

Category 1 – Presentation (3 marks)

(a) The Report has a logical structure appropriate to the Investigation and must include:

- a title page/a contents page/at least 3 references in standard format

1

Title and contents page are essential – the contents page must show page numbers and the pages throughout the Report must be numbered.

At least 3 different references must be cited in the main body of the Report and also listed at the back of the report.

When cited in the text, the author's surname and the year of publication should be given, as in the exemplar below:

The reduced form of indigo is soluble and colourless while the oxidised form is insoluble and blue (Brown et al, 2001).

References may include books, journals/periodicals and websites and should be listed near the end of the Report as shown below. There is no need for these to be listed in alphabetical order.

Note that it must not be the same book/website referred to on 2 or 3 occasions even if the reference is to different page numbers. The onus is on the candidate to find at least 3 references, ideally at the planning stage.

There must be a **minimum of 3 references** cited correctly in the text and listed in the correct format at the end of the Report.

Reference to Higher or Advanced Higher PPA instructions is acceptable but must be cited in a recognisable way such that it is obvious what is being referred to.

For example, D. Hawley, Prescribed Practical Activities, Advanced Higher Chemistry, Scottish CCC, pp23-24.

If a candidate puts in “et al” wrongly, then ignore as most candidates are unlikely to have been taught Latin.

Books

Author(s), (surname followed by initials) (Year of publication) *Title*, Publisher, Place of publication, Page number(s).

eg Aldridge, S (1998) *Magic Molecules: how drugs work*, Cambridge University Press, Cambridge, p134.

Journals/Periodicals

Author(s), (surname followed by initials) (Year of publication) Title of article, *Name of Journal*, **Volume number** (Part number if appropriate), Page number(s).

eg Brown, TM, Cooksey, CJ and Dronsfield, AT (2001) Indigo – forever in blue jeans, *Education in Chemistry*, **38**(3), pp69-71.

Websites

As many of the following items as **are available** should be given: author, date, title, publisher, date the material was accessed (because the 'site' may be updated between the time the writer uses it and the point at which a reader refers to it) and the URL.

For example, PDR health Malic Acid. Visited: September 2005.

URL: http://www.pdrhealth.com/drug_info/nmdrugprofiles/nutsupdrugs/mal_0292.shtml

The reference **must** be listed at the end of the Report in this format.

Ideally the name of the author should be cited in the text. This may not always be possible and, for websites cited in the main body of the text, an appropriate alternative to author can be used in the text. The full URL and the date visited must **not** be cited in the text but must be given in the list of references at the back of the report.

For example, Malic acid, also known as apple acid, hydroxybutanedioic acid and hydroxysuccinic acid, is a chiral molecule (PDRhealth. or PDRhealth.com).

Citing the year in the text is acceptable for websites but not necessary. If the year is cited in the text we have to assume that this is the year that the website was written. The date (Month, year) that the website was accessed by the student must be given at the back of the report as in the example above but this would not be acceptable in the text.

For example, (PDRhealth.com, 2006) cited in the text is acceptable but (PDRhealth.com, visited November 2008) is not.

- **a brief summary, or abstract, stating the aim(s) and overall finding(s) of the Investigation.** **1**

A brief summary **must** immediately follow the contents page and should be under a separate heading. The summary **must** state the main aim(s) **and** overall finding(s) of the Investigation and must be separate from and placed before the Underlying Chemistry. The overall findings must be consistent with the conclusions given near the end of the report and should relate to the aims.

- (b) The Report is clear and concise.** **1**

The Report should be easy to read and understand.

If you have to keep going back and forth for the Report to make sense or if you have to hunt for relevant details then the Report is **not** easy to read and this mark should not be awarded.

The word count of **about 2000-2500** words is for guidance only. However a mark may be deducted here for Investigation Reports which obviously fall well short of this recommendation. If you feel that the Report is short because not enough work has been done then zero marks should be awarded here, but if a candidate has obviously done a lot of work and has written up a very clear but concise yet accurate Report then award the mark. Markers are not expected to count the number of words in each Report.

Most candidates will get this mark.

(3)

Category 2 – Underlying Chemistry (4 marks)

An account of the underlying chemistry in which terms are used accurately and ideas are clearly explained.

Look for some interesting information which the candidate has obviously found out from doing some background reading. While the emphasis is on ‘chemical’ information, it may include ‘historical’ information as well but the marks are for chemistry:

Appreciation of underlying **chemistry**/terms accurately described/brief outline of relevant background theory/**chemical** significance of chosen topic.

Look for formulae, equations etc which demonstrate that the Investigation is obviously a **chemistry** one.

Terms must be used accurately and ideas must be clearly explained. Penalise for “wrong chemistry”. Allow minor slips but not if fundamental to the chemistry behind the Investigation.

Look for underlying chemical principles behind the Investigation/background theory of techniques used.

Theory may be given elsewhere in the Report, eg in the 'Procedures' section, but marks for good chemistry written elsewhere in the Report are given under this category.

This is an opportunity to give marks for '**quality**'. Think in terms of 4/3/2/1/0 marks equating to A/B/C/D/NA grades. (Markers will have to use professional judgement and comments from markers on the record sheet would be helpful here). Zero marks may be awarded here.

If a fundamental error is perpetuated throughout the Report then this should be penalised on a **maximum** of two occasions. For example, deduct a maximum of 2 marks for the same error repeated through “Underlying Chemistry”, “Calculations”, “Conclusion” and “Evaluation”. Again comments on the record sheet are helpful.

(4)

Category 3 – Procedures (6 marks)

The procedures must be written in the past tense and the impersonal passive voice.

- (a) **The procedures are appropriate to the aim(s) of the Investigation.** 1

Do the procedures allow the aims to be achieved?

If the aim has not been given previously, it may be fairly obvious or may be possible to work out the aim from the title of the Investigation. If so then mark may be awarded here for appropriate procedures. If not then deduct 1 mark here.

- (b) **The procedures are clearly described and in sufficient detail to allow the Investigation to be repeated.** 1

Must be at least one procedure clearly described. If more than one procedure is carried out, then the major one used in the Investigation must be described. The procedure should be described well enough for another competent AH Chemistry student to be able to repeat the procedure from the description.

It would be appropriate in this section for candidates to include labelled diagrams or photographs of assembled apparatus.

Looking for concentration of solutions, temperature used etc.

Ignore the omission of a small number of minor details. Use professional judgement here.

Zero marks here if not written in past tense or impersonal voice not used, eg if written as a set of instructions in the imperative voice. Any part of the procedures listed as set of instructions, then zero marks here, except if given as safety instructions, which would be ignored.

Consider use of first person on one occasion only as a slip, but more than once then deduct the mark.

May be given as a numbered list or list of bullet points but must be in sentences and must make sense if numbers or bullet points were to be removed.

- (c) **The procedures are at an appropriate level of demand for Advanced Higher Chemistry in relation to:**

- **the complexity of the design of the experiments** 1

Treatment of the topic must be at AH level for 1st mark.

Most candidates will get the mark here.

- **two or more techniques/modifications to procedures in the light of experience/control experiments** 1

If Investigation is based on a PPA or two PPAs with **no modification or only minor modification** then deduct 1 mark here.

Look for modifications to original plan and some original thought on the part of the candidate rather than simply following a set of instructions. Any modification **in light of experience** as candidate does the Investigation. This includes dilution of solutions to get better titration values or changing solvent in chromatography experiment if first one hasn't been effective.

Acceptable if modification carried out is mentioned later in the Report eg in Evaluation but it would be helpful if commented upon by marker. Original thought on part of candidate might be that he/she explains why something different was carried out rather than, for example, simply following a recipe.

or

Using different techniques rather than just one. Do not count as two techniques if one has been carried out by, say, a university technician. It is acceptable if the candidate has actually done the work. This should be obvious from the description of the procedure given in the report. Refluxing followed by distillation done as part of an organic preparation would **not** count as two separate techniques.

or

Any modification in **light of experience** such as dilution of titrant.

It would be helpful if markers commented on reason for giving or not giving the 2nd mark in less obvious situations.

or

controls and/or control of variables.

Accept carrying out blank titration unless this is crucial to the technique.

Look for doing control experiments, eg with pure ascorbic acid, aspirin etc when doing the determination of these substances in commercial products.

- **experiments duplicated**

1

Carrying out a procedure in duplicate **when practicable** – not just repeating titrations to get concordancy. Duplicates must be done, **where practicable**. If more than one technique used then there must be duplicates for at least one.

Candidate must have actually done something to get this mark – not good enough just to state, say, in Evaluation, that duplicates have been carried out. Need to see evidence in the results given.

- **accuracy of measurements**

1

Choosing correct apparatus to achieve aim of experiment or to give measurements of appropriate accuracy eg pH paper/pH meter or adding acid from burette/measuring cylinder. Also look for candidates using measuring cylinders for dilutions when standard flasks would be more appropriate. May be able to mark this from looking at list of apparatus given by candidate. Candidate must have used the correct apparatus etc for **all** procedures described, but allow one **minor** slip.

This mark is for accuracy of measurements in “Procedures” not in “Results”. For example in preparing a standard solution to be used in a titration later.

Number of decimal places etc, appropriate to measurements taken, apparatus used in procedures (eg making up standard solutions etc) rather than in results data. For example, weighing out 5 g of substance, rather than, say, 5.03 g when preparing a standard solution would lose this mark, ie accurate value must be specified here, where accuracy is required or is critical.

If titration values are very low using ordinary burettes and no modification made then deduct mark here. In general less than 5 cm³ would be considered too low a titre value.

However professional judgement has to be used here for special circumstances such as titrations carried out as part of an Investigation into chemical kinetics.

Calibration graph drawn wrongly would lose a mark here.

(6)

Category 4 – Results (5 marks)

Your decision to mark this category as Quantitative or Qualitative should be made to benefit the candidate with respect to the number of marks awarded.

Quantitative

- (a) **The results are relevant to the aim(s) of the Investigation and readings (raw data) are recorded.** 1

Ideally raw data should be given for all techniques or procedures. However, professional judgement should be used where more than one technique/procedure has been used. Must be raw results for main technique/procedure used and majority of techniques/procedures should be covered. For example, if four techniques/procedures used, it would be acceptable to include raw data for 3 out of the 4 but not for 2 out of the 4.

Must give, for example, initial and final burette readings etc, not just titre volumes.

Interfacing data in the form of graphs acceptable as raw data but not if unclear what graph (or spectra) is showing. Graphs, spectra etc must be labelled clearly and correctly.

When using the tare button on a balance, the recorded mass is considered as raw data.

- Results are within the limits of accuracy of measurement.** 1

Number of decimal points etc, appropriate to measurements taken, apparatus used.

For example, burette readings should be to 1 decimal place, except for an initial reading of 0. Also accept a statement that the burette was zero-ed before each titration.

This mark may apply to both raw results and final results and may be deducted where an inappropriate number of significant figures are given in the final results.

- (b) **Raw and processed results are presented in a clear and concise manner with appropriate use of tables, graphs, diagrams and calculations.** 2

Graphs, tables etc set out properly.

Graphs should be line of best fit where appropriate and should be of suitable dimensions in terms of size and scale. This is particularly true if a value or measurement is to be taken manually from the graph. However it is acceptable if drawn using a computer package and the value or measurement is calculated from the graph by the computer.

Look for correct headings, units etc.

Photos are acceptable in place of diagrams.

Calculations should be clearly set out and done correctly.

One sample calculation adequate rather than similar ones repeated throughout Report.

Look for, at least, two operations. If two correct, ignore minor errors in others except when that particular operation is crucial to the Investigation, for example, in a repeated calculation. Main procedure/operation must be covered correctly here.

Graph drawn wrongly would lose a mark here if values read from the graph are crucial to the Investigation, even if another two operations are done correctly.

If an error such as a non-concordant rough titre is included in average of titration results, then deduct mark here.

- (c) **In descriptive components of the work, observations are detailed and suitably recorded.** 1

Look for descriptions of colour changes, precipitates forming etc.

Must be at least one observation recorded. This may also be found in the Procedures or Discussion Sections and the mark awarded here. No mark awarded if observations mentioned only in "Underlying Chemistry".

(5)

Category 4 – Results (5 marks)

Qualitative

- (a) **The results are relevant to the aim(s) of the Investigation and readings (raw data) are recorded. Accept chromatograms, photographs, diagrams of results as raw data.**
- (b) **Raw and processed results are presented in a clear and concise manner using an appropriate format.**
- } 2

An example of a final result might be a white solid or colourless liquid etc.

Initial and final masses and other relevant measurements.

Is the data presented properly and clearly?

Must be in an appropriate format including lab report style – not necessarily tabulated.

Chromatograms, photographs and diagrams may also be acceptable as raw data.

- (c) **In descriptive components of the work, observations are detailed, suitably recorded and where appropriate, quantitative.** 3

Including colours/colour changes/shapes of crystals/precipitate forming/redissolving/melting points/yield/percentage yield etc.

It is almost inevitable that there will be some quantities given and these should be recorded within appropriate limits of accuracy.

Some of these may appear in Category 3 – Procedures, but should be given credit here.

If you are aware of certain observations that should have been made and recorded but are not presented in the Report then deduct the appropriate number of marks and marker should comment to that effect. Should be looking for at least 3 “observations”.

Deduct 1 mark for incorrect calculation, eg calculation of % yield.

When marking a “qualitative” Investigation, it may be fairer to deduct the relevant number of marks for omissions of expected observations, measurements etc.

(5)

Category 5 – Conclusion and Evaluation (7 marks)

- (a) **The overall conclusions relate to the aim(s) of the Investigation and are valid for the results obtained.** 1
1

Ideally, conclusions should be under a separate heading. If conclusions given after each experiment but not tied together at end then deduct 1 mark.

Conclusions must relate to aim(s) and **all** must be valid for both marks.

All aims given in the Summary/Abstract must be covered in the conclusion. Do not penalise for extra conclusions which are valid but do not relate to original aim(s). If mistake made in processing results, making them invalid and mark has already been deducted under results then do not deduct mark here.

- (b) **Evaluation of procedures and results**

- **The evaluation of the procedures addresses such points as accuracy of measurement/adequate replication/adequate sampling/adequate controls/sources of error in relation to measurements/the ways in which problems encountered in the Investigation were dealt with/ways in which the procedures might have been modified to improve the Investigation.** 2

This is an opportunity for the candidate to review and evaluate the procedures used in a positive way as well as suggesting modifications and/or improvements which might have given better results.

Look for sources of error in relation to individual pieces of apparatus/how problems were dealt with/modifications to procedures/controls or sample size/‘magic numbers’ without explanations.

Not everything has to be covered but main sources of error must be covered.

The candidate may not have done the procedure correctly but has shown that he/she realises this in the evaluation.

Again this part is meant to be discriminating and is an opportunity to award ‘quality’ marks. Markers may find it helpful to make mental notes of what might be expected here as you read through the Investigation.

“What you might have expected” = 2 marks

“Some bits missing” = 1 mark

“Too much missing” = 0 marks

- **The evaluation of the results includes analysis and interpretation of the results/an account taken of the errors described and consideration of the effect of error on the outcome(s)/(suggestions for further work).** 2

Look for a meaningful/valid analysis and interpretation of the results.

Look for awareness of accuracy of measurements/sources of error in relation to measurements or individual pieces of apparatus. Can get this mark for correct error values in apparatus/techniques.

Have experimental results been interpreted correctly?

Correct follow through from main sources of error.

Candidate has considered the effects of errors in apparatus and techniques in (b) and considers the effect on the results in (c).

The candidate may have done this quantitatively – uncertainty calculations – but this is not necessary.

Where uncertainty calculations are presented properly this would cover the above two aspects (analysis and effect of error) and therefore may be worth 2 marks.

Suggestions for further work only acceptable if information given as to how this would be done. Should not just be a list of suggestions.

It is usually easier to mark evaluation of procedures and results together to get a mark out of 4.

The evaluation is meant to be an overview by the student of what he/she has done in the Investigation. It is a review of the positives as well as the negatives. Sources of error, possible improvements, accuracy of equipment and of measured values should be discussed. The effect of these on the final results should be considered. For example if it was difficult to see the end-point in a titration and therefore the titre values may be out by 0.2 cm^3 , what effect would this have on the value of the final calculated result.

If conclusion and/or evaluation have been done in the wrong place and no overall conclusion/evaluation given at end then deduct one mark after marking (a) and (b).

Marker should comment on record sheet.

(c) The overall quality of the Investigation **1**

This is a final quality mark for the standard of the Investigation – not just the evaluation part of the report. This is for a good investigation well worked through, taking particular account of the Chemistry involved.

To get this ‘bonus’ mark the candidate must also have scored at least 3/4 in “Underlying Chemistry” and at least 3/4 for “Evaluation”.

(7)

Total marks = **(25)**

[END OF MARKING INSTRUCTIONS]