**Writing the Chemistry Research Investigation (IA3) (Individual task) **

**To begin your research investigation, the following sequence is highly recommended.**

1. **Choose a claim from the task sheet (and have a rough idea of a research question)**
2. **Find the data you can use (tables,graphs) that relates to the claim**
3. **Now write a specific research question. (explained in research question section)**
4. **Then continue with rest of the report.**

**Reason: Finding relevant data that exactly matches your research question is sometimes difficult, time consuming and prevents you from making your way through the report. So it is okay to find data from multiple sources that relate to your claim first, and then write your research question. When you find your data, it is essential you understand how the data was obtained by the author (i.e save the entire source that contains the data, do not just cut and paste tables and graphs that you want to use)**

This assessment requires you to evaluate a claim. You will do this by researching, analysing and interpreting secondary evidence (data) from scientific texts to form the basis for a justified conclusion about the claim. Since a claim is a very general statement , you will be required to develop a more specific research question (that relates to the claim).

The secondary evidence you need is obtained by researching scientifically credible sources, such as scientific journals, books by well-credentialed scientists and websites of governments, universities, independent research bodies or science and technology manufacturers.

An essential part of science is learning to communicate findings from a scientific investigation. Thus, preparation of a report in the form of a scientific paper is regarded as an important part of your learning.

 **How your Research Investigation will be marked**

Your report will be marked out of 20 – 3 sections worth 6 marks and 1 section worth 2 marks.

A summary of each section is provided below. In the pages that follow is a more detailed description to help you write your report.

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| **Criteria** | **Marks** | **Summary of key points of what each section is about** |
| Research and Planning | 6 | Why is the claim important?What is your specific and relevant Research Question?What references have you chosen along with key findings? |
| Analysis and Interpretation | 6 | This section focuses on the **actual data itself** that includes identifying trends, patterns and relationships along with limitations of the data that you are using. This will allow you to make a justified scientific argument from the research evidence. |
| Conclusion and Evaluation | 6 | This section focuses on the **processes of how** the research by the author was undertaken to justify conclusions. Discuss the quality of the evidence and then whether you can make a justified conclusion. Then look at extrapolation of the findings along with improvements and extensions.  |
| Communication | 2 | Use of scientific language/representations.Use of genre conventions.Appropriate referencing conventions. |

Be very clear about the difference between “**Analysis and Interpretation**” and “**Conclusion and Evaluation**”. The first is all about **the data** and the latter is about how the research/evidence **processes** were used/not used. Do not confuse “Conclusion and Evaluation” to think it simply means what each source concluded.

In the first three criteria:

A good mark = 5 or 6

A medium mark = 3 or 4

A poor mark = 1 or 2

Does not satisfy any of the descriptor = 0

In the “You are marked on” sections below, use the definition of your cognitive verbs to aid in your writing.

In Year 11, these can be found on your task sheet.

In Year 12, see your teacher for a copy if you need to.

e.g Justified – sound reasons or evidence are provided to support an argument, statement or conclusion.

Where you see the word “***Heading”*** use the word next to it as a heading in your report. **Indicated word lengths are only a guide**.

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| **Research and Planning – 6 marks** |
| ***Heading :* Rationale** 1. Start with the **claim** from the task sheet. Provide two or three sentences that give the claim some context – for example, why the claim may be in doubt and/or background context to why the investigation of the claim is important.

(Length: 40-80 words)1. Next, narrow the focus of the claim down to something specific that you can answer more easily. One way to do this is to pick a **key variable** and a **specific context**. For example:

 Claim: “Natural body cleaning products are better than synthetic ones.”Specific research question: “Are natural shampoos better *cleaners* (specific context) than synthetic shampoos based on their *surface tension* and *foaming ability* (key variables)?”1. The bulk of the rationale involves describing **why** you chose those things to focus on (hence the name ‘rationale’ = reason behind a decision). This is where you can provide the chemistry knowledge that relates to your research question. It would be good to have about 3 references in this section from your sources (you could use other references here as well) that support the chemistry knowledge.

(Length: 150-200 words)*Some useful sentence starters*•This review will use three sources from …….. that have been undertaken to determine ……•The results of these sources will be compiled to investigate ……..• ………………… (2017) carried out the first investigation using ……….. They found ………..*You are marked here on:** *whether your rationale is “considered” (good mark), “reasonable” (medium mark) or “vague” (poor mark), and*
* *whether your sources (of data) that you have referenced are “sufficient” (good mark), “relevant” (medium mark) or “insufficient and irrelevant” (poor mark).*
 |
|  **Heading : Research Question** * One sentence.
* Short and sharp.
* Relate the independent to dependent variable.

*In general, a good research question has the following attributes:**•* ***Clearly phrased and focused:*** *State what needs to be investigated.**•* ***Not require a simple answer:*** *Cannot be answered by a simple ‘yes’ or ’no’ answer.**•* ***Not too complex to answer :****Data can be collected within a reasonable timeframe and with appropriate scope.**•* ***Researchable (feasible):*** *You must have access to appropriate methods of data collection or sources.**•* ***Analytical rather than descriptive:*** *Your research question should allow you to produce an analysis of an issue or problem rather than a description of what was observed.* *issue issue or problem rather than a description of what was observed*Iearchi*You are marked here on:** *whether your research question is “specific and relevant” (good mark), “relevant” (medium mark) or “inappropriate” (poor mark), and*
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| **Analysis and Interpretation – 6 marks** |
| **Heading : Analysis** (Length: 400-500 words)In the analysis section, you look for evidence/data (qualitative and or quantitative) to determine an answer to the research question. To do this, you may need to consider evidence that supports or does not support your research question. Evidence is a decision you make by identifying a trend, pattern or relationship within the data of your sources. It is difficult to put a number on how many pieces of evidence you use as it will depend on the quality of the source and the availability. Multiple sources would be recommended usually.The analysis section should be the most heavily referenced part of your assignment.Build your paragraphs in the analysis section by:* Starting with an opening sentence stating your most important piece of evidence. You are looking to identify trends, patterns or relationships.
* 1-3 sentences of **details** about this evidence including a **reference** on how one or more of your sources support this.
* Any major **limitations** of the study/studies that you have just referenced (e.g., small sample size, conducted in another culture, conducted under lab conditions, etc.).

Similar arguments from different sources should be grouped together in the same paragraph.*You are marked in this section on:** *whether your evidence is “sufficient and relevant” (good mark), “relevant” (medium mark) or “insufficient and irrelevant” (poor mark);*
* *whether your analysis of the data (such as identifying trends, patterns and relationships) is “thorough” (good mark), “obvious” (medium mark) or “incorrect or irrelevant” (poor mark);*
* *whether your identification of the limitations of the evidence is “thorough” (good mark), “basic” (medium mark) or “incorrect or insufficient” (poor mark);*

When you have presented the evidence, make an **overall argument** about how well the evidence from the *combination* of your sources supports the research question. *You are marked in this section on:** *whether your interpretation of research evidence is “justified” (good mark), “reasonable” (medium mark) or “inappropriate or irrelevant” (poor mark).*

Some useful sentence starters* The significant points that appear include …….
* The key features of ……… are ……
* The most significant elements of …….. include ……….
* The graph/table/result showed/revealed that …..
* The data revealed the following trends …..
* The data revealed a strong connection between …..
* There is very little relationship between ….. and …..
* The table/graph supports the information in the text by …..
* However, not all factors were tested …..
* There were a number of anomalies found in ……….
* Limitations of the studies included ……
* Some data was excluded because …..
 |
| **Conclusion and Evaluation – 6 marks** |
| **Heading : Conclusion** *Note: No referencing is required from this point forward.** Draw a **conclusion** about the answer to your research question. Your conclusion should use most of the same words as you used in the original research question. Avoid stating that the answer to your research question is ‘inconclusive’; try to conclude more one way or another. Then **justify** why you have decided more in favour of one side than another. You do not need to use references in this section (although you still may choose to discuss your sources), since you have already presented all of your evidence in the analysis section.

 (Length: 100-200 words)*You are marked here on whether your conclusion is “justified” (good mark), “reasonable” (medium mark) or “inappropriate or irrelevant” (poor mark).*Now that you have given your answer to the research question,2. Consider what this may say about the original claim. For a high mark you are also asked to provide an extrapolation of the research to the claim. Extrapolation means : concluding something by assuming that existing trends will continue. A lesser mark would include an application of the findings of the research to the claim.**Example** **of an extrapolation:**Claim: “Natural body cleaning products are better than synthetic ones.”Specific research question: “Are natural shampoos better cleaners (specific context) than synthetic shampoos based on their surface tension and foaming ability (key variables)?”Conclusion: Natural shampoos are equally good at cleaning based on similarities in surface tension and foaming ability.Extrapolation to claim: Other natural body cleaning products such as soap (other contexts) that contain similar properties are likely to be as good as synthetic products. (Length: 50-100 words)You are marked here on whether your discussion relating the findings of your research to the claim are a “credible extrapolation” (good mark), a “relevant application” (medium mark) or an “insufficient or inappropriate application” (poor mark).Some useful sentence starters* When considering all the evidence provided ……..
* The weight of evidence would suggest that …..
* The evidence collected allows the following statement to be made …..
* There is very little evidence that …..
* All the evidence suggests …..
* Several sources have been used to create …..
* All evidence and supporting documentation points to …..
* Research has enabled the following conclusion to be reached …..
* In conclusion, the claim …….

**Heading : Evaluation** The final three paragraphs are an evaluation of your assignment itself. Any conclusions that you want to draw about the research question or claim should be said before this point. Reflecting back on the assignment,1. Discuss your own thoughts on the **quality of evidence** that you used to draw your conclusion. Are the sources trustworthy and reliable? How do you know? Did you lean too heavily on one source, or use a variety of sources? Did you use websites or journal articles? (Note that if you have used only journal articles, the quality of your evidence is likely to be high but limited by the number of references that you were able to collect.) Do your sources support each other or do the sources suggest conflicting findings?(Length: 80- 100 words)*You are marked here on whether your evaluation of the quality of evidence is best described as an “insightful discussion” (good mark), “reasonable description” (medium mark) or “cursory or simplistic” (poor mark).** Next, make one or two suggestions for **improvements** to the investigation. This should follow logically from the previous paragraph where you talked about the quality of your evidence. For example, the investigation may be improved by obtaining more sources to provide evidence about a particular aspect of your research question or making minor adjustments to the research question to look at a more specific area.

(Length: 80 -100 words)* Finally, make one or two suggestions about **extensions** to the investigation. The most logical way to do this is to consider other parts of the claim that were *not* examined by your research question.

(Length: 50-80 words)*You are marked on these last two paragraphs on whether your improvements and extensions are “considered and relevant” (good mark), “relevant” (medium mark) or “ineffective or irrelevant” (poor mark)*Some useful sentence starters* There are more details to be examined and these include …..
* Improvements might include …..
* It could be recommended that …..
* It would appear reasonable to conclude that ….., and therefore recommend …..
* Based on the findings, the following recommendations can be made.

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| **Communication – 2 marks** |

 Some general guidelines:* Be concise, and accurate with the use of scientific terms.
* Use a passive voice (emphasises the action not the subject) and no personal pronouns.
* Use past or present tense (past tense is traditional but both are now considered generally acceptable), but do not mix tense.
* Use appropriate labelling and title for tables and graphs.

 References Include an alphabetical list of any references that you used. You should paraphrase from a range of sources, quoting is not appropriate and shows a limited consideration of the topic. You may choose to use any appropriate format such as Harvard. |

**Some things to keep in mind about writing scientifically**:

**Reducing Unnecessary Words and Phrases**

The Research Investigation report has a stringent word limit (1500 – 2000 words), exceeding these word limits will have a negative impact on the mark awarded for the report. It is important to use accurate but concise language when writing your report.

Below is an example of a student’s work. Below the students work is an example of how a teacher has re-stated the exact same information but in a more concise manner. This has improved the response, not diminished it!

Students work

|  |
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| One of the important benefits of fire is in forestry, where fires often aid in the regeneration of forests. A proposition was made by Smith *et al* (2009) that indicated that the frequency of brushfires was correlated with the number of melaleuca trees saplings in the area. These saplings are important as they provide eucalyptus oil which is the second largest horticultural sector in Australia. The eucalyptus oil industry is a significant contributor to the Australian export market. **78 words**  |

Re-stated

|  |
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| Forests benefit from the regenerating effects of fire. Smith *et al* (2009) indicated that brushfire frequency was correlated with melaleuca sapling density. These saplings produce eucalyptus oil. The eucalyptus oil industry is the second largest horticultural sector in Australia and contributes significantly to our export market. **49 words**  |

Selecting words carefully and omitting any unnecessary words can eliminate wordiness. Here are some examples of common changes:

|  |  |
| --- | --- |
| **WORDY**  | **CONCISE**  |
| One of the problems  | One problem  |
| In only a very small number of cases  | Occasionally / Rarely  |
| An additional piece of evidence that helps to support this hypothesis  | Further evidence supporting this hypothesis  |
| In spite of the fact that knowledge at this point is far from complete  | Although present knowledge is incomplete  |
| It is also worth pointing out that  | **Omit it**  |
| Before concluding, another point is that  | **Omit it**  |
| It is interesting to note that  | **Omit it**  |

The following table indicates what is included and excluded in the 1500 – 2000 word count from the policy handbook.

|  |
| --- |
| **Determining word length count of a written response**  |
| **Inclusions**  | • all words in the text of the response • title, headings and subheadings • tables, figures, maps and diagrams containing information other than raw or processed data • quotations • footnotes and endnotes (unless used for bibliographical purposes)  |
| **Exclusions**  | • title pages • contents pages • abstract • raw or processed data in tables, figures and diagrams • bibliography • reference list • page numbers • in-text citations  |

General Guidelines

Follow these guidelines for your work.

Written Work

* 1.5 line spacing
* 11 point (Arial or Calibri font recommended)
* Header on each page including student name, teacher name, and submission date.
* Footer on each page including page number.
* \*Stapled with no loose leafs
* \*Task sheet attached to front of final copy.

\*Note: You will hand in your work through Turnitin (you **must** do this by the due date) however you should also have a hard copy of your final copy available to be handed in to your teacher. This is done either on the due date or in the next lesson after the due date. No changes can be made to your hard copy after you have submitted through Turnitin on the due date. The hard copy will allow your teacher to make annotations on your work where appropriate.

Figures

Figures include graphs, maps, photos and technical diagrams. Presentation of data in graphs is generally more desirable than tables because they aid the reader in visualizing trends in the data. There are many different types of graphs, but the most common graphs used in scientific writing are line graphs, used for continuous data such as time and temperature (Fig. 1), and vertical bar graphs used for discrete data such as apples vs oranges OR boys vs girls (Fig. 2). Regardless of the type of graph you use, all contain similar elements.

1. **Axes**. A graph consists of a horizontal axis and a vertical axis. The independent variable is plotted on the horizontal axis (bottom line) and values of the dependent variable (the effect or the outcome you measured) are plotted on the vertical axis (up and down line).
2. **Labels**. Both axes should be clearly labelled and include units of measure.
3. **Data Points**. These should be visible and include errors bars where appropriate.
4. **Figure Caption**. There should be a figure caption ***below*** the graph that briefly describes the information in the figure. It should be clear, concise, and informative. The figure caption should be understandable ***without reference*** to the text and answer, if appropriate, “what”, “where”, “when”, and “why”. Figures are numbered in the order they appear in the text.

Tables

In contrast to figures, tables allow precise numerical presentation of data. As with figures, they should be concise and organized such that relations and trends in the data are evident without reference to the text. All tables contain similar elements.

1. **Title**. Tables are numbered in order they appear in the text. The title briefly describes the information presented in the table and is presented at the ***top*** of the table.
2. **Column and row headings**. Column headings identify variables or data in each column below the heading. They contain variable names and units of measurements and the uncertainty in the measurement. Row headings identify entries in the rows to the right of the heading. Note that only the initial letter of words or phrases in column and row heading is capitalized.
3. **Body**. The body contains the data presented in the table. Data should be presented so that similar elements read down (i.e., in columns). When presenting numbers, give consistent numbers of significant figures; enter numbers in a column under the column heading.

1. **Horizontal lines**. Horizontal lines separate the table title from the column headings, the column headings from the subheadings and the column headings from the body

Example

Table 1: Changes in the mass of 1cm potato cube over time for the concentrations of salt 0.5% and 1.0%.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| % Salt (NaCl)  | Initial Mass ±0.005 (g)  | Mass at 5 min ±0.005 (g)  | Mass at10 min ±0.005 (g)  | Mass at 15 min ±0.005 (g)  |
| 0.5  | 0.34  | 0.34  | 0.35  | 0.35  |
| 1.0 | 0.37  | 0.37  | 0.38  | 0.39  |