**HOW TO WRITE A DEADLY ERT**

***in the Persuasive Exposition Genre***

***for Senior Chemistry***

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**INTRODUCTION**

This article is about completing an Extended Response Task in Queensland Senior Chemistry in the *persuasive exposition* genre.

**What is an Extended Response Task?**

An Extended Response Task (ERT) is an assessment instrument that requires you to respond to a “science question, statement, circumstance or issue”. It is essentially non-experimental, but will require research and use of secondary (someone else’s) data – although you may have to draw on primary (your own) experimental data.

**What is Persuasive Exposition?**

Persuasive exposition is just one type of genre. In a ***persuasive exposition*** ERT you have to argue for (or against) a statement usually called a *thesis*, *focus* or *topic* statement) and provide evidence to justify your claims. For example:

* *That ozone depletion and greenhouse effect are serious environmental problems but are not linked.*

**THE RESEARCH & WRITING PROCESS**

There are two phases to preparing your ERT: *Research Phase*, and *Writing Phase*. You can’t do the writing without the research.

**THE RESEARCH PHASE**

**1.1 PREPARATION**

**(a) What is the purpose of the background “stimulus” information?**

Your ERT is likely to be introduced with some background information. This will set the scene for the task by relating it to you personally and possibly putting it in a social context. The aim is to help you understand the task and guide you to your initial research.

Here’s an example of a stimulus about airbag safety:

You are a science reporter for the magazine “Science Nation”, a magazine similar to the “New Scientist” magazine, but focussing mainly on producing science articles clarifying issues for senior science students and the general public with an interest in science.

Your editor has just asked you to produce an article to be titled “The Death of Ozone by the Greenhouse Effect: Myths Busted”.

As your editor explains to you, there is a lot of confusion in the public about these two issues (i.e. ozone depletion and the Earth’s warming via the greenhouse effect). In the eyes of some members of the public, it is thought that the burning of fossil fuels will eventually be responsible for the destruction of the ozone layer, meaning all on Earth will die as the dangerous sun’s rays hit Earth. To others, the issue is a non-event, as scientists and governments have stopped the use of dangerous chemicals called CFCs and any damage will be repaired by time. The editor wants you to propose a strong statement (thesis) and write an article to argue the case.

**(b How do I develop a focussed topic for my ERT?**

There are two things that you need to consider when proposing and developing your ERT topic: these are the *Research Question* and the *Thesis (or Focus) Statement*.

**(c) How do I develop a Research Questions?**

In the stimulus you may be given a situation or phenomena that is contentious, controversial or socially important (eg ozone hole) and you will be expected to take a personal stand based on sound chemistry principles. The most common in science around the world are global warming, cloning, stem cells, genome projects and alternative fuels. The research question can be fairly broad but will identify a query about this 'world out there' with some chemistry ideas relating to it. If your topic is, for example, the chemistry of the atmosphere; your research question should not be something simple like *What is the ozone hole?* A question of this nature will limit your ability to access the criteria in the upper achievement levels. It would be better to ask: *Are ozone depletion and greenhouse effect linked?*

**(d) How do I develop a thesis (focus) statement?**

A thesis statement is a tentative statement about an observation, phenomenon or scientific problem (posed in the Research Question) that you can argue about. You may also see it referred to as the *focus*. It should be something that people could reasonable have differing opinions on. Just as a hypothesis in an EEI has to be testable, a thesis or focus statement in an ERT should be debatable and resolvable based on clear logical chemistry concepts and facts; that is, it must allow you to bring scientific evidence forward to justify your stand, resolve opposing views and come to a conclusion. If it requires no scientific concepts or data about real-world phenomena then it is not a science ERT – and it won’t allow you to meet the full range of syllabus criteria.

Your teacher may provide the research question and a thesis statement but you may be encouraged to develop your own within the context of the unit. If you do develop your own focus you are better able to demonstrate *formulation of justified significant questions/hypotheses* – an essential element in mastery of the argumentation genre and one of the syllabus criteria. Significant means ‘not trivial’; in other words, something that is important to society or to you personally. Be aware that some perfectly reasonably sounding ideas can soon turn completely impractical with huge time invested and a poor return.

Example of a poor (non-debatable) thesis:

* *Air pollution is a real problem.*

Of course it is – no one would disagree; no-one would say that pollution is good.

Examples of good thesis (focus) statements taken from ERTs in Queensland schools:

* *That ozone depletion and the greenhouse effect are serious environmental problems but are not linked.*
* *That biofuels are better than petrol.*
* *Based on only its chemical/biochemical properties, aspirin is a better drug than paracetamol.*

It is most likely – particularly in Year 11 – that you will be given the focus to argue. But you should be able to choose whether you are for it or against it based on clear chemistry principles. It is always better in a science ERT to argue in favour of a proposition; and to allow for that you should word it appropriately: for example, either *That biofuel is better than petrol*, or *That petrol is better than biofuel* depending on your belief or understanding from preliminary scientific reading.

**(e) What types of claims are there?**

There are several types of claims you can make. Knowing the differences may help you decide the way you want to argue. Here they are with some examples:

* *Claims of fact*: The ozone hole is no longer a problem: it is shrinking.
* *Claims of cause and effect:* CFCs and CO2 have destroyed the ozone layer.
* *Claims about solutions or policies:* The government was correct to ban CFCs to stop us getting skin cancer.
* *Claims about value*: Biofuels are better than diesel and petrol as they don’t waste a non-renewable resource.

 **(f) How narrow should my thesis be?**

A broad focus will require too many arguments to be done in the recommended word length. You should keep you focus narrow. For example: *Renewable fuels are better than fossil fuels* is quite broad. You could narrow it to: *Biofuels are better than petrol.* Likewise: *the chemistry of drugs is important to society* would be a tough thesis as the terms “drugs”, “important” and “society” need a lot of clarification. Broad thesis statements are usually too general and will not allow you to clearly demonstrate “A level” standards.

**(g) How do I word my thesis (focus) statement?**

This is called **“framing”**. The statement can be written in a number of ways but for the purposes persuasive argumentation a simple form is: “A is better than B”. This makes it immediately apparent what the two sides of the argument are. Unless there are two sides an argument cannot occur. Using “A is better than B”, the two observations, phenomena or scientific problems are “A” and “B”. For example, the thesis statement “Nuclear magnetic resonance imaging is worth the risk” could be reframed to read “In spite of the risks, NMR imaging is *better* than the alternatives. If “better” is not an appropriate word then you still need a comparative word linking the opposing views. Comparative words that you could use are “better” or “worse”; and “same” or “not the same”. For example: “Microwave cooking is not the same as radioactive medical treatment”. Remember, you want to reframe the thesis so that you can argue in favour of it.

This statement needs reframing: *The use of radiation for the treatment of foods is an effective and safe way to extend the shelf life of perishable foods and address an impending crisis in food shortages in the world today*?The reframed statement would be something like *The use of radiation for the treatment of foods is better than not irradiating food in terms of effectiveness and safety, to extend the shelf life of perishable foods and address an impending crisis in food shortages in the world today.*

Framing establishes your authority over the way the argument will proceed. It immediately puts you in command and control.

**(h) How do I deconstruct the topic?**

The object here is to ‘define the topic', that is, elaborate or define the key words (digital, analogue, laser, microwave etc). If one of the words is “better” or “best” then the definition is particularly important. You could define it in terms of: cost, efficiency, longevity, energy use, safety, thrill, speed, quality of life etc. We must never forget that this is a **Chemistry ERT** and the emphasis must always be on establishing the chemistry facts, concepts and understanding. The syllabus criterion says “analysis and evaluation of complex scientific interrelationships” and the word scientific is underlined because we are most interested in the science that is going on and not so much the other social issues that may impinge upon it. Keep the science to the forefront at all times. That’s what your chemistry teacher will be looking for.

**1.2 RESEARCH**

**Can I work in a group?**

Your teacher will probably allow some class time for you to be able to effectively undertake each component of the ERT. You may be allowed to work in pairs or small groups during the initial stages when you discuss the focus and come up with a research question and thesis statement. You may work together to decide your stand on the topic; understanding the chemistry concepts concerned and how you will tackle the task. However, the writing will be done individually.

**Do I need a logbook?**

You may find a journal or logbook helpful for recording important points when you begin writing. They will also provide evidence that you have personally engaged in research (important when the teacher has to authenticate your work). You will need to date all entries. Schools often encourage weblogs, *OneNote* or *Moodle*.

**How do I go about the Research Process?**

**(a) Conduct a preliminary literature/internet search about the topic; read broadly.**

You may already have an opinion on the topic but you need to become more informed so you begin by reading up on it. Gather and sort information and data from a variety of sources, and write down appropriate references in your log if you keep one. You may need to make some assumptions about quantities or do calculations.

**(b) Identify, interpret, analyse and explain relationships between underlying science concepts/ideas**

You should now try to work out which scientific concepts are involved. One way is to draw a *concept map*. ‘Concepts’, in this sense, include events (eg collisions), ideas (momentum) or objects (air bags). A concept map provides one of the best methods to sort out what the important concepts are, and how they inter-relate. The similarities between two different ideas that you are arguing about will become clear; so too will the differences. Here’s the process:

* 1. Use your stimulus article and Research Question to identify key scientific concepts (events, ideas or objects). List these concepts (usually 5 to 10 is enough, and then add concepts that you discovered during your preliminary research so you end up with about 10 - 15 concepts You should also include the words defining ‘better’ if that is a part of your topic.
	2. Rank order the concepts in the list from most general to most specific. Start with the concepts from your thesis statement at the top of the list. This list is called the ‘parking lot’. Some concepts may remain in the parking lot as the map is completed, if you cannot see a good connection for these with other concepts in the map.
	3. Construct the preliminary map by writing the concepts on Post-it notes or using CmapTools computer software (free download available at <http://cmap.ihmc.us>).
	4. Once the preliminary map is built look for crosslinks (eg between *greenhouse effect* and *electromagnetic radiation*). Use arrows to join concepts.
	5. Be selective in identifying crosslinks and be precise in identifying linking words between science concepts.

|  |  |  |
| --- | --- | --- |
|  | is heating of the atmosphere caused by the absorption of |  |
| Greenhouse effect |  | electromagnetic radiation |

* 1. Revise the map, reposition concepts in ways that lend to clarity and better overall structure to prepare the final map.
	2. If any concepts do not relate to chemistry concepts then prune them out.

Alternatively, you may need to analyse the data and/or do a series of calculations to determine a position on the research question.

**(c) Tentatively commit yourself to a position**

Record your thinking in your log → Read more narrowly or analyse more thoroughly → Take a final position and state your thesis. If you can’t take a final position, read broadly or rework your data until you can.

**(d) What sort of evidence do I want?**

There are two types of evidence:

1. First hand – in which you have conducted the research yourself such as an experiment (eg EEI), interviews, surveys, personal experience, and anecdotes;
2. Second hand data is that supplied and compiled by others, for example: textbooks, journals, newspapers and websites. In an ERT you are more likely to be using second-hand data, but there are many ERTs based on a student’s own data collection from an experiment. You should also ask yourself what sources does my reader value? The reader (teacher) is more likely to value journals such as *New Scientist* more so than a newspaper; and value internet sites from government organisations or universities over unspecified ones. When you make mathematical calculations using science formulas (eg n = m/M) you are using second-hand data to justify your thesis statement.

**(e) Reconstruct your thesis (synthesise data)**

Write down, specifically, an outline of how you will use these concepts to make an argument for your thesis and against the opposing views.

**WRITING PHASE**

**How many words do I need to write to get an A+?**

Your task sheet probably gives recommended work lengths for your assignment (eg 800-1000 for Year 11, and 1000-1500 for Year 12). However, you can go over or under these recommendations if you need to. The criteria in Queensland schools for an “A” will require you to “discriminating selection, use and presentation of scientific data and ideas to make meaning accessible”. If it takes you extra words to do this, then so be it. But your teacher will be looking to see if you have used words and numerical data “with discrimination” and not waffled on. You should aim to stick to the recommendations; you don’t want to test your teacher’s patience. The important point here is that you can produce an ERT in 1000 or 1500 words worthy of an A+. It has been done and is being done. Getting a narrow, correctly worded thesis is critical, even if it means reframing it. As a reminder: one A4 page is about 250 words of double spaced 12pt font.

**How much feedback from the teacher will I get?**

Your task sheet will specify a number of “checkpoints” where the teacher will monitor your work. There will most likely be one at the end of the research phase, and one when your draft is finished. Your teacher will provide feedback to provide ethical guidance and to monitor your work for progress and authenticity (Teachers are required to implement strategies to ensure authentication of student work). Feedback and assistance is usually fairly general (maybe in the form of a checklist) and you should not expect them to rewrite parts for you or tell you if it worth an “A”. Don’t submit your draft for feedback until it is complete (or almost complete) and you are generally satisfied with it. As you get more experience and confidence (by Year 12) you will get less feedback. However, you can use the feedback process more strategically. It makes a difference if you can present your argument face-to-face as well as in writing. During the drafting process you will be required to submit a draft to your teacher but you should also get a chance to discuss the argument face-to-face.

**Should I include diagrams?**

The answer is “yes” providing they function as a better way of presenting a part of your argument instead of words. Remember – a picture is worth a thousand words. Students generally lift images from books or the internet and rarely acknowledge the sources. Sources must be acknowledged. You can also *PhotoShop* them to remove unnecessary words or add explanatory captions. They should be labelled (Figure 1 etc), given a caption (“Diagram of the photochemical reactions in …”) and referenced in the text. If you are making calculations using physical quantities such as time, distance, force, temperature, mass etc diagrams will be just as important as when you solve problems in other formats.

**Should I include calculations?**

This will depend on the type of response you are presenting. If you need to make assumptions about quantities (eg mass, time, rate, temperature) or perform mathematical calculations to justify your conclusion or to come up with a solution (answer) then these need to be shown. Extensive calculations may be better in an appendix which is referred to in the text.

**Who is my audience?**

Your task sheet may specify an audience; that is, the recipients of your information. In real life, audiences have different *backgrounds*, *attitudes* and *purposes* for receiving your work. The earlier stimulus on airbags specified an audience with a senior science background. It is very unlikely that you would be writing for a more expert audience, and if your task sheet doesn’t mention it – assume you are writing for your classmates who are just interested and unbiased readers. Whatever you do don’t load up your response with formulas and technical terms that are way beyond the audience. You’ll be marked down for sure.

**What about the “format” (medium)?**

This article is scaffolding you in the genre “persuasive exposition” but the *format* of your response can be varied, depending on what the task sheet requires. I’m assuming you are preparing a *written paper* so that is your *format*. In other subjects it could be a debate, speech, letter, billboard, movie and so on.

**What about “time”, “place” and “community”?**

All arguments occur in specific contexts or environments. You may have to write your assignment set in a specified *time*, *place* and *community*. In the senior sciences we can safely assume you are writing for an audience with the *time* set in the present. However, the *place* could be a lecture hall, a court room or a classroom; or for an assignment like you are doing – the pages of a journal or newspaper. Lastly, the *community* could be one of school children, members of a club, people at a protest meeting or a group of academics and so on. If your task doesn’t specify these things assume the reader will be at home in your home town and reading your essay in a journal or newspaper or as a written statement.

**How do I make my arguments convincing?**

Some people think that you need two people to have an argument. This is not the case. The famous scientist Charles Darwin, in his most famous book “On the Origin of Species”, wrote that it was “one long argument”. Argumentation is a contention (thesis) supported by evidence and reason. Other genres such as analytical, explanatory or discussion are also forms of argumentation. In writing a persuasive exposition you are presenting an argument and then also taking the role of the second person in questioning your evidence and logic. Some people call this imaginary ‘second person’ a *naysayer* who is providing counter-arguments for everything you say. It is like having an imp on your shoulder questioning everything you say. It helps make your argument more persuasive by insisting on evidence for your claims and logic for your reasoning.

The type of argumentation used in an ERT is similar in many ways to that used in an EEI. In both cases you are trying to use evidence and reason to support your thesis (ERT) or hypothesis (EEI). The main difference is the source of evidence: in an EEI you mainly use your own (first-hand) data obtained by manipulating variables. In an ERT you may gather some data first-hand but you won’t manipulate any variables; anyway, you are more likely to use secondary data.

**Key Rules for the Argumentation Genre**

1. FRAMING: As well as presenting arguments supporting your position, it is critical that you refute arguments opposing your argument. Students tend to think that if they provide enough supporting data the argument is won; but this is not true. You have to demolish the negative. Remember – this is an argument not a ‘discussion’ where you weigh up both sides dispassionately then make a judgement. In an argument, you have made your judgement and now you are convincing the reader that it is the only possible judgement that could be made.
2. LESS IS MORE: If you try to present too many arguments supporting your position the less value the reader will ascribe to each one of them; their power becomes diluted. Pick a few (say three) and go in hard. The other arguments you have are probably weaker and you can comfortably leave them out.
3. FACE TO FACE: It makes a big difference if you can present your argument face-to-face rather just in writing. During the drafting process you will be required to submit drafts to your teacher but you should also get a chance to discuss the argument face-to-face. Many teachers use observation checklists to monitor your progress. This is where you can make a good first impression.
4. STYLE OVER SUBSTANCE: Hesitancy in speech – such as “I mean”, “you know” and “isn’t it” – is a killer in an argument as it reduces the speaker’s power. The same is true for written words. Make the sentences sound strong and stylish as it will be more convincing. Style is very important as sometimes the reader will skim read much of your text and make a judgement on the way you write rather than the content.
5. GET THEM INVOLVED: You need to make the reader involved in your argument and you can do this by getting them personally involved. The key is to ensure they understand that you are passionate about this very important issue. The sequence is clear: 1. Make your argument personal (the issue has to be framed so that it is personally relevant to the reader, eg car accidents, radiation effects on the unborn, dangerous road conditions, eye defects and so on); 2. Get them stirred up by providing a clear (local) example the problem; 3. Offer a solution. A solution makes an argument very persuasive.

**What language conventions are there for a persuasive exposition?**

It is a formal genre and therefore, the language needs to be formal:

* Avoid colloquial expression.
* Avoid contractions (e.g. don’t/shouldn’t/wouldn’t).
* Use full sentences, paragraphs and linking sentences.
* Make varied and extensive use of cohesive ties (eg repetition and references from one sentence/paragraph to the next. These help unify relationships, and promote cause and effect links.
* Use first and second hand data (citing the source) to support arguments.
* Use a combination of past and present verb tenses (“this data **reveals**…”, “the scientists **have** **been** investigating this problem **to demonstrate** the consequences of excessive…”.
* Use of bibliographical conventions and citation of references throughout the text.

Avoid hesitancy words such as “I mean”, “you know” and “isn’t it”. These are killers in an argument whether written or spoken as they make the user seem unsure of the topic. Make the sentences sound strong and stylish as it will be more convincing.

Use “I” where appropriate in your report, after all you wrote it and certainly you should express yourself in active voice rather than passive terms. However, make sure that any personal opinion is evident as such to the reader.

**How big should a paragraph be?**

The rule is “one idea per paragraph” but you don’t want them to be too big or too small. What is easy to read for an essay (but not too fragmented) is about three paragraphs per page (perhaps 50-100 words per paragraph).

**What is the structure of an ERT?**

A widely used format for written expression is the three part model:

1. Introduction,
2. Body,
3. Conclusion.

Some call it the five part model as they break the body up into three sections.

## 1. Introductory paragraphS (1-2 pages)

The introductory paragraphs should include: a topic sentence which includes the thesis or a specific purpose statement, followed by a brief outline of the essay. This is where you establish the intention of your writing and inform the reader of what the paper is about; and outline the main points to be argued convincing the reader of your point of view. The brief outline is where you try to make your story engaging so your reader will want to read on. The best way to do this is by highlighting why the issue is personally relevant to you and your teacher; better still if you have a local example (eg radiation concerns from overhead power wires). This also can have the effect of making the reader stirred up by the problem which engages the reader even more. Secondly, say why it is relevant to society (cost electrical transmission, health dangers). Next, you should present definitions of the comparative words and of other terms that may not be familiar to your audience. You need to define these key terms so they are unambiguous. There are two types of definitions: one is the formal explanation of technical terms. You need to judge whether any explanation is really necessary for straight-forward words like ‘electricity’ or ‘nuclear waste’. The second type of definition is more important as it is so that you can position yourself to better argue your case. These are sometimes called ‘contingent’ or ‘tactical’ definitions. In the earlier example of a thesis: “That refractive laser surgery better than the use of optical devices” this is where you would argue the meaning of ‘better’ (eg lower cost, safer, simpler etc). You must avoid basing your Chemistry ERT on social, historical or emotional arguments more appropriate to other non-science subjects.

Then it is time to briefly present the three arguments you will be using and how you will be considering and refuting the opposition arguments. You should be careful not to mock the opposition because the way to persuade a reader who has an opposing point of view is to acknowledge their view and then slowly demolish it. If you are too critical from the outset you will lose the reader’s empathy and they will not want to read further.

As this is a science essay, you will certainly need to present the science behind each of the two opposing terms. You are not presenting your argument here but merely – in terms of the QSA syllabus – *reproducing and interpreting, and comparing and explaining concepts, theories, principles and phenomena*. How much about the science should you write? The answer depends on how complex and challenging the issues are but no more than two pages would be warranted (and this would include diagrams).

The last sentence of this paragraph should also include a transitional sentence that moves the reader to the first paragraph of the body of the essay.

In summary:

* Thesis (topic, focus) statement and overview
* Personal relevance
* Social relevance
* Reframed thesis
* Definitions (of comparative words, and technical terms)
* Scientific explanations (valid and accurate)
* Closing statement and link to next section

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| **Your Checkpoint:** although your teacher will be marking according to the criteria sheet, he/she will be looking for indicators of these criteria. The main ones in the introduction will be:* Is the thesis (topic, focus) clearly stated?
* Does the thesis (topic, focus) show solvability
* Are the knowledge statements scientifically valid and accurate?

**Syllabus criteria likely to apply** (aspects of, at VHA level)**:*** reproduction and interpretation of complex and challenging concepts, theories and principles (KCU1)
* comparison and explanation of complex concepts, processes and phenomena (KCU2)
* linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex and challenging situations (KCU3)
* formulation of justified significant questions/hypotheses which inform effective and efficient design, refinement and management of investigations (IP1)
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## 2. Body paragraphs (3-5 pages)

These will consist of two sections - the arguments; and the counter-arguments, although you shouldn’t label them as such.

**2.1 ARGUMENTS:**

Three arguments is the right number to have. If you try to present too many arguments supporting your position the less value the reader will ascribe to each one of them; their power becomes diluted.

**Structure**

For all arguments, the first sentence should contain a link to the transitional sentence from the previous paragraph. The subject for this paragraph should be in the first or second sentence and should relate to the thesis statement in the introductory paragraph. Remember, only one idea/concept per paragraph. If you change ideas, start a new paragraph. The closing sentence (clincher) ideally should not only sum up the paragraph, but also provide a link to the next paragraph, in order to provide fluency of expression and cohesion in the argument. Arguments and support should be logically linked and sequenced in a way that makes it easy and interesting to follow the author's train of thought.

**Quantitative evidence**

Seeing this is a chemistry task – you should be justifying your argument with quantitative (numerical) data and analysis. What you will be looking for are some ‘rich’ data sets; that is, a variety of data sets that can be analysed in ways to help your case. In the words of the syllabus you will be *attempting systematic analysis of primary and secondary data to identify relationships between patterns, trends, errors and anomalies.* When you do find relationships (eg correlation between two sets of data, or graphs that trend the same way), be careful not to say one causes the other. Just because a relationship is evident and seems plausible (logical), do not fall into the trap. You need to ask if the relationship suggests a probable cause, not just a plausible one. Lastly, in many cases you will need to make an argument using a series of mathematical calculations. Keep this straightforward: data → formula → result, and don’t get bogged down by showing the working.

**Argument 1 – the first idea that supports the argument for your thesis.**

*Data & Theory 1:*

* The first paragraph should clearly set out the first and most important argument (premise).
* It should then include the data (facts, statistics, principles, examples, real-life experiences) and the relevant theory (concepts, laws, formulas, quantities, units) that support the premise. All of the evidence (data and theory) should be specific, relevant and explanations (sometimes called *warrants* or *backings*) are given that show how each piece of evidence supports and convinces of the author's position. Be careful that if you cite scientific theories or mathematical calculations in support of your thesis, you must explain why and how they relate. It is no good just saying “supported by Newton’s Second Law” without explanation. Students do this a lot – they are not specific.
* It should then draw a clear connection to the conclusion (thesis); and most importantly – it should be plausible. The last sentence in this paragraph should include a transitional statement that ties into the next paragraph of the body.

Example 1: For the ozone and greenhouse thesis, the first argument could be:

 Premise 1: that “link” means have similar causes (your definition)

 Premise 2: that ozone depletion and greenhouse effect have different causes (your evidence)

 Claim: ozone depletion and greenhouse effect are not linked (logical reasoning)

**Argument 2 – the second idea that supports the argument for your thesis.**

*Data & Theory 2:*Begin with linking words that makes it clear that you have another piece of evidence to support your argument in favour of the thesis. Repeat the three points above for your second argument. As said before, the last sentence in this paragraph should include a transitional statement that ties into the next paragraph of the body.

Example 2: For the ozone and greenhouse thesis, the first argument could be:

 Premise 1: that “link” means have similar effects (your definition)

 Premise 2: that ozone depletion and greenhouse effect have different effects (your evidence)

 Claim: ozone depletion and greenhouse effect are not linked (logical reasoning)

**Argument 3** **– the third idea that supports the argument for your thesis.**

*Data & Theory 3*:Repeat the process used for Argument 2 above for your third argument. You do not need more than three arguments. You will probably find that your 4th and 5th arguments are weaker and will inevitably detract from your main points. Expert public speakers know this to be true. The last sentence in this paragraph should include a transitional statement that makes it clear your major premises have been stated but will be brought together in the summary. This will tie it into the next paragraph of the body.

Example 3: For the ozone and greenhouse thesis, the first argument could be:

 Premise 1: that “better” means cheaper to make (your definition)

 Premise 2: that digital fabrication has mass market cheapness (your evidence)

 Claim: digital is better (logical reasoning)

**Argument Summary:** Begin by reminding the reader that three arguments have been presented to support your thesis, and that you have justified them by providing evidence using first-hand or secondary data, or theory and facts taken from an authoritative and reliable source. Then you need to summarise them and present a tentative conclusion. Your concluding sentences should state that the data and theory combined are a logical argument for your thesis; that is, there are no errors in logic. You should acknowledge that some of the evidence can be challenged but that in the next section you will raise and rebut any limitations of your evidence and reasoning to show how they remain valid. This is the “killer” section in critical reasoning.

**2.2 COUNTERCLAIMS (REFUTATIONS) & REBUTTALS**

Here you can qualify the limitations of your arguments in terms of the quality of the data you used, the supporting formulas or theory, and the logical process you have adopted. Not all of the following points need to be used – only where and when appropriate. You can lump them all together in a “Counter-claims and Rebuttal” section or you can address them in each of your three arguments.

**DATA**

**Quantitative Data Refutation 1:** You should examine the data that has been presented by you or by the stimulus. In it you should examine the quality of the data: is it appropriate for the argument; is there sufficient data to make the claim; is it up-to-date and does it apply to the thesis today; has it been collected fairly by impartial (unbiased) observers; could there be errors in the data because of limitations of the measuring devices; could there be mistakes in the data because of sloppy collection (eg reading of scales); were the observers qualified.

Example: a scientist claimed that the variations in ozone concentrations is natural ………

**Quantitative Data Rebuttle 1:** You should then rebut any refutations that can be made in relation to the data. If your argument can possibly be refuted by any points you have raised in the “Refutation” above, then this is your chance to explain why your use of the data is sound, appropriate and logical. If you cannot do this you should be honest and say so.

Example: data provided by the CSIRO has been peer-reviewed and is considered robust.

**Qualitative Data Refutation 1:** Students tend to take trustworthiness of scientists and their data for granted. You should examine the theory that has been presented to you in the stimulus or that you have located on the internet or book as support for the claim using the above-mentioned data. There is a lot of rubbish on the internet – and a lot of it by scientists commenting outside their area of expertise, or for some more sinister reason. You should examine the *authority* on which the claims in the theory have been made:

* Is the theory presented correctly without mistakes;
* Are the formulas, units, quantities, and symbols correct and appropriate;
* Have scientific terms been used in an everyday sense to change the meaning;
* Does the theory apply to a limited range of situations or is it able to be generalised more broadly;
* If you are quoting or responding to the claim of a scientist, is it in the scientist’s field of expertise? That is, a rocket scientist may not be an expert in climate science.
* Is the cited expert really an expert?
* How recent is the source? Table of constants and properties of elements may be still fine even if published 20 years ago, but data on communications, electronics, diseases, and plastics may go out of date quickly.
* How authoritative is the expert? Are they recognised by colleagues as an outstanding expert?
* If several scientists disagree on the topic, have you consulted several experts as well?
* Is supporting evidence available, and is the statement by the scientist in accordance with this evidence?
* Is the expert’s statement clear and intelligible, and correctly interpreted?
* Does the scientist have a vested interest in the research? That is, does the scientist work for a company or institution with a financial interest in the research; if so, you may have to question the scientist’s personal reliability (is he/she honest, unbiased, and conscientious?). This has been a problem in the asbestos, cigarette, swine flu, mobile phone, vaccination, nuclear and oil industries.

**Qualitative Data Rebuttle 1:** You should then rebut any refutations that can be made in relation to the theory. If your argument can possibly be refuted by any points you have raised in the “Refutation” above, then this is your chance to explain why your use of the data is sound, appropriate and logical. For example, if it could be claimed that the theory is “old”, state why it is still current and not superseded.

**ASSUMPTIONS**

**Assumptions 1:** You will use a lot of unstated assumptions in your justification. Is there any way you could be challenged on your use of theory, formulas, terms and so on? Is it logical to use this theory in support of your claim? Is this argument commonly used by experts in the field? Are all assumptions you have made about physical quantities (such as mass, forces, volume, time etc) reasonable?

**Assumptions Refutation 1:** Are there unstated assumptions made in supporting the claim? Could you be challenged with the statement: “no one has used this theory before to support such a claim”. Critics will often say “you don’t have enough evidence; there may be a situation scientists haven’t seen which refutes your claim”. If for instance you have made an assumption about the coefficient of friction on a particular road surface, could someone ask “how did you know it wasn’t raining?”.

**Assumptions Rebuttle 1:** Say why the assumptions are appropriate for the claim. To the argument that “a case may come along one day to refute your claim” you merely have to acknowledge this and say that on the current evidence your claim is the simplest and best there is.

**LOGICAL REASONING**

**Logical reasoning 1:** In you summary of the arguments you should have stated that the data and theory combined are a logical argument for your thesis; that is, there are no errors in logic. If you used the logic of: “premise 1, premise 2, conclusion” fairly then you should be safe. This also applies when you are selecting formulae and substituting values in to it.

**Logical reasoning refutation:** Do the data and theory logically support the argument you have made in support of the thesis. That is, is there any other claim that could also be made from the data and theory you have presented? There is a common statement in argumentation is that “correlation is not causation”, that is, because two quantities are related mathematically, one does not necessarily cause the other. For example, there is a relationship between reading ability and shoe size: the larger shoe sizes correlate with better reading ability, but this does not mean large feet cause good reading skills. Instead it is caused by the fact that young children have small feet and have not yet (or only recently) been taught to read.

**Logical reasoning rebuttle:** You should critically evaluate the data for bias, emotive language, contradictions, false premises and assumptions.

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| **Your Checkpoint:***Reasoning structure** Are there multiple lines of reasoning (more than 2, fewer than 4)?
* Is the reasoning plausible?
* Is the reasoning logical?
* Do the lines of reasoning converge to a conclusion (has there been linking and application of algorithms, concepts, principles, theories and schema)?
* Has the reasoning been put with conviction?

*Observational Evidence (Data and Theory)** Is specific empirical (observable) data used?
* Has the method of gathering and interpreting empirical evidence been justified and evaluated?
* Are the data (including theory) appropriate and relevant? Are they clearly identified?
* Are they clearly explained?
* Are they sufficient?
* Has the explanation of why or how the data supports the claim been made (including the underlying assumptions that connects the data to the claim)?
* Have unsubstantiated statements or generalisations been avoided?
* Are there sufficient and appropriate “inscriptions” (graphs, diagrams, images, photographs etc)?
* Have “inscriptions” been referenced in the text, captioned and the source acknowledged?
* Is quantitative evidence included and has it been systematically analysed to identify relationships between patterns, trends, errors and anomalies?
* Have any ‘counterclaim’ statements been made to refute the data (and rebutted)?
* Have any ‘counterclaim’ statements been made to refute the logic (and rebutted)?

*Explanatory Evidence** Are the data and theory used appropriately to justify the thesis?
* Is the relevance of the data clearly stated?
* Do your claims account for all the evidence?
* Have single pieces of evidence that support personal belief been avoided (and instead a focus on the patterns and relationships in the data been made)?

**Syllabus criteria likely to be used** (aspects of, at VHA level)**:*** reproduction and interpretation of complex and challenging concepts, theories and principles (KCU1).
* comparison and explanation of complex concepts, processes and phenomena (KCU2).
* linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex and challenging situations (KCU3).
* systematic analysis of primary and secondary data to identify relationships between patterns, trends, errors and anomalies (IP3).
* analysis and evaluation of complex scientific interrelationships (EC1)
* exploration of scenarios and possible outcomes with justification of conclusions/ recommendations (EC2).
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## 3. Concluding paragraph/s (1-2 pages)

Each sentence should sum up the main idea or point of the individual paragraphs in the essay. These paragraphs are the summary paragraphs. The conclusion should be very strong and clear and follow logically from information collected and judgments made and must not introduce new information. Ideally, it would contain three critical conclusions: Firstly, an effective restatement of the position statement should strongly begin the closing paragraph. This is the main conclusion. It is important to restate the thesis and the supporting ideas in an original and powerful way as this is the last chance the writer has to convince the reader of the validity of the information presented. Secondly, you may be able to state a conclusion about the limitations of the argument; and thirdly – a conclusion about the implications of your thesis. In essence, you would make the following:

1. A restatement of the thesis statement, using some of the original language or language that "echoes" the original language. (The restatement, however, need not be a duplicate of the thesis statement.)
2. A summary of the main points from the body of the essay and how they link to this thesis.
3. A statement about the limitations of the argument and the thesis (can you generalise this idea to other areas in industry or society, or do they only apply to the narrow area of your thesis statement?.
4. A final statement that gives the reader signals that the discussion/presentation has come to an end. This final statement may be a "call to action" or the implications of the thesis. It is sometimes where you can offer a solution to the reader. Students often think “what more could I possibly say?” but your last few sentences should leave a lasting and profound impression on the reader (well, try to anyway).

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| **Your Checkpoint:*** Is there a statement that the thesis is supported?
* Have other conclusions (acceptable alternative explanations) based on the evidence been considered and weaknesses in them challenged (rebutted)?
* Is a reflection on possible future action or consequences offered?

**Syllabus criteria** (aspects of, at VHA level)**:*** exploration of scenarios and possible outcomes with justification of conclusions/ recommendations (EC2).
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**4. REFERENCES, FOOTNOTES & BIBLIOGRAPHY (1 PAGE)**

To provide credibility to your argument you will need to present a Reference List and a Bibliography. Students treat these as two fairly unimportant aspects of the writing. However, you should see them as a way to bolster your argument and a way to provide evidence that you have engaged in the research process (to help authenticate the work as being your own).

**(a) REFERENCES & FOOTNOTES**

References are used to acknowledge the source of comments, quotations, diagrams, photos and so on. Citation of primary sources establishes that you have gone to the trouble of finding the original source of the material rather than rely on someone else’s report of it. Citations show that your argument rests on solid foundations and that your comments should not be treated lightly. Acknowledgement of secondary sources will show you have still provided evidence of the source of your material to bolster your case. *Footnotes* or *endnotes* can also be used to show the examiner that you have additional interesting and relevant material to elaborate the point you are making but that it is incidental to your argument. The last thing you want to do is to upset the flow of your logic as this is where the power of your argument comes from. It will create a favourable impression; an impression that you are genuinely interested in the argument and that you can cater for stylistic and logical needs.

**(b) BIBLIOGRAPHY**

A bibliography is a list of sources that you have consulted during your research. It is different to a Reference List in that you can cite sources that were read but not quoted. Bibliographies and Reference Lists are usually treated as proof that you have consulted more than just one source or format (not just the internet, but books and journals for example). The Bibliography is used to assert that your argument is credible and the quality of the research is high. You don’t need to cite every source you consulted; you should be discriminating. There are two approaches: *focused* and *broad*. A *focused* bibliography will have a few, very specific, highly relevant, recent, authoritative sources in different formats and can be very persuasive as they show your competence and control of the subject matter. Alternatively, you can show that you have consulted a *broad* range of sources and have left no stone unturned in your quest to get to the bottom of things. Sources should be listed alphabetically according to the referencing style advised in the task sheet. Your teacher will expect to use consistent, accepted conventions of in-text citations and referencing. A simple rule-of-thumb is to use about seven references for a 1500 word assignment.

**Annotated Bibliography**

You may also be asked to annotate your bibliography; but, if not, you can do this anyway. An *annotated bibliography* is your list of cited sources (as in the *Bibliography* above), each followed by a brief paragraph that discusses aspects of the source. An annotated bibliography is useful for documenting your research in a specific area, exploring varying viewpoints, and summarizing main points from different sources. It is a powerful way to show your control and mastery.

There are two parts to every entry in an annotated bibliography: the citation and the annotation. The first is the *Citation* which includes the bibliographic information of the source (as above). Secondly, there is the *Annotation* which is a brief paragraph following the citation. Its purpose is provide a critical review of each source, including a critical analysis of:

* **Coverage**: How much detail and depth does the article include?
* **Audience:** describe the intended audience.
* **Credibility:** evaluate the credibility of the source
* **Authority**: What is the author/webpage/book’s status or credibility? Does it have its own references and are they decent references?
* **Accuracy**: How accurate is this article when compared to all the other articles, textbooks, encyclopaedia entries you’ve read.
* **Objectivity** refers to bias: Does the author show an objective approach through using objective “matter of fact” language and simply explaining the subject matter “scientifically”? This can also link back to who wrote it. I.e., are they trying to sell something? Who is paying their salary? Do they have something to gain by trying to persuade you?
* **Currency** refers to the date the article was published: Is the science and the discoveries of science current and does it show the latest information about your topic?
* **Usefulness:** describe the usefulness of the source. You should describe how useful it was for understanding the research problem and justifying the thesis statement.

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| **FOR WHOLE ASSIGNMENT****Checkpoint:*** Have the features of the genre been adhered to?
* Are the language functions appropriate (formal) and consistent.
* Is language used with discrimination to make meaning clear?

**Syllabus criteria** (aspects of, at VHA level)**:*** discriminating selection, use and presentation of scientific data and ideas to make meaning accessible to intended audiences through innovative use of range of formats (EC3).
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**Other examples**

* The use of radiation for the treatment of foods is an effective and safe way to extend the shelf life of perishable foods and address an impending crisis in food shortages in the world today.
* The effect CO2 is having on global warming
* The effect CH4 is having on global warming
* The effect H2O is having on global warming
* Acid Rain
* The pollutant CO
* The pollutant NO and NO2
* The pollutant SO2
* The pollutant CFCs and the effect they have on Ozone
* Ozone
* The science behind monitoring air quality
* Why scientist believe CO2 increase is causing global warming
* Why scientists are not sure if CO2 is causing global warming
* Earth’s energy balance
* Acidity of Ocean

**Useful Words and Phrases for Formal Argumentative Writing**

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| Examples* For example
* For instance
* This is evident
* Illustrated by
* To exemplify this
* To illustrate this
* As an illustration
* As in the case of
* Like
* Such as

Cause and Effect* Because
* Since
* As
* Owing to the fact that
* Due to
* Therefore
* Thus
* So
* Consequently
* As a result
* With the result that
* Nevertheless
* In order to
* For the purpose of
* The reason for
* Leading to
* As an outcome
* It is therefore clear
* In response to
* Led to
 | Change of Direction Markers* As the same time
* Less obviously
* At the other extreme
* Despite
* Even so
* However
* In contrast to In spite of
* Nevertheless
* Notwithstanding
* On the other hand
* Although
* But
* Even though
* Whereas
* While
* Yet

Importance Markers* It is essential to realise that
* However, these are minor issues
* That… is well worth noting
* Specifically
* Moreover
* Obviously
* If course
* In fact
* Overall
 | Linking Markers* In addition
* Moreover
* Thirdly
* Not only… but also
* Furthermore
* Again
* Additionally
* In the same way
* Similarly
* Initially
* Commencing with
* Later
* Subsequently
* Finally
* Originally
* During
* Concluding with
* Meanwhile
* Eventually
* Prior to
* Earlier
* Afterwards
* Hence
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