Researching Chemistry
2015 -2016

Antioxidants & Vitamin C

KHS Pupil Guide

Name:

Antioxidants and Vitamin C

Many of the oxidation reactions that occur in the human body are harmful and can lead to disease.

It is believed that antioxidants (chemicals that can help prevent oxidation) help keep the body healthy and even treat disease. Examples of antioxidants include vitamins A, C and E.

Food manufacturers are keen to advertise the presence of antioxidants in their products in the hope that the potential health benefits will lead to an increase in sales. However, many people claim that frozen fruit and vegetables lack the 'goodness' found in fresh fruit and vegetables.

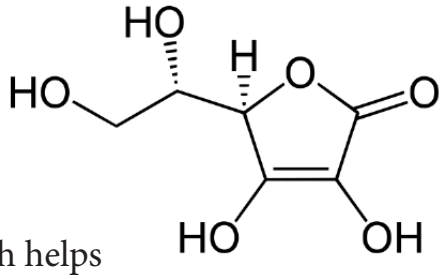
There is also the belief that fruit and vegetables lose Vitamin C over time as they are stored, transported and then sit on supermarket shelves. Fruit and vegetables are usually stored in chilled sheds in the belief that this will slow down the deterioration of Vitamin C.

Concern has recently been expressed that cooking may destroy the antioxidants in foods. Many people claim that boiling a vegetable for too long destroys the antioxidants in the vegetable.
Vitamin C

Scurvy, the symptoms of which are haemorrhages, diarrhoea, exhaustion and the tell-tale "scurvy" ulcerated gums, killed many seamen during long sea voyages until, in 1795, the British Navy ordered a daily ration of lime juice for every sailor. This practice earned them the nick-name "limeys", but all but eradicated the disease. The component of the lime juice that prevented scurvy is the reduced form of ascorbic acid, now called vitamin C.

While scurvy is no longer a major health issue, poor nutrition means it has not completely gone away even in wealthy countries like Scotland.

Vitamin C is a water-soluble vitamin found in fruits and vegetables, including oranges, strawberries, broccoli, tomatoes and green peppers. Chemically speaking it is the compound ascorbic acid $C_6H_8O_6$.



The body uses ascorbic acid when making collagen, a protein which helps skin, bone, hair and blood vessels stick together. Ascorbic acid also helps the body absorb iron.

Lots of claims are made about vitamin C, for example, taking large amounts is supposed to stop us getting colds and it may help us stop getting some types of cancer.

We need to take in about 90 mg each day. We can store up to one month's supply of vitamin C, but no more. As we cannot make it in the body, we need to keep ingesting a constant. Anyone under stress needs extra vitamin C, because the body will use it up more quickly than in a unstressed state. Smokers need more vitamin C, because smoking is a 'stress' on the body.

Cooking

Cooking can reduce the vitamin content of food because some vitamins are sensitive to heat, water and air. Water-soluble vitamins are most vulnerable to heat, particularly vitamin C and the B vitamins. The type of food preparation influences the loss of vitamins.

Choose cooking methods that use minimal heat and water to preserve the vitamin contents of food. Vitamin C is easily destroyed by excessive heat and water, as well as exposure to air. In studies, boiling caused the most loss, while steaming retained the most vitamin C.

An earlier Danish study showed that boiling for just five minutes caused 45 to 64 percent of vitamin C to be lost.

Steaming, microwaving or using a pan or wok with a small amount of water are the preferred cooking methods. The most vitamins are retained when there is less contact with water and a shorter cooking time. In the Danish study, steaming broccoli for five minutes retained almost 100 percent of the water-soluble vitamins. Microwaving and stir-frying reduce vitamin loss because they cook food quickly. Avoid deep-frying. The high heat required for frying destroys heat-sensitive vitamins.

Fresh v Frozen

As winter approaches, fresh produce is limited (or expensive)in much of the country, which forces many of us to turn to canned or frozen options. While canned vegetables tend to lose a lot of nutrients during the preservation process (notable exceptions include tomatoes and pumpkin), frozen vegetables may be even more healthful than some of the fresh produce sold in supermarkets.

Why? Fruits and vegetables chosen for freezing tend to be processed at their peak ripeness, a time when—as a general rule—they are most nutrient-packed.

While the first step of freezing vegetables—blanching them in hot water or steam to kill bacteria and arrest the action of food-degrading enzymes—causes some water-soluble nutrients like vitamin C and the B vitamins to break down or leach out, the subsequent flash-freeze locks the vegetables in a relatively nutrient-rich state.

On the other hand, fruits and vegetables destined to be shipped to the fresh-produce aisles around the country typically are picked before they are ripe, which gives them less time to develop a full spectrum of vitamins and minerals.

Outward signs of ripening may still occur, but these vegetables will never have the same nutritive value as if they had been allowed to fully ripen on the vine. In addition, during the long haul from farm to fork, fresh fruits and vegetables are exposed to lots of heat and light, which degrade some nutrients, especially delicate vitamins like C and the B vitamin thiamin.

Summary of Internal Component - 'Short Report'

You will be researching Anti-oxidants and Vitamin C.

You are required to carry out a literature search and then plan and carry out a practical investigation.

Skills, Knowledge & Understanding	***Description*** *I can:*	***Success Criteria***
1.1 Sources	* Gather and record information from two sources	* describe clearly what is to be investigated to show understanding. * reference at least two sources in sufficient detail to allow someone else to find them. * explain at a depth appropriate to H using: principles, formulae, equations, calculations, properties.
2.1 Plan and design	* Planning/designing the practical investigation, including safety measures.	* write a clear aim for the practical research investigation. * write a clear and detailed description of how the practical research investigation should be carried out in enough detail that someone else can follow it. * include safety considerations. * include observations/measurements to be made.
2.2 Practical	* Carrying out the practical investigation safely, recording detailed observations/ measurements and results correctly	* carry out practical work safely and be observed doing so. * record observations and measurements such as raw titration data and any colour changes. * repeat results where appropriate * present results in an appropriate format such as a table or line graph. * label results using correct units.

1.1 Gathering & Recording Information															
Research			Report												
	①			Background Chemistry								②	③		④
Check 1	Check 2	Check 3	Statement								Chemistry	Chemistry	References	Ref Check	All
0	0	0	0	0	0	0	0	0	0	0	FALSE	0	0	0	FALSE

① You should keep a 'Day Book' and keep a full record of your Research. Your teacher will check regularly to monitor progress and ensure that it is your own work.

② There are specific areas that you should cover in your Background (Underlying) Chemistry . You will be provided with Research questions to help you match these requirements.

③ You should provide at least two references which your teacher will check.

④ You will have to satisfy all requirements for ① - ③ before your teacher can award Outcome 1

2.1 Planning/Designing a Practical Investigation							2.2 Carry Out a Practical Investigation								8
⑤							⑤		⑥						
Involved		Report				⑦	Involved		Obs	Report				⑦	
Self-Check	Peer-Check	Aim	Description	Safety	Measurements Observationa	All	Self-Check	Peer-Check	Safety	Raw Data	Observations	Measurements	Present	Labels & Units	All	Unit
0	0	0	0	0	0	FALSE	0	0	0	0	0	0	0	0	FALSE	FALSE

⑤ You will be provided with forms that you must complete as evidence of your involvement in both the Planning and the Carrying Out of your Investigation..

⑥ Your teacher will observe you doing your Investigation to ensure that you are implimenting your Safety precautions.

⑦ Your report must be completed exactly as described in your Candidate Guide.

⑧ You will have to satisfy ⑤ - ⑧ for Outcome 2, and ① - ⑧ to be awarded a Unit Pass.

	'Short Report'		Tasks		Assignment	
Individual	*easier to plan your Practical Investigation to 'match' external Data than other way round.* *main options are:* *sources of Vit C* *effect of time* *effect of temperature* *effect of oxygen*	☞	**① *Research Data Source*** You should find ***at least one*** *external* source of Data to use as a *comparison* with the Data you will produce *experimentally*. You will be provided with some '*web starters*' but ***you*** must decide which are ***appropriate*** sources. You are free to find your own.	☞	*the source(s) will have to be properly **referenced** and you will have to **justify** in terms such as* *robustness* *validity* *reliability* *all 'raw data' should be included in report and can then be **processed** as appropriate.*	Individual
Individual	*you will need a **general focus** (background) for your research as well as a **specific aim** for your Practical Investigation.*	☞	**② *Focus Question*** You need to decide the specific aspect which you want to research. This will become the aim of your assignment.	☞	*the aim of your Assignment is **not** simply the aim of your Practical Investigation.* *however, any sources of Data that you use that are based on Practical work (own or external) must include original **Title & Aim***	Individual
Group	*you must provide **evidence** of the individual roles and responsibilities of **all** members of the group on form provided.* *the details of your plan can be taken from references, eg SSERC documentation or from methods found on web.* *can include copy but much better if written out exactly as you plan to carry it out - better understanding.* *you should also be prepared to do some preliminary calculations based on expected levels of Vit C and predicted volumes/concentration of iodine solutions available.* *use the sources researched in ① when considering suitable sources of Vit C and the implications of the various possibilities in terms of time and equipment available.*	☞	**③ *Investigation Plan*** Your plan must include: a clear aim the plan for the practical research investigation detailing: — the experiments to be done — the apparatus and materials required — any relevant points that are required to ensure consistency and a 'fair' experiment clear and detailed description(s) of how the practical(s) should be carried out. safety considerations where appropriate observations/measurements to be made	☞	*whilst there are no marks as such available for writing up the procedure (method) used SQA advice is:* *1. The marker will find it difficult to assess your **Safety** and **Evaluation** without knowing your method.* *2. An attached print-out of method may be enough but you are more likely to include all relevant information if you write your own.* *3. You may also include information that would allow the examiner to award you marks available under other headings within Assignment.*	Individual
Group	*you must provide **evidence** of the individual roles and responsibilities of **all** members of the group on form provided.* *you will be observed to ensure all safety considerations are followed.*	☞	**④ *Experiments*** You should carry out your experimental work safely. Record your observations/ measurements in an appropriate way, including repeat measurements where appropriate. You should include labelling and SI units; standard abbreviations are acceptable.	☞	*raw data must be included in assignment and then **processed** as appropriate.* *evaluation of experimental procedure can include:* *— accuracy* *— adequacy of repetition* *— adequacy of range of variables* *— control of variables* *— limitations of equipment* *— reliability of methods* *— sources of errors, uncertainties*	Individual

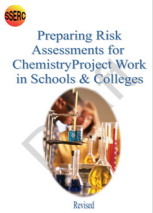
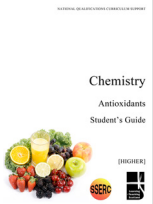
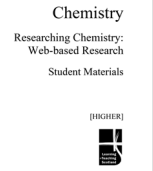
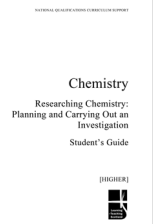
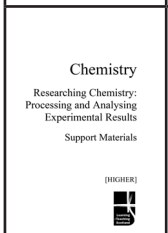
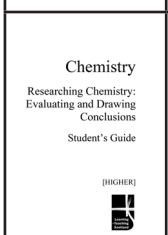
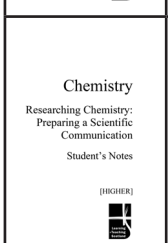
	'Short Report'		Tasks		Assignment	
Individual	*You must use at least two sources of information such as two different websites and you must record these sources of information in enough detail to allow someone else to find these sources easily. You may use a referencing system.* *In this report your focus should be firmly on VitC and Oxidation* ***What is the Nature of the Vitamin C molecule?*** *- structure* *- functional groups* *- nature of bonding* *- intermolecular bonding* *- properties (explain)* ***What is the Chemistry of the Vitamin C molecule?*** *- reactants/products* *- labels/terms* *- equations* *- balanced equations* ***How is the amount of Vitamin C determined?*** *- method/principles* *- good practice* *- calculations (equations)*	☞	⑤ ***Underlying Chemistry*** You should research the Chemistry behind your chosen topic. Stay relevant. Only ***Chemistry*** relating to Higher Key Areas will be credited - don't get carried away by the Biology/Food aspects. Key Areas could be: ***Structure and bonding*** Polar covalent bonds ***Structure and bonding*** Intermolecular forces called vdW forces. London dispersion forces, permanent dipole-dipole, hydrogen bonding and the resulting physical properties including solubility. ***Chemistry of cooking*** Influence of functional groups on solubility, boiling points and volatility. ***Oxidation of food*** Antioxidants. Ion-electron equations for the oxidation of antioxidants. ***Getting the most from reactants*** Determination of quantities of reactants and/or products using balanced equations, concentrations and volumes of solutions and/or masses of solutes ***Oxidising or reducing agents*** Elements, molecules, group ions and compounds as oxidising and reducing agents, electrochemical series as reduction reactions. Uses of oxidising agents. Ion-electron for redox, oxidation and reduction equations. ***Chemical analysis*** Volumetric titration Volumetric analysis for quantitative reactions. Standard solutions, acid base and redox titrations.	☞	*Downloads directly from the internet or copying directly from books may suggest to the assessor that you have not understood the chemistry involved. This may be considered plagiarism unless you acknowledge the **sources** carefully.* *It is always best to put things in your own words to make sure you really understand them.* ***References*** *- robust (supported by other sources)* *- valid (bias/unbiased - good/bad science)* *- reliable (source)* *You may need (or wish) to expand the range of the Underlying Chemistry to include this Key Area.* ***Skin care*** *Structure, reactivity and reactions of free radicals.* *Free radical scavengers in food products.* *Reaction of free radical scavengers with free radicals to prevent chain reactions.*	Individual
Individual	*this will be written up first and will have to be 100% 'correct' and should be in full accordance with the **Candidate Guide** provided.*	☞	⑥ ***Write-Ups*** You will have to formally write up both Reports ***under exam conditions*** using '*Day Book*' as your sources.	☞	*this will be written up second and will be sent to SQA to be marked out of 20. It should also be in full accordance with the **Candidate Guide** provided.*	Individual
school	**Internal**	☞	⑦ ***Marking***	☞	**External**	SQA

Summary of External Component - Assignment

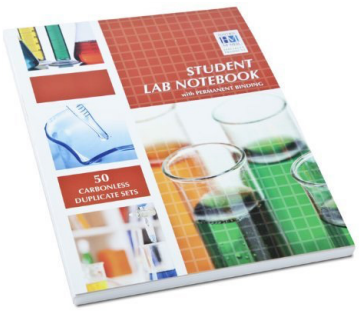
Skills, Knowledge & Understanding	Description	Success Criteria I can:	Marks available
Aim	* State appropriate aim	* describe clearly what is to be investigated	**1**
Knowledge and Understanding	* Explain underlying chemistry	* explain at a depth (Higher) using: principles, formulae, equations, calculations, properties.	**4** (4 = correct and at appropriate depth, 3 = mostly correct, 2 = some, 1 = limited)
Selecting Information	* Select sufficient relevant data / information	* include relevant information from sources eg experimental data, tables, graphs, diagrams, text.	**2** (1 = relevant but not sufficient)
Risk	* Safety measures taken	* state the appropriate safety measures taken during experimental work.	**1**
Process and Present	* Process information from the sources * Present in at least two formats	* process information from at least 2 sources eg calculations, summarise referenced text. * present processed info. in two different formats. * label all information effectively. * reference the original sources of data/information.	**4** (4 = process and present all correctly and a ppropriately, 3 = most, 2= some, 1 = little)
Analyse	* Data / information is analysed	* interpret data / information to identify relationships.	**2** (2=correct analysed data, 1 = some correct analysis)
Conclusion	* State a valid conclusion	* write a conclusion that relates to the aim. * support my conclusion using evidence from the research.	**1**
Evaluation	* Evaluate the investigation	* make judgements based on criteria such as robustness of findings, validity of sources, reliability of data/info., evaluation of experimental procedures).	**3** (one mark for each valid comment to max of 3)
Presentation	* Appropriate structure * References	* use an informative title and headings. * record at least two references in sufficient detail to allow someone else to find them. * write my report in a clear and concise manner.	**1** **1**

Other Documents Available

Researching Chemistry was introduced into the *Revised Higher* a few years ago. A number of documents were produced by *Learning Teaching Scotland* (***LTS***) and *Scottish Schools Education Research Centre* (***SSERC***) which should still be useful and relevant. They can be viewed on my website. *Skim & make Notes if useful.*

	***SSERC*** ***Preparing Risk Assessments***	
	***SSERC*** ***Vitamin C Student Guide***	
	***SSERC*** ***Antioxidants Student Guide***	
	***LTS*** ***Web-Based Research***	
	***LTS*** ***Planning an Investigation***	
	***LTS*** ***Processing & Analysing***	
	***LTS*** ***Evaluating & Concluding***	
	***LTS*** ***Scientific Writing***	

Using Your Day Book



Your Day Book will be much more than a normal Lab Notebook.You will be issued with a Jotter which you may wish to 'split' into 3 parts -

Part 1 - Your Research into Practical matters which should provide you with some External Data and a Plan for your Investigation.

Part 2 - A Record of your Investigation with all your Raw Data, Measurements & Observations.

Part 3 - Your Research into the Underlying Chemistry.

All 3 parts should be being added to simultaneously - one source may provide you with some possible Data as well as some ideas / details for your Investigation as well as including some useful Underlying Chemistry. Your Day Book should be the main Resource used when writing up your Reports (under exam conditions).

① The first page of the lab notebook should be used as a title page and should include your name, course, school, chemistry teacher and email address (so your teacher can communicate quickly and easily when necessary e.g. if needing clarification when checking your Day Book).

② The second page should be left blank to be used as a contents page. This page should be completed as you progress.

③ The remaining pages should be shared between the ***3 Parts*** listed above. Number each section (A1, A2 ... and then B.1, B.2 ... and finally C1, C2) and give each section a suitable Title.

④ To begin with, only write on the right hand side page. The left hand side page can be used for noting down other information e.g. risk assessment of the chemicals used, adaptations to the original method, calculations and graphs etc. as well as to help organise and re-draught some of the underlying Chemistry.

⑤ ***Make sure all pages are numbered and dated.***

⑥ To begin with, only write on the right hand side page. The left hand side page can be used for noting down other information e.g. risk assessment of the chemicals used, adaptations to the original method, calculations and graphs etc. as well as to help organise and reword some of the underlying Chemistry.

⑦ It is acceptable to print off and stick into your Day Book exerts from various Sources e.g instructions for an experimental set-up, but the left hand page should be used to note any amendments etc.

⑧ When writing a method, use clear language and simple direct statements in a numbered list so that instructions can be followed easily in the laboratory.

⑨ You should also note any special safety instructions in a given method, or you should write a risk assessment for the chemicals used in the experiment.

⑩ A diagram should be used to illustrate novel or unfamiliar apparatus, and should show the cross-section of the equipment. Keep it simple. Label where appropriate. Do not use diagrams for common apparatus or procedures.

⑪ Observations, measurements and data should be recorded immediately and in full (with units, where relevant). Take the lab notebook to the balances to record masses. Do not use scraps of paper and then transfer the data to the lab notebook later.

⑫ When working in pairs or groups, ensure that an individual record of all the observations, measurements and data, is taken at the time of the experiment. ***Do not rely on a copy of someone else's 'mistake'***

⑬ Data should be recorded in a table, where possible, and the table should be written in vertical columns using headers and units at the top of each column. Individual cells in the table should only contain a number; units only appear in headers.

⑭ A graph or graphs may be necessary for the experiment. Graphs should be generated from a table of data and should usually be hand drawn in the first instance.

⑮ Each graph should be drawn on graph paper, should have the experiment title and date written on it, and should be stuck in to the lab notebook as soon as possible.

⑯ Axes should be labelled with the quantity and the unit. If possible, give error bars on each point. Always use a ruler to draw straight lines.

⑰ Include clear presentation of any calculations with working that can be followed by an assessor reading the lab notebook.

⑱ Use words to explain the meaning of different steps, and include units throughout.

⑲ Comments should be made about how the results relate to or how they answer any question posed in the experimental aims.

⑳ The conclusion should state the experimental findings and should include any error analysis and any notes about unusual findings or improvements that could be made if the experiment were to be performed again.

Remember: Underlying/background Chemistry is not just for 'Knowledge' - there is Chemistry underlying Practical Techniques and Calculations as well.

Final Word - You and Your Teacher

Your challenge (as with any '*exam*') is to firstly understand (*take ownership*) what you are being asked to do and then demonstrate ***your ability*** to fulfil the various requirements. *In the middle of an exam you cannot put your hand up and ask someone to tell you if your answer is correct*.

Similarly, you cannot ask your teacher to '*read this and tell me if it is correct*'.

What you can do, for example, is ask your teacher to explain again some aspect of Researching Chemistry - listen carefully and then check to see if what you're thinking of writing matches.

The ***Assignment***, in particular, will be written up and handed in and may well be sent into the SQA without your teacher even reading it. Just like your Exam Papers. It will then be marked and a mark allocated.

The '***Short Report***' is different in that it is Pass or Fail, and you are expected to redraft sections until they satisfy the requirements for a pass. However, again your teacher is not allowed to '*tell you what to write*'. They can explain which parts of your Report are '*not perfect*' and they can try and help you recognise the problems by asking you some questions that should help you understand better what you need to do. Sometimes, they might just ask you to re-read your ***Candidate Guide*** and check yourself that you have done what was asked.

Researching Chemistry is supposed to be a *challenge*.

You should try and embrace that challenge and appreciate that you have the opportunity to learn or improve upon some really important skills and should emerge with a real sense of achievement and be stronger as a result.