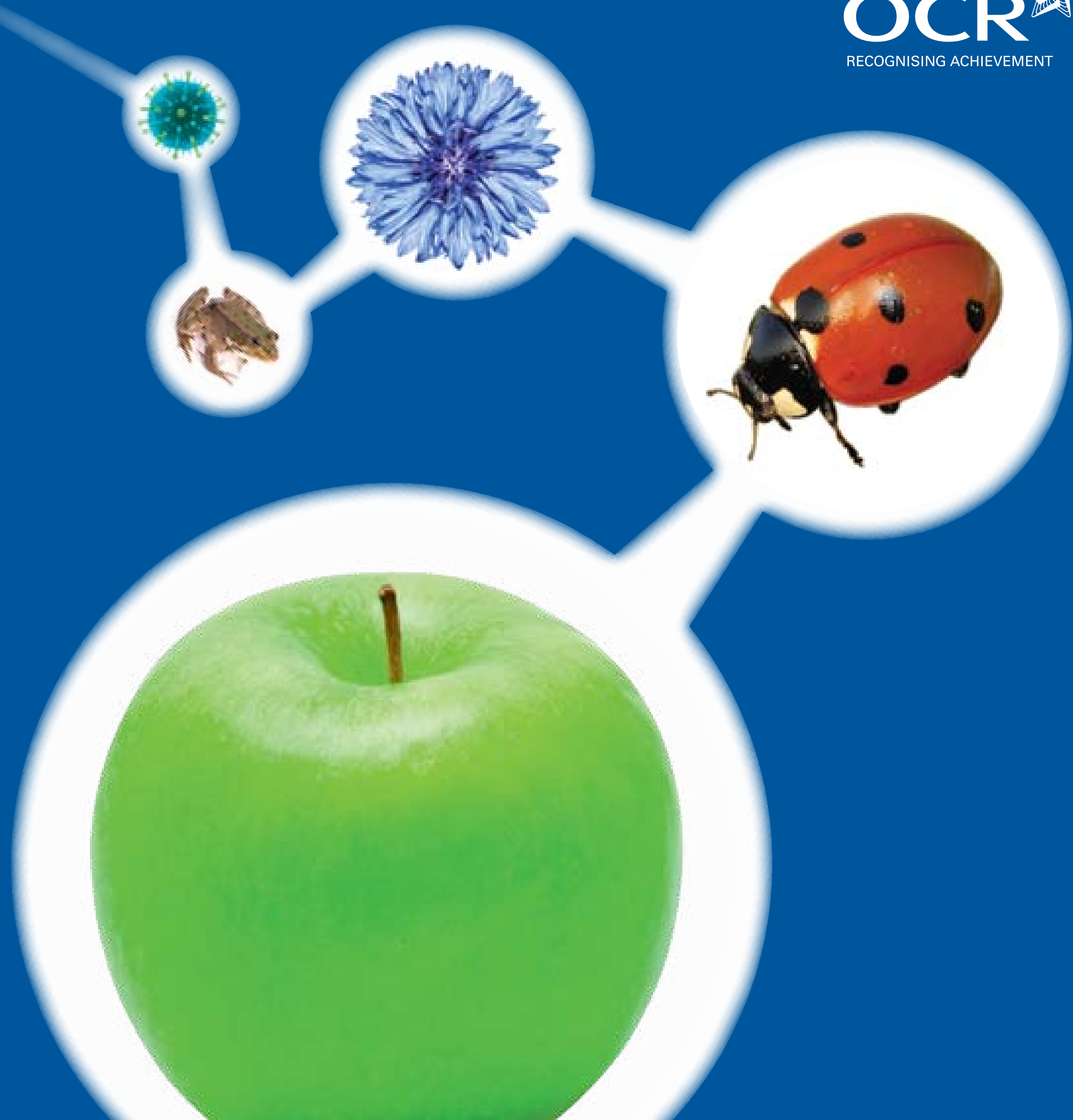

GCSE ENVIRONMENTAL AND LAND-BASED SCIENCE

CANDIDATE STYLE ANSWERS - CANDIDATE A

VERSION 1 APRIL 2012

www.ocr.org.uk/science

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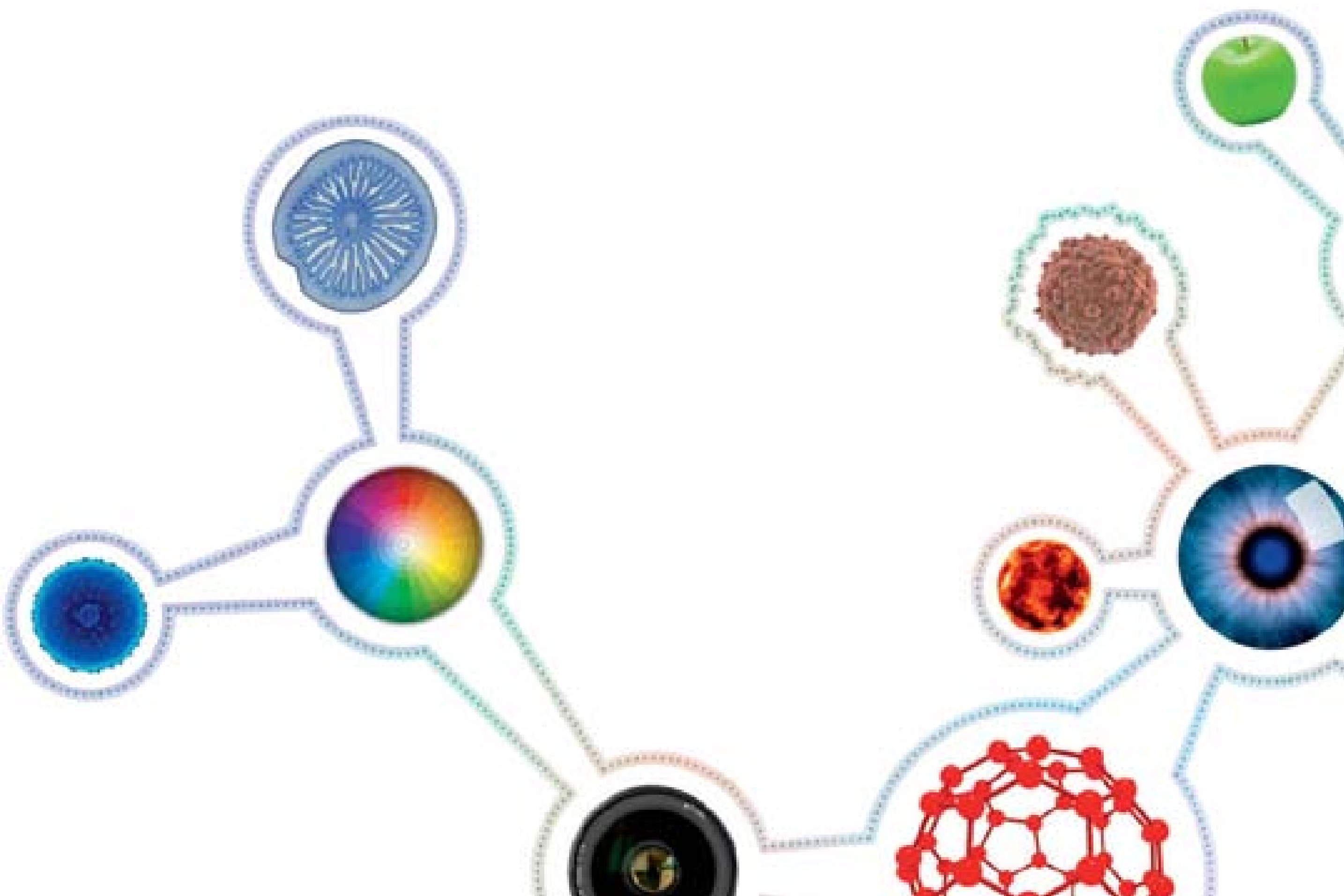


INTRODUCTION

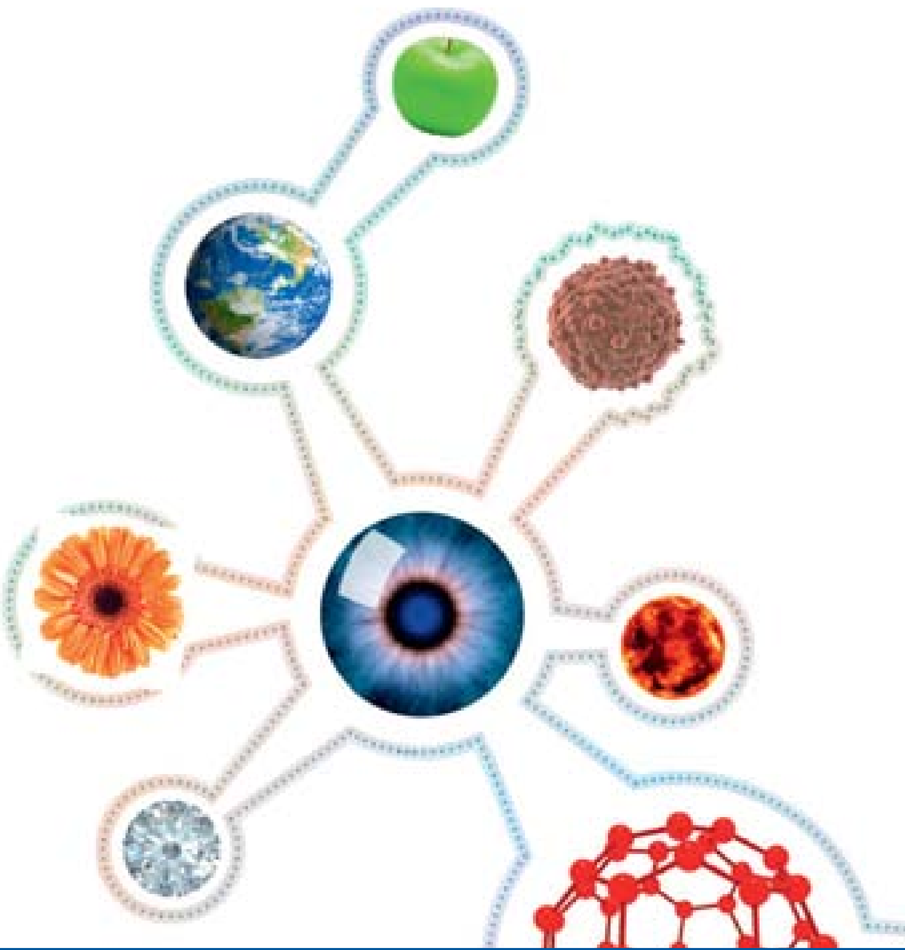
These support materials are intended to support teachers in their marking. There are three candidate style responses with accompanying commentary. These exemplars are based on the published Specimen Assessment Materials (SAMs), which can be downloaded from the relevant OCR webpage for the specification.

The exemplars and commentaries should be read alongside the Specifications and the Guide to Controlled Assessment for GCSE Environmental and Land-Based Science, all of which are available from the website.

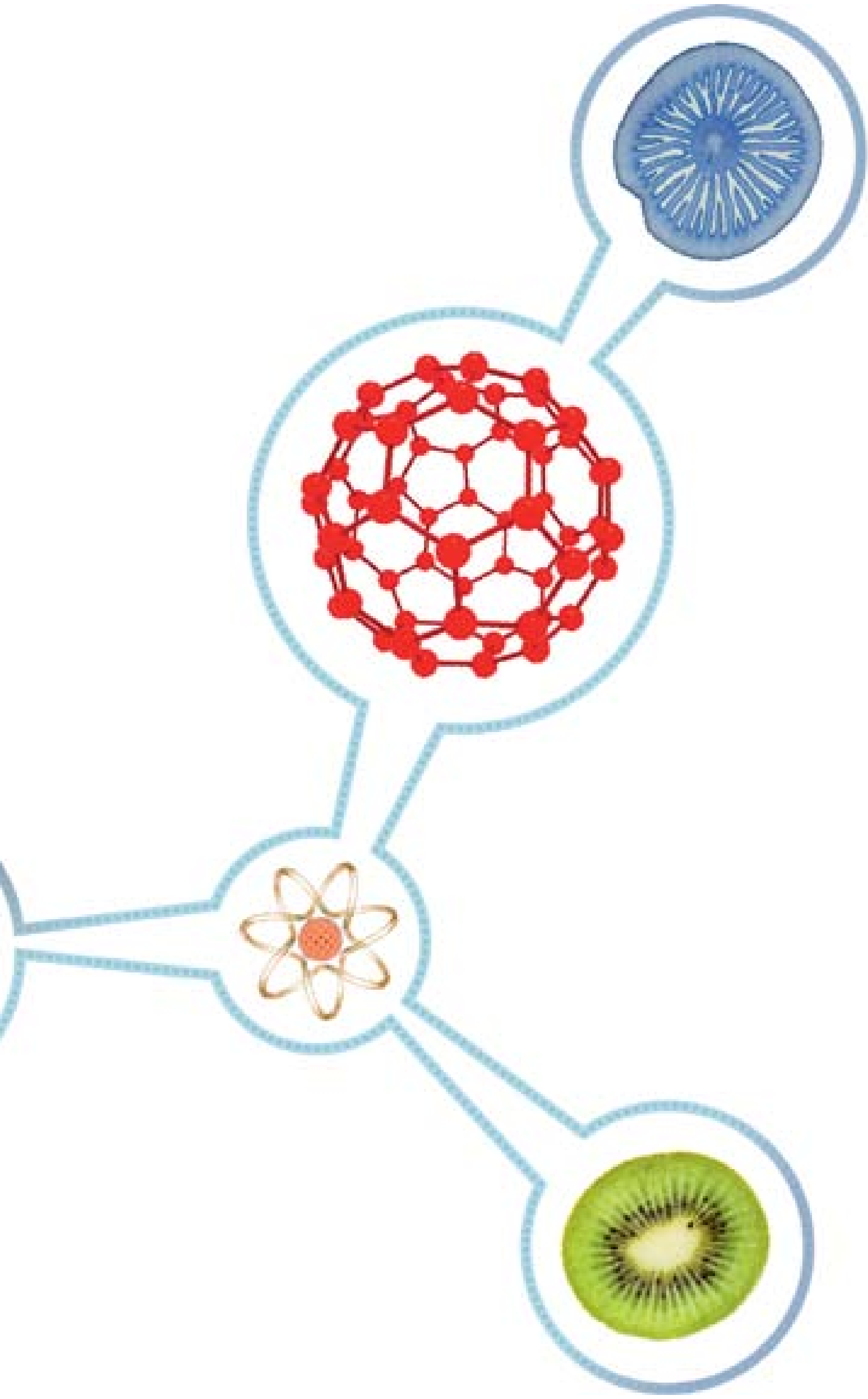
OCR will update these materials as appropriate.

Centres may wish to use these support materials in a number of ways:

- teacher training in interpretation of the marking criteria
- departmental standardisation meetings
- exemplars for candidates to review.



UNIT B681: PRACTICAL SCIENTIFIC SKILLS



Task: Carry out an ecological survey of two contrasting habitats using quadrats to collect quantitative data on distribution of plant species

View towards inland dune and dune 1

Quadrate placed in dune 3 inland note the mixed community in spite of many hostile abiotic factors.

In the photograph I am attempting to identify plants in practice quadrates so that I can apply this technique accurately in my survey.

Using ranging poles to establish a suitable line for quadrats from shore to dune 3

Dune 1 collecting data and dune 3 showing dense Erica tetralix

Collecting up our field equipment we had to take care not to lose any equipment in the dunes

Erica tetralix dune 3 in more moist and acid conditions area key abiotic factor

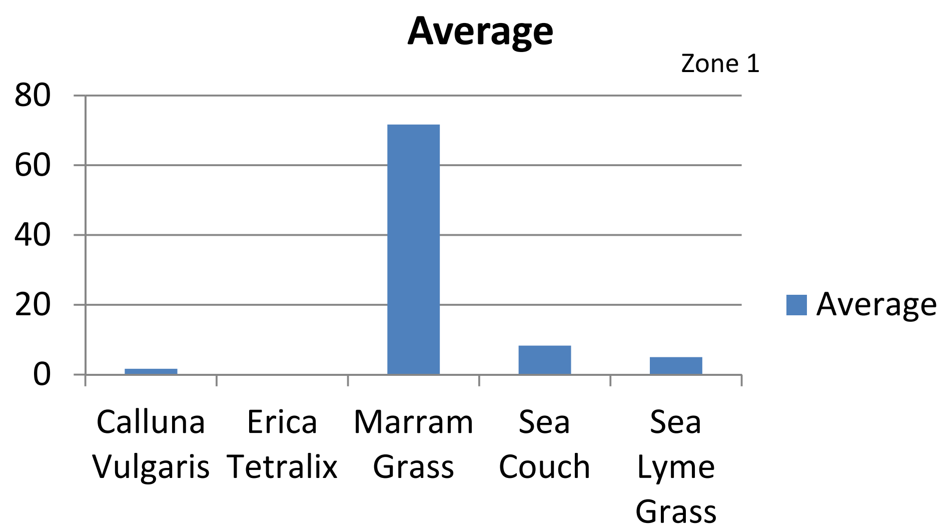
Typical vegetation inland dune 200m inland and dune 1 10m above strand line

Note Erica tetralix and still some marram grass and Calluna vulgaris

Dune 1 marram grass and some sea Lyme and sea couch

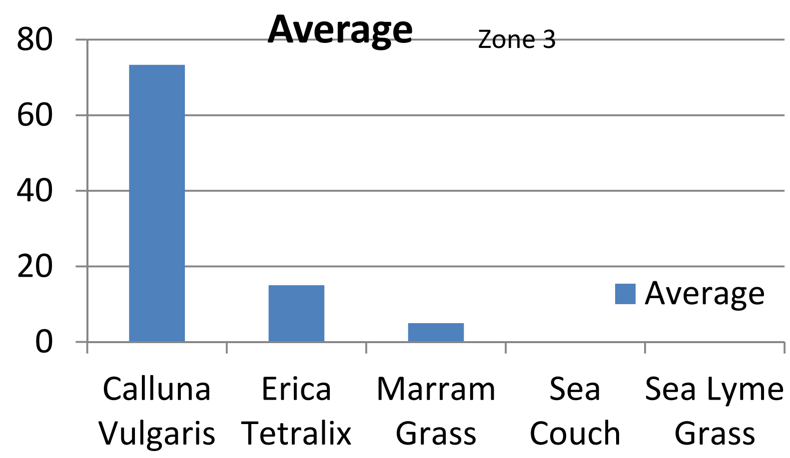
Survey results dune one 10 m above the strand zone

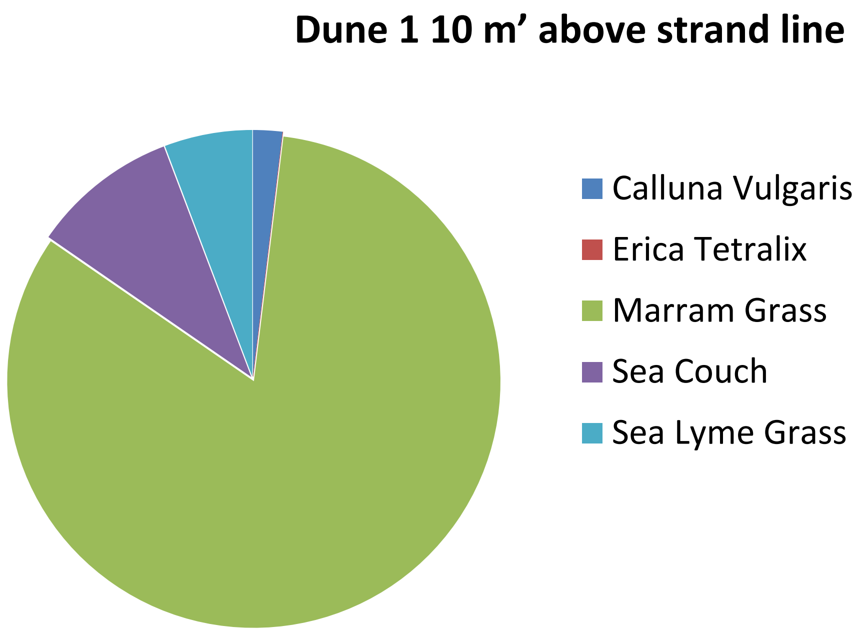
Species	Q1	Q2	Q3	Average
Calluna Vulgaris	0	0	5	1.6
Erica Tetralix	0	0	0	0.00
Marram Grass	60	80	75	71.7
Sea Couch	10	5	10	8.3
Sea Lyme Grass	5	0	10	5.00

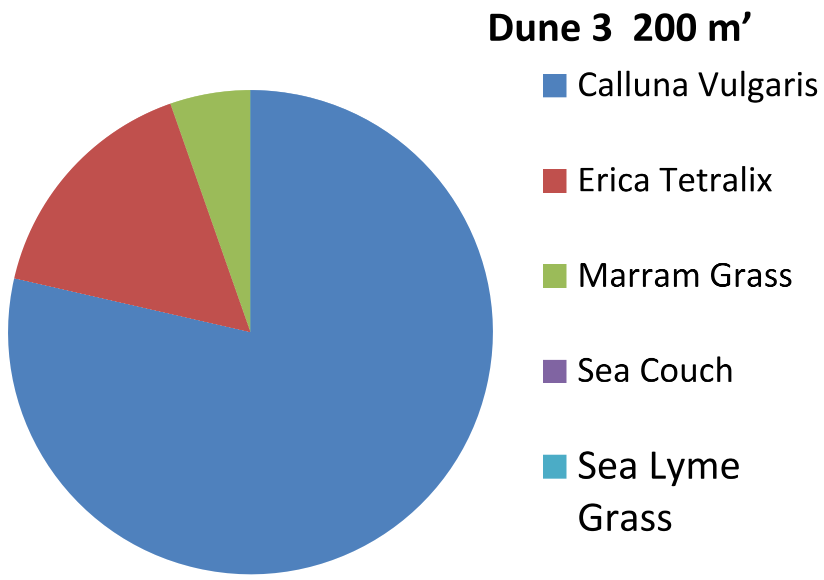


Survey results dune 3 200m inland

Species	Q1	Q2	Q3	Average
Calluna Vulgaris	80	75	65	73.3
Erica Tetralix	15	10	20	15.0
Marram Grass	5	10	0	5.0
Sea Couch	0	0	0	0.00
Sea Lyme Grass	0	0	0	0.00




Dune 1 10 m' above strand line
Calluna Vulgaris
Erica Tetralix
Marram Grass
Sea Couch
Sea Lyme Grass


Dune 3 200 m'
Calluna Vulgaris
Erica Tetralix
Marram Grass
Sea Couch
Sea Lyme Grass

3

Reflection on the task

We carried out a days field work on Studland dunes. We first assessed risks and took care not to work alone but in groups of three. Snakes are a hazard so we wore appropriate footwear. A first aid kit was available and each group had access to a phone. Trips and falling were a hazard so due care was needed. We also had to take responsibility to avoid excessive trampling or damaging the special habitat. The data we collected from the random quadrate survey generally supported our researched prediction that as you move inland the pH falls from pH 7.0 on dune one to 4.5 on dune 3. We only had time to take 3 quadrate readings in each site . The results were generally supportive of our expected results although if we had taken more results I could have been more confident. I did carry out some practice samples to become familiar with the species to be found with teacher checking the results . Dune 3 shows much greater variation away from the shoreline and the salt spray sea couch and sea Lyme were only found on the first dune. We used a 500 mm sq quadrate and to increase accuracy we also held a gridded quadrate above the quadrate to avoid squashing the different species. The species diversity also increased as the dunes became older supporting the species diversity theory, even though the pH was low and so restricted the species diversity. Had we had time we could have pooled our data.

Reflection continued

The graphs show clearly that species diversity is greater on the older dune even with its low pH . Erica tetralix is also only found in this more acid and moist area with water rising from the freshwater slack. My sample was quite small although it can be easily seen in my photos that they would appear to be a fair representation.

Competence in identification and ensuring a better system for random quadrats might make for even more accurate results in an extended task/investigation.

It was a most interesting survey. I am glad I wore strong sun screen as with wind and salt air my skin felt quite tight after the day in the field.

Unit B681: Practical Scientific Skills: Mark Allocation

Strand to be assessed:

(a) Demonstrate competence in practical scientific skills

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
5-6 marks **Award 6**	Performs independently a practical task which involves a series of step-by-step practical operations and makes decisions, amendments and modifications to improve the task outcome.	Be able to carry out a series of practical skills required by the task making necessary amendments and modifications to the procedure without the need for any advice and achieve a professional and improved outcome as a result of their modification and amendments where and when needed.	The photos show a mature well organised student working with others in the field on a task in quite a challenging habitat and clearly a task which was being used to plan a full investigation. A full mark would be most suitable as the student was modifying and making a whole range of decisions independently.

(b) Collect and process primary data

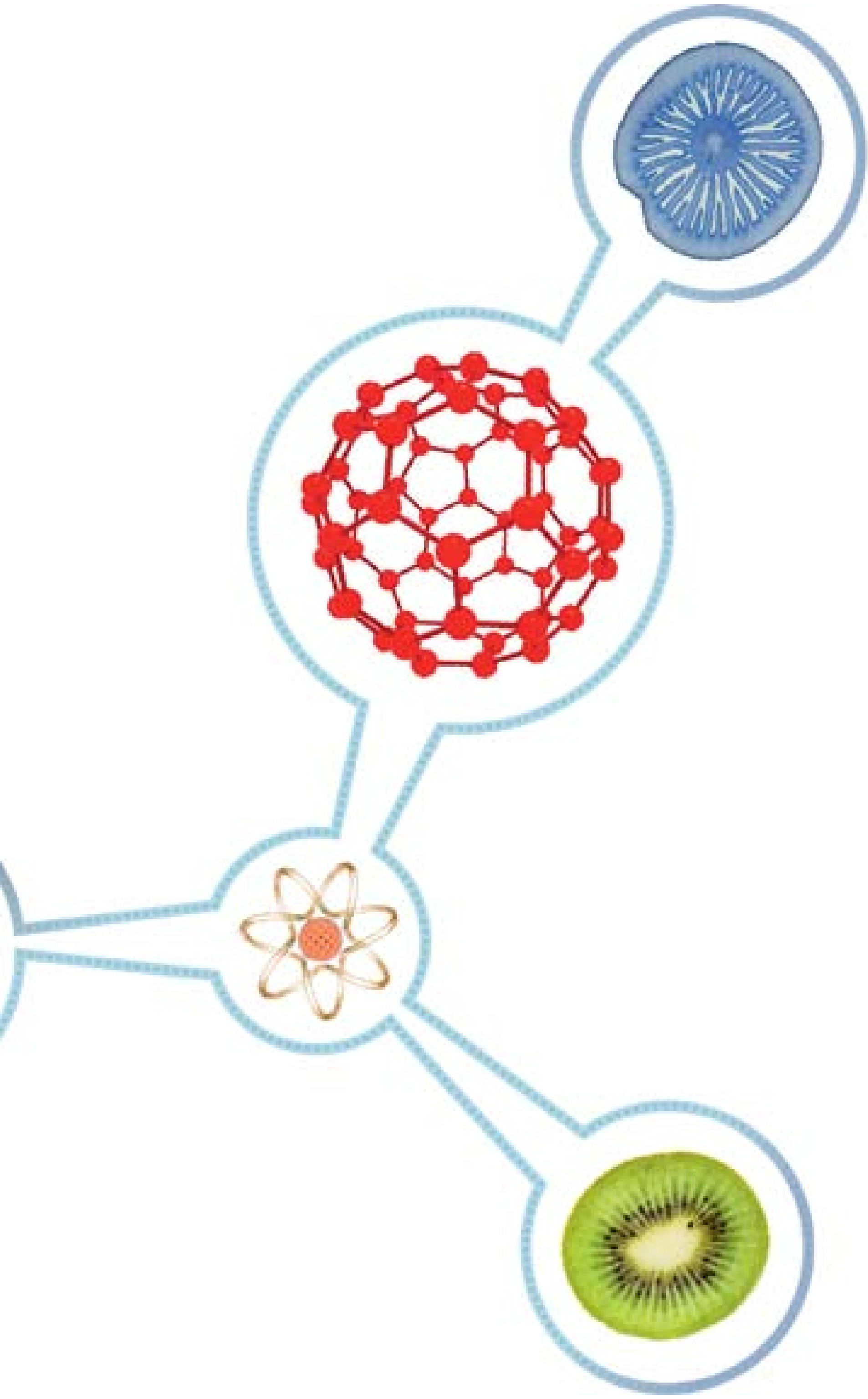
Mark allocated	Specification statements	Teacher Guidance	Task specific justification
5-6 marks **Award 5 marks**	Collects and records accurately and in the most appropriate format, the full range of data and information specified by the task. Uses correctly the graphical or mathematical techniques appropriate to the task.	Candidates will produce well-drawn line graphs or other appropriate graphs or charts and where appropriate lines of best fit, axes will be labelled and appropriate scales will be chosen. Mathematical techniques will be correctly carried out with answers clearly and accurately presented relevant to the task.	Suitable graphs for the nature of the task were evident. They presented the information in an easy to interpret way. Data was processed to a standard demand level, although not complex, it was sufficient for the task.

(c) Evaluate method used and data collected

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
5-6 marks **Award 6 mark**	Writes a detailed critical evaluation of the task, including the management of risks and the appropriateness of the procedure used. Account is clear and organised and specialist terms are used appropriately.	Candidates will produce information on potential hazards and whether they are high or low risk and the steps which were made in order to minimise these risks. Uses detailed annotation of film or photographic evidence to inform the reader and make constructive and appropriate observations about the data and they will say how it may have related to the performance of the task.	A very sensible risk assessment which was suitable for the task showing a full appreciation for the need to manage risks appropriate for the task. Shows a clear understanding of the limits of the data collected and relates the information to other factors discovered or learnt about the habitat.

Overall for task: 6 marks

UNIT B682: PRACTICAL SCIENTIFIC SKILLS



Task: Monitor the health and development of a small animal by handling it in the correct way.

Firstly approach in a calm relaxed way. Speaking to the rabbits greatly helps make them feel relaxed and unstressed.

Reaching well in to avoid harming the rabbit or stressing the rabbits and pulling them out to check their condition.

Health checks

Eyes nice, bright and clear with no discharge . I always look out for rogue hairs which can grow into the eye.

Ears were clean cool and mite free. A good indication of health and no developing problems

Checking toe nails and feet; note I am holding the rabbit firmly in a positive way and the rabbit is calm and comfortable.

Genital and anus check

Overall check for messing and fleas or soiled coat

Genitals checked for discharge or smell.

Weighing

Sir checking that I had correctly zeroed the balance I always do this.

Carefully placing the rabbit in the bucket keeping it calm as possible to avoid inaccurate readings.

Having weighed my rabbit sir kindly recorded it for me

Recorded demonstrating the need to read the balance at eye level

Sir lends a hand!!

Completion of task

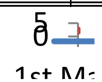
Checking all results are clearly recorded for the stockman.

Remembering to wash my hands well with soap and water drying well with clean towels.

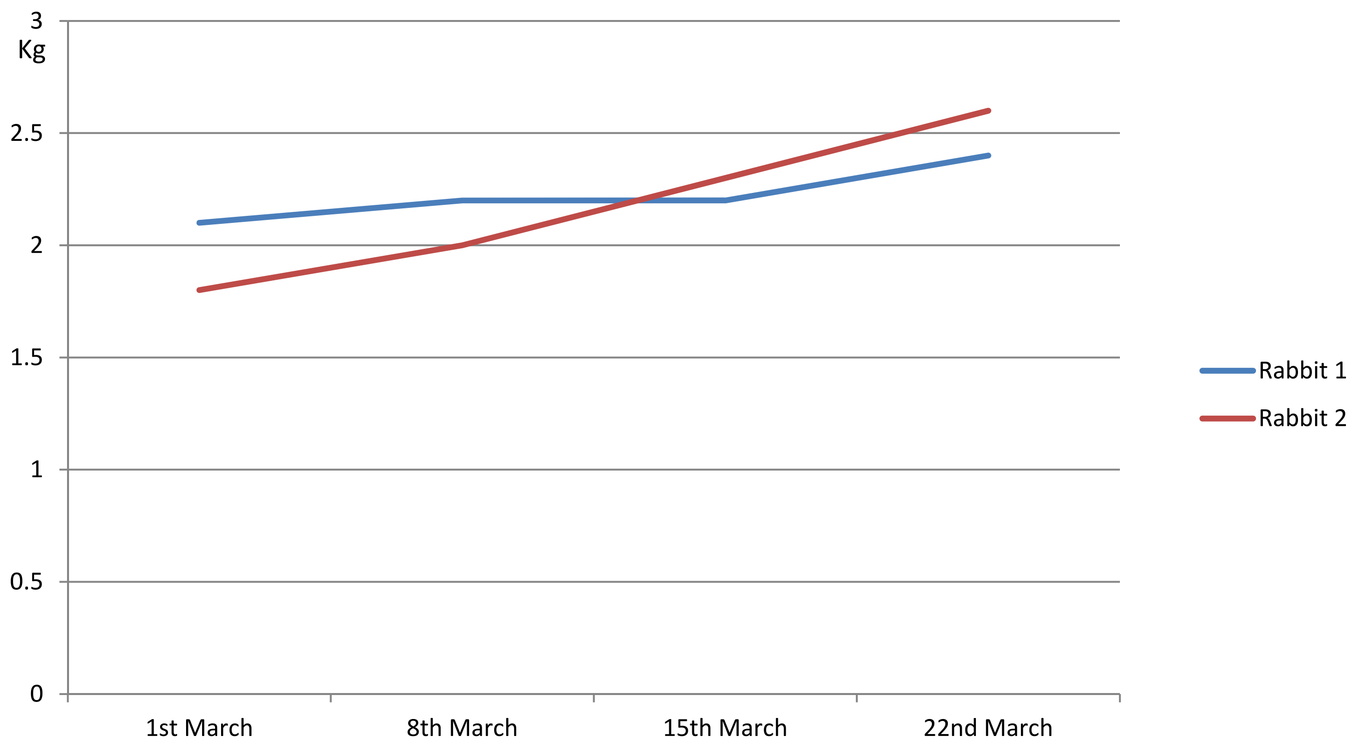
My records of rabbits growth

rabbit 1	1st March	8th March	15th March	22nd March
eye check	clear and bright	clear and bright	clear and bright	clear and bright
nose check	moist	clean	clean	clean
anus check	clean	clean	clean	clean
coat	shiny	shiny	shiny	shiny
claws	ok	ok	clipped	ok
weight in KG	1.8	2	2.3	2.6

Rabbit2	1st March	8th March	15th March	22nd March
eye check	clear and bright	bright	slight discharge	bright
nose check	clean	clean	dry	clean
anus check	clean	clean	slight scouring	clean
coat	shiny	shiny	dull	clean
claws	clipped	ok	ok	ok
weight in KG	2.1	2.2	2.2	2.4



Graph to compare the growth of mt two rabbits



Task reflection

- The first thing I do when working with the rabbits is to don an overall. I take care not to have exposed cuts as Weiles disease could be a serious problem when handling hay or straw .
- I kept records for 5 weeks for two rabbits of their general health and weight gain. Both rabbits were 7 months old.
- Although both stayed healthy, rabbit 2 did get slight scours although it did not affect its weight gain, which supported my deduction at the time that she had probably eaten a bit too much apple as she tends to be much more interested in feeding than rabbit one.
- The eyes and nose always stayed clean and the eyes bright. Any change in this along with a dulling of coat proves to be an indicator of concern.
- Rabbit one needed her claws clipping but rabbit 2 tends to claw and scratch the floor in her hut .
- I managed risk by not working alone ,washing hands and using clean overalls each time this helps to protect me and the rabbits.
- The data collected proved valuable to confirm healthy growth of the young rabbits . The stock check observations are the most useful on a day to day basis for the stock manager, although weight is a good long time indicator .
- The decline in weight of rabbit is shown in the graph and is linked to other indicators and provides confirmation of ones own deductions .

Unit B682: Practical Scientific Skills: Mark Allocation

Strand to be assessed:

(a) Demonstrate competence in practical scientific skills

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
5-6 marks **Award 6 marks**	Performs independently a practical task which involves a series of step-by-step practical operations and makes decisions, amendments and modifications to improve the task outcome.	Be able to carry out a series of practical skills required by the task making necessary amendments and modifications to the procedure without the need for any advice and achieve a professional and improved outcome as a result of their modification and amendments where and when needed.	Photographs showed the confidence and independent working skills of the candidate and the ability to modify situations. Clearly meeting the criteria fully.

(b) Collect and process primary data

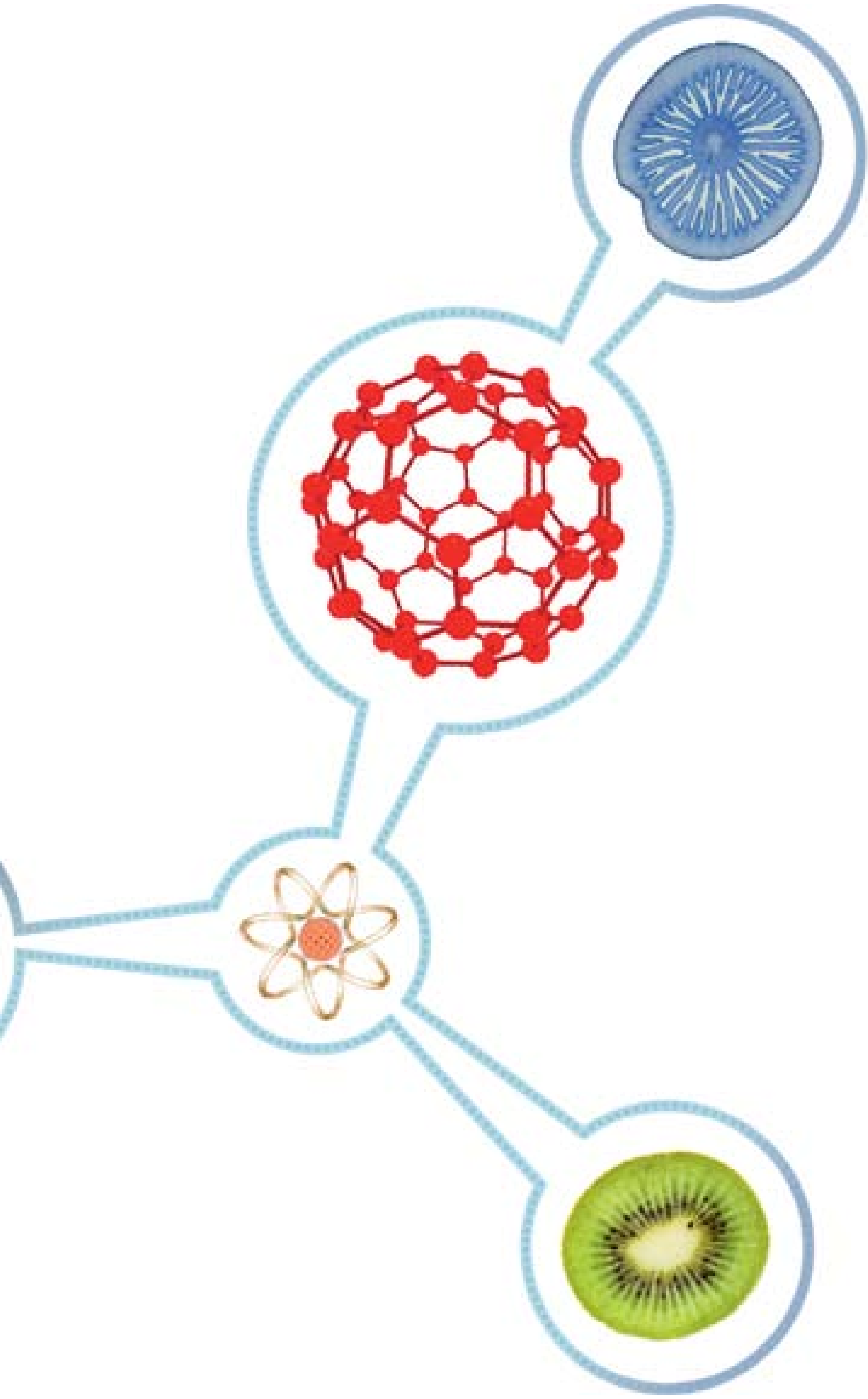
Mark allocated	Specification statements	Teacher Guidance	Task specific justification
5-6 marks **Award 6 marks**	Collects and records accurately and in the most appropriate format, the full range of data and information specified by the task. Uses correctly the graphical or mathematical techniques appropriate to the task.	Candidates will produce well-drawn line graphs or other appropriate graphs or charts and where appropriate lines of best fit, axes will be labelled and appropriate scales will be chosen. Mathematical techniques will be correctly carried out with answers clearly and accurately presented relevant to the task.	Collected data in a simple clear and easy to use format. The graph of the numerical data helped to confirm conclusions and decisions relating to health and provides evidence of the student being able to make complex decisions using a range of health indicators and shows ability to amend the diet without further advice.

(c) Evaluate method used and data collected

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
5-6 marks **Award 6 marks**	Writes a detailed critical evaluation of the task, including the management of risks and the appropriateness of the procedure used. Account is clear and organised and specialist terms are used appropriately.	Candidates will produce information on potential hazards and whether they are high or low risk and the steps which were made in order to minimise these risks. Will use detailed annotation of film or photographic evidence to inform the reader and make constructive and appropriate observations on the data and they will say how it may have related to the performance of the task.	Well reflected. There is real understanding shown in the reflection and in helpful informative annotation of the task photo evidence. A clear understanding of the importance of qualitative and quantitative data and of how accurate recording is helpful to other users.

Overall for task: 6 marks

UNIT B683: PRACTICAL SCIENTIFIC SKILLS



Monitoring my ewe.

Task : Monitor the health and development of a farm animal by taking appropriate observations and measurements ,handling the correct way

Checking the ewes and lambs

This is me feeling the ewe to check her condition and for any signs of the need for dagging or any brambles in her wool. I felt her nose and ears for a temperature assessment. Her eyes are bright and clean and her composure is perfect.

I then waited for her to become calm and relaxed and prepared to turn her to check her feet for overgrown hoofs which can cause infection leading to lameness.

Turning to check her feet

This is me calmly preparing to carefully but firmly turn the ewe onto her back.

Turned and holding her between my legs and offering calming support.

Feet and general check

Checking mouth and ears while settling her

Getting ready to check the feet

Foot trimming

Cutting back over grown hoof using sharp clippers ,some people use a hoof knife but these can be dangerous in inexperienced hands.

Checking each foot is time consuming and if not done firmly the ewe may get restless. You can see I have managed to make her very relaxed.

Udder and completion

While turned I checked her udder has started to dry up and that there are no signs of mastitis.

Finishing off preparing to re-turn and mark her with a crayon to show she was checked.

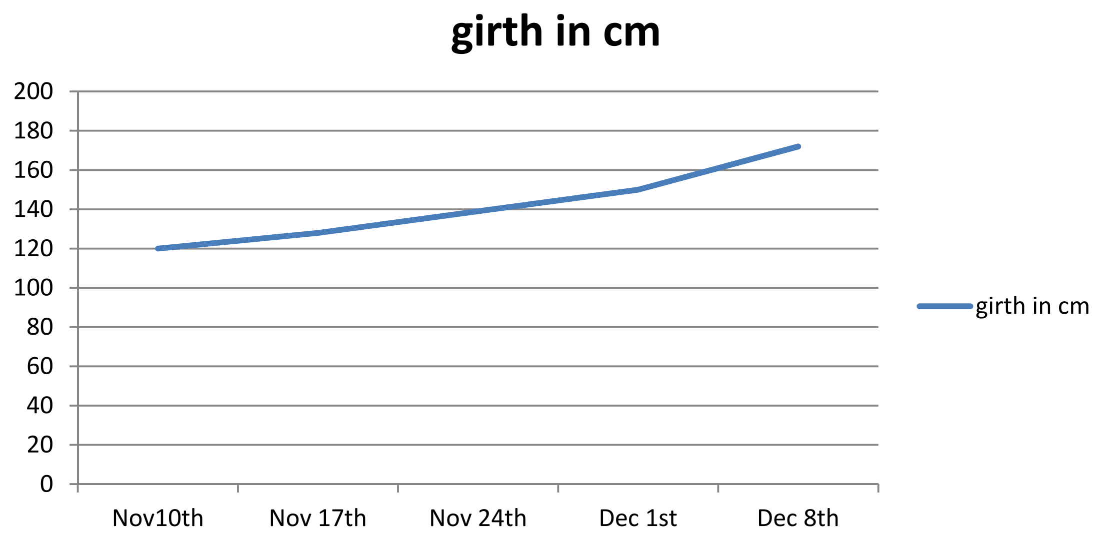
Task reflective evaluation

- I recorded my health checks and evaluation of my ewes for five weeks and measured the girth of one of the in-lamb ewes to monitor the increase of the girth. It might be possible to do this as part of a future investigation .
- The main risk in doing this these tasks was personal injury when turning the ewes or simply falling, or the ewe standing on my foot .I never worked alone and took care to keep a straight back to avoid injury .
- I use steel caped wellington boots to avoid harm from the hoofs
- When I had completed my observations I always washed my hands to avoid infection after removing my overalls, which avoids cross contamination .
- The data allows the farm manager to spot any heath issues which might develop and provides insurance against public complaints about animal welfare. This is always a potential problem especially when animals are in public view. Feet problems can be addressed and treated before becoming a problem . The data is most useful when taken as a whole and not just my personal data for my sheep.
- It is good to be able to spot any trends
- I enjoy working independently but always ensure at least two other people know what I am doing including sir or the farm manager.

Health check monitoring data record of my ewe (Matilda) Nov- Dec 2011

	Nov10th	Nov 17th	Nov 24th	Dec 1st	Dec 8th
checks					
feet	trimmed	ok	retrimmed right hoof	ok	ok
eyes	bright	bright	bright	bright	bright
vulva	moist	clean and dry	clean and dry	slightly moist	slightly moist
general demina	alert/bright	alert hungry	calm and rested	keen to feed / alert	bright but resting
girth in cm	120	128	139	150	172

Growth of ewes girth in the widest place. The data indicates the general development and shows that her lambs are developing properly. (I say lambs because she was ultra sound diagnosed by a mobile sonographer who attends the school.)



Unit B683: Practical Scientific Skills: Mark Allocation

Strand to be assessed:

(a) Demonstrate competence in practical scientific skills

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
5-6 marks **Award 6 marks**	Performs independently a practical task which involves a series of step-by-step practical operations and makes decisions, amendments and modifications to improve the task outcome.	Be able to carry out a series of practical skills required by the task making necessary amendments and modifications to the procedure without the need for any advice and achieve a professional and improved outcome as a result of their modification and amendments where and when needed.	Not an easy task and made minimum use of others. The photographs show the student performing a task in a mature confident way and, by the tasks very nature, involves a need to amend and modify the procedure all the time.

(b) Collect and process primary data

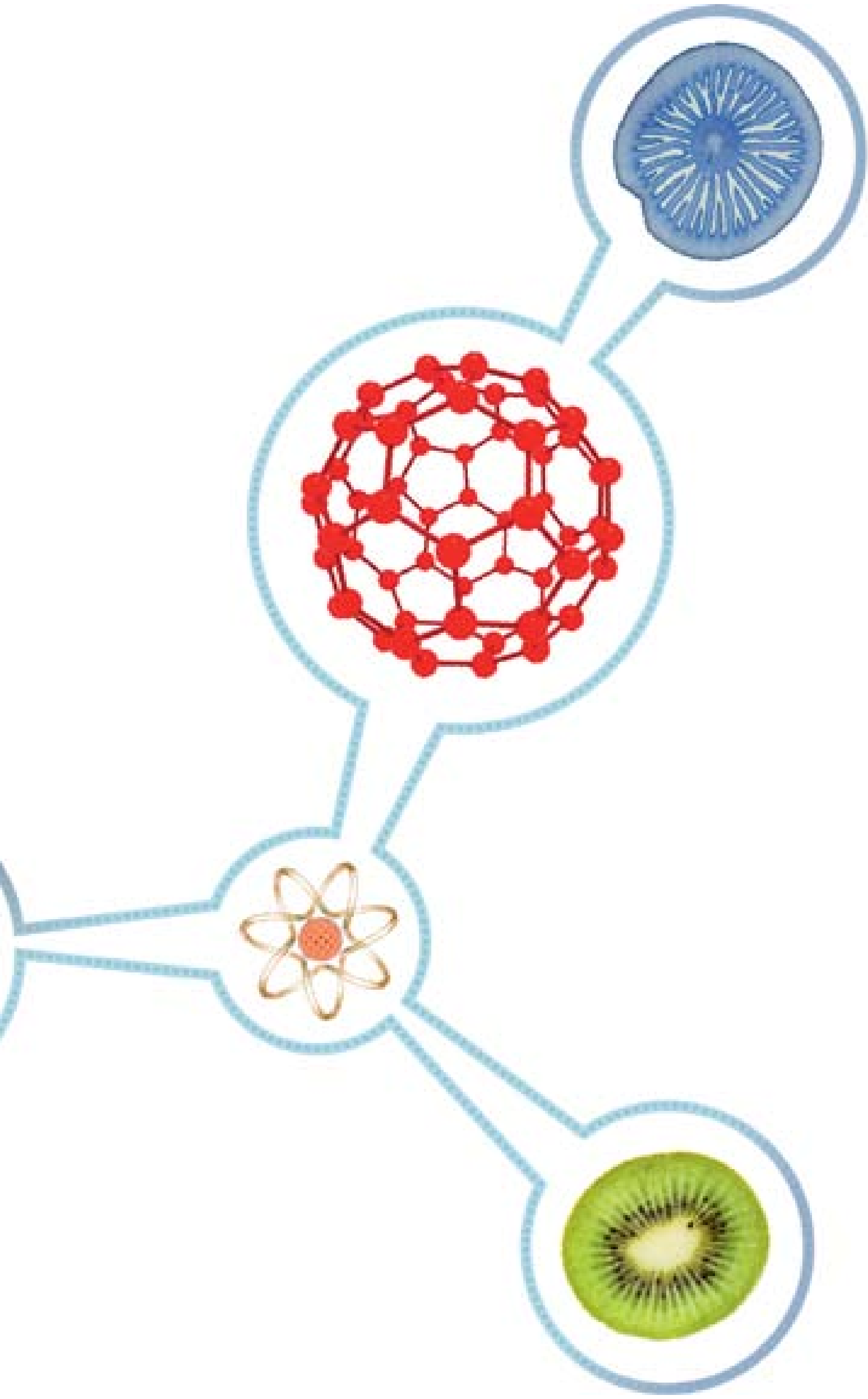
Mark allocated	Specification statements	Teacher Guidance	Task specific justification
5-6 marks **Award 6 marks**	Collects and records accurately and in the most appropriate format, the full range of data and information specified by the task. Uses correctly the graphical or mathematical techniques appropriate to the task.	Candidates will produce well-drawn line graphs or other appropriate graphs or charts and where appropriate lines of best fit, axes will be labelled and appropriate scales will be chosen. Mathematical techniques will be correctly carried out with answers clearly and accurately presented, relevant to the task.	Excellent appropriate qualitative data, well recorded and well evidenced in the photographs. The numerical evidence is useful and allows easy collection with minimum inconvenience to the ewe and the data is cleverly linked to the sonographer's findings.

(c) Evaluate method used and data collected

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
5-6 marks **Award 6 marks**	Writes a detailed critical evaluation of the task, including the management of risks and the appropriateness of the procedure used. Account is clear and organised and specialist terms are used appropriately.	Candidates will produce information on potential hazards and whether they are high or low risk and the steps which were made in order to minimise these risks. They will use detailed annotation of film or photographic evidence to inform the reader and make constructive and appropriate observations on the data and say how it may have related to the performance of the task.	A clear understanding of risk management and one that evolves from understanding the nature of the task.. The interpretation of data is sound and the reason for collecting it is explained. Good and appropriate use of specialist terms.

Overall for task: 6 marks

SCIENTIFIC INVESTIGATION



Elbs investigation beans growth and soil intensification of farming

Investigate the impact of intensification of farming on the soil.

Investigate the impact of intensification by looking at the effects of using sterilized, non-sterilized (natural) and fertilized soil on the germination and growth of broad beans (*Vicia faba*)

Contents

Abstract:

The aim of the investigation is to devise an investigation that will model some of the possible effects of intensification of farming on the soil to find out if there is a difference between the growth rates of Broad Beans depending on the soil quality they are grown in.

Growth rates were recorded on broad beans grown in:
· Sterilized soil (soil harmed by intensification over time)
· Natural soil (control)
· Fertilized soil (intensive farming)

The base soil is the same but it is treated in different ways to create the independent variables. Soil quantity in each pot is the same. Each pot will be given the same amount of sun light and liquid at the same time each day.

The results were collected for 13 days following the first bean germinating. The results were then compared to try and find any significant difference between the growth rates of the beans.

When collecting the data the method I used was to measure the plants at the same time every day just before watering them. I measured them individually from the soil surface level up to the stretched out tip of the tallest leaf using a cm ruler.

The analysis proved that there is a difference between the growth rates of the beans growing in the three different soils. The beans that grew in the fertilized soil grew better on average than the beans in the other two soils. The closest growth rate was between the beans grown in fertilized soil and natural soil. The slowest growth was from the beans grown in sterilized soil showing the possible harm and yet fertilizer increases yield suggesting that intensification must be managed and organic

matter is important.

Overview:

This is a project looking at the effects that the quality of soil has on the growth of broad beans to model the impact of intensification.

The procedure will be planned so that the variables are controlled in a way so that we can judge the effect the soil quality is having on the growth of the broad bean.

There will be replicas of each type of soil quality. The control pot will be the soil that has had no change to the natural soil quality in my local area.

Introduction:

My original intention was to grow a selection of different herbs; Basil, Coriander and Parsley and show the effects of using fertilizer would have on the growth of these plants which are consumed by humans. However, when I was doing my research for this I thought that there are more other factors that will affect the healthy growth of food plants. The main thing that I wanted to include in my modified investigation was the quality of the soil and the effect that the micro-organisms have on growth and not just the nutrients that you get in fertilizers.

My original experiment was going to use compost, which has a good amount of organic matter in it but I wanted to replace this variable with local soil in my area. From my research I knew that this soil would be full of the micro-organisms, organic matter and nutrients that are naturally in the soil in this area. It also means that I can sterilize the soil that I use in one of my rows to kill off the micro-organisms. I will then be able to use the plants in the sterilized soil to compare them with the plants in the natural soil and also with the natural soil that has extra-added nutrients.
Another modification that I made was with what I decided to grow. The small pots of herbs were already quite grown, as you would find in the shops. I was going to transplant them into my experiment planting but they would have been very difficult to collect growth data from. I would have had to measure the leaf size and there wasn't going to be very much noticeable growth between each measuring time. They also didn't look like they would live to the end of the investigation and so I decided to grow another plant that is still eaten but that is much clearer and easier to measure.

I also needed to make sure from my research that the seed would germinate and grow quickly enough to use for this investigation. After the research I did, the plant I have chosen to satisfy all of these needs is the Broad Bean.

Hypothesis:

If the broad beans are planted in a soil that is watered with water, which contains extra macronutrients, then the beans will grow taller because they will have the extra nutrients and food to grow well.

Hypothesis continued:

My hypothesis is that plants will have a better, stronger and faster growth pattern when planted in a richer quality of soil.

My reasons for this hypothesis is that the plant takes its nutrition from the soil, if the nutrition provided by the soil is good and rich then the plant will have the elements it needs for strong, healthy growth.

I predict that the beans grown in the row potted with natural soil and enriched with nitrogen will grow the quickest and tallest within the time of the investigation.

I want to look at how the soil quality (micro-organism, nutrients, organic matter, humus and minerals) might increase the strength and growth pattern of the Broad bean.

Null Hypothesis:

There will be no difference between the growth rates of beans planted in three different quality soils.

Background:

Plants need different things from the soil and the environment to grow well.

Soil is made up of three main factors. These are water film, pore spaces and soil crumbs. All of these effect the way the soil is. The soil crumbs are made from organic matter (the decay of plants and animals and living organisms), which leads to the production of humus. Humus is a black structure-less substance that acts as a 'glue' to stick the sand and clay particles together. Depending on the type of rock area this will change the proportion of sand and clay particles and affect the quality of the topsoil. Different soils also contain different soil properties; these include different amounts of dirt, nutrients and micro-organisms.

Elbs investigation beans growth and soil intensification of farming

(Mr Ian Fowler's lesson – 01.10.07)

Micro-organisms offer benefits to growing plants. Plants need micro-organisms because they are important for the nitrogen cycle. The bacteria and fungi in the soil play a vital part in converting organic matter from humans into mineral salts and making them available to plants and cementing soil to plants, and ultimately, sticking particles together to form crumbs. (www.wikapedia.com)

Nutrients, humus and minerals (mineral salts) can be added to the soil in the form of farmyard manure or other organic matter providing both humus and mineral salts. Plants remove the mineral salts, which are replaced by the death and decomposition of plants and animal bodies – humus.

One important nutrient that plants need is nitrogen (N_2). The nitrogen builds proteins and nucleic acids that grow healthy stems and leaves. This is found in NPK fertilizers. (Mr Richard Chickens lesson – 05.10.10)

I decided to research this further on the Internet and I found out in order for a plant to grow and thrive it needs a number of different chemicals elements.

The most important are:

· Carbon, hydrogen and oxygen
- available from air and water and so are in plentiful supply.

· Nitrogen, phosphorus and potassium
- Are the three macro-nutrients plants need.

· Secondary nutrients
- Sulphur, calcium and magnesium.

· Micronutrients
- Boron, cobalt, copper, iron, manganese, molybdenum and zinc.

The most important or the nutrients that are needed in the biggest quantity by the plants are nitrogen, phosphorus and potassium. They are important because they are necessary for the basic building blocks, for example every amino acid contains nitrogen. With out nitrogen phosphorus and potassium the plant cannot grow because it cannot make the pieces it needs.

If any of the macronutrients are missing or hard to obtain from the soil this will limit the growth rate of the plant. In nature the NPK often comes from the decay of plants that have died. In the case of nitrogen, the recycling of nitrogen from dead to living plants is often the only source of nitrogen in the soil. (http://science.howstuffworks.com)

To make plants grow faster I would need to supply the elements that the plants need in readily available forms.

Although the earth's atmosphere is made up of 79% nitrogen, plants cannot use nitrogen in this form. So I will need to add extra nitrogen as a feed. The type of nitrogen I will use to feed my broad beans is an NPK fertilizer (nitrogen – phosphorous - potassium) with high nitrogen content. It is a type of fertilizer that can be dissolved in water and added to the soil each day in small quantities. (www.sciencebuddies.com)

Beans grow better with a draining system from the bottom. This is why we chose to have the pots with a small hole in the bottom so it forms good drainage for them. I also paced small rocks and stones in the bottom of each pot so that the soil has easy drainage without blocking the holes in the bottom of the pots.

Other limiting factors are also important for me to consider in this project. In this experiment the limiting factors are the things that will control or affect the process of the growth of the Broad beans. There are major abiotic limiting factors that could affect this process. These are the amount of water the beans get, the quality and quantity of water and the soil type and how it is treated. This also includes the temperature of the environment.

Research:

I wanted to find out as much as I could about the local topsoil. The area is in the Cotswolds on the Oxfordshire / Gloucestershire border, postcode - 0X6 6CS. The soil is in its natural state before I either added nutrients or killed off the micro-organisms by sterilizing one batch.

Soil pH is an indication of the acidity or alkalinity of soil and is measured in pH units. The pH scale goes from 0-14 with pH 7 as the neutral point. As the amount of hydrogen ions in the soil increases, the soil pH decreases, therefore becoming more acidic. From pH 7 to 0 the soil is increasingly more acidic, and from pH 7 to 14, the oil is increasingly more alkaline or basic. (www.agric.cov.ab.ca)

Table 1. Soil pH and Interpretation

5.0	5.5	6.0	6.5	7.0	7.5	8.0
Strongly Acid	Medium Acid	Slightly Acid	Neutral	Neutral	Mildly Alkaline	Moderately Alkaline

	Best Range for Most Crops	

Risk management

The main risk in these experiments will be infection from soil borne organisms and this will be managed by hand washing every time it is handled. The use of nutrients gloves will be worn when handling concentrated solutions or powders and care with any dust. The pH test requires eye protection as with any other mixing procedure.

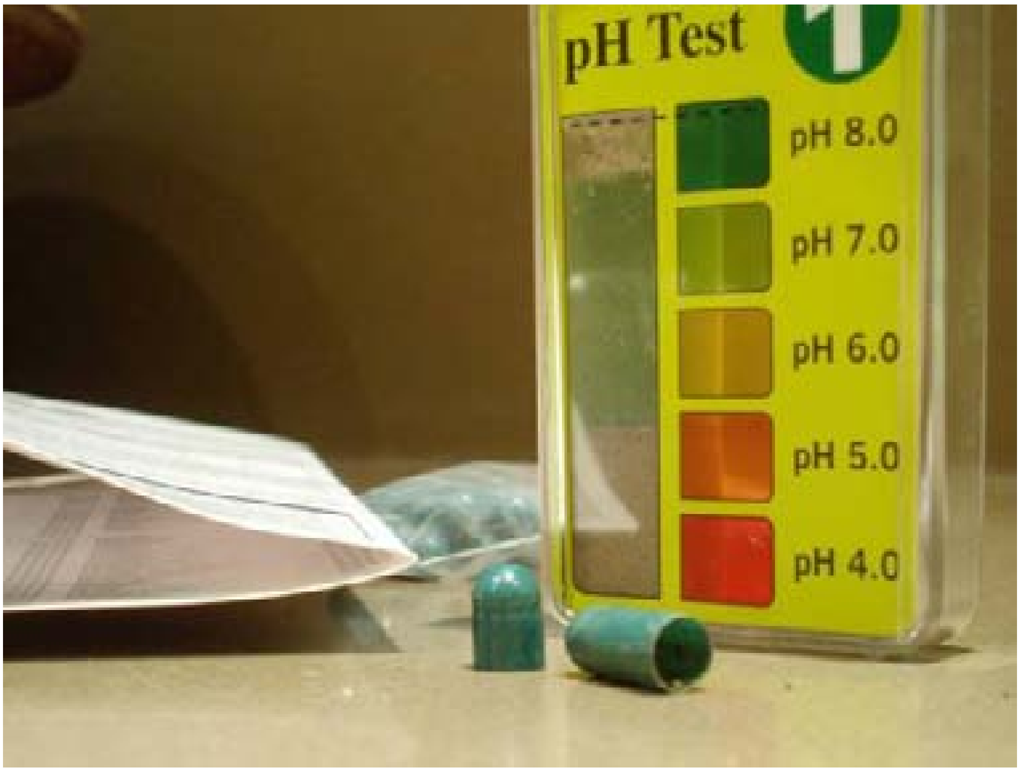
Heating and lighting equipment I will check is free from water and that all have an up to date PAT test.

pH test

I did a pH test on the soil that I was going to use and the result showed that the soil was mildly alkaline with a pH of 7.5 (Fig 0). It comes from an area of limestone, which is a soft alkaline rock.

Fig.0

Elbs investigation beans growth and soil intensification of farming



The soil has quite a crumbly texture but is not very porous because when I poured water into it became quite sodden and 'close'. This would suggest that there is enough clay content to make it do this. I did a quick soil test by squeezing a handful of slightly damp soil in my hand. A clay soil forms a compact lump and retains its shape. Loam soil forms a ball but falls apart if pocked and sandy soil doesn't hold its shape. (www.howstuffworks.com) My handful / soil type seemed to be most like the description of the loam soil.
When I dug down deeper into the topsoil the soil becomes very stony, there are a lot of small stones on the top of the soil (Fig 1). For the soil that I used for my investigation I skimmed away all the little stones and took the richer soil from just below the surface. I took out all the worms because I did not want them as a variable in this investigation. The organic matter found in this soil has come from the decaying remains of the plants that grow in the flower bed, dead insects and micro-organisms. This is what gives life to the soil. It is the worms and micro-organisms that have processed this organic matter into compounds that can be used by the plant.

Fig 1

Elbs investigation beans growth and soil intensification of farming

I took out all the earthworms as I did not want the as a variable in this experiment. I also killed off the micro-organisms in 1/3 of the soil, as I also wanted to eliminate this variable.

So, from the base garden soil I can create three qualities of growing environments for the broad bean. These are the three different independent variables that will have an effect on the growth of the organism;

The first growing environment (row) uses sterilized soil; this is natural topsoil that I baked at a high temperature of 180°C to kill off all of the micro-organisms and to weaken the nutrients that are naturally in the soil.

The second growing environment (row) uses natural topsoil that is untreated by me and is what the beans would be planted in if I grew them in my garden.

The third growing environment (row) uses the natural soil with added nitrogen fertilizer – see calculations below.

Calculations for the nitrogen feed:

The instructions for the high nitrogen feed said that 'normal strength' feed is to use every 7 to 10 days. This is 10mL of feed to 5liters of water. I calculated that if I wanted to water every day I would need to reduce the strength of the nitrogen feed mixture even more. The quantity I used was 10ml of feed to 10lts of water.

The nitrogen feed (fertilizer) quantities:

10ml of feed to 10 litres of water

= 10ml feed to 10000ml of water

(10ml of feed to $\frac{10000}{10000}$ *to get 1ml)*

$\frac{10ml}{10000}$ *to 1ml*

= 0.001 to 1ml

0.001 x 30 to get 30ml daily watering

= 0.03ml of feed for each watering of each pot in row 3

The numbers on a bag of fertilizer tells you the percentage of available nitrogen, phosphorus and potassium found in the bag. So this means my bag is 25-15-15 fertilizer, so has 25% nitrogen, 15% phosphorus and 15% potassium, plus trace elements. This means that 25% of the 0.03ml of fertilizer is nitrogen. The fertilized water is therefore supplying all three macronutrients.

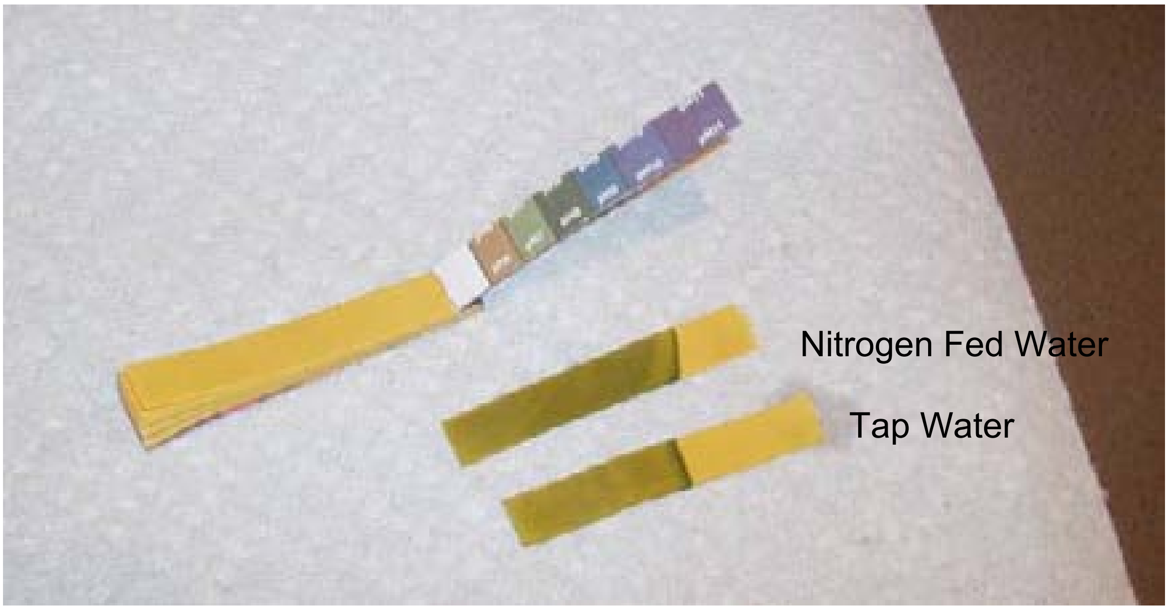
My research into the type of added nutrient shows me that for strong stem and leaf growth I need to add nitrogen. The pack of plant fertilizer that I chose stated that it would “help the plants grow well in the early stages”. My research also showed me that the nitrogen feed that I am using is best for early season feeding, this is relevant now because it is coming into the early springtime which is planting season for broad beans. The broad bean that I have chosen has a planting season of between February and May.

The first row with sterilized soil and the second row with natural soil will use identical water supply from the tap. This will be different from row three which uses the water with extra fertilizer added to it.

I decided to also do a pH paper strip test (Fig 3) to compare the pH of the water from my home tap with the fertilized water to see how it varied and to see how it related to the soil and rock type around the area. It corresponded by showing pH 7.5 on both water tests.

Fig 3

Elbs investigation beans growth and soil intensification of farming



In my background research when I was looking at what plant to grow I did a quick trial with some broad beans and I noticed something interesting that could affect the control of the investigation. The beans that had been planted stayed in the exactly the same position for all the time they grew-they sat in a butlers sink with the light coming from the right. I noticed that the two plants nearest the light source grew much quicker and taller and the two furthest away grew the slowest (See fig 2). The further away from the light source the less growth. This means I will take this into account when I design my procedure. I may need to rotate the tray of plants so they all get the different positions.

Fig 2

- Window / sun light this direction

If micro-organisms and nutrients are so important for plant growth then it would mean that if a soil did not have the micro-organisms in it, it may not be such a good medium to grow food in.

If micro-organisms and nutrients are so important for plant growth then it would mean that if a soil did not have the nutrients in it, it may not be such a good medium to grow food in.

Variables:

This experiment will have several variables, which are the things that I will control and measure.

I will have independent variables in this experiment. These are the factors that I change. Here the independent variable is the treatment of soil in each pot.

The control variable is what I keep constant, this will be the amount of water given to the plants at the same time each day and the amount and direction of light. It will be difficult to control temperature totally but all groups will experience the same conditions keeping this complex investigation as fair as practicable

To study this I need to test the independent variable (soil quality), so I am using three stages of soil quality;

i) Sterilized top soil- with no micro organisms & reduced nutrients
ii) Natural top soil- with natural micro-organisms, nutrients
iii) Fertilized natural top soil- with natural micro-organisms and nutrients plus nitrogen fertilizer

The dependent variable, the growth of the bean, will then be compared in all three growing environments. I will keep other variables constant so that the results of the investigation are realistic and controlled. I will keep the amount of water the plants are given the same for all pots and I will turn the tray each day, so that each row gets an equal direction of light while they are growing.

Procedure:

I will use medium sized planting pots with holes in the bottom. The beans will be *Vicia Faba*. I will make three duplicates or replicas of the planted beans and soil conditions of each of the 3 and will treat them all exactly the same. Therefore when planting I will make sure there is the same amount of soil and the beans will be planted at the same depth in the same position (middle of pot). Each will then be covered over with the same amount of soil. This means also giving them the same amount of water / fertilizer and light. This keeps everything the same and well controlled and means that the dependent variable (the growing seedling) is measured accurately.

<u>This is the outline of how the pot will be arranged:</u>

Row:	Replica:	Planting:	Soil:
In row 1 –	three pots –	One Broad Bean -	Sterilized topsoil
In row 2 –	three pots –	One Broad bean -	Natural topsoil
In row 3 –	three pots –	One Broad Bean -	Fertilized topsoil

<u>To set up the experiment we will need:</u>

· 9 pots to pant the beans, each of a 10cm diameter circle – See Fig 4
· 9 beans in total
· Cotswolds garden topsoil
· Small rocks for the bottom of the pots – See Fig 5
· Tray to stand the pot on
· Water
· Fertilizer granules for water mixture 30ml at 5.00pm every day
· Measuring cylinder to get the right amount of water and fertilizer
· Ruler for measuring growth
· Note pad for recording data
· Pen/pencil

Fig 4

Elbs investigation beans growth and soil intensification of farming

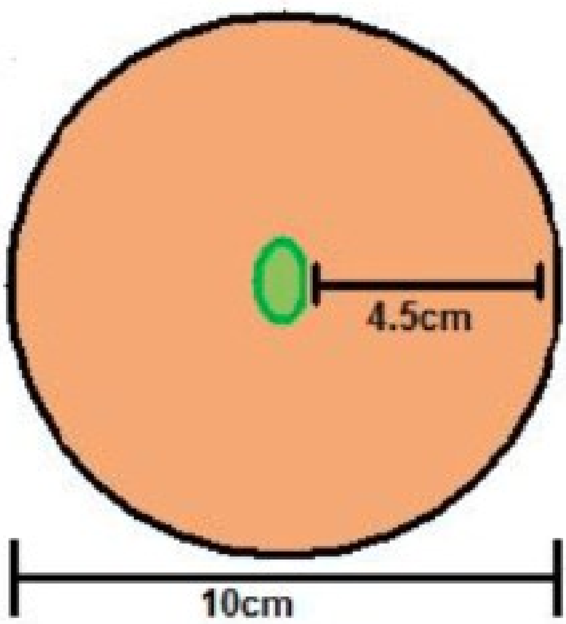


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Fig 5

<u>How to plant up:</u>

· I will fill the pots with 7 cm of topsoil each.
· I then make furrows 2 inches / 5 cm deep in the soil to place them in.
· I will then cover them up with 1 inch / 2.5 cm of topsoil - See Fig 6

Fig 6

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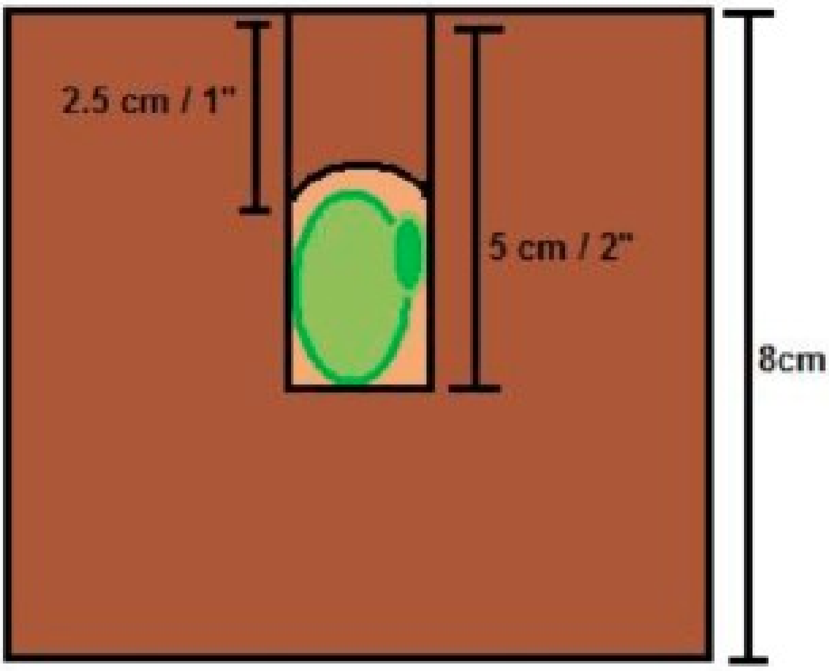

Below are pictures of me preparing the soil and planting the beans. In Fig 7 I can be seen digging up the topsoil and putting it into the pots and then measuring them to make sure they are all the same. This was done for all the 9 pots. Fig 8 shows the soil and the stones that will be at the bottom of the pot ready to be sterilized in the oven at 180°C (Aga - Fig 9). They will then be put back into the 3 pots to create row 1. Finally Fig 10 shows me plating up the beans into all 9 pots; 3 with sterilized soil and 6 with natural soil.

Fig 7

Fig 8

Elbs investigation beans growth and soil intensification of farming

Fig 9

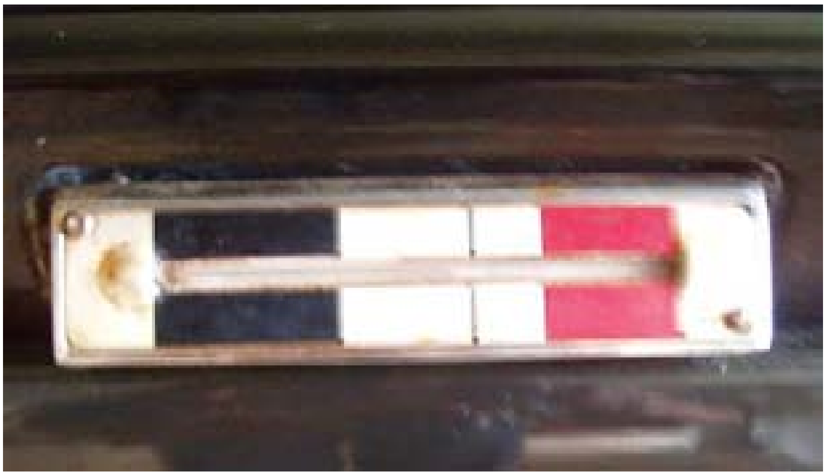

Fig 10

Elbs investigation beans growth and soil intensification of farming

After the pots had all been planted up I had to wait for the broad beans to germinate. I recorded when the shoots started to elbow out of the pots and I started to take my data when the first ones started to show.

I recorded the measurements at the same time each day and made any notes of things that I observed.

<u>Method:</u>

The investigation consisted of obtaining the growth data from the potted broad beans. The same method was used on all three growing environments. I measured each plant from the base where it came out of the soil to the straitened, tallest leaf tip. (Fig 11) On completion on a set-growing period my results will be analysed and compared, giving a final result to either support or disprove my hypothesis.

Fig 11

I maintained a consistent watering programme of 30ml at 5.00 pm each day (Fig 12) I also ensured that the pots stood in natural light throughout the experiment, turning the tray 180° every day.

Fig 12

I recorded data onto a chart that records the height of each plant from each replicates in the three different treatments to the soil. I recorded data as soon as the beans started to elbow out of the soil and began to germinate. The aim was to find out which of the three different soil environments was the most successful at producing the tallest broad bean. To do this accurately I had 3 replicates of each type of soil environment. The results could then later be averaged out over the three replicates. This also meant that there was a lower risk of my data being affected by a random growth or non growth in one of the pots.

Data:

Below is the data of how the beans grew over the 13 days. I looked at the pots individually out of the three replicates and made an average of the measurements on each date from all three pots – e.g. Monday 4th Sterilized, average (blue) 0.16.
Here are my results:

Monday 4th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	0.5	0	0	**0.16**
Natural	Elbowing out	0	0	**0**
Fertilized	0	0	Elbowing out	**0**

Elbs investigation beans growth and soil intensification of farming

Tuesday 5th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	0.5	0	Elbowing out	**0.16**
Natural	1.0	0	0	**0.3**
Fertilized	0	Elbowing out	Elbowing out	**0**

Wednesday 6th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	1.0	0	0.5	**0.5**
Natural	3.5	0.5	0.2	**1.4**
Fertilized	0.5	2.0	1.4	**1.3**

Thursday 7th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	2.5	0	1.3	**1.3**
Natural	7.0	2.5	4.5	**2.7**
Fertilized	3.3	5.0	3.4	**3.9**

Friday 8th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	4.0	0	2.5	**2.2**
Natural	9.1	5.1	4.8	**6.3**
Fertilized	5.1	7.8	6.4	**6.4**

Saturday 9th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	6.5	0.3	5.2	**4.7**
Natural	12.8	8.2	7.9	**9.6**
Fertilized	9.0	13.1	11.1	**11.1**

Sunday 10th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	8.6	1.6	7.5	**5.9**
Natural	16.5	11.6	11.7	**13.3**
Fertilized	12.2	16.5	14.6	**14.4**

Elbs investigation beans growth and soil intensification of farming

Monday 11th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	12.3	1.2	11.5	**8.3**
Natural	20.7	15.5	15.6	**17.3**
Fertilized	16.7	22.6	19.8	**19.7**

Tuesday 12th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	15.6	3.2	12.1	**10.4**
Natural	24.0	19.3	19.4	**20.9**
Fertilized	20.4	27.1	24.3	**23.9**

Wednesday 13th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	18.5	4.3	19.1	**13.9**
Natural	26.8	22.6	24.1	**24.5**
Fertilized	24.9	34.1	26.8	**28.6**

Thursday 14th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	22.6	5.9	22.8	**17.1**
Natural	29.1	27.1	26.3	**27.5**
Fertilized	28.9	38.3	31.5	**32.9**

Friday 15th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	26.3	6.8	28.4	**20.5**
Natural	31.7	29.8	30.9	**30.8**
Fertilized	30.6	39.9	37.2	**35.9**

Saturday 16th	Pot 1	Pot 2	Pot 3	**Average**
Sterilized	29.1	8.0	30.0	**22.4**
Natural	35.6	32.7	34.4	**34.2**
Fertilized	33.8	42.5	40.6	**39.9**

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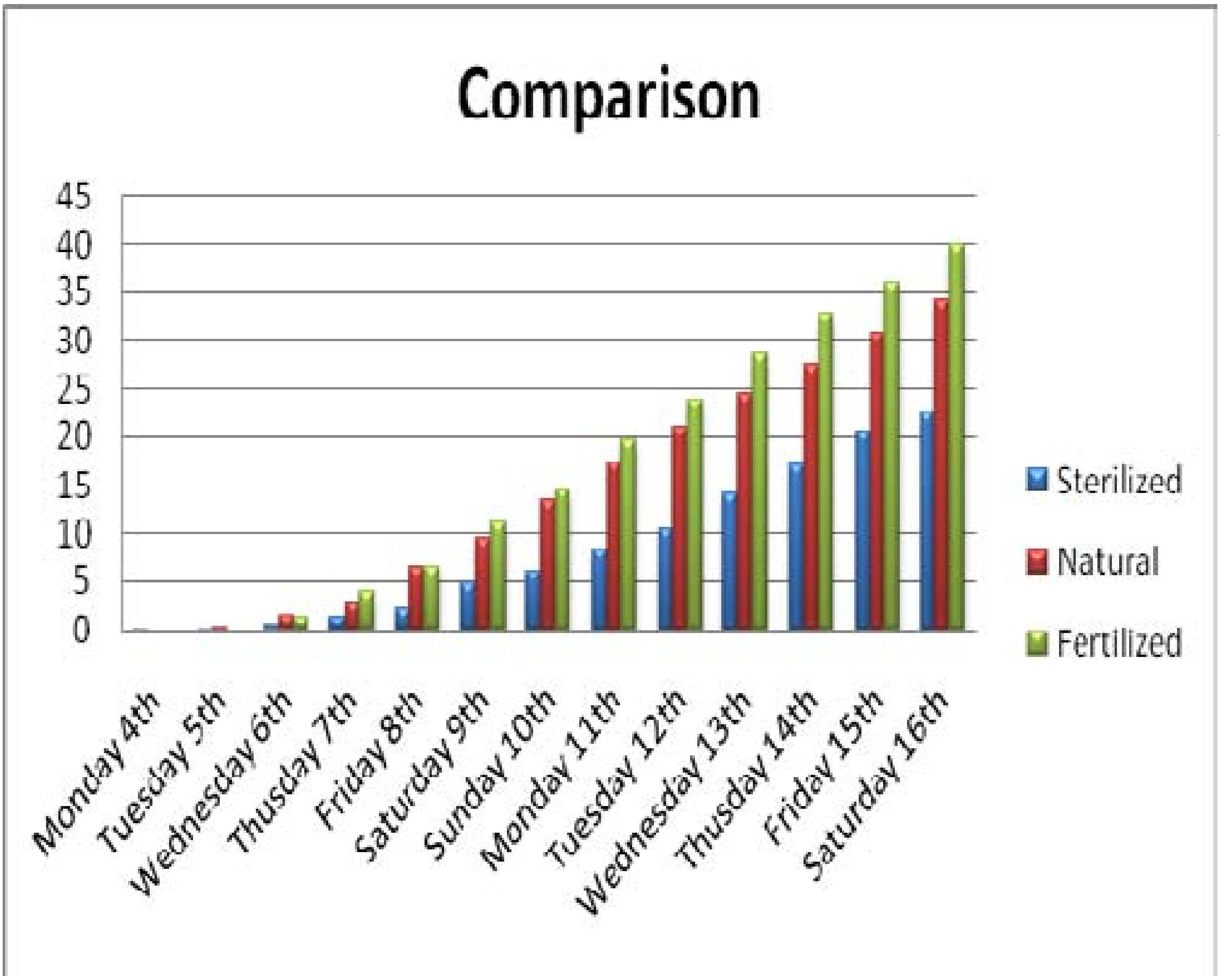
Dig 1 – February 2010



Dig 1 - compares the average growth of the plants in cm from each of the different soil treatment over the 13 days. It is a clear way to see how the growth pattern compares on each day between the sterilized, natural and fertilized soils.

Dig 2 – February 2008

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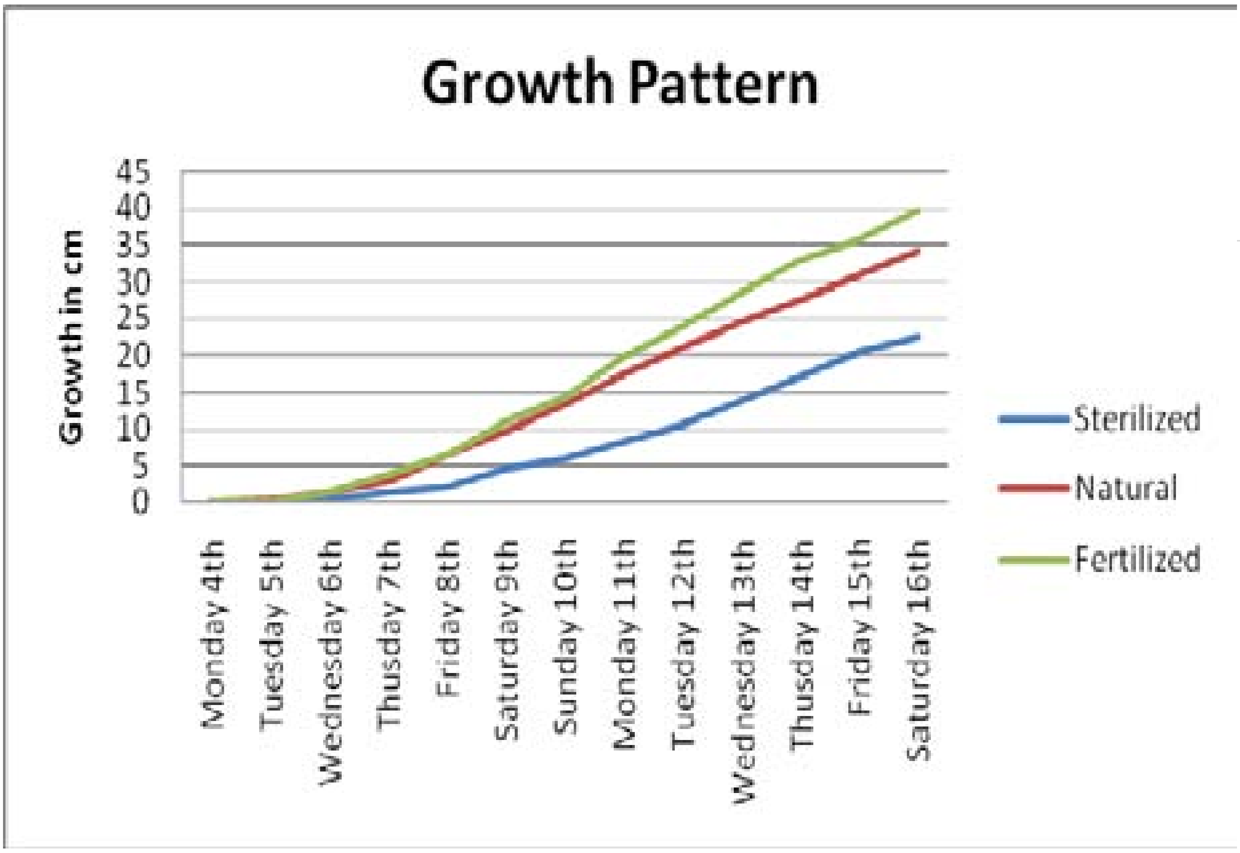

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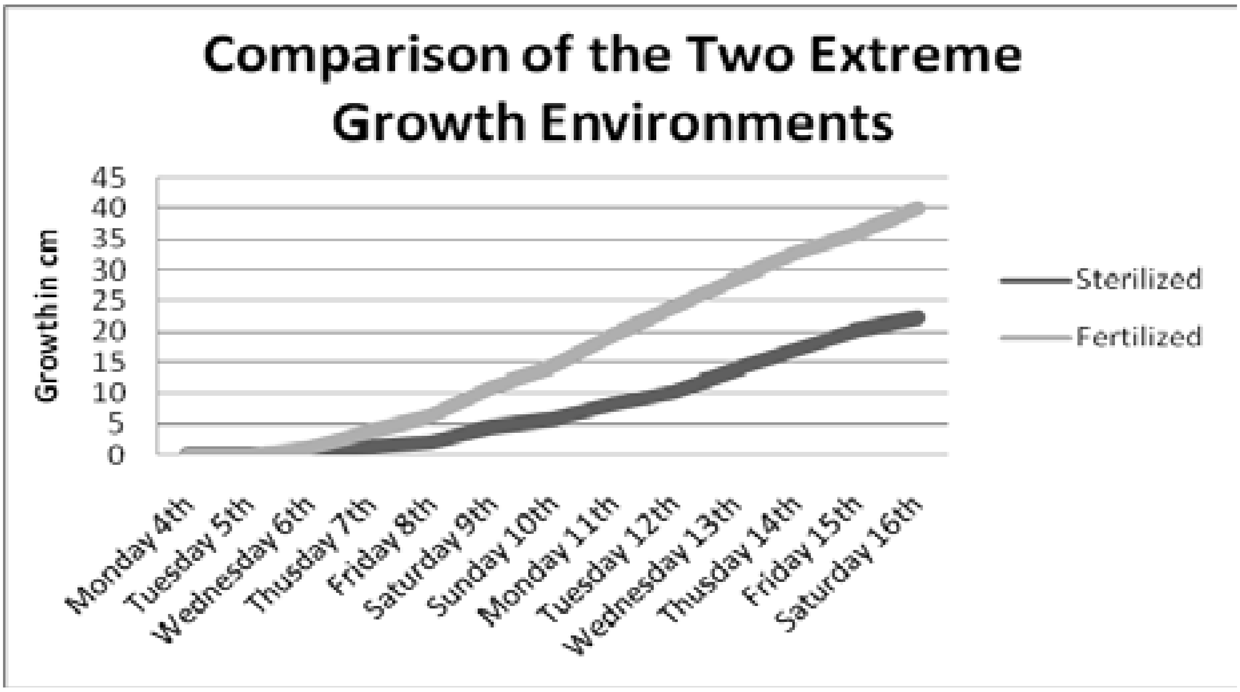
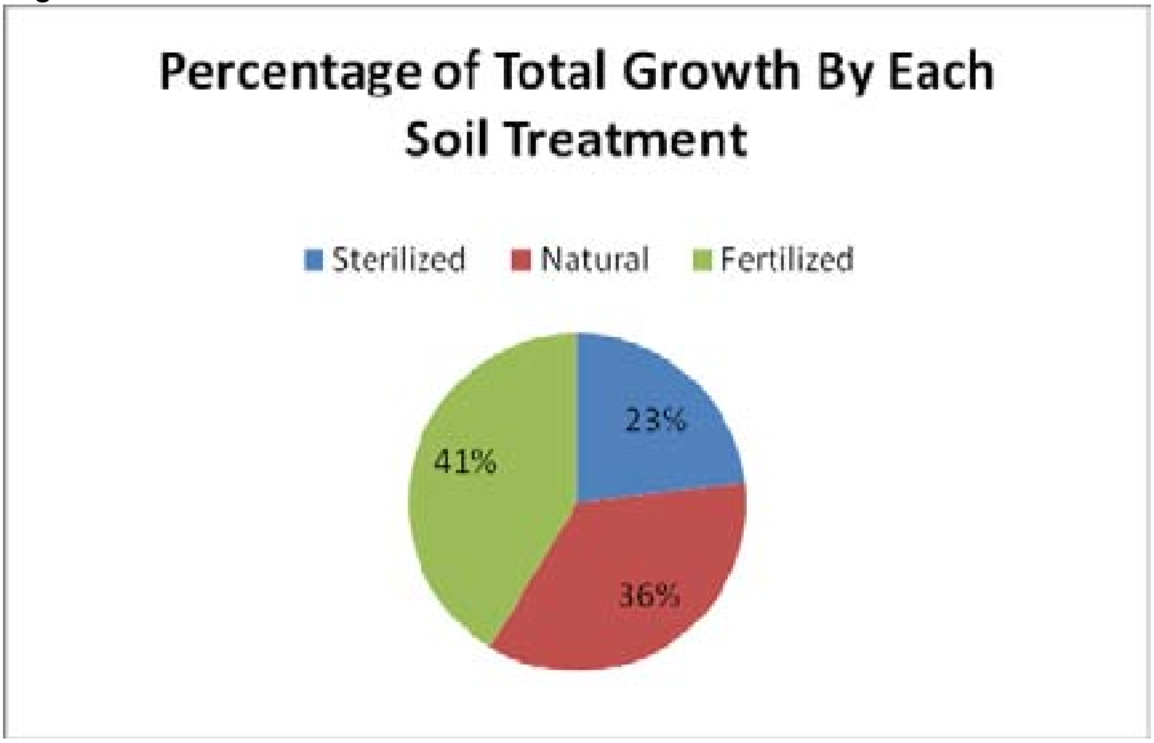
Dig 2 - shows the average growth of all three sets of beans growing in the differentially treated soils as a line graph.

Dig 3 - February2008



Dig 3 – Here I have created a line graph (using the average) that compares the data between the two growth extremes; from the beans grown in sterilized soil with no natural goodness and the beans grown in the natural soil with extra fertilizer help.

Dig 4



Dig 4 - Lastly I have place a pie chart that lets us see the complete data compared together from the sterilized soil, natural soil and fertilized soil. It shows the percentage of the total growth of each of the three differently treated soils.

Analysis:

With the data collected I have produced different charts that display and compare the data in different ways. I have used bar charts and line graphs as well as a pie chart to help me with my analysis and conclusion.

I have made a comparison of the individual plants over the 13 days in the different soil environments (Dig 1). I have also produced a line graphs and pie chart that compare the growth patterns of all the 3 beans growth to analyse the data (Dig 2, 3 and 4).

Dig 1:

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This bar chart p 20 shows that the natural soil that used water fertilized with extra nitrogen instead of just plain water, grew the best the most consistently. The 4th 5th and 6th of February, at the beginning were the only days where the growth in the natural soil had a greater height on average, but on Friday 8th they drew on their average height and from then on the beans in the fertilized soil shot ahead in height across the three replicates. This earlier germinating from the natural soil could have been because the bean came towards the surface while it was watered or because the soil was loosened.

It I clear to see that the broad beans that grew in the sterilized soil had the lowest average growth all the way throughout the thirteen days of the experiment.
You can see that the growth from the natural soil and the fertilized soil were always closer together in growth pattern than the sterilized soil which had a considerably weaker growth pattern.

<u>Dig 2:</u>

From this line graph p 21 you can see the overall growth pattern from each soil environment. The sterilized soil beans were always a lot slower growing than the other two treated soils.

The broad beans in the fertilized and natural soil have always seemed to be growing at a fairly similar speed. Both beans from these two different soils were up and down at the beginning over taking and each other until about the fifth day of the experiment (8th Feb). Here the fertilized soil took the lead and stayed ahead of the natural soil bean growth for the rest of the time, even though the natural soil growth pattern stayed close behind.

It is clear from this graph that midway through the experiment is where the nitrogen fertilizer really started to take affect on the broad beans' growth.

<u>Dig 3:</u>

This is a line graph (Dig 3) p23 showing the two soil treatments that had the most different growth patterns.

Here you can see that the fertilized soil always gives the strongest growth with the tallest beans.

You can see that it took the first three days for each growth pattern to become more significant; this was once the beans had begun to germinate and elbowed through.

By the end of the experiment after 12 days, the beans treated with fertilized water had almost twice the amount of growth as the beans grown in sterilized soil. The fertilizer on average at the end of the experiment had beans that had grown to 39.9cms and the sterilized soil beans on average at the end measured 22.4cms. That means the beans grown with the nitrogen fertilizer grew almost twice as high as the beans growing in the sterilized soil.

Dig 4:

This pie chart shows the percentage of growth of each of the three differently treated soils out of the combined total measured growth. It is clear to see that the beans in the soil that got fertilizer instead of just water had the best growing environment for the broad beans. The fertilized soil beans grew 41% of the total measured growth over the three variables. Whereas the sterilized soil only grew beans that measured 23% out of the total combined growth across the three different treatments.

Experiment Observations:

· The soil level reduced over the length of the experiment as it settled, this might have been caused by the water when watering them every day.

· Soil particles were washed out of the bottom of the pots as the water drained out – this happened even though I placed pebbles and small stones in the bottom of each pot.

· Some beans worked themselves out of the soil to different degrees – Fig 13, and others stayed underneath the soil remaining covered, this again could have been due to the way they were watered.

· The texture of the soil became finer once it had been sterilized. It looked sandier than the natural soil – Fig 14.

· At the end of the experiment the surface of the fertilized soil started to grow while spots on the tips of the clumps of soil, see Fig 15.

· The roots of some of the beans on the fertilized and natural soil started to come through the bottom of the pots.

· The last few days of the experiment a few of the beans had to be held up with a peg as a way of support, see Fig 16.

Fig 13

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Fig 14

Fig 15

Elbs investigation beans growth and soil intensification of farming

Fig 16

Conclusion:

I feel that my investigation has been a success because I fully met the objectives to produce and record the effects of sterilized, natural and fertilized soil on the growth and germination of Broad Beans. To do this I worked through the investigation carefully, collected and recorded all the required data thoroughly and made a suitable comparison between the three soil environments. This enabled me to get the results that I needed and that I had predicted in my hypothesis. My original hypothesis was met in this investigation. My results show that fertilized soil will produce better plant growth and sterilized soil is a poor growing medium. I can conclude that Broad Beans grow the best in soil that has added nitrogen fertilizer and that growth is reduced if the quality of soil is poor. This supports the idea that intensification can have positive effects but where it might destroy micro organisms the soil has to managed in a way which still encourages micro organisms ideally as in mixed farming practised for years but in a flexible way and that as I had predicted in my hypothesis.

Evaluation:

My investigation demonstrates clear, concise, reliable and valid data. Appropriate investigation methods have been used and the data has been collected and displayed using graphs and tables.

From my observations during my experiment and from my analysis of the data I can see there are certain things that could be done to improve the experimental design.

From the analysis you can see how close the total growths of the natural and fertilized soil treatments were to each other. One reason for this could possibly be because the roots of the natural soil that came through the bottom of the pot might have been picking up nutrients from the.

fertilized water that drained out of the pots in the row next to it. If this experiment were to be replicated, I could improve this next time by making sure that each row has its own separate drainage tray so that the fertilized water cannot drain away and possibly feed other rows by capillary action.

Because of the problem of the soil particles draining through and the movement of the beans to the surface of the soil, if I were to replicate this investigation I would consider watering the beans from the bottom so that the pots were sat in the water, so that the soil and roots soaked up the water instead of the water being poured from above.

To make sure my results were as accurate as possible I followed my objectives and carefully considered the variables that would have affected my results

To improve this investigation I would also chose to put more replicas in each row. I would then get a more reliable result on the growth data because there would be less possibility of random growth or if one seed did not grow it would not have such a big effect on the overall growth data for that row.

The biggest problem / error was choosing broad beans although used by D G Mc Kean (much respected) they have far too large cotyledons which contain excess nutrients.

I would modify this another time by using grass or barley with much smaller seeds. Another possible plant might be radish which would model large root crops in a short period of time.

If I were to expand my investigation I could include data from leaf spread and biomass instead of just measuring the height of the growth. If the investigation went on for long enough I could also measure the size and quantity of broad bean that the plant produced. Using much larger samples would greatly reduce error since in any biological sample a proportion of plants will die or underperform due to disease or infection or simply genetic variability so a large sample reduces this factor to I would then have reliable and thorough information to pass on to other growers.

Another future experiment would be to see how the quality of soil might apply to other types of crop. I also note that the plant growth measured in this investigation does not equal bigger, more or better beans. The experiment cold be extended to see how the intensification affects soils commercially farmed but using mono culture and rotational mixed farming in the field for this they would need to be on the same type of soil.

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> Book - GCSE Biology – Soil, By D.G.Mackean

> Teacher - Mr Robert Chicken

> Teacher – Mrs Diana Ducks

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I would like to say thank you to my subject teachers, Mr Robert Ford for his advice and knowledge on soil and plants and giving me understanding on how to conduct a pH tests. And a thank you to Mrs D Ducks for answering any questions I had throughout the experiment. To thank Mr Netherlands and Mrs Rose Bucket who provided valuable discussion, as well as Mr Robert Sticking for taking the photos that I am seen in.

Scientific Investigation: Mark Allocation

Strand to be assessed:

(a) Planning using appropriate secondary data

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
9-10 marks **Award 9 marks**	Selects relevant questions without guidance; clearly expresses information; plans an appropriate investigation using detailed secondary data to inform the plan and identifies a suitable procedure. Justifies how the plan will ensure precision and minimise error. Produces a detailed risk assessment and researches the necessary control procedures.	No need for support independently devised the investigation. Secondary research is detailed and appropriate and discussed and is used to inform the plan for the investigation. The information sourced will be used, explained and clearly identified. The awareness of limitations in the planned procedure will be clear. Candidates will be aware of and identify and manage all risks, showing clear evidence of appropriate research.	Quite a diffuse plan but procedures are justified and linked to the secondary data. It is evident that although this student acknowledged considerable discussion with the sources used, the candidate can be assumed to have worked independently. Appropriate risk controls used. Good and extensive use of secondary data.

(b) Collecting primary data

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
7-8 marks **Award 8 marks just**	Reveals patterns in the data using graphical and/ or mathematical techniques. Provides an analysis of the trends/patterns based on the evidence and scientific knowledge and understanding. Uses the general pattern of results to give conclusions, with reasons, linked to scientific models.	As above but uses more data and clearly explains and identifies patterns and trends identifying some specific data expressed in the graphs and makes comments to address and justify the significance of this. Relates the outcomes to basic predictions within the plan and uses the underlying science to attempt to explain the results and patterns shown. Uses scientific models to support the conclusion drawn.	Patterns and trends identified clearly based on and related to the science and the findings are related to the evidence In some ways this work is worth eight marks but equally much of the material is also above this, however, not written as a fully comprehensive and clear account.

(c) Processing and analysing data

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
7-8 marks	Reveals patterns in the data using graphical and/or mathematical techniques. Provides an analysis of the trends/patterns based on the evidence and scientific knowledge and understanding. Uses the general pattern of results to give conclusions, with reasons, linked to scientific models.	As above but uses more data and clearly explains and identifies patterns and trends identifying some specific data expressed in the graphs and makes comments to address and justify the significance of this. Relate the outcomes to basic predictions within the plan and uses the underlying science to attempt to explain the results and patterns shown. Uses scientific models to support the conclusion drawn.	Patterns and trends identified clearly based on and related to the science and the findings are related to the evidence In some ways this work is worth eight marks but equally much of the material is also above this, however, not written as a fully comprehensive and clear account.
9-10 marks **Award 9 marks**	Identifies complex relationships between variables using appropriate complex graphical and/or mathematical techniques. Uses an appropriate quantitative treatment of level of uncertainty of the data. Provides a comprehensive, effective and coherent analysis based on the evidence and gives conclusions with reasons fully explaining and incorporating the appropriate science. Presents clear links to scientific models.	Identifies complex relationships between variables using appropriate complex graphical and/or mathematical techniques. Uses an appropriate quantitative treatment of level of uncertainty of the data. Provides a comprehensive, effective and coherent analysis based on the evidence and gives conclusions with reasons fully explaining and incorporating the appropriate science. Presents clear links to scientific models.	Certainly within the limits of the task and equipment, the investigation is complex and a considerable number of factors are considered in formulating an analysis to draw conclusions from the graphs and data. The work on best fit is better than eight marks.

(d) Evaluating the procedure and the evidence

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
7-8 marks **Award 7 marks**	Considers critically the quality of the evidence, including repeatability and uncertainty, and the management of risks. Considers whether the evidence is sufficient to support conclusions, accounting for any anomalies. Describes in detail, with reasons, further work to provide additional relevant evidence and information which will support conclusions.	Candidates need to include an evaluation of the methods used with an explanation to support and justify reasons for suggested improvements. Anomalous and unusual or unexpected results need to be explained to show how they do not match the trends shown and give possible scientific explanations or account with reasons for error in the collection of data and information on which the results are based.	A comprehensive and well argued evaluation linked to the original question and applying the appropriate science . Showed awareness of variations and identified the major problem involving the use of broad beans, which is a procedure advised in a much respected student text.

(e) The quality of scientific communication

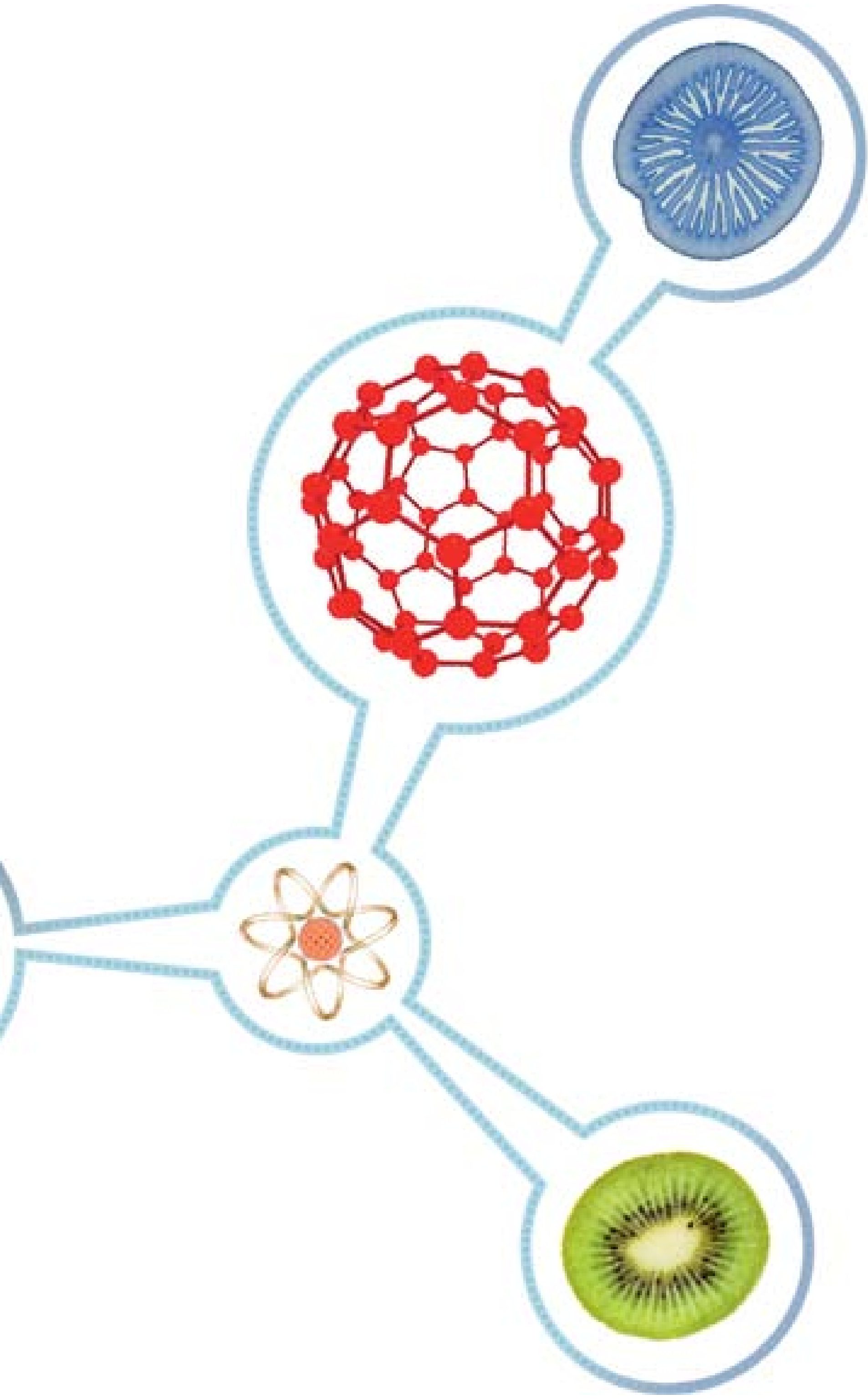
Mark allocated	Specification statements	Teacher Guidance	Task specific justification
5-6 marks **Award 6 marks**	Report well presented, well structured and detailed with good use of visual information, sub-headings, a table of contents and an accurate and detailed bibliography. Pages numbered and cross referenced where appropriate. Good spelling, punctuation and grammar. Scientific and technical terms used accurately and appropriately.	Full explanation in scientific terms of how the investigation might be improved to further strengthen and support any conclusions drawn. If candidates' work did not require any significant changes then a statement indicating this, with sufficient justification of why methods were successful, will still support the award of higher marks.	Well set out and cross referenced. Excellent use of data and pictures supporting the report and punctuation, spelling and use of scientific terms is good

(f) Determination, initiative and independence

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
5-6 marks **Award 5 marks**	Completes investigation and deals well with any difficulties without direct support.	Candidate got on with the investigation in a mature and responsible way was able to use his /her own initiative to resolve problems although they might have decided to discuss these following their own initial action.	The work appears to be that of a highly motivated student who dealt with problems and used many different people for advice and deciding on the procedures needed.

Overall for task: 44 marks out of 48

WORK-RELATED PORTFOLIO



Paignton zoo

Contents page

Introduction

- Founded by Herbert Whitley Paignton Zoo opened in 1923 entry was 5p.
- 1955 Herbert Whitley died. The zoo was then registered as a Scientific and education charity.

Information about the zoo

Paignton Zoo Torbay South Devon houses thousands of plants and animals. It has a lot of sections such as a desert, savannah, forest and the tropics. The sections, which the animals live in, are made to be like their natural habitat. These have evolved from being a traditional collector's zoo to now being part of a conservation and educational establishment of international acclaim. The animals are cared and looked after by the staff and the veterinary team. There is also research staff that ensure the zoo animals are active and stimulated.[1]

The zoo is a very large place and has a lot of different areas for different animals. There is a map to show where all the different areas are and where to go for food drinks etc.

Figure 1- map of the zoo and all of its features

Description of the work placeThe wider organisation.

locally

the picture above shows how Paignton zoo is linked to other organisations

Internationally:

The zoo has conservation projects in Nigeria, Vietnam, Kenya, Indonesia, Tanzania, Philippines, Brazil, South Africa, Columbia, Mexico, Zimbabwe.

Description of the work place

Jobs at the zoo:

Department	Number of employees
Directors	8
Maintenance Dept.	13
Retail Dept.	17
Catering Dept.	32
Marketing	7
Education and Graphics Dept.	13
Vet Dept.	5
Volunteers	126

Administritation and Finance Dept.	25
Gardens and Litter Dept.	17
Birds Dept.	19
Reptile Dept.	5
Mammal Dept.	21

Science in the work place.

Endangered species breeding programmes:
Many of the species in the Zoo are managed in captivity as part of co-operative breeding programmes with other zoos in the UK and Europe. These programmes are managed by the European Association of Zoos and Aquaria (EAZA). Each species has a studbook keeper and programme co-ordinator who recommends suitable pairings to prevent inbreeding, maintain maximum genetic diversity and ensure the captive population is genetically healthy.

The inheritance of acquired characteristics is a hypothesis that physiological changes acquired over the life of an organism (such as the enlargement of a muscle through repeated use) may be transmitted to offspring. It is also commonly referred to as the theory of adaptation equated with the evolutionary theory of French naturalist Jean-Baptiste Lamarck known as Lamarckism. (7)
Around 100 species at Paignton Zoo are included in formal breeding programmes. Zoo staff co-ordinate European breeding programmes for white-faced Saki monkeys, Sulawesi crested black macaques, Abyssinian Colobus monkeys and red-tailed amazons. They also monitor the EAZA populations of blue crowned Motmot, European turtle dove and pied imperial pigeon. (3)

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Zoo based research

Paignton Zoo Environmental Park is part of the Whitley Wildlife Conservation Trust along with Newquay Zoo, Living Coasts (Torquay) and three nature reserves in South Devon. All research at the WWCT's zoos and reserves is co-ordinated by the WWCT Field Conservation and Research Department. Each year the department carries out, supervises or facilitates over 100 research projects in three core areas:

- Behavioural Husbandry and Animal Welfare
- Behavioural Ecology and Cognition
- Conservation, Ecology and Environment

Qualifications
There are many jobs at the zoo each one requiring different qualifications:

Qualities to be a zoo keeper:

Zoo keepers have to be
- Practical, hardworking and don't mind getting dirty
- Physically fit and able to repetitive work
- Dedicated, caring but not over sentimental
- Good communication skills, able to talk to groups
- Confidence and patience when working with the animals
- Good observation skills and precision-weighing and recording
- Awareness of health and safety
- IT literate

Keeper Qualifications:
- Good GCSE results, Animal care course or degree ,most today have some form of biological or zoological degree
- The advanced national Certificate in the management of zoo animals course. Previously known as the zoo animal Management course (done whilst in the job.

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A day in the life of a zoo keeper- Michael Jones
22/09/2011 (5)

' I get up in the mornings at 6.30 and get to work for about 7.30. I have to check all of the animals to make sure they are all healthy and have good water. I then have to clean them out. Make sure they are all comftable and clean. At about 10-10.30 I feed them all make sure they are eating so that they at healthy. It's a long day at the zoo and again and 2.30 the animals have to be fed again, cleaned out and water. Sometimes during the day the animals have to be washed which is always a lot of fun. A lot of work to do and by the time I finish at 5. I am very tired."

I asked '' what science do you use in your every day life?"

"Well I have to know about the animals natural habitats what food they need and a lot of things like that really."

'' what technical skills do u use?"
'' I have to weigh out precise amounts of food for certain animals, if they don't get the right amount of food and the correct nutrition then they could become ill. I need to be able to take animal temperatures with ear thermometers and anal thermometers. I have been trained to deliver hypodermic injections of antibiotics. Regulating temperature and setting climatic control programmes for light and humidity and checking these with standard instruments to confirm the data sensors and computer managed systems"

The information that he gave was helpful and gave me the understanding of how hard the work of being a zoo keeper is.
He told me that he had to be at the zoo at 7.30am which surprised me. He had to check all the animals then by 10.30am. He had to do more jobs such as feeding the animals. It must be very tiring for him and not finishing until 5pm is a long day.

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Veterinary surgeon Skills and Qualities

- Concern for animals without being too sentimental
- Calmness and confidence when handling animals
- An interest in science, particularly biology
- Willingness to carry out messy or unpleasant tasks
- To ability to communicate well with colleagues and keepers
- Administrative and IT skills

Qualifications needed

- ''A" grades at GCSE and A-level
- A degree in veterinary science
- Post graduate study in exotic animal medicine

Vet Nurse:

- NVQ level 2&3- training in an approved vet centre

OR

- HDN/Degree in veterinary nursing

Warden Qualifications:

This can vary from place but it's usually necessary to have at least 3 GCSEs. It's also important to have the right experience.

Possible Training includes:

- NVQ's in countryside management and environmental conservation
- Countryside management courses and HND and degree level
- National Trust career ship scheme

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It is clear from talking to people that the qualifications whilst important for getting the job in the first place it is in reality more important to be flexible in your approach and willing to amend your practice day by day. At the end of the day the staff is a team and need to be able to use each other's strength and weakness to their full potential. The information obtained was from direct practitioners with senior roles or web sites such as deffra or other independent non political but scientific in nature.

<u>More explaining the science- what is sustainable hydroponics –detail.? Advantages, disadvantages.</u>

Television presenter John Craven, of BBC Country File, is to open an innovative new plant growing system at Paignton Zoo Environmental Park.

Some of the latest Science and technology in use at the zoo

The VertiCrop sustainable hydroponics installation is the first of its kind in Europe and the first in a zoo or botanic garden anywhere in the world.

Guests from the UK, Canada and New Zealand will gather for the invitation-only opening at the Zoo on Wednesday 30th September.

The Zoo has teamed up with the developers of VertiCrop, Valcent Products (eu) ltd., based in Launceston, a company at the forefront of global efforts to find new ways of growing plants in a world of rapidly-diminishing resources. It was first used in intensive dairy farming almost 25 years ago in Cornwall

Paignton Zoo Curator of Plants and Gardens Kevin Frediani said: "We are making history here. Installing VertiCrop at Paignton Zoo means we can grow more plants in less

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room using less water and less energy. It will help to reduce food miles and bring down our annual bill for animal feed, which is currently in excess of £200,000 a year."
The system allows crops to be grown in confined spaces maximising light and water and nutrients and monitored and managed by a complicated computer programme and a range of sensors for mineral salt concentration, light and photo period regulation and heat control.
The system is automatic but we regularly test the nutrient solutions and make visual observations of the plants to ensure all is working.
The system allows the growing of many tropical and sub tropical plants which are needed in small amounts but on a daily or weekly basis which it would be expensive and difficult to import in such ways. The plants tend to work on 12-14 hrs of light and an optimum temperature of 25-28 degrees centigrade and most also need high humidity.

To begin with, the Zoo will grow a whole range of herbs such as parsley and oregano, as well as leaf vegetables like lettuce and spinach, plus a range of fruits such as cherry tomato and strawberry. Reptiles, birds and most of the mammal collection - including primates and big cats – will benefit from the production of year-round fresh food. Paignton Zoo animals crunch their way through about 800 carrots a day and approximately £8,000-worth of fruit per month. Herbs are used as enrichment for many species.

Chris Bradford, Managing Director of Valcent, explained: "The world population is growing, food supply is shrinking, water supplies are becoming more limited, food production is competing for land with housing and the production of fuel crops. We have to make better use of available land.

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"VertiCrop is the latest in plant growing technology, meeting the needs of the human population while reducing the pressure to clear precious habitat to grow crops. This technology could usher in a new era of urban horticulture."

A zoo seems an unlikely location for this ground-breaking project, but Kevin explained: "Valcent wanted to promote their technology to the public as well as to growers, and we have over half a million visitors a year. As a botanic garden, Paignton Zoo is keen to educate people about all aspects of horticulture, particularly new, environmentally-friendly inventions like this."

VertiCrop is a commercial high-density vertical growing system which increases production volume for field crops up to 20 times over but requires as little as 5% of the normal water supply. It is a non-GM solution to food problems, using trays on a looped dynamic conveyor belt and automatic feeding stations to grow plants efficiently. This system allows the zoo to provide plants which would be expensive to import and provide specific species for which the animals' digestive system has evolved to gain essential nutrients.
The system was used for intensive dairy farming but costs are too high however it is ideal for meeting special dietary requirements of the animals.
(6)

Verticorop

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Note the tray system provides space needed for each plant and all the nutrients and environmental conditions most suited to the plant species

The importance of these technologies in the Zoo are immense. In conclusion it is fair to say that the Zoo is faced with difficult problems of supply of unusual foods at all times of the year and with tight financial and regulatory systems. The import of many of the plants grown would present a whole range of problems regarding plant disease and transmission of viral and fungal disease not found in Europe and the UK as can be seen in the deffra web site re importing plants from foreign countries (7) The avoidance of disease and ease of availability has enabled the zoo to continue to develop while maintaining tight fiscal controls yet cope with the demands of an expanding organisation yet being so needed at a time of austerity.

The zoo allows the local area to benefit from a high quality educational resource and be part of an international conservation scheme. This is of great benefit to all types of schools and Universities who are strong in providing related courses. As mentioned in the employment section the Zoo makes good use of post graduate students who make valuable contributions to the zoo's research work.

The amount of employment from scientists to caterers and cleaners is very important in an area of fairly high unemployment and with some areas of high deprivation.

11

Overview of the Laws Affecting Zoos

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Michigan State University College of Law
Publish Date: 2004
Place of Publication: Animal Legal & Historical Center
Printable Version

Overview of the Laws Affecting Zoos

Zoos and similar facilities that publicly exhibit wild animals have existed throughout history, beginning as far back as Ancient Egypt. In the past, animals were kept in small cages and used by rulers to display their wealth and satisfy the curiosity and fascination surrounding wild creatures. Society's views about zoos have changed. No longer are people willing to view animals pacing nervously back and forth behind bars. Instead, the public has begun to express concern for the welfare of the animals within zoos, preferring aesthetically pleasing and more natural habitats for zoo enclosures. Zoo proponents now claim the exhibitions exist for education, conservation, science, and recreational purposes. The imprisoned animals are the property of the zoo and laws are in place to regulate and protect them. Unfortunately, the current mandates lack effective protections and enforcement to ensure the welfare of animals kept in captivity. This paper will examine current laws pertaining to zoo animals, exposing their benefits and downfalls, and illustrating that more protection is needed.

Laws pertaining to zoo animals exist on international, federal, and state and local levels. On the international level, the Convention on International Trade of Endangered Species of Wild Flora and Fauna (CITES) regulates the trade and movement of roughly 5,000 types of endangered animal species. Membership of nation states is completely voluntary. CITES covers both live animals and their products. The act works by employing restrictions on trade, both import and export, through licensing and permitting systems. The species are listed in three appendices, which determine how much protection they are afforded. Trade in species listed on Appendix I is almost never permitted, while trade in species listed on Appendix III is much less regulated. Additionally, all animals housed in zoos prior to the signing of the treaty in 1973 are exempt from its provisions. And animals born in captivity are afforded much less protection their free-roaming counterparts.

In addition to CITES, on the international level, the International Air Transport Association (hereinafter "IATA") regulates the majority of airlines. Membership is voluntary, but 12
highly regarded within the industry. Member airlines must meet the IATA industry standards for shipping live animals, whether

The numerous references to rules and regulations for importing plants and animal species makes the import of plant material a nightmare so the verti crop system is a way of providing food economically and without the need for import regulations .
The Zoo has to work under tight regulation and the keepers have to consider risk assessments to protect the public livestock and themselves.
With the increasing role of education having workable and effective risk assessment is even more complex. Michael Jones keeper(5) commented 'increasingly we have to make risk assessments for temporary employees or post graduate students who are involved in specific student based activities and behavioural studies.
I have found the day at the zoo and subsequent research a fascinating glimpse of an organisation which in less than 80 years has grown into a large and important conservation and educational botanical and zoological resource.

1http://www.paigntonzoo.org.uk/index.php (25/3/11)
2http://www.paigntonzoo.org.uk/conservation.php (26/3/11)
3h)tp://www.paigntonzoo.org.uk/conservation/breeding-programmes.php (26/3/11)
4) http://www.paigntonzoo.org.uk/conservation/breeding-programmes.php (27/3/10)
5 Michael Jones (20/09/2010)
6 http://www.paigntonzoo.org.uk/news-events/news-detail.php?id=167 (20/3/10)

7 http://en.wikipedia.org/wiki/Inheritance_of_acquired_characteristics Defra -

(8)Department for Environment, Food and Rural Affairs

*www.**defra**.gov.uk/*Cached
http://www.animallaw.info/articles/ovuszoos.htm

(29/3/10)

13

Work-Related Report: Mark Allocation

Strand to be assessed:

(a) Collecting primary data (information)

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
(a) Collecting primary data (information) **7-8 marks** **Award 7 marks**	Collects, selects and records accurately an appropriate range of valid data from a variety of relevant sources including a practitioner and/ or workplace visit.	Candidates will have collected and selected relevant primary data for their report from a variety of sources, which includes suitable selection of the data collected from a visit or practitioner and or from their own enterprise. For 7-8 marks, candidates will comment on the validity of the sources used.	Good and extensive range of information collected within the time for such a visit with a large class of students all needing such data. Made some direct and indirect comment about the sources and role of the people with direct quotes
(b) Reference to sources **7-8 marks** **Award 7 marks**	Collects, selects and records accurately an appropriate range of valid data from a variety of relevant sources including a practitioner and/ or workplace visit.	Candidates will have identified a range of sources that they have accessed to complete collection of primary data, and it will be recorded in sufficient detail to know from whom, when and how data was collected (see marking criteria).	A large range of data collected and linked directly to the visit and or things seen and discussed even if somewhat superficial.

7 marks

(b) Collecting secondary data (information)

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
(a) Collecting secondary data (information) **7-8 marks** **Award 7 marks just**	Researches, selects and records accurately an appropriate range of valid data from a variety of relevant sources.	For higher marks, candidates should show research skills demonstrating suitable selection of appropriate material from the available resources rather than indiscriminate copying. 7-8 mark, higher level candidates will show the ability to adapt and re-structure secondary data	The information collected was suitable and not just plagiarised
(c) Reference to sources **7-8 marks** **Award 7 marks**	Identifies sources clearly using references that are accurate, fully detailed and dated.	Collected to suit the purpose of the Work-related Report. At this level, candidates possibly will comment on the validity of the sources used.	Sources identified appropriately

7 marks

(c) The work carried out

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
(a) The organisation/ workplace ** 7-8 marks Award 7 marks	(c) The location of the organisation/ workplace and the effect on society** *	For 7-8 marks, candidates need to use their researched information to analyse the importance of the roles of the employees. Material should be suitably selected from their research and link directly to the specific organisation the candidate is studying. At this level work should not be generic.	Focused on the science of verticulture
(b) The work carried out in a chosen job role and its place in the wider organisation 7-8 marks Award 8 marks**	Analyses the purpose of the work and its importance to the wider organisation.	For 7-8 marks, candidates need to use their researched information to analyse the purpose of the work and its importance in the wider organisation. Material should be suitably selected from their research and link directly to the specific organisation the candidate is studying. At this level work should not be generic.	Fully covered
(c) The location of the organisation/ workplace and the effect on society 5-6 marks Award 6 marks	Explains the reasons for the location of the organisation and some effects on society.	For 5-6 marks, candidates need to give explanations on the reasons for the location of the organisation and more than one effect the work has on society rather than simple comments or statements.	Insufficient to reach the 7-8 mark but a firm 6

7 marks

(d) Skills used in the workplace

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
(a) Technical skills applied in the workplace **7-8 marks** **Award 8 marks**	Analyses the technical skills applied in the workplace.	For 7-8 marks, candidates need to use their researched information to analyse the technical skills applied in the workplace e.g. why and how these skills are necessary. Material should be suitably selected from their research and link directly to the specific organisation the candidate is studying. At this level work should not be generic.	Showed a good understanding of the technologies and reasons for their use
(b) The expertise needed by an individual, or a working group, with the vocational qualifications and personal qualities required **7-8 marks** **Award 8 marks**	Analyses the expertise needed by an individual, or a working group and explains the relevance to the work of the vocational qualifications and personal qualities required.	For 5-6 marks, candidates need to explain how the expertise, personal qualities and qualifications needed in the job role are applied in the workplace. Note that as well as the need to include all three qualities, the work needs to be an explanation of what these are and how they are used, and not just statements to identify them. For 7-8 marks, candidates need to use their researched information to analyse the expertise needed in the workplace e.g. why and how this expertise is needed. It is also necessary to explain the relevance of the personal qualities and qualifications needed in the job role, e.g. why and how they link to the job role. Material should be suitably selected from their research and linked directly to the specific organisation the candidate is studying. At this level, work should not be generic.	Well covered in several areas

8 marks

(e) Scientific knowledge applied in the workplace

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
(a) Scientific knowledge applied in the workplace	Analyses the scientific knowledge needed and explains how it underpins the work described.	For 7-8 marks, candidates need to use their researched information and their scientific knowledge to analyse the science knowledge required in the workplace e.g. why and how this science is needed. It is also necessary to explain how the science underpins the job roles. Material should be suitably selected form their research and linked directly to the specific organisation the candidate is studying. At this level, work should not be generic.	Showed how the science underpins and impacts on the organisation and work.
(b) Financial or other regulatory contexts that impact on the work done (e.g., health and safety regulations) **7 -8 marks** **Award 7 marks**	Analyses the impact of two examples of financial or other regulatory factors on the work.*	For 7-8 marks, candidates need to use their researched information to analyse the impact of their two chosen examples. Material should be suitably selected form their research and linked directly to the specific organisation the candidate is studying. At this level work should not be generic.	Looked at DEFFRA and COSH materials And regulatory factors relating to importation of plants

7 marks

(f) Quality of the presentation

Mark allocated	Specification statements	Teacher Guidance	Task specific justification
(a) The structure and organisation of the scientific report **7-8 marks** **Award 7 marks**	Produces a comprehensive, relevant and logically sequenced report which includes contents listing of key elements, reference page and page numbering. Presents the information in a form and structure that fully suits its purpose.*	The aim of this strand is to assess how candidates can organise and write a scientific report, using relevant scientific or technical vocabulary and suitable visual material.	Concise well structured and easy to read
(b) Use of visual means of communication (charts, graphs, pictures etc) **7-8 marks** **Award 8 marks**	Uses pictures, diagrams, charts and/or tables effectively and appropriately to convey information or illustrate ideas.		Used illustration data and photos appropriately and in an effective way communicating effectively
(c) General quality of communication **7-8 marks** **Award 7 marks**	Uses full and effective relevant scientific or technical terminology. The report is clear and fully comprehensible. Spelling, punctuation and grammar are almost faultless.		

7 marks

Total mark 43 out of 48

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