# Applied Science Bridging Project

For BTEC Applied Science we follow Pearson's specification. Over the two years you study for Pearson BTEC Level 3 National Extended Certificate in Applied Science

## General Resources:

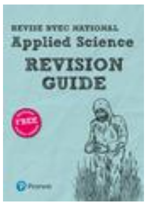
1. Pearson website (you may have to select from the drop down menu "Extended Certificate"

https://qualifications.pearson.com/en/qualifications/btec-nationals/applied-science-2016.html

2. Specification. This is very long. In Year 12 you study Unit 1 and Unit 2.

https://qualifications.pearson.com/content/dam/pdf/BTEC-Nationals/Applied-Science/2016/specification-and-sample-assessments/9781446938164_BTECNat_AppSci_ExtCert_Spec.pdf

3. Revision Guide. BTEC National Applied Science Revision Guide




Publisher: Pearson

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ISBN: 9781292150048

## Information about Unit 1:

Unit 1 is split into 3 sections; Biology, Chemistry and Physics. This project will look at some of the topics covered in this Unit.

The links below are to documents where you can read about what is covered in Unit 1, in lots of detail.

Biology:

https://qualifications.pearson.com/content/dam/pdf/BTEC-Nationals/Applied-Science/2016/external-assessment/Unit1-AdditionalGuidance-SectionB-Biology%20final4_applsci.docx

Chemistry:

https://qualifications.pearson.com/content/dam/pdf/BTEC-Nationals/Applied-Science/2016/external-assessment/Unit1-AdditionalGuidance-SectionA-Chemistry%20final3_applsci.docx

Physics:

https://qualifications.pearson.com/content/dam/pdf/BTEC-Nationals/Applied-Science/2016/external-assessment/Unit1-AdditionalGuidance-SectionC-Physics%20final2_applsci_v2.docx

**BIOLOGY**

**Section 1: Biology – Cell Structure**

The first part of the taught aspect for Biology looks at the structure of cells in more detail than you have learnt already, it will feel like you are bombarded with new terminology so use this time to recap what you have learnt at GCSE and familiarise yourself with some new terms! Using your GCSE knowledge, as a baseline before completing further tasks.

Tasks:

1. Draw a typical animal cell and label the parts.
2. Draw a typical plant cell and label the parts.
3. Do a table to compare and contrast plant and animal cells (considering the similarities and differences).
4. What do the different parts of the cell do? Make a table for structure and function.

The rest of the tasks will involve research, reading and watching videos and completing tasks on what you have read/watched/researched.

5. Watch: The wacky history of cell theory - Lauren Royal-Woods https://www.youtube.com/watch?v=4OpBylwH9DU
6. Make a timeline of events in the history of cell theory. Research further information of some of the key scientists and add this to your timeline. You should include images to make your timeline interesting.
7. Watch the video on Biology: Cell Structure | Nucleus Medical Media https://www.youtube.com/watch?v=URUJD5NEXC8
8. Read these notes on Cell Organelles:
   - https://pmt.physicsandmathstutor.com/download/Biology/A-level/Notes/OCR-A/2-Foundations-in-Biology/Summary/2.1.%20Cell%20Structure.pdf
   - https://www.physicsandmathstutor.com/biology-revision/a-level-ocr-a/module-2/cell-structure-flashcards/
   - https://www.s-cool.co.uk/a-level/biology/cells-and-organelles/revise-it/organelles
9. Write notes on the functions of the following. You should use the notes you have read.

| | | | | |
|---|---|---|---|---|
| Ribosomes | Mitochondria | Chloroplasts | Nucleus | Nucleolus |
| Centrioles | Endoplasmic reticulum – rough (RER) and smooth (SER) | Golgi apparatus | Flagella | Cilia |
| Lysosomes | Vacuole | Cytoskeleton | Cell wall | Amyloplast |
| Tonoplast | Vesicles | Cytoplasm | Pits | Plasmodesmata |

10. With all the additional new words you have looked at – find a diagram of a more complex animal and plant cell, draw and label.
11. Find a definition of "prokaryotic" and "eukaryotic".
12. Draw a diagram of a generalised prokaryotic (bacterial) cell. You need to label it with the key features. Highlight any key differences.
13. Draw a table to compare prokaryotic and eukaryotic cells.
14. Complete the question in the form of an essay. You will be given credit for the quality of written communication.

    Q: Plant cells are also eukaryotic. Outline the function(s) of each part of a **plant cell.**

15. Extended creative task: Make a model of a cell – plant or animal - OR large poster. Both need to include the functions of the organelles. This needs to include new terminology.

**Section 2: Biology - Microscopy**

There are two main types of microscope: light and electron. You are going to research into these two types.

Tasks:

1. Watch the video: Microscopes and How to Use a Light Microscope.

https://www.youtube.com/watch?v=tVcEEw6qbBQ

2. Make a fact sheet or presentation on light microscopes.
3. Research into Electron microscope and write some notes.
4. Read the information on: https://alevelnotes.com/notes/biology/cells/cell-structure/magnification
5. Make a comparison table of the microscope types you have researched.
6. Watch the video on: Microscope Drawings – Biology A Level.

https://www.youtube.com/watch?v=ElqjDBI_g9M

7. Write a set of rules on how to make a scientific drawing. This could then be used as a checklist for anyone completing a scientific drawing.
8. Find an image of some cells under the microscope and have a go at doing a scientific drawing for it.

9. Watch the video on gram staining: Gram Stain HD Animation

https://www.youtube.com/watch?v=L9batS-vGDY

10. Make a storyboard on how you complete the gram staining technique, with pictures and instructions.
11. Research the differences between bacteria that are gram positive and gram negative. Make a table to compare these.

Make a poster on performing microscopy – include using stains, measuring the sizes of objects.

**Section 3: Biology - Specialised Cells**

1. What is a specialised cell? Why are these important?
2. Watch the video "Specialized Cells: Significance and Examples". Write some notes. https://www.youtube.com/watch?v=wNe6RuK0FfA&t=68s
3. Make a detailed table for the different specialised cells. In the explanation column you need to give reasons why the key features help the cell to carry out its function.

| Cell and diagram | Function & location | Key features (specialisations) | Explanation |
|---|---|---|---|
| | | | |

You should include the following cells: red blood cell, white blood cell (two types: lymphocyte, neutrophil), sperm cell, egg cell, root hair cell, palisade cell, ciliated epithelial cell, squamous epithelial cell, muscle cell, neurone.

4. Select three examples of specialised cells you have researched in the table and make a detailed fact file for each. You should include: a diagram, location of where the cell is found, key features annotated, explanations of how each part helps this cell be specialised.

**Section 4: Biology - Maths Skills**

Download/View/Save using the link: The Transition from GCSE to A Level

http://fdslive.oup.com/www.oup.com/oxed/secondary/science/Science_A_Level_Transition_Pack_Biology.pdf

Work through reading the information and the questions that follow. It is in a logical order and links to the work you have completed on magnification,

As you work through the tasks, write some key notes on the Maths skills that you have been using.

**Section 5: Biology - Exam Questions**

Have a go at these exam questions, the questions prepare you well for the questions you could get asked in the examination.

Cell Structure 1 Questions:

https://pmt.physicsandmathstutor.com/download/Biology/A-level/Topic-Qs/OCR-A/2-Foundations-in-Biology/2.1-Cell-Structure/Set-B/Cell%20Structure%201%20QP.pdf

Cell Structure 1 Answers:

https://pmt.physicsandmathstutor.com/download/Biology/A-level/Topic-Qs/OCR-A/2-Foundations-in-Biology/2.1-Cell-Structure/Set-B/Cell%20Structure%201%20MS.pdf

**CHEMISTRY**

**Section 1: Chemistry - Atomic and Electronic Structure**

The first part of BTEC Applied Science looks at the structure of atoms in more detail than you have previously learnt. It will feel like you are bombarded with new models, so use this time to recap what you have learnt at GCSE and familiarise yourself with some new terms! Using your GCSE knowledge as a baseline, before completing further tasks.

Tasks:

1. Draw a typical Bohr's model of an atom and label the parts.

2. Draw the plum pudding model and nuclear model of the atom, and label them.

3. Draw a table to compare and contrast all three models (considering the similarities and differences).
4. What are the relative masses, charges and locations of all the subatomic particles? Make a table to display this.

The rest of the tasks will involve research, reading and watching videos and completing tasks on what you have read/watched/researched. **Building on GCSE Chemistry, these tasks will give a more in-depth view of the structure of the atom.**

5. Try this GCSE quiz about atomic structure: https://www.bbc.co.uk/bitesize/guides/z3sg2nb/test

6. Watch this video tutorial about atoms and isotopes from Free Science Lessons: https://www.youtube.com/watch?v=MGLrYaI_UfE

7. Read these notes on Atomic and Electronic Structure:
   - https://pmt.physicsandmathstutor.com/download/Chemistry/A-level/Notes/OCR-A/2-Foundations-in-Chemistry/Summary%20Notes%20-%20Module%202%20OCR%20(A)%20Chemistry%20A-level.pdf
   - https://www.physicsandmathstutor.com/chemistry-revision/a-level-ocr-a/module-2/atomic-structure-isotopes-compounds-formulae-equations-flashcards/
   - https://www.s-cool.co.uk/a-level/chemistry/atomic-structure/revise-it/the-structure-of-the-atom

8. Try the simulation on the following webpage to help you to build atoms according to the model you learned at GCSE.
   http://jiscscience.weebly.com/task-1.html

9. In a blog post, discuss the model we have for the structure of the atom (as you understand it). Explain how electrons are arranged in shells according to the model you learned in GCSE. If you do not have a blog yet you will have to set one up. You might like to try Wordpress or Blogger or you could word process or handwrite it. The model you learned at GCSE will change at Level 3 BTEC Applied Science and this can be confusing for some students. You might like to read ahead using this page on the website: http://www.jiscscience.weebly.com/orbitals and then put a comment on your blog post about how this model is different to the one you learned at GCSE.

10. Write the definitions of:

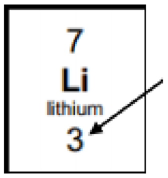
a) Atomic number b) Mass number c) Complete the missing data in the table below:

Use the example given, and your understanding of atomic structure and how atoms become ions.

| Atom | Metal or non-metal atom | Atomic No. | Electron Configuration of Atom | Gains /loses e- | No. of e- gained /lost | Ion formula produced | Electronic configuration of Ion |
|---|---|---|---|---|---|---|---|
| Li | Metal | 3 | 2,1 | loses | 1e- | $Li^+$ | $[2]^+$ |
| Na | | | | | | | |
| Mg | | | | | | | |
| Al | | | | | | | |
| F | | | | | | | |
| O | | | | | | | |
| S | | | | | | | |

**You will have used the rule of electrons shell filling, where:**

The first shell holds up to 2 electrons, the second up to 8, the third up to 8 and the fourth up to 18 (or you may have been told 8).




Atomic number =3, electrons = 3, arrangement 2 in the first shell and 1 in the second or: Li = 2,1

For the BTEC you will learn that the electron structure is more complex than this, and can be used to explain a lot of the chemical properties of elements. The 'shells' can be broken down into 'orbitals', which are given letters:'s' orbitals, 'p' orbitals and 'd' orbitals.

11. Read about orbitals here: http://bit.ly/pixlchem1 and http://www.chemguide.co.uk/atoms/properties/atomorbs.html#top

12. Now that you are familiar with s, p and d orbitals try these problems, write your answer in the format: $1s^2$, $2s^2$, $2p^6$ etc. Write out the electron configuration of:

    a) Ca b) Al c) S d) Cl e) Ar f) Fe g) V h) Ni i) Cu j) Zn k) As

13. Extension question: Can you write out the electron arrangement of the following ions?
    a) $K^+$ b) $O^{2-}$ c) $Zn^{2+}$ d) $V^{5+}$ e) $Co^{2+}$

## Section 2: Chemistry - Chemical Calculations

Many students find the manipulation of, understanding and substituting values into, mathematical equations challenging. **This task builds on and extends the chemical calculations that you will have encountered at GCSE.**

**Tasks:**

1. Watch this video to remind you how to complete a % by mass question: https://www.youtube.com/watch?v=ZAxl502Yl9g

2. Download and complete the "% by mass" worked example task on this webpage: http://jiscscience.weebly.com/task-2.html

3. Refresh your memory of other calculation questions by trying some of the questions from this website: http://www.gcsescience.com/m31.htm

   **Note:** You do not have to complete all of these questions! Read through the list quickly then select some to try. If you cannot decide, I suggest you complete **1, 3, 5, 7, 17, 20, 21, 24, 33, 38, 40, 45, 46, 60** and **63**. You can check your answers by clicking the **Answer** link next to each question.

4. Write a blog post, explaining how to calculate the following:

    a) A relative formula mass from atomic masses;
    b) An empirical formula from % composition data,
    c) The % yield of a product when given the actual yield and reaction equation.

5. When GCSE Chemistry students are required to complete calculations, the most common error highlighted in examiners reports is an inability to produce a ratio. If you need help doing this, then read through http://www.shodor.org/unchem/math/r_p/ first. End your blog post with a comment about any differences you could see between your answer and the model answer on this webpage http://jiscscience.weebly.com/model-answers.html. You may also like to look at the other model answers for the explanations of the other calculations. Perhaps you learned something from doing this? If so, comment about what you have learned, on your blog post.

Now that we have our chemical equations balanced, we need to be able to use them in order to work out masses of chemicals we need or we can produce. The mole is the chemist's equivalent of a dozen, atoms are so small that we cannot count them out individually, we weigh out chemicals.

Remember "Mass over Mr Moles"

For example: magnesium + sulfur → magnesium sulfide

$$Mg + S \rightarrow MgS$$

We can see that one atom of magnesium will react with one atom of sulfur. If we had to weigh out the atoms we need to know how heavy each atom is. From the periodic table: Mg = 24.3 and S = 32.1

If I weigh out exactly 24.3g of magnesium this will be 1 mole of magnesium, if we counted how many atoms were present in this mass it would be a huge number ($6.02 \times 10^{23}$). If I weigh out 32.1g of sulfur then I would have 1 mole of sulfur atoms. So 24.3g of Mg will react precisely with 32.1g of sulfur, and will make 56.4g of magnesium sulfide.

6. Read through these comprehensive pages on measuring moles; there are a number of descriptions, videos and practice problems. You will find the first 6 tutorials of most use here, and problem sets 1 to 3: http://bit.ly/pixlchem9 and http://www.chemteam.info/Mole/Mole.html

7. Answer the following questions on moles:
    a) How many moles of phosphorus pentoxide ($P_4O_{10}$) are in 85.2g?

    b) How many moles of potassium in 73.56g of potassium chlorate (V) ($KClO_3$)?

c) How many moles of water are in 249.6g of hydrated copper sulfate(VI) ($CuSO_4.5H_2O$)? For this one, you need to be aware the dot followed by $5H_2O$ means that the molecule comes with 5 water molecules attached, so these have to be counted in as part of the molecule's mass.

d) What is the mass of 0.125 moles of tin sulfate ($SnSO_4$)?

e) If I have 2.4g of magnesium, what mass of oxygen ($O_2$) will I need to react completely with the magnesium? $2Mg + O_2 \rightarrow MgO$

In chemistry a lot of the reactions we carry out involve mixing solutions rather than solids, gases or liquids. Remember n = cv.

You will have used bottles of acids in science that have labels that say 'Hydrochloric acid 1M'. This means the solution of hydrochloric acid has 1 mole of HCl, (hydrogen chloride, which is a gas) has been dissolved in 1 $dm^3$ of water.

The $dm^3$ is a cubic decimetre or 1 litre, but from this point on as a Scientist you will use the $dm^3$ as your volume measurement.

8. Read through these webpages: http://bit.ly/pixlchem10 and http://www.docbrown.info/page04/4_73calcs11msc.htm

9. Answer these questions:

a) What is the concentration (in mol $dm^{-3}$) of 9.53g of magnesium chloride ($MgCl_2$) dissolved in 100$cm^3$ of water?

b) What is the concentration (in mol $dm^{-3}$) of 13.248g of lead nitrate ($Pb(NO_3)_2$) dissolved in 2$dm^3$ of water?

c) If I add 100$cm^3$ of 1.00 mol $dm^3$ HCl to 1.9$dm^3$ of water, what is the concentration of the new solution?

d) What mass of silver is present in 100$cm^3$ of 1mol$dm^{-3}$ silver nitrate ($AgNO_3$)?

e) The Dead Sea, between Jordan and Israel, contains 0.0526 mol$dm^{-3}$ of bromide ions ($Br^-$), what mass of bromine is in 1$dm^3$ of Dead Sea water?

One key skill in BTEC Applied Science is the ability to carry out accurate titrations. You may well have carried out a titration at GCSE; you will have to carry them out very precisely and be able to describe in detail how to carry out a titration.

10. Read about how to carry out a titration here. The next page in the series (page 5) describes how to work out the concentration of the unknown: http://bit.ly/pixlchem11 http://www.bbc.co.uk/schools/gcsebitesize/science/triple_aqa/further_analysis/analysing_substances/revision/4/

11. Remember for any titration calculation you need to have a balanced symbol equation; this will tell you the ratio in which the chemicals react, e.g. for a titration of an unknown sample of sulfuric acid with sodium hydroxide: A 25.00cm$^3$ sample of the unknown sulfuric acid was titrated with 0.100moldm$^{-3}$ sodium hydroxide and required exactly 27.40cm$^3$ for neutralisation. What is the concentration of the sulfuric acid?
12. Read through these additional problems, which are harder; ignore the questions about colour changes of indicators. http://bit.ly/pixlchem12 and http://www.docbrown.info/page06/Mtestsnotes/ExtraVolCalcs1.htm

13. Use the steps on the last page to help you answer this: A solution of barium nitrate will react with a solution of sodium sulfate to produce a precipitate of barium sulfate.

$$Ba(NO_3)_{2(aq)} + Na_2SO_{4(aq)} \rightarrow BaSO_{4(aq)} + 2NaNO_{3(aq)}$$

What volume of 0.25moldm$^{-3}$ sodium sulfate solution would be needed to precipitate all the barium from 12.5cm$^3$ of 0.15moldm$^{-3}$ barium nitrate?

## Section 3: Chemistry - Structure and Bonding

**This activity builds on the knowledge and understanding of bonding you learned at GCSE level.**

Tasks:

1. Try these quick quizzes about covalent and ionic bonding:

- https://www.bbc.co.uk/bitesize/guides/zcvy6yc/test
- https://www.bbc.co.uk/bitesize/guides/ztc6w6f/test

2. Download and read through the "intermolecular forces blog task" on this webpage: then answer the final question in a blog post: http://jiscscience.weebly.com/task-3.html

3. Download and complete the "bonding quiz" on this webpage: http://jiscscience.weebly.com/task-3.html

4. Run the simulation about shapes of molecules on the webpage http://jiscscience.weebly.com/task-3.html

5. If you are unsure about covalent bonding, read about it here: http://bit.ly/pixlchem5

   And http://www.chemguide.co.uk/atoms/bonding/covalent.html#top

6. Draw a dot and cross diagram to show the bonding in a molecule of aluminium chloride ($AlCl_3$)

7. Draw a dot and cross diagram to show the bonding in a molecule of ammonia ($NH_3$)

## Section 4: Chemistry - Redox

At GCSE you know that oxidation is adding oxygen to an atom or molecule and that reduction is removing oxygen, or that oxidation is removing hydrogen and reduction is adding hydrogen. You may have also learned that oxidation is removing electrons and reduction is adding electrons.

At BTEC we will use the idea of ***oxidation number***. You know that the metals in group 1 react to form ions that are +1, i.e. $Na^+$ and that group 7, the halogens, form -1 ions, i.e. $Br^-$. We say that sodium, when it has reacted has an oxidation number of +1 and that bromide has an oxidation number of -1.

All atoms that are involved in a reaction can be given an oxidation number. An element (e.g. Na or $O_2$) is always given an oxidation state of zero (0); any element that has reacted has an oxidation state that is positive or negative.

As removing electrons is reduction, if, in a reaction the element becomes more negative it has been reduced; if it becomes more positive it has been oxidised.

**Tasks:**

1. Read about the rules for assigning oxidation numbers here:

   http://www.dummies.com/how-to/content/rules-for-assigning-oxidation-numbers-to-elements.html

Elements that you expect to have a specific oxidation state actually have different states, so for example you would expect chlorine to be -1, it can have many oxidation states e.g. in NaClO. In this compound it has an oxidation state of +1

There are a few simple rules to remember:

- Metals have a + oxidation state when they react.
- The more electronegative element has the negative oxidation state.
- Oxygen always has an oxidation state of -2 except in peroxides or compounds with fluorine.
- Hydrogen has an oxidation state of +1, except in metal hydrides.
- The oxidation states in a molecule must add up to the charge on the molecule.

2. Work out the oxidation state of the **underlined** atom in the following:

a) $Mg\underline{\mathbf{C}}O_3$ b) $\underline{\mathbf{S}}O_3$ c) $Na\underline{\mathbf{Cl}}O_3$ d) $\underline{\mathbf{Mn}}O_2$ e) $\underline{\mathbf{Fe_2}}O_3$ f) $\underline{\mathbf{V_2}}O_5$ g) $K\underline{\mathbf{Mn}}O_4$ h) $\underline{\mathbf{Cr}}_2O_7^{2-}$ i) $\underline{\mathbf{Cl_2}}O_4$

**PHYSICS**

**Section 1: Physics - waves**

The Physics module is predominantly focused on waves, specifically how they may be used in communications technology. A large part of the basis for this topic is material you have already learnt at GCSE, so you should ensure that you know this material inside and out.

Tasks:

1. Draw a diagram representing a longitudinal wave and label all the parts
2. Draw a diagram representing a transverse wave and label all the parts
3. All waves can be absorbed, transmitted, reflected, refracted, and diffracted. Look up these terms and begin a glossary

**Section 2: Physics – drawing graphs**

An essential skill in Physics is the ability to produce a clear and accurate graph from a set of values from an experiment. We use graphs because the visual information in the line is easier to interpret than a list of values. They can also be used to take errors into account, and to show up possible mistakes.

**If you are given a set of data, the best way to obtain values from it is to PLOT A GRAPH.**

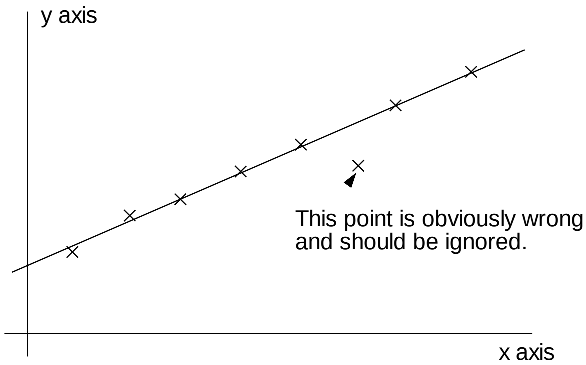
**Good Graph Practice**

- Use a **sharp** pencil for all lines and points. Preferably, use pencil for everything: if you make a mistake in pen (and *everyone* makes mistakes plotting graphs) you cannot rub it out.
- Plot your points as small crosses (× or +) so it will be easy to draw a line through the centre and still see where the point is. Dots will be obliterated by the line, and large dots are inaccurate.
- Label your axes with the quantity and its units.
- Choose a sensible scale that fills as much of the page as possible.
- Make sure you have a 30cm ruler available.
- Put a title on the graph, explaining what it is showing.
- If you are plotting more than one line on the same axes, either label the lines or use a key.
- NEVER draw a bar chart unless strictly asked to do so.
- Always draw a line or curve of best fit. NEVER do dot-to-dot!

## Straight Line Graphs

If there is a simple relationship in your experiment the graph that you plot will be a straight lines. When you come to draw the line in, you must draw a *line of best fit*: the line that goes as near as possible to as many points as possible, and has roughly the same number of points below the line as above it. Sometimes it will be easy to draw, other times it will be difficult. You may find that a transparent plastic ruler helps.

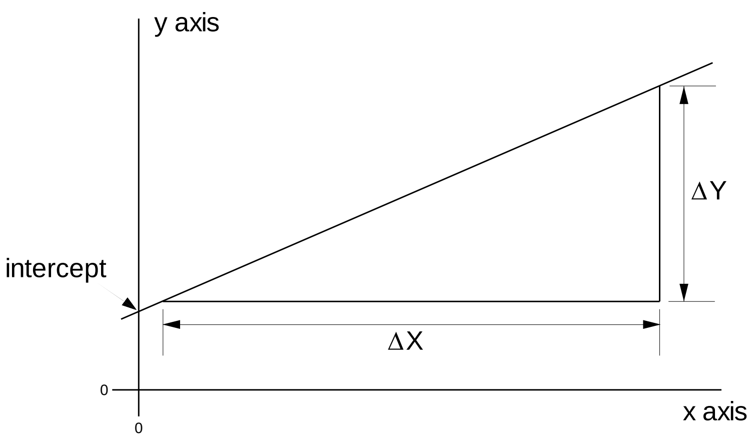
Any points that seem to be way out of line with the rest can be assumed to be the result of an error somewhere, and should not be taken into account when fitting the line. Look at the diagram below.




Once you have plotted the graph, you can get some values from it:

Firstly there is the **intercept**. This is where the line crosses the *y* axis.

Secondly, there is the **gradient**, or **slope** of the graph. To work this out, you need to draw a right angled triangle on the line. Make this triangle as **big** as is possible on the paper, as this will improve the accuracy of your result.




The gradient is calculated by: $\text{gradient} = \frac{\Delta Y}{\Delta X}$

The units of the gradient come from the units of the axes, eg: if *y* was time in seconds and *x* was distance in metres, then the units of the gradient would be metres ÷ seconds, ie: m/s.

**Task 4**

Plot the following set of data from an experiment with refraction

A ray of light was shone into a transparent block and the incident angle $\theta_1$ and refracted angle $\theta_2$ were measured. The relationship between these angles is $\sin\theta_1 = \sin\theta_2$ multiplied by the refractive index.

Use $\sin\theta_2$ on the *x* axis and $\sin\theta_1$ on the *y* axis:

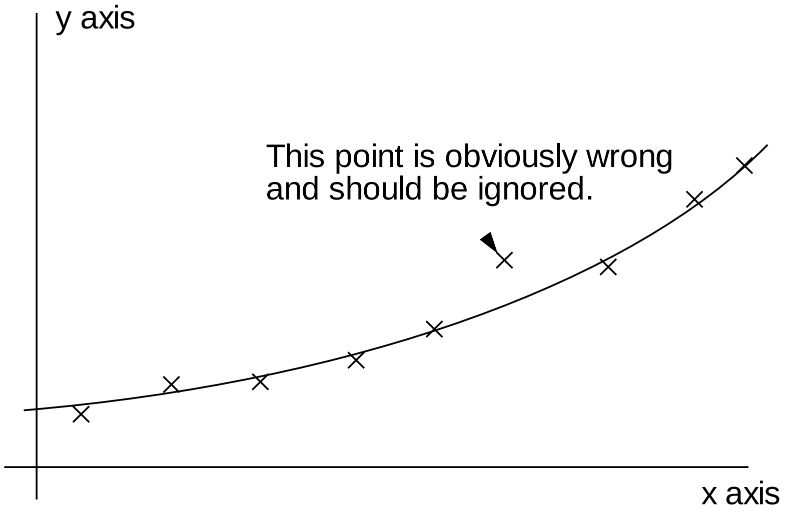
| $\sin\theta_1$ | $\sin\theta_2$ |
|---|---|
| 0.000 | 0.000 |
| 0.087 | 0.066 |
| 0.174 | 0.131 |
| 0.259 | 0.194 |
| 0.342 | 0.257 |
| 0.423 | 0.317 |
| 0.500 | 0.376 |
| 0.574 | 0.431 |
| 0.643 | 0.483 |
| 0.707 | 0.531 |
| 0.766 | 0.576 |
| 0.819 | 0.616 |
| 0.866 | 0.651 |
| 0.906 | 0.682 |
| 0.940 | 0.707 |
| 0.966 | 0.727 |
| 0.985 | 0.741 |
| 0.996 | 0.749 |

Calculate the gradient showing working and determine the refractive index of the material

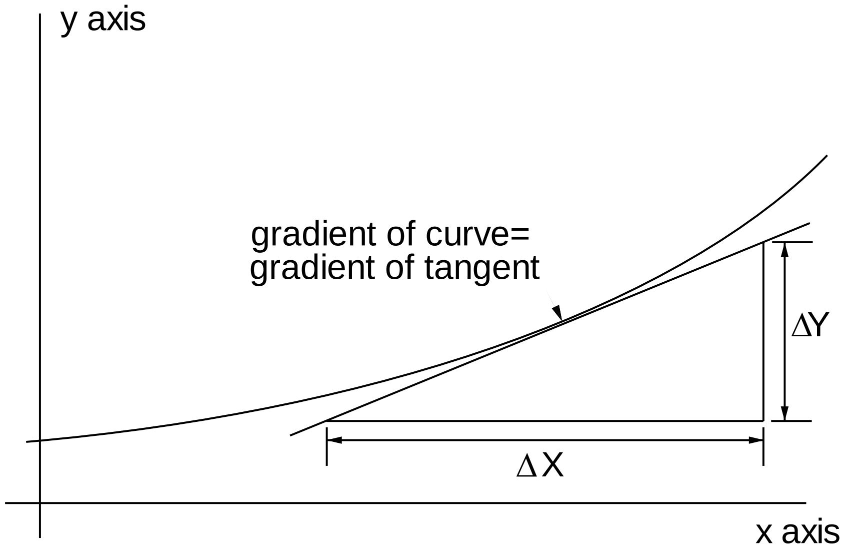
Use your research skills to find out what the material is.

**Curves**

Not all graphs can be put into a straight line form, and sometimes we actually want to produce a curve on a graph. When you are drawing a curve to a set of points, try to draw a smooth curve of best fit, and avoid lines that wobble up and down:




Because it is not a straight line, the curve does not have a gradient. However, you can measure the gradient *at a point* by drawing a line at a tangent to the curve at a particular place, then calculating the gradient of that as before. The gradient of a curve represents the *rate of change* of *y* with respect to *x*.




When you are asked to calculate the gradient of a curve, **always** draw the tangent, and make the triangle nice and big, to reduce errors. It also helps to write the values of ΔX and ΔY on the sides of the relevant triangle.

**Task 5**

Plot the following set of data, with time an the *x* axis and current on the *y* axis:

| Time (s) | Current (A) |
|---|---|
| 0 | 0.0 |
| 5 | 1.55 |
| 10 | 2.75 |
| 15 | 3.70 |
| 20 | 4.42 |
| 25 | 5.00 |
| 30 | 5.43 |
| 35 | 5.80 |
| 40 | 6.05 |
| 45 | 6.26 |
| 50 | 6.43 |

Calculate the gradient (including units) at the following times:

10s: gradient=.......................................................................................................

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20s: gradient= ......................................................................................................

.......................................................................................................................

38s: gradient= ......................................................................................................

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## Section 3: Physics – waves in communication

**Table 1.14:** Frequencies, sources and applications

| Application | Power and mode of transmission | Frequency band | How it is used and regulated |
| --- | --- | --- | --- |
| Satellite communications | High power signals over very long distances; concentrated by dish antennae. | 1 to 40 GHz (microwaves) | Satellite transponders receive incoming upload signals, amplify them and retransmit them as a download signal on a different frequency band. *For more info search 'satellite frequency bands' on the European Space Agency website www.esa.int* |
| Mobile phones | High power networked system, range several km. | 800 MHz to 2.6 GHz (UHF radio to microwave borderline) | 5 or 10 MHz bands allocated to different operators. 2G, 3G and 4G cellular networks offering increasing speeds for data. Higher frequencies have greater data capacity but travel less distance through air and penetrate into buildings less well. |
| Bluetooth® | Low power device to device links, range up to about 10 m. | 2.4 to 2.4835 GHz – the Industrial, Scientific, Medical (ISM) unlicensed band – borderline between UHF radio and microwave frequencies | Early Bluetooth devices interfered with Wi-Fi devices because both would use the same channel for an extended period of time. Modern Bluetooth uses frequency-hopping – i.e. broadcasting in short bursts on a number of different frequency channels across the band. This reduces the amount of data lost, and in most cases both Bluetooth and Wi-Fi can maintain service. *For more info search for 'Bluetooth and Wi-Fi' at IntelligentHospitalToday.com* |
| Wi-Fi | Medium power networked system, range ~10 to 100 m. | | |
| Infrared | Low power device to device links, range only a few metres. | IR wavelength 870 nm or 930 to 950 nm (frequency about 320 THz) | Used for remote controls and for data transfer between computers, phones, etc. The longer wavelength band is better because it does not suffer from 'sunlight blinding'. Atmospheric moisture blocks that range in sunlight. |

Research the uses of all the communication waves in the table above and write notes on them.