Physical Graph-iti

(Maths in Science)

Key Stage 4 Revision Programme

Pupil Name	
Handbook Designed by	Dr Stackhouse

Timetable

Timetable – Tutorials

Tutorial	Date	Time	Location
1 (Pre-assessment)		0745	S1
2		0745	S1
3		0745	S1
4		0745	S1
5		0745	S1
6 (Final Assessment + exam technique)		0745	S1

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Course Rationale

A lot of physics is transferrable skills that can be used across the curriculum. This might be something as simple as putting the units at the end of a calculation or knowing how to put graph together.

In this course, we will delve into working scientifically in great detail. Doing this will enable you to gain a deeper understanding of the nuts and bolts of physics, and why we choose to represent things the way we do.

'Practice makes perfect', are words often uttered but rarely taken to heart. We are constantly looking for a quick fix, a shortcut, some kind of way to save time. However, when it comes to the true mastery of something, there really is no substitute for doing it over and over, in as many ways as you can think of. Much as you cannot hope to pick up a guitar and play a tune, you cannot pick up a mathematical or scientific problem and expect to be able to solve it.

The framework of deliberate practice relies on this concept. By creating detailed worked examples that cover every eventuality, then allowing the student (you) time to practice many similar but contrasting cases, the hope is that you will eventually master the concept.

I hope that this workbook will provide this for you. It will tighten up your mathematical skills in science, enabling you to add an extra mark here and there that may make the difference between the grade you expect and the one above.

Let's get maths-ing.

Subject Vocabulary

Word	Definition	In a sentence
S.I.	Systeme international, the units used worldwide throughout science.	
Unit	Added to a quantity it enables you to ascertain the relative size of that quantity.	
Prefix	Put in front of a unit to make the number more easy to handle. E.g. 1000 g = 1 kg.	
Dinmensional analysis	A method of obtaining the units of a quantity by substituting units into the equation instead of numbers.	
Derive	Obtain an answer by a mathematical process.	
Standard Form	A way of writing large or small numbers to make them more manageable.	
Mantissa	The first part of a number in standard form. E.g. 1 is the mantissa in 1×10^4.	
Exponent	A 'power' of something. For example the 2 in x^2.	
Power of ten	A ten with an exponent, the second part of the number in standard form. E.g. 10^4 in 1×10^4.	
Whole number	Any number between –infinity and infinity that has no decimal part.	
Subject	The part of the equation alone next to the equals sign.	
Independent variable	The part of an experiment that you change to examine its effect.	
Dependent variable	The part of the experiment that you measure.	
Control variable	During an experiment you must keep this the same to make it valid!	
Anomalous	Out of place.	

Tutorial 1 – S.I. Units

What is the Purpose of Tutorial 1?

- Define S.I. units
- Convert to the correct units
- Derive units from equations

Starter

Order the following measurements for mass from smallest to largest.
kg
Mg
mg
Gg
g
µg
cg

Objective 1 – Define S.I. units

In physics, and more generally in all science, it is very important to state almost all measurable quantities as a number and a unit. The UNIT is paramount as without it you have no real idea about the size of the quantity, and also what that number represents.

For example, if I state the result of an experiment as 10, does it mean anything? You can have no idea about the actual size of the result, or what 'type' of thing the result is. If I say 10 metres however, you know two things: first, the quantity must be a length, you cannot measure a mass or time in metres; second, you have an idea about the size of this length compared to others. It is longer than 10 cm but shorter than 10 miles.

In science, seven units have been chosen as the standard that everyone should use (in order to avoid confusion). These are called the S.I. base units. In GCSE physics (and science) you are expected to be able to use 6 of these. They are:

Quantity	Unit name	Unit Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	Kelvin	K
Amount of substance	mole	mol

Practice 1 – Define S.I. Units

1. What is the S.I. unit for mass?

   _____

2. What do almost all measurable quantities have to consist of?

   _____

3. Jimmy does an experiment to measure temperature. He records his temperature as 13 degrees Celsius when his teacher asked him to record it in S.I. units. What unit should he have recorded his temperature in instead?

   _____

4. Jimmy does another experiment involving length. He records his result as 10. What has he done wrong? Why is this a problem?

   _____

   _____ .

5. Jenny is doing an experiment involving circuits. She is testing the relation that V=IR. What S.I unit will she need to deal with during her experiment?

   _____ .

Assessment 1 – Define S.I. Units

Which of the following statements is correct?

1. The S.I. unit of mass is kg
2. The S.I. unit of mass is mg
3. The S.I. unit of mass is g
4. The S.I. unit of mass is Mg

Which of the following statements do you most agree with?

5. It is important to state the size of any measured quantity
6. It is important to state the unit of any measured quantity
7. It is important to state the size and unit of any measured quantity
8. Units allow you to decide the relative size of measurements of the same type

Objective 2 – Convert to the correct units

In addition to these base units, you may need to use a prefix to ensure the number itself is in a more suitable form. Some of these, such as centi (100) and kilo (1000) you will use all the time, but others you may not recognise or remember. The full list you can encounter in science at GCSE is:

Prefix	Symbol	Power of 10
Pico	p	10^{-12} (0.000000000001)
Nano	n	10^{-9} (0.000000001)
Micro	µ	10^{-6} (0.000001)
Milli	m	10^{-3} (0.001)
Centi	c	10^{2} (100)
Kilo	k	10^{3} (1000)
Mega	M	10^{6} (1000000)
Giga	G	10^{9} (1000000000)

Prefixes are used when it makes the writing of the number easier. For example, instead of writing 10 mm, one can write 1 cm. Instead of writing 1000 g, one can write 1 kg.

Worked example 1:

Convert the measurement 1500 cm into metres (m)

Answer 1:

100 cm = 1 m <- Write down how many cm are in a metre

1 cm = 1 ÷ 100 m <- Find what one centimetre is (You can skip this step or the one above)

1500 cm = 1500 ÷ 100 m <- You want 1500 cm, so switch your 1 cms for 1500 cms

1500 cm = 15 m <- Do the calculation on the right hand side to get your answer

Worked example 2:

Convert 6.70 kg into grams (g)

Answer 2:

1 kg = 1 x 1000 g <- Write down the conversion from kg to g

6.70 kg = 6.70 x 1000 g <- You want 6.70 kg so switch the 1s for 6.70s.

6.70 kg = 6700 g <- Do the calculation on the right hand side to get your answer

Worked example 3:

Calculate the number of cubic metres (m^3) in 1250 cubic centimetres (cm^3).

Answer 3:

100 cm = 1 m	<- Write down how many cm are in a metre
100 x 100 x 100 cm^3 = 1 m^3	<- 1 m^3 is basically a cube with 100 cm sides, find the volume to find the conversion.
1 000 000 cm^3 = 1 m^3	<- Do the calculation above to get...
1 cm^3 = 1 ÷ 1 000 000 m^3	<- You need to find out what 1 cm^3 is.
1250 cm^3 = 1250 ÷ 1 000 000 m^3	<- Switch the 1s for the value you need again.
1250 cm^3 = 0.00125 m^3	<- Do the calculation on the right hand side to get your answer.

Practice 2 – Convert to the correct units

Convert the following into the stated units.

1. 240 cm into metres.

_____

2. 3800 g into kg.

_____

3. 4250 cm^2 into m^2.

_____

4. 1520 cm^3 into m^3.

_____

5. 1.5 x 10^9 g into kg.

_____

6. 2.5 km^2 into m^2.

_____

7. 3.80 x 10^{-4} kg into g.

_____

8. 1.5 x 10^4 cm^3 into m^3.

_____

Assessment 2 – Convert to the correct units

What is 300 cm in metres?

1. 30 000 m
2. 3 cm
3. 3 m
4. 0.3 m

What is 1 m^3 in cm^3?

5. 0.000001 cm^3
6. 10 000 cm^3
7. 1 000 000 cm^3
8. 1×10^6 cm^3

Objective 3 – Derive units from equations

As you already know, in any subject it is good to check your answer. This is a skill that you can transfer to units as well via a process called dimensional analysis. Dimensional analysis essentially involves replacing the symbol in an equation with its unit. So, for example, you would substitute kg in for mass, or m in for length.

While you will not be tested on this in your GCSE course, it can help you figure out the units of a quantity if you have forgotten them in the moment!

Worked example 1:

Find the S.I. derived units for velocity from the equation v = d/t

Answer 1:

First, write down what you know.

The unit of length is m
The unit of time is s

units of velocity = units of distance ÷ units of time <- Now write out the equation in terms of units
= m ÷ s <- substitute in your units
= m/s. <- get your answer

The units of velocity are m/s.

Worked example 2:

Find the units for momentum from the equation p = m v

Answer 2:

First, write down what you know.

The unit of mass is kg
The unit of velocity is m/s

units of momentum = units of mass × units of velocity <- Now write out the equation in terms of units
= kg × m/s <- substitute in your units
= kg m/s. <- get your answer

The units of momentum are kg m/s.

Worked example 3:

Find the S.I. derived units for energy from the equation $E = 0.5\ m\ v^2$

Answer 3:

First, write down what you know.

The unit of mass is kg
The unit of velocity is m/s

The constant has no units

units of energy = units of mass × units of velocity^2 <- Now write out the equation in terms of units
= kg × (m/s)^2 <- substitute in your units
= kg × m/s × m/s <- expand your square bracket
= kg m^2 / s^2. <- get your answer

The S.I derived units of energy are kg m^2/s^2. You might know the units of energy as J (Joules), which is the case, but Joules = kg m^2/s^2 in terms of S.I. units.

Practice 3 – Derive units from equations

Work out the correct S.I. derived units for:

Quantity	Equation	Unit in terms of S.I. base units
Area	A = L^2	
Acceleration	a = (v – u)/t	
Kinetic energy	E = 0.5 m v^2	
Gravitational potential energy	E = mgh	

Assessment 3 – Derive units from equations

Which of the following statements is correct?

1. The S.I. derived unit of energy is J
2. The S.I. derived unit of energy is kg m^2 / s^2
3. The S.I. derived unit of energy is m^2 kg/ s^2
4. The S.I. derived unit of energy is g cm^2/ s^2

Which of the following statements do you most agree with?

5. To find the S.I. derived unit you first need to know S.I. units
6. To find S.I. derived units of energy you need to know it is measured in J
7. To find the S.I. derived units you substitute the S.I. base units into the equation you are working with
8. S.I. derived units are not useful, I just have to remember the units

Tutorial 2 – Standard form

What is the Purpose of Tutorial 2?

- Define the mantissa and exponent
- Convert to standard form
- Calculate with numbers in standard form

Starter

Write down what you think standard form means. Discuss with the class.

_____
_____

Objective 1 – Define the mantissa and exponent

Some quantities in physics are very large or very small, e.g.

The radius of the Earth is 6 400 000 m.

The speed of light is 300 000 000 m/s.

The width of a human hair 0.000002 m.

Numbers sometimes become unwieldy to write. When this happens, we use something called standard form to make writing, and understanding them, easier.

If we write the above numbers in standard form you get:

6.4×10^{6} m

3×10^{8} m/s

2×10^{-6} m

The first number is called the mantissa, the second is called the power of ten.

number in standard form = mantissa x power of ten

The mantissa is always between 1 and 10 (inclusive).

Powers of ten are multiples of 10. So, you start with 1 and you can multiply or divide as many times by 10.

Numbers like, 10, 100, 1000, 0.1, 0.0000001 and 10 000 000 000 000 000 are all powers of ten, but numbers such as 0.42, 89, 32, 3200 and 40 000 are not.

Numbers that are powers of ten can be written as exponents (e.g 10^4 instead of 10 000).

Worked example 1:

Identify which of the following numbers could be a mantissa: 0.94, 1.5, 32, 4.3, 7.5, 101.

Answer 1:

0.94 – no, less than 1
1.5 – yes, smaller than 10 and larger than 1.
32 – no, larger than 10
4.3 – yes, less than 10 and larger than 1.
7.5 – yes
101 – no

Worked example 2:

Find the exponent for each of the following numbers: 10 000, 100, 0.0001.

Answer 2:

First you can write the number as how many 10s it is:

10 000 = 10 x 10 x 10 x 10

This is 4 tens, therefore,

10 000 = 10^4, so the exponent is 4.

100 = 10 x 10 = 10^2.

0.0001 = 1/10 000 = 1/(10 x 10 x 10 x 10) = $1/10^4 = 10^{-4}$.

Worked example 3:

Identify which of the following numbers is in standard form: 2.5×10^3, 24×10^{-3}, 1.6×20^3.

Answer 3:

2.5×10^3 – yes, mantissa is between 1 and 10 and power of ten is in correct form.

24×10^{-3} – no, mantissa is not between 1 and 10.

1.6×20^3 – no, there is no power of ten.

Practice 1 – Define the mantissa and exponent

1. Identify which of the following numbers is a suitable mantissa? (circle all that apply).

   9.5, 0.5, 3.2, 34, 10.3, 10.0000001, 9.99999, 0.04, 3.4, 22

2. Identify whether the following are powers of 10 and if so, write the exponent.

Number	Power of ten	Exponent
0.0003		
0.001		
1 000 000		
0.000 000 01		

3. Identify whether the following numbers are in standard form and if not, explain why:

   7.2×10^{11}, 34×10^{2}, 2.2×2^{4}, 3.7×10^{3}, 0.01×10^{22}.

   _____
   _____
   _____

Assessment 1 – Define the mantissa and exponent

Which of the following statements is correct?

1. The mantissa is a number between one and ten.
2. The power of ten is a multiple of ten.
3. The exponent can be any positive or negative whole number (no decimals).
4. A number in standard for consists of the mantissa multiplied by the exponent.

Objective 2 – Convert to standard form

Now that we've tackled mantissas and powers of 10, we can have a go at converting numbers into standard form.

To do this, it is easiest to note that the exponent just counts the number of times the first number must be moved to become a mantissa.

As an example, $0.0024 = 2.4 \times 10^{-3}$. The 2 has to be moved 3 spaces to the left (negative direction) to become between 1 and 10.

If it is easier, you can also write your number as a mantissa times a power of 10. So, for example, $0.0024 = 2.4 \times 0.001 = 2.4 \times 10^{-3}$.

Worked example 1:

Write the number 3 400 000 as a mantissa times a power of 10 and then convert to standard form.

Answer 1:

$3\,400\,000 = 3.4 \times 1\,000\,000$ <- Split into mantissa and power of 10.

$= 3.4 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$ <- Split power of 10 into 10s (you may want to miss this step out)

$= 3.4 \times 10^{6}$ <- There's 6 tens, so the exponent is 6.

Worked example 2:

Express the number 6.51 in standard form.

Answer 2:

This one is tricky, the number is already in the form of a mantissa, so what do we do?

$6.51 = 6.51 \times 1$ <- Split into mantissa and power of 10.

$= 6.51 \times 10^{0}$ <- If ever you're just multiplying by one, this is 10^{0}.

Worked example 3:

Write the number 3.245×10^{-4} in the 'normal' way (e.g. 0.002, 3000 etc).

Answer 3:

You just switch this one round. So,

$3.245 \times 10^{-4} = 3.245 \times 0.0001$ <- 10^{-4} make sure you move that 1 4 places to the right!

$= 0.0003245$ <- Multiply these two numbers together to get ...

Practice 2 – Convert to standard form

1. Write the following numbers as a mantissa and a power of 10. Then write the exponent and finally in standard form.

Number	Mantissa x power of 10	Exponent	Standard form
4 500 000	4.5 x 1 000 000	6	4.5×10^{6}
0.04			
13.2			
1456			
0.00000156			
3 250 000 000			
7.5			
3600			

2. Express the following numbers in standard form:

(a) 35 000 - _____
(b) 920 - _____
(c) 830 000 - _____
(d) 0.0020 - _____
(e) 0.000002451 - _____
(f) 0.0001002 - _____

3. Write the following in the normal way (not in standard form):

(a) 3×10^{4} - _____
(b) 34×10^{-2} - _____
(c) 3.54×10^{0} - _____
(d) 4.3×10^{1} - _____
(e) 4.0340×10^{8} - _____
(f) 1.032×10^{-4} - _____

Assessment 2 – Convert to standard form

Which of the following shows the number 4 000 000 in standard form?

1. 4 x 1 000 000
2. 40×10^{5}
3. 0.4×10^{7}
4. 4×10^{6}

Which of the following is the number 3×10^{-3} in the normal way?

5. 3000
6. 0.03
7. 0.003
8. 0.0009

Objective 3 – Calculate with standard form

This is the 'easy' bit, using standard form on a scientific calculator. To key in standard form on your calculator all you need to do is use the button $\times 10^n$.

Worked example 1:

Use the $\times 10^n$ button on your calculator to calculate $2.4 \times 10^2 \times 3.6 \times 10^5$.

Answer 1:

Type in 2.4 $\times 10^n$ 2 x 3.6 $\times 10^n$ 5 <- Simply type in the two numbers, no need for brackets

= 8.64 $\times 10^n 7$ <- Your calculator will show you an answer like this

= 8.64×10^7 <- Rewrite your answer

Worked example 2:

Use the $\times 10^n$ button on your calculator to calculate $4.1 \times 10^4 \div 8.3 \times 10^7$.

Answer 2:

Exactly like last time:

Type in 4.1 x 10^n 4 ÷ 8.3 x 10^n 7 <- Again, no need for brackets, just type in.

= 4.9 x 10^n–4 <- Your answer will show up like this.

= 4.9×10^{-4} <- Rewrite your answer

Practice 3 – Calculate with standard form

Practice the following calculations using your calculator.

1. $2.0 \times 10^4 \times 2.0 \times 10^4$

---

2. $2.0 \times 10^4 \div 3.6 \times 10^8$

---

3. $3.2 \times 10^{-3} \times 2.2 \times 10^2$

---

4. $4.5 \times 10^{-3} \div 5.1 \times 10^5$

---

5. $6.8 \times 10^{-2} \times 7.6 \times 10^{-3}$

---

6. $4.3 \times 10^{-6} \div 5.1 \times 10^{-5}$

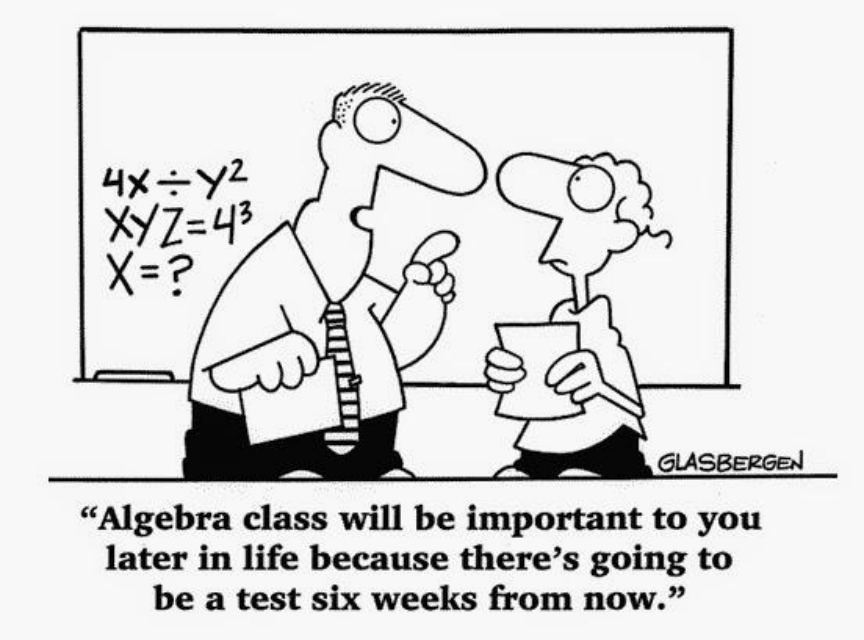
_____

Assessment 3 – Calculate with standard form

Which of the following calculations could produce the answer 20?

1. $2 \times 10^{6} \div 1 \times 10^{6}$
2. $4 \times 10^{-4} \div 2 \times 10^{-5}$
3. $6 \times 10^{0} \div 3 \times 10^{1}$
4. $4 \times 10^{-10} \times 5 \times 10^{11}$

Tutorial 3 – Rearranging equations



What is the Purpose of Tutorial 3?

- Define the subject of an equation.
- Rearrange simple equations.
- Rearrange equations with powers and roots.

The amount of equations one has to remember in physics can sometimes feel like a tidal wave of unobtainable knowledge. The reality, however, is that with practice these equations can become second nature. Being able to remember an equation often comes down to the amount of time you have spent using it and this is the point of tutorial 3; to give you the extra practice time lacking from your class.

Starter

Rearrange the equation V = IR so that I and R are the subject.

Objective 1 – Define the subject of an equation

The subject of an equation is purely whatever is on its own beside the equals sign. So, as an example, for the equation that arises from Ohm's law, V = IR, V is the subject. However, if you were to rewrite this as I = V/R, I would now be the subject.

Practice 1 – Define the subject of an equation

1. For the following equations identify the subject:

   (a) V = IR
   (b) P = IV
   (c) W = Fs
   (d) W/F = s
   (e) F = ma

(f) E/P = t

2. Write down the definition for the subject of an equation.

_____

Assessment 1 – Define the subject of an equation

Which of the following statements do you most agree with?

1. The subject is the term on its own in an equation
2. Any term in an equation is the subject
3. Some equations do not have subjects
4. Equations can be rearranged so that any term was the subject

Objective 2 – Rearrange simple equations

When I say rearranging equations I am talking about changing the subject of them. You may do this by using addition, subtraction, multiplication, division, taking roots, or powers but you must ALWAYS do the same to both sides of the equation.

The equation you end up with is only equivalent IF you do this. Otherwise you end up with something else entirely!

Worked example 1:

Rearrange the equation a = b + c so that b is the subject.

Answer 1:

a – c = b + c - c <- To get b on its own you need to subtract c from both sides.

a – c = b <- Simplify the right hand side.

b = a – c <- Rearrange so that b is the subject.

Worked example 2:

Rearrange the equation Q = It (charge = current x time) so that t is the subject.

Answer 2:

Q ÷ I = It ÷ I <- To get t on its own you need to divide both sides by I.

Q ÷ I = t <- Simplify the right hand side.

t = Q ÷ I <- Rewrite so that t is the subject.

Worked example 3:

Rearrange the equation P = E ÷ t (power = energy transferred ÷ time) so that E is the subject.

Answer 3:

P x t = E ÷ t x t <- multiply both side by t to get E on its own.

P x t = E <- Simplify the right hand side.

E = P x t <- Rearrange so that E is the subject.

Practice 2 – Rearrange simple equations

1. Rearrange the following equations so that the term in brackets is the subject.

   (a) y = mx + c (c) _____

   (b) P = W ÷ t (t) _____

   (c) Efficiency = Useful P ÷ Total P (total P) _____

   (d) V = IR (R) _____

   (e) P = IV (I) _____

   (f) V = E/Q (Q) _____

   (g) ρ = m/V (m) _____

   (h) W = mg (g) _____

   (i) s = W/F (F) _____

   (j) F = ke (e) _____

   (k) F = ma (m) _____

   (l) P = mv (v) _____

2. For the following equations, rearrange each equation so that every term has been the subject: v = s ÷ t, v = f x λ, E = mgh, E = mL, ΔE = mcΔθ.

   _____

   _____

   _____

   _____

   _____

   _____

Assessment 2 – Rearrange simple equations

Which of the following is the correct rearrangement of the equation W = mg so that m is the subject?

1. m = Wg
2. m = g ÷ W
3. m = W ÷ g
4. mg – W = 0

Which of the following statements is incorrect?

5. When rearranging equations you must do the same thing to both sides
6. When multiplying the left hand side by W you must multiply the right hand side by W
7. When multiplying the left hand side by m you must divide the right hand side by m
8. All of the statements above

Objective 3 – Rearrange equations with roots and squares

In this final section we will tackle how to rearrange more complicated equations, with roots and squares. In addition, we will look at rearrangements that involve more than one operation, e.g. multiplication and then subtraction.

Worked example 1:

Rearrange the equation $y = mx + c$ so that m is the subject.

Answer 1:

$y - c = mx - c$ <- Take c away from both sides to get mx on its own.

$y - c = mx$ <- Simplify the right hand side.

$(y-c) \div x = mx \div x$ <- Divide both sides by x to get m on its own.

$(y-c) \div x = m$ <- Simplify right hand side.

$m = (y-c) \div x$ <- Rearrange so that m is the subject.

Worked example 2:

Rearrange the equation $E = mc^2$ so that c is the subject.

Answer 2:

$E \div m = mc^2 \div m$ <- Divide both sides by m to get c^2 on its own

$E \div m = c^2$ <- Simplify the right hand side.

$\sqrt{(E \div m)} = \sqrt{(c^2)}$ <- Take the square root of both sides (brackets are important here).

$\sqrt{(E \div m)} = c$ <- Simplify right hand side.

$c = \sqrt{(E \div m)}$ <- Rearrange so that c is the subject.

Worked example 3:

Rearrange the equation $v = \sqrt{(2E \div m)}$ so that m is the subject.

Answer 2:

$v^2 = 2E \div m$ <- First square both sides.

$m \times v^2 = 2E \div m \times m$ <- Multiply both sides by m.

$m \times v^2 = 2E$ <- Simplify the right hand side.

$m \times v^2 \div v^2 = 2E \div v^2$ <- Divide both sides by v^2 to get m on its own.

$m = 2E \div v^2$ <- Rearrange so that c is the subject.

Practice 3 – Rearrange equations with powers and square roots

1. Rearrange the following equations so that the term in brackets is the subject.

   (a) $E = 0.5\ mv^2$ (v) _____

   (b) $e = \sqrt{(2E \div k)}$ (k) _____

   (c) $v^2 - u^2 = 2as$ (u) _____

2. Make r the subject of the following equation:

$$F = \frac{kQ_1Q_2}{r^2}.$$

3. Make T the subject of the following equation

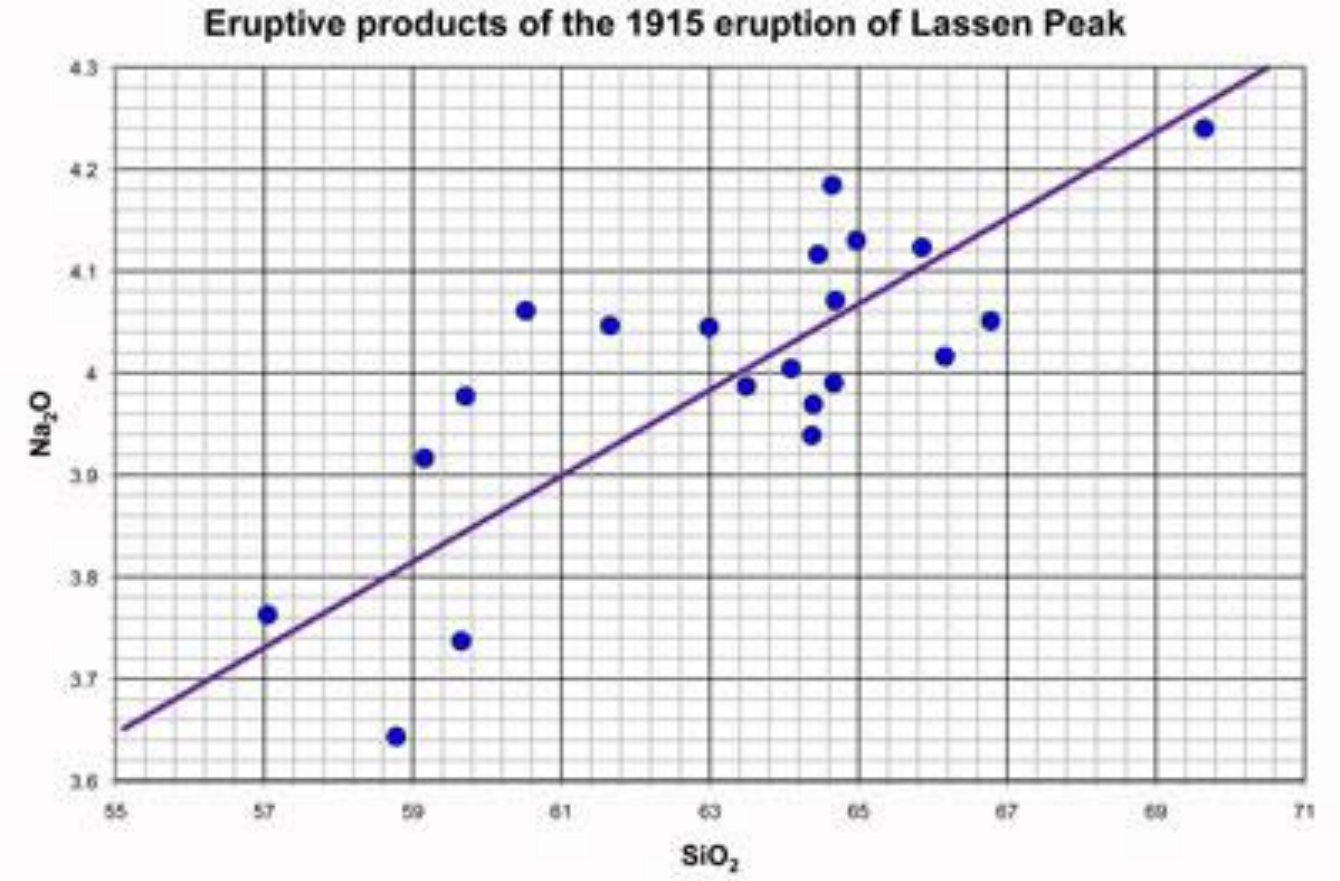
$$r\left(\frac{2\pi}{T}\right)^2 = \frac{GM}{r^2}.$$

Assessment 3 – Rearrange equations with powers and square roots

Which of the following is the correct rearrangement of $s = 0.5(u+v)t$ at so that u is the subject?

1. $u = 2s \div t - v$
2. $u = 0.5s \div t - v$
3. $u = 2s - vt$
4. $u = 0.5s - vt$

Tutorial 4 – Graphing skills



What is the Purpose of Tutorial 4?

- Define dependent and independent variables
- Plot data on a graph
- Draw a line of best fit

Graphing skills form an essential part of all sciences. Being able to both interpret and draw graphs is of the utmost importance. To do this correctly, one needs to understand which variables are which, and which one goes on which axis.

Drawing a line of best fit is almost guaranteed to come up in your GCSE science papers. So we tackle that here as well.

Starter

Define the words control, dependent and independent.

_____
_____

Objective 1 – Define dependent and independent variables

There are three types of variable in scientific method: dependent, independent and control. Control variables are things you must keep the same during an experiment in order to ensure your results are valid, and are not pertinent to graphing. The dependent and independent variables are important when it comes to graphing, so we tackle them here.

In any experiment, you must systematically change one variable to examine its effect on another quantity, this is the independent variable. Another way of thinking of this is it is the variable YOU change.

The quantity that changes value because of your changing independent variable is the dependent variable. This can be thought of as the one you measure!

If you were going to plot a graph of experimental results, your independent variable would go on the x-axis and your dependent variable would go on the y-axis.

Practice 1 – Defining dependent and independent variables

1. Write down the definition of a dependent variable.

   _____
   _____
   _____

2. Write down the definition for an independent variable

   _____
   _____
   _____

3. Jimmy is doing an experiment into how mass affects the time taken for a car to run down a ramp. What are the dependent and indepent variables here?

   _____
   _____
   _____

4. Beth wants to measure the maximum height reached by different football brands. She measures a number of things, size of the ball, material of the ball, height before being dropped, height reached after being dropped, brand of ball, mass of ball and material onto which the ball is dropped. From this list, identify the dependent and independent variables. Explain why you chose them.

   _____
   _____
   _____
   _____

Assessment 1 – Define dependent and independent variables

A scientist wants to measure the acceleration of a car as it moves down a ramp. There are several variables that are of interest. For the following, state whether it is a control, independent or dependent variable.

Variable	Variable type
Length of the ramp	
Distance the car rolls	
Time for car roll	
Mass of the car	
Angle of the ramp	
Surface material of the ramp	

Objective 2 – Plot data on a graph

Now, we've already mentioned that when plotting graphs that the independent variable goes on the x-axis and the dependent variable goes on the y-axis. In a table the independent variable is always on the left and the dependent is on the right. So the left column is x and the right column is y!

When plotting a graph you must ALWAYS remember to label your axes, this is often worth a mark!

Worked example 1:

Plot the data in the table on the graph paper below.

Potential difference (V)	Current (A)
-5.6	-0.27
-3.9	-0.20
-1.2	-0.09
1.1	0.10
4.0	0.22
5.5	0.26

Worked example 2:

Plot the data in the table on the graph paper below.

length (m)	Resistance (Ω)
0.1	2.1
0.2	2.9
0.3	3.8
0.4	4.2
0.5	4.9
0.6	0.26

Practice 2 – Plot data on a graph

1. Plot the data in the table on the graph paper below.

x	y
1	1
2	4
3	9
4	16
5	25
6	36

2. Plot the data in the table on the graph paper below.

Time (s)	Speed (m/s)
1.5	0.1
1.1	0.4
0.8	0.7
0.6	0.9
0.4	1.2
0.1	1.7

3. Plot the data in the table on the graph paper below.

Force applied (N)	Acceleration (m/s^2)
10	-1.1
20	-1.9
30	-3.3
40	-4.1
50	-4.9
60	-6.1

Assessment 2 – Plot data on a graph

Which of the following statements is incorrect?

1. The independent variable goes on the y-axis
2. The independent variable goes on the x-axis
3. The depedent variable goes on the y-axis
4. The control variable goes on the y-axis

Objective 3 – Draw a line of best fit

Plotting a line of best fit is often the final piece of the jigsaw. A lot of students think it has to be a straight line, or go through all the points, but neither is correct, A best-fit line is a line that is your best approximation of the relationship between the two variables. You must get close to most of the points without forcing it to go through any of them (you can go through some).

In short, your best fit line should always have about the same number of points above as there are below, unless there is an anomalous point.

Worked examples:

Draw a line of best fit for the two examples in objective 2.

Practice 3 – Draw a line of best fit

1. Draw a best fit line for the three examples in the previous objective.
2. Plot a graph and draw the best fit line for the three examples below (graph paper on next three pages.)

mass (kg)	Acceleration (m/s^2)
100	4
200	9
301	15
405	22
502	26
599	31

Potential difference (V)	Current (I)
-5.0	-3.1
-3.1	-2.9
-1.1	-1.0
1.1	1.3
3.0	3.0
5.0	3.2

Potential difference (V)	Current (I)
-5.0	0.0001
-3.1	0.0000
-1.1	-0.0001
1.1	0.0025
3.0	0.0100
5.0	0.0250

Assessment 3 – Draw a line of best fit

Swap your graphs with someone else, mark them out of 5. 1 mark each for:

1. Correctly labelled axes with independent on x and dependent on y.
2. Units (if given) stated in this label.
3. Acceptable axis values chosen (e.g. highest axis point 2.5 if highest value is 2.4)
4. Correct points plotted (allow one little square error)
5. Line of best fit that correctly fits the points.

Revision Technique

What is the Purpose of this page?

People in all walks of life often struggle with where to start. This is especially true of what we do when we start revising. We often think that reading or copying notes out is a good idea but this is NOT true.

The number one tip I can give you when you get down to it is it needs to be active. Your notes are a great start but it really is what you do with them that counts.

Below are Dr Stackhouse's top-tips for getting the most out of revision...

Revision guide

1. Know where to start: you need to know what you're revising for. When it's an end of unit test it's really easy, you just look back a few lessons, but what about for those final exams?

   I would always suggest starting with something broad and low-stakes, seneca learning is a great resource for jogging your memory on a topic, and its easily split up into each unit you need to tackle! So if you want to revise energy, look at Physics Unit 1 in our class.

2. Check exactly what you need to know: use your AQA spec and tick off which bits you think you have!

3. Use your notes, textbooks, revision guides, to make some dediciated revision resources: flashcards are a great way to test yourself or others on definitions or the many many equations you need to know in science!

4. Deliberate practice: work in rich and varied examples. You need to think of every way you could be asked a question on a particular topic. Think about how I've set up this book! Examples from your textbook and revision guides are a good start here (THIS IS THE MOST IMPORTANT PART).

5. Apply it: exam questions, exam questions, exam questions, you can never do too many! The more you do, the more you PRACTICE, the better you get at answering the style of question AQA is going to throw at you!

6. Work in rest: If you feel yourself flagging, make a cuppa!

Exam Technique

What is the Purpose of this page?

EXAMS!!!! Arrrrggghhhhhh, right? Here's my top tips!

Exam guide

1. Questions have a common theme: in other words, question 1 is all about question 1, that's why it's a single question. It might have (a), (b), (c), etc but they're probably all about 1 unit or part of a unit.

2. If you're stuck on something, move on: just because you can't do one bit, doesn't mean you can't do the next. Try it, what's the worst that can happen?

3. If you're unsure of context, think what it's similar to: instead of thinking, 'hmm, I've never done that before,' think, 'aha, I've done this thing that's very close to it.' See also, OSMOSIS HAPPENS IN CARROTS AS WELL.

4. Look at the marks: if you've spent 5 minutes on a 1 mark question it's waaaaaaayyyy too long. 1 mark = 1 minute, stick to it.

5. Stop and think before you start to write: make sure you take the information you've just read in, like, all the way. If you need to make some rough notes before answering an extended question, do it, it's better than waffling on like a monologuing supervillian!

6. Use graphs, diagrams, and tables: no, really, they don't put them in for giggles.

7. Look at bold print: it's important...if it says **one** answer, give one, any more will probably lose you marks.

8. Highlight key terminology, words, and command words: if that's your gig, I mean, I never did it but it might help you focus on what's needed. This neatly leads me onto...

9. KNOW YOUR COMMAND WORDS: there's a list, online, download it. I've always found it helps to know what a question is actually asking you to do...and finally,

10. Breathe: when it feels like all is lost, take yourself a nice deep breath, we don't want you passing out in an exam do we?..No, but seriously, sometimes taking a minute not looking at a question you're struggling on can make all the difference. The answer may just come to you in a vision!

Feedback

What is the Purpose of Feedback?

- To receive feedback on final assignments.
- To share examples of best practice with the other pupils in your group.
- To write targets for improvement in school lessons.
- To reflect on the programme including what was enjoyed and what was challenging.

Final assignment feedback

What I did well…	What I could have improved on…
•	•
•	•
•	•

My target for future work is…

Reflecting on Uni Pathways

What did you most enjoy about Uni Pathways?
•   •   •

What did you find challenging about the programme?	How did you overcome these challenges?
• • •	• • •

Notes

Notes

Notes

Physical Graph-iti

Key Stage 4 Programme

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