Welcome to the Physics Department

CRGS SIXTH FORM

We look forward to meeting you and welcoming you to the Sixth Form.

This Transition Pack contains information to support your transition from GCSE to A Level study.

Please read all the documents ready to begin Year 12

- Independent Learning in Physics
- Useful websites for exploring Physics
- Physics Introductory Tasks

✓ **Read the Subject Information Sheet** which is available here: CRGS Sixth Form Subject Sheet - Physics

✓ **Download the exam board specification** which is available here: AQA A Level Physics

✓ **Read the section called 'Specification at a Glance'**, focusing on the A Level content.

✓ Some of these resources will become more useful when you have moved further through the course, such as the A Level specification, so store them where you can revisit them over the next 2 years.

✓ Don't worry if some of the work sounds challenging. A Level work is more difficult than GCSE work after all. Your teachers will be supporting you through this transition. Please talk to us if you are unsure about any aspect of the course.

We look forward to seeing you soon.

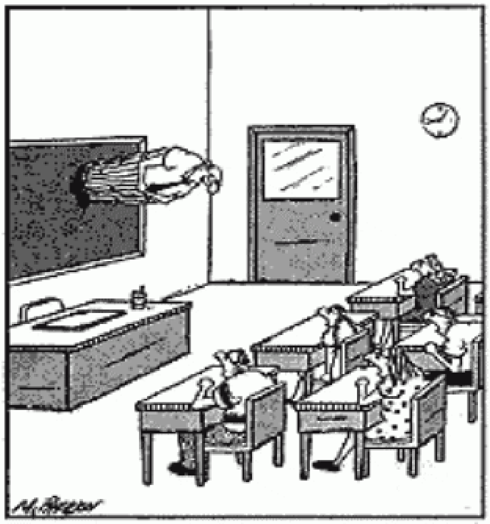
Physics Department

Useful Websites for Physics

Explore these websites. They will be used in the Physics A Level course.

1. Great website on Physics Topics: http://www.sixtysymbols.com/
2. Physics simulation:
   http://www.focuselearning.co.uk/u/827/pAwklhtiwdFEoypfeqCxccluCswykpEzj
3. Flipped around Physics
   https://www.flippedaroundphysics.com/
4. Physics simulation: http://phet.colorado.edu/
5. Dr Becky Physics:
   https://www.youtube.com/channel/UCYNbYGl89UUowy8oXkipC-Q
6. A Level Physics Online
   https://www.alevelphysicsonline.com/

Physics A level
Introductory tasks



"Good morning, and welcome to The Wonders of Physics."

Physics is the study of reality, from the smallest things that can exist to the sum total of everything that does exist (additional dimensions and universes included!). The purpose of physics is being able to use the understood 'laws' of physics to make testable predictions about real systems.

Theory and Experiment
A theory is only as good as the experimental evidence that supports it. If a repeated, verified experimental result contradicts a theory, then the theory is wrong and a new one is needed. This is how science works. Measurement, the collection of data and its analysis are major parts of physics, along with mathematical equations and calculations describing the 'rules' of physics.

QUANTITIES USED IN PHYSICS EQUATIONS
In physics equations, quantities such as speed and force are denoted by letters. These **algebraic equations** show the relations between various quantities. Some letters are easy to remember: force is F, for example. Others are less obvious: current is I. It is important to remember what each letter stands for in an equation. Care is needed, as the same letter can be used to represent different quantities in different equations.

variable/constant	symbol	variable/constant	symbol
force	**F**	acceleration due to gravity	**g**
mass	**m**	distance	**x**
acceleration	**a**	displacement	**s**
electric charge	**Q**	height	**h**
electric current	**I**	radius	**r**
time	**t**	diameter	**d**
potential difference, voltage	**V**	area, amplitude	**A**

resistance	**R**	volume	**V**
speed, velocity	**v**	temperature	**T**
energy	**E or W**	power	**P**

TASK 1

Complete the table below showing symbols used in physics. Check your answers against the table above.

variable/constant	symbol	variable/constant	symbol
	F	acceleration due to gravity	
	m	distance	
acceleration		displacement	
	Q		**h**
electric current			**r**
time			**d**
potential difference,		area, amplitude	**A**
	R	volume	
speed, velocity		temperature	
	E or W		**P**

LARGE AND SMALL NUMBERS AND STANDARD FORM

Large and small numbers in physics

To represent measurements of many different variables in a universe of such diverse phenomena means we often need to write very large and very small numbers. This can be time-consuming if they have to be written out in full. For example, the charge on an electron (measured in coulombs) is 0.00000000000000000016 C, and the mass of the Earth is 5 970 000 000 000 000 000 000000 kg!

Powers of 10

The following table shows what 'powers of 10' actually mean:

10^4	10^3	10^2	10^1	10^0	10^{-1}	10^{-2}	10^{-3}	10^{-4}
10 000	1000	100	10	1	0.1	0.01	0.001	0.0001

When we multiply a number by a positive power of 10, we move the decimal place to the right. When we multiply a number by a negative power of 10, we move the decimal place to the left.

The charge on an electron measured in coulombs is 0.00000000000000000016 C, and can be written as 1.6×10^{-19}, which is the same as saying '1.6 ×

0.0000000000000000001', which equals 0.00000000000000000016 C. The decimal point has moved 19 places to the left because we multiplied by 10^{-19}. This provides a far quicker way of writing such a small number.

The mass of the Earth is 5 970 000 000 000 000 000 000 000 kg, and can be written as 5.97×10^{24}, which equals $5.97 \times 1\,000\,000\,000\,000\,000\,000\,000\,000$, which is the same as 5 970 000 000 000 000 000 000 000 kg. The decimal point has moved 24 places to the right because we multiplied by 10^{24}.

Using powers of 10 saves writing a lot of zeros.

Standard Form

When a number is written in the shorthand way just discussed, it is in **standard form**. The first part of standard form is a number between 1 and 9.9999… (any other number can be represented by a number of this size in standard form). This is then multiplied by a power of 10, which effectively moves the decimal point to the correct position for the original number.

Examples

$$1012 = 1.012 \times 1{,}000 = 1.012 \times 10^{3}$$

$$0.0794 = 7.94 \times 0.01 = 7.94 \times 10^{-2}$$

$$23 = 2.3 \times 10 = 2.3 \times 10^{1}$$

Calculator Use

Your calculator can be set to give all answers in standard form. Usually you press **mode** or **setup** until you get 'Norm Fix' or 'Sci'. Select 'Sci' and you will be asked for a number between 0 and 9. This will set the number of decimal places shown on your calculator when an answer is in standard form. Select 3 or 4. If you have trouble doing this with a scientific calculator, read the instruction booklet or check online instructions for your model of calculator.

TASK 2

1 Write 100 as a power of 10.

2 Write 100 000 as a power of 10.

3 Write 10 as a power of 10.

4 Write 1 000 000 000 as a power of 10.

5 Write 0.1 as a power of 10.

6 Write 0.001 as a power of 10.

7 Write 0.000000001 as a power of 10.

8 Write 1 as a power of 10.

9 Write 280 in standard form.

10 Write 2530 in standard form.

11 Write 0.77 in standard form.

12 Write 0.0091 in standard form.

13 Write 1 872 000 in standard form.

14 Write 12.2 in standard form.

15 Write 2.4×10^{2} as a normal number.

16 Write 3.505×10^{1} as a normal number.

17 Write 8.31×10^{6} as a normal number.

18 Write 6.002×10^{-2} as a normal number.

19 Write 1.5×10^{-4} as a normal number.

20 Write 4.3×10^{-1} as a normal number.

UNITS IN PHYSICS - WHY UNITS ARE IMPORTANT

Units, the things quantities are measured in, are very important in physics. An answer of 4.3 means a very different thing in metres to an answer in miles.

The Mars Climate Orbiter Spacecraft was lost because one NASA team used *imperial units* while another used *metric units* for a key spacecraft operation.

BBC News, Thursday 30 September 1999.

Luckily we use the metric system (metres, kilograms), which makes all the formulae and conversions between units much easier than imperial units (feet, pounds). It is always important to know what units quantities are measured in so that data can accurately be communicated to others without confusion.

SI units

The full name of the metric system of units is from the French name Système International d'Unités which translates as International System of Units. This is abbreviated to **SI**. There are seven base units from which all other units can be constructed.

what is being measured	unit name	symbol
length	metre	**m**
time	second	**s**
temperature	kelvin	**K**
mass	kilogram	**kg**
amount of substance	mole	**mol**
electrical current	ampere	**A**

Combining units

Equations in physics, such as **speed = distance / time**, also apply to the units of the various quantities.

The unit of speed (metres per second, or ms^{-1}) is the unit of distance (m) divided by the unit of time (s).

Some combinations of units formed in this way have their own names

e.g. coulomb.

charge = current × time

1 coulomb = 1 amp second

While most of the base units in the table above are used in physics A-level, there are also a lot of others constructed from these. Each unit has a symbol, and the quantity that it is a measure of also has a symbol: eg time (t) is measured in seconds (s).

Which unit will I need to use?
Centi**metres**, milli**metres**, kilo**metres** – what unit to use for distance? Easy: in physics, equations **always** use the unit without the prefix; so for distance, use **metres**. (The one exception is that the basic unit for mass is the **kilogram**, not the gram.) See Chapter 9 for more about prefixes.

All equations in physics need quantities measured in the base unit: distance in m, not cm or km; energy in J, not MJ or mJ. (Again, the **only** exception is mass, where the **kg** is the quantity used in equations.)

TASK 3

Complete the table below to see how many units you already know. Guess those you don't.

quantity	symbol	unit	symbol
charge	**Q**	coulomb	**C**
current			
time			
potential difference		volt	
resistance			
power			
energy			
area			
distance			
force			
velocity			
mass			
magnetic field strength		tesla	
capacitance		farad	

PREFIXES FOR UNITS

What are prefixes?

A prefix is a multiplier, such as kilo- or milli-, which can be used with any unit of measurement: for example, kilometres (km) or kilojoules (kJ), millivolts (mV) or millimetres (mm).

Why are prefixes important?

A length of 7.2 means one thing in metres but a very different thing in nanometres! **Measurements** in physics may use units with various prefixes, but all **equations** in physics require the use of a value in the main unit (see Chapter 8). In an equation, metres are always used, never nanometres.

What prefixes are used in A-level physics?

Most questions use the prefixes in the table below. Some particular topics use additional ones to those below; check your course specification to find out if this will apply to your course.

Common prefixes

prefix	symbol	multiplier
Giga	G	1000 000 000 $= 10^9$
Mega	M	1 000 000 $= 10^6$
kilo	k	1000 $= 10^3$
milli	m	0.001 $= 10^{-3}$
micro	μ	0.000001 $= 10^{-6}$
nano	n	0.000000001 $= 10^{-9}$

How do I convert a value to its main unit?

In A-level physics you need to be able to convert from units with prefixes to the main unit. The best and easiest way to convert from a unit with a prefix to one without a prefix is to replace the prefix with the multiplier it stands for.

Remember, however, that mass is the exception. The only base SI unit used in physics with a prefix is the kilogram (kg). Grams are not used in physics equations, only kilograms. Look through the following worked examples.

Example 1

Convert 600 nm into m.

- Identify the prefix: here it is ‘n’ for nano
- Look up the multiplier (if not known): here **nano** = $\mathbf{10^{-9}}$

- Write out the value, replacing the prefix with the multiplier: 600×10^{-9}
- This is the answer in metres: 600 nm = $\mathbf{600 \times 10^{-9}}$ **m**
- If the answer is needed in standard form, let your calculator change it: enter 600×10^{-9} into the calculator and press '='. This will give 6×10^{-7}.
- So 600 nm = 600×10^{-9} m = $\mathbf{6 \times 10^{-7}}$ **m** in standard form (see Chapter 7).

Always think about the answer. Does it make sense? Nanometres are tiny, so even 600 of them won't give you much of a metre. So yes, the answer seems sensible

Example 2

Tip: Write down your working so you can check if the answer seems reasonable.

Convert 48.2 μA into amperes (A).

μ = micro = 10^{-6} so 48.2 μ = 48.2×10^{-6} and 48.2 μA = $\mathbf{48.2 \times 10^{-6}}$ **A**

In standard form: $48.2 \times 10^{-6} = \mathbf{4.82 \times 10^{-5}}$ **A**

This is a small number of amperes, as you would expect, since μA are only a millionth of an ampere (10^{-6}) and we only have 48.2 of them.

Example 3

Tip: Remember to let your calculator convert the number into standard form.

Convert 0.027 GW into watts (W).

G = Giga = 10^9 so 0.027 G = 0.027×10^9 and 0.027 GW = $\mathbf{0.027 \times 10^9}$ **W**

In standard form: $0.027 \times 10^9 = \mathbf{2.7 \times 10^7}$ **W**

This is a large number of watts, as you would expect, since a GW is a billion watts (10^9); although we only have 0.027 of them, this is still a lot at 27 million watts.

TASK 4

1. How many metres in 2.4 km?
2. How many joules in 8.1 MJ?
3. Convert 326 GW into W.
4. Convert 54 600 mm into m.
5. How many metres in 1 μm?
6. How many grams in 240 kg?
7. Convert 0.18 nm into m.
8. Convert 0.096 mJ into J.

9 How many eV in 125 GeV?

10 How many Ωin in 470 MΩ?

11 Convert 632 nm into m. Express in standard form.

12 Convert 1002 mV into V. Express in standard form.

13 How many eV in 0.511 MeV? Express in standard form.

14 How many Ωin 11 kΩ? Express in standard form.

15 Convert 9212 km into m. Express in standard form.

16 Convert 1.385 kg into g. Give answer in the SI unit for mass.

17 Write 2.3×10^{2} μm in m. Express in standard form.

18 Write 0.55×10^{4} km in m. Express in standard form.

19 Write 4.61×10^{-2} mm in m. Express in standard form.

20 Write 0.062×10^{-5} MJ in J. Express in standard form.