How to prepare for A level physics

We follow the OCR "Physics A" specification. It is a good idea to prepare yourself for the transition from GCSE to A-level physics with some of the tasks you will find here. The tasks are intended to give you practice at some of the skills that you need for studying A level physics.

Answers to questions are at the end!

At A level you need to remember all the following prefixes. You will be using these from the start of your A level course.

Prefix	Symbol	Power of ten
Nano	n	x 10^{-9}
Micro	μ	x 10^{-6}
Milli	m	x 10^{-3}
Centi	c	x 10^{-2}
Kilo	k	x 10^{3}
Mega	M	x 10^{6}
Giga	G	x 10^{9}

Here are some common quantities, their symbols and units:

Quantity	Symbol	unit
Time	*t*	s
Displacement	*s*	m
Velocity	*v*	ms^{-1}
Acceleration	*a*	ms^{-2}
Force	*F*	N
Energy	*E* or *W*	J
Power	*P*	W
Density	*ρ*	kgm^{-3}
Pressure	*p*	Pa

Prefix and unit conversions. Solve the following:

1. How many metres in 3.8 km?	6. Convert 0.32 nm into m. Express in standard form.
2. How many joules in 4.5 MJ?	7. Convert 589 nm into m.
3. Convert 730 GW into W.	8. Convert 0.204 mV into V.
4. Convert 9680 mm into m.	9. How many seconds in 5 hours and 20 minutes?
5. How many grams in 4710 kg?	10. How many hours is nine seconds?

Using standard form

Number	Number in standard form
134 000	1.34×10^{5}
0.0034	3.4×10^{-3}
82 000 000	8.2×10^{7}
270	2.7×10^{2}
0.000 000 000 026	2.6×10^{-11}

Significant figures

Have a go at re-writing these:

Re-write the value	15.0	to	2	significant figures
Re-write the value	2.3498	to	3	significant figures
Re-write the value	0.003004	to	3	significant figures
Re-write the value	150	to	1	significant figure

Significant figures and standard form

When using standard form, the number of significant figures (sig figs) a number is written to can always be shown.

For example, all the values below are 'eight hundred', but expressed to 1, 2, and 3 sig figs.

8×10^{2} (1 sig fig)

8.0×10^{2} (2 sig figs)

8.00×10^{2} (3 sig figs)

Standard form will always indicate the number of sig figs, whereas '800' will not.

Writing 800 does not tell us whether this is 1 sig fig, 2 sig figs, or 3 sig figs.

Significant figures in calculations

Measurements are not exact, and the recorded value is written to the appropriate number of significant figures that indicates the accuracy of the measurement. Calculations normally involve using measured values in a formula. The result from calculating a formula cannot be more accurate than the least accurate value used. The answer should be written to the same number of sig figs as the least accurate value in the formula.

Write the answers to the following calculations to the appropriate number of significant figures:

0.0032×12.1 $\qquad$ $105/35$ $\qquad$ $73.4 + 13.002$

Rearranging formulae

This is an important skill. Can you change the subject of the following formulae?

$E = mgh$	Rearrange to make	m	the subject
$E = ½mv^2$	Rearrange to make	v^2	the subject
$E = ½mv^2$	Rearrange to make	v	the subject
$v = u + at$	Rearrange to make	t	the subject
$v^2 = u^2 + 2as$	Rearrange to make	a	the subject
$v^2 = u^2 + 2as$	Rearrange to make	s	the subject

Recording data during practical work

Whilst carrying out practical activities you will write all your raw data in a results table.

Tables should have column headings and units in this format: quantity/unit e.g. Force/N

All results in a column should have the same precision. Most experiments have repeat measurements, so the mean should also be recorded in the results table.

The results below are from an experiment to investigate the motion of a marble. The measuring equipment was a metre rule and a stopwatch. Identify the errors this student made.

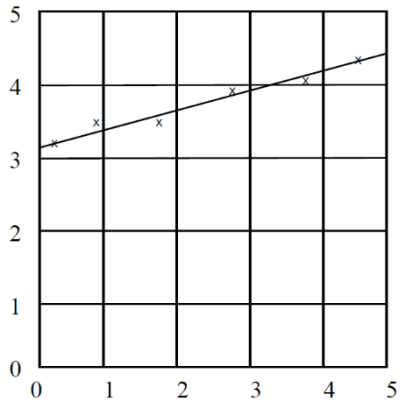
	Time			
Length/cm	**Trial 1**	**Trial 2**	**Trial 3**	**avg**
10	1.45	1.48	1.46	1.5
22	2.78	2.72	2.74	2.75
30	4.0	4.01	4.03	4.01
41	5.46	5.47	5.46	5.5
51	7.02	6.96	6.98	6.99
65	8.24	9.68	8.24	8.72
70	9.01	9.02	9.1	9.04

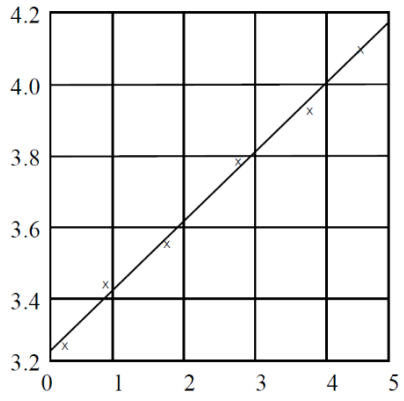
Working with graphs

The data collected from almost all A level physics experiments is presented in graphs.

You need to be able to:

- Choose appropriate scales
- Plot data points to the nearest millimetre
- Draw lines of best fit that may be straight or may be curved
- Calculate gradients





1. Two friends produced the graphs above. Have they both done an equally good job? Write down an explanation of your reasoning.
2. Calculate the gradient of each graph. How easy/difficult did you find this? How many significant figures should you write your answer to? Write down your reasoning.

Working with vectors

A scalar has magnitude (size) only, a vector has magnitude and direction. For example, temperature is a scalar; it is meaningless to say the temperature is 20°C horizontally north. Force is a vector; it does make sense to say the horizontal force of 20 N is in the direction north.

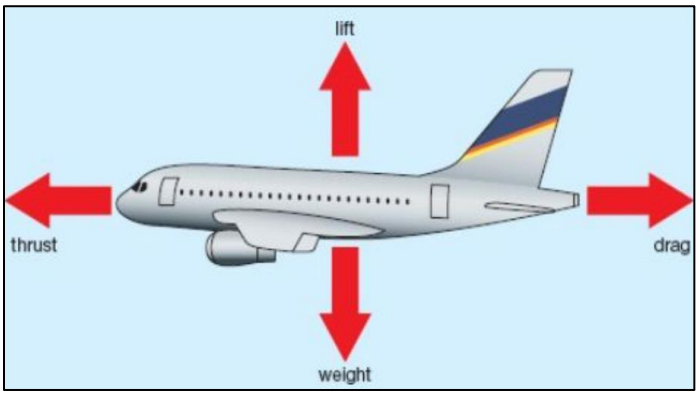
Can you decide which of these are vectors and which are scalars?

Quantity	Vector or scalar?
Displacement	
Velocity	
Acceleration	
Energy	
Power	
Density	
Pressure	
Time	

Can you add vectors? Can you find the resultant of the forces on this aircraft?

Name of force	Magnitude of force / kN
Lift	3300
Weight	3300
Thrust	1000
Drag	800

Resultant = _____



Answers

Prefix and unit conversions

1. How many metres in 3.8 km? **3800 m**	6. Convert 0.32 nm into m **3.2×10^{-10} m**
2. How many joules in 4.5 MJ? **4 500 000 J or 4.5×10^{6} J**	7. Convert 589 nm into m. **0.000 000 589 m or 5.89×10^{-7} m**
3. Convert 730 GW into W **7.3×10^{11} W**	8. Convert 0.204 mV into V. **0.000 204 V or 2.04×10^{-4} V**
4. Convert 9680 mm into m **9.68 m**	9. How many seconds in 5 hours and 20 minutes? **19 200 s or 1.92×10^{4} s**
5. How many grams in 4710 kg? **4 710 000 g or 4.71×10^{6} g**	10. How many hours is nine seconds? **0.0025 hours or 2.5×10^{-3} hours**

Did you automatically use standard form for Questions 2, 3, 5, 7 and 8, or did you write a string of zeros?

Significant figures

The value	15.0	to	2	significant figures	is	**15**
The value	2.3498	to	3	significant figures	is	**2.35**
The value	0.003004	to	3	significant figures	is	**0.00300**
The value	150	to	1	significant figure	is	**200**

Significant figures in calculations

0.0032 x 12.1 = 0.03872 = 0.040 to 2 sig figs.

The answer should be written to 2 sig figs because the least accurate data, 0.0032, is 2 sig figs.

$\frac{105}{35}$ **= 3 = 3.0 to 2 sig figs.**

The answer should be written to 2 sig figs because the least accurate data, 35, is 2 sig figs.

73.4 + 13.002 = 86.402 = 86.4 to 3 sig figs.

The answer should be written to 3 sig figs because the least accurate data, 73.4, is 3 sig figs.

Rearranging formulae

$E = mgh$	Rearranges to give	$m = \frac{E}{gh}$
$E = \frac{1}{2}mv^2$	Rearranges to give	$v^2 = \frac{2E}{m}$
$E = \frac{1}{2}mv^2$	Rearranges to give	$v = \sqrt{\frac{2E}{m}}$
$v = u + at$	Rearranges to give	$t = \frac{v-u}{a}$
$v^2 = u^2 + 2as$	Rearranges to give	$a = \frac{v^2-u^2}{2s}$
$v^2 = u^2 + 2as$	Rearranges to give	$s = \frac{v^2-u^2}{2a}$

Recording data during practical work

	Time			
Length/cm	**Trial 1**	**Trial 2**	**Trial 3**	**avg**
10	1.45	1.48	1.46	**1.5**
22	2.78	2.72	2.74	2.75
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41	5.46	5.47	5.46	**5.5**
51	7.02	6.96	6.98	6.99
65	8.24	9.68	8.24	8.72
70	9.01	9.02	**9.1**	9.04

Time **should be Time/s**

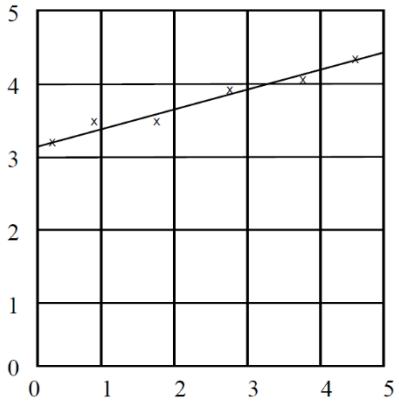
4.0, 9.1, 1.5, and 5.5 **should all be two decimal places**

avg **should be *mean* (there are different types of average)**

Working with graphs

Scales need to be chosen so that the plotted points fill the majority of the graph paper. There is no need to start either scale at zero. The gradient is always $\Delta y / \Delta x$ which is $(y_2 - y_1)/(x_2 - x_1)$

Have a look at these two graphs below:

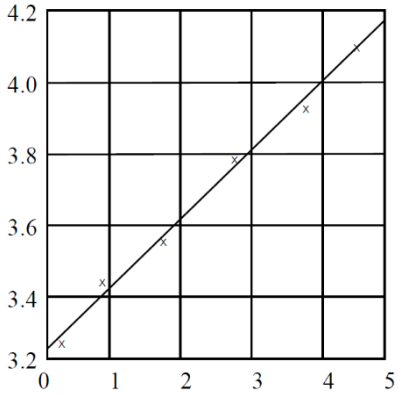


The *y*-axis scale should start at 3, not zero, because in this example over half of the graph paper is not being used.

The gradient is

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{4.3 - 3.2}{4.5 - 0.2} = \frac{1.1}{4.3} = 0.26$$

It is convenient (but a coincidence) that the two points at the ends of the line are on the line because their coordinates can be used to calculate the gradient.



The axes' scales have been chosen well. The full width and full height of the graph paper are being used for the plot area.

The gradient is

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{4.10 - 3.24}{4.5 - 0.0} = \frac{1.1}{4.3} = 0.19$$

The top-right point (4.5, 4.10) is on the line and so can be used. At the bottom left, the intercept (0, 3.24) has been chosen. The *y*-axis scale allows an extra decimal place to be used for Δy, improving gradient measurement accuracy.

Working with vectors

Quantity	Vector or scalar?
Displacement	**Vector**
Velocity	**Vector**
Acceleration	**Vector**
Energy	**Scalar**
Power	**Scalar**
Density	**Scalar**
Pressure	**Scalar**
Time	**Scalar**

Name of force	Magnitude of force / kN
Lift	3300
Weight	3300
Thrust	1000
Drag	800

Resultant = **200 kN to the left**