The transition from GCSE to A-level Physics

Welcome to A-level physics! September is going to come round fast and you need to be ready.

There is a significant step up from GCSE to A-level so we need to make sure that you are fully ready for September.

Summer transition work

The tasks on the following pages are intended to give you the opportunity to practice some of the key skills that you need on the A-level physics course.

Complete all the tasks before the start of term either and bring the completed booklet to your first Physics lesson.

Section A: How to become a better physicist over the summer:

1. Compulsory:

Complete the work in section B.

2. Recommended:

Join the Institute of Physics – this is completely free for A-level students. Here you can keep up-to date on cutting edge physics topics. http://members.iop.org/16-19.asp and in the 'school details'

section you need to enter school address: Plympton Academy, Moorland Rd, Plympton, Plymouth PL7 2RS

3. Recommended: read books. It can help to stand back and see physics in a wider context. Scientific truth is actually stranger and more interesting than science fiction!

Here are some recommendations:

a. A short history of nearly everything by Bill Bryson

b. Seven brief lessons of physics by Carlo Rovelli

c. Six Easy Pieces: Fundamentals of Physics Explained by Richard Feynman

d. Seduced by logic: Emilie du Chatelet, Mary Somerville and the Newtonian Revolution by

Robyn Arianrhod → this book is about two of the most influential female physicists of all

time

Section B: Physics Transition tasks

1. Dealing with symbols and SI units

One of the biggest jumps between GCSE and A-level physics is the way things are written down. At A-level you are expected to start using standard scientific notation.

Standard scientific notation means:

- Using conventional symbols for quantities
- Writing all quantities in terms of SI units (Système International)
- Writing very large and very small numbers in standard form (e.g. 1×10^{-6} instead of 0.000001)

Task 1: you need to memorise the unit prefixes shown in the table. Take note of whether the symbols are capital or lower case letters! They will be used in all exams and it is assumed that you know what they mean.

Multiple	Prefix	Symbol
10^{12}	tera-	T
10^{9}	giga-	G
10^{6}	mega-	M
10^{3}	kilo-	k
10^{-3}	milli-	m
10^{-6}	micro-	µ
10^{-9}	nano-	n
10^{-12}	pico-	p

Task 2: In the following pairs of quantities, circle the quantity that is greater.

a. 12 mW or 12 MW

b. 3.0 µs or 3.0 ns

c. 27 kV or 27 GV

d. 6 pm or 6 µm

e. 1024 TW or 1024 GW

f. 22×10^{-2} Ω or 220 Ω

g. 300 kg or 3×10^{3} kg

h. 121 kN or 0.121×10^{6} N

i. 20×10^{-6} F or 0.003 pF

j. 14000 MHz or 1.4×10^{9} Hz

Task 3: When you write out the name of a unit in full it is always written completely in lower case letters. For example the unit for power is watt (symbol W). In the box above write the full name of the SI unit in the question. Bonus point if you can find out why some symbols are written in lower case while other are in upper case (e.g. N).

Task 4: you must bring a working scientific calculator to all of your physics lessons and exams. Your calculator has a button on it that says ENG. Find out what this button does, and why it will be useful to you on your physics course. Describe the function and usefulness in the space below.

2. Graph skills

Graph skills are incredibly important for both analysis data and presenting new data. You need to be confident at drawing graphs, interpreting graphs and calculating quantities from graphs.

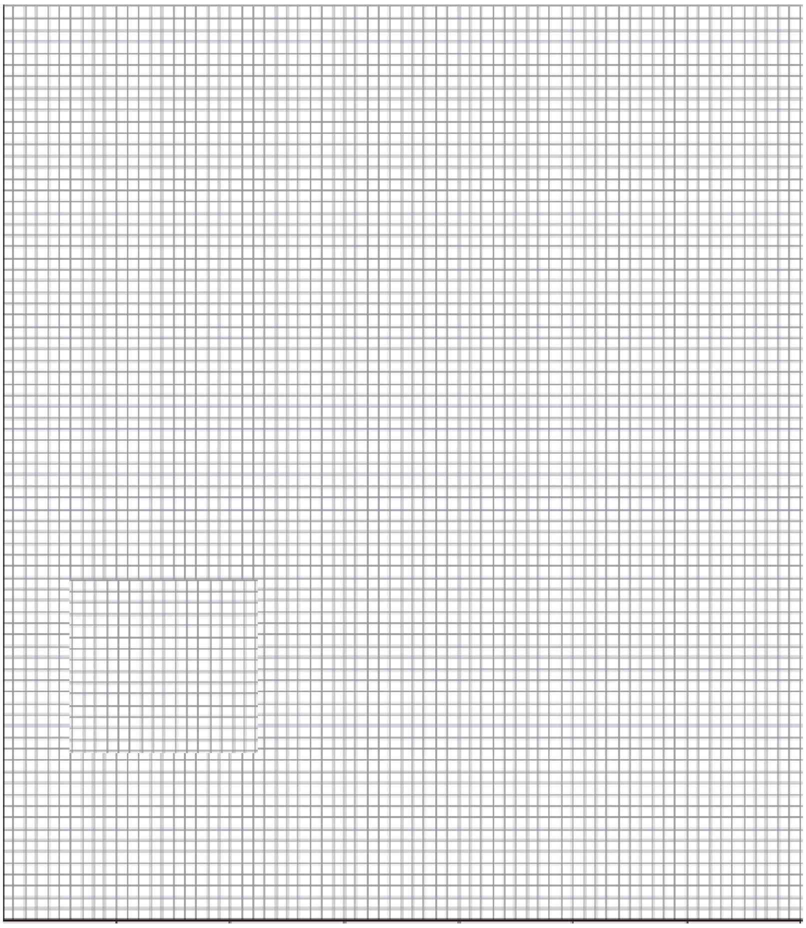
Task 1: Drawing graphs

Rules when drawing a graph:

- Use pencil and ruler
- Independent variable does on the x-axis, dependent variable goes on the y-axis
- Range of data points must take up AT LEAST half the page
- Axes must be labelled with name and units
- If plotting a scatter graph, a line of best fit must be one continuous line (NEVER join the dots!)

Use the data below to plot a graph of atomic radius against atomic number and draw a line of best fit.

Atomic number	Atomic radius in picometres (pm)
15	100
35	115
50	130
70	150
95	170

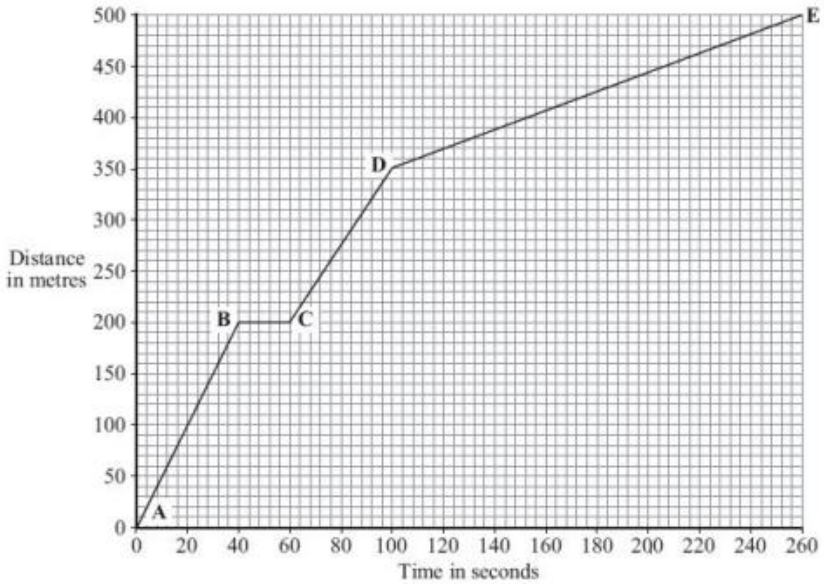


Use your graph in **Figure 2** to predict the atomic radius of an atom with atomic number 126.

Atomic radius = ... pm

Task 2: Interpreting graphs and calculating quantities from graphs. This question is about distance-time graphs, covered in your physics GCSE course.

The distance – time graph shows how far the bus travelled along the high street and how long it took.



(a) The bus travels the **slowest** between points **D** and **E**. How can you tell this from the graph?

....

....

(1)

(b) Between which two points was the bus travelling the **fastest**? ....

(1)

(c) There is a bus stop in the high street. This is marked as point **B** on the graph.

(i) What is the distance between point **A** on the graph and the bus stop?

Distance .... metres

(1)

(ii) How long did the bus stop at the bus stop?
Show clearly how you work out your answer.

....

Time = ... seconds

(2)

(d) A cyclist made the same journey along the high street. The cyclist started at the same time as the bus and completed the journey in 200 seconds. The cyclist travelled the whole distance at a constant speed.

(i) Draw a line on the graph to show the cyclist's journey. **(2)**

(ii) After how many seconds did the cyclist overtake the bus? After............................ seconds.

(1)
(Total 8 marks)

Dealing with vector quantities

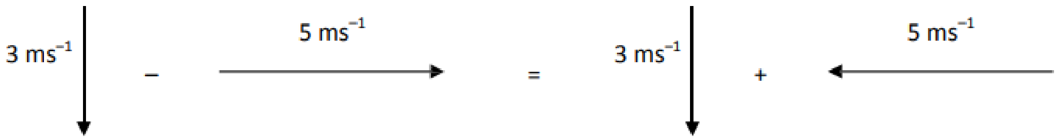
You should already know that a quantity like speed only has a size (e.g. 13 ms^{-1}), but there is another type of quantity (called a vector) that has a size and direction, e.g. a velocity of 13 ms^{-1} *to the left*. You can represent velocities with arrows – the longer the arrow the greater the size (speed) of the velocity.

At AS level you will become proficient at working in more than one dimension, and in order to do this you will need to master vectors. For example, the formula for working out the change in velocity looks simple enough:

change in velocity (ms^{-1}) = final velocity (ms^{-1}) – initial velocity (ms^{-1})

However, you can't just subtract one speed from the other – you have to account for the directions of the two velocities.

Example: find the magnitude (size) of the change in velocity if you have an initial velocity of 5 ms^{-1} to the right and a final velocity of 3 ms^{-1} downwards.



Δv is the <u>change in velocity</u>.

You find Δv by reversing the arrow for the intial velocity and adding this new arrow to the final velocity.

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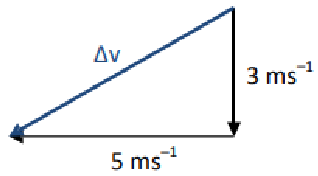

Either by measuring from a scale drawing, or by using Pythagoras' theorem, the answer is **Δv = 5.8 ms^{-1}**.

Have a go at finding the changes in velocity in these two cases:

a. initial velocity = 4 ms^{-1} upwards;
final velocity = 4 ms^{-1} to the right

b. initial velocity = 3 ms^{-1} down;
final velocity = 4 ms^{-1} to the left.

Dealing with equations

Forces stretch things, squash things and twist things. When we consider things as whole objects ("bodies" in physics language) then Newton's Second Law of Motion deals with the way that forces make bodies go faster, slower or change direction. The resultant force acting on a body makes it accelerate, and the size of the acceleration is directly proportional to the size of the force.

resultant force (N) = mass of body (kg) $\times$ acceleration (ms^{-2})

or, in symbols

F = m a

Example: A car of mass 1000 kg accelerates uniformly from rest at a rate of 0.75 ms^{-2}. What is the size of the resultant force accelerating it?

Solution: F = m a = 1000 kg $\times$ 0.75 ms^{-2} = 750 N

Answer the following in the spaces provided:

a. A bus of mass 10000 kg accelerates at 0.25 ms^{-2}. What is the resultant force acting on it?

b. A car pulls a caravan of mass 800 kg. If it accelerates at 0.4 ms^{-2}, what force must the caravan experience?

Example: What would the acceleration of a 0.5 kg body be if a force of 10 N acted on it?

Solution: F = ma. Dividing both sides by m gives F/m = a, so a=F / m = 10 N /0.5 kg = 20 ms^{-2}.

Answer the following in the spaces provided:

a. What would be the initial acceleration of an arrow of mass 0.3 kg shot from a bow if the force from the bow-string is 200 N?

b. What would be the acceleration of a train of mass 10^4 kg if the force form the engine is 8kN?

Example: What is the mass of a body if a force of 250 N produces an acceleration of 2 ms^{-2}?

Solution: F = ma. Dividing both sides by a gives F/a = m, so m = F/a = 250 N / 2 ms^{-2} = 125 kg

Answer the following in the spaces provided:

a. What is the mass of a sailing boat if a force of 120 N produces an acceleration of 0.5 ms^{-2}?

b. What is the mass of an electron if a force of 1.8×10^{-14} N produces an acceleration of 2.0×10^{16} ms^{-2}?

Practical tasks:

Collecting and recording data - Density

Theory

Use BBC Bitesize to refresh your memory on the topic on density.

1. Define density and state its units

2. Look up the densities of these common substances:

i. Air

ii. Copper

iii. Water

iv. Nylon

3. Calculate the mass (in kg) of a cylinder of copper of length 8.0 cm and diameter 3.0 cm (use your value from question 2 for the density of copper). When calculating densities, beware of values in grams or cm, you will need to convert these to kg and m.

Practical

Using equipment you have available at home, have a go at determining the density of the following objects:

1) A regular shaped object (e.g. a block of butter or a block of wood)

2) A liquid (e.g. water, milk, fruit juice)

3) A sheet of paper

4) An irregular shaped object (e.g. an apple)

Think carefully about the information you will need to record and how you will record this for each object.

How did your method vary for each item? Did you encounter any problems when trying to measure the density of each object? How did you overcome them?

Which method do you think gives you the most accurate result?

Bring all your observations and calculations for each object to your first Physics lesson in September.