TRANSITION WORK

PHYSICS

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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

1. Dealing with symbols and SI units

One of the highest jumps between GCSE and AS physics is the way things are written down. At AS level you're expected to start using standard scientific notation.

Standard notation means:

- using the 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. 10^{-6} instead of 0.000001)

You will need to have memorised the unit prefixes shown in the table on the right – they are used in exams and it is assumed that you know what they mean.

Of course people in the real world don't use standard scientific notation – you don't see car speedometers with ms^{-1} scales on them or tyre pressure gauges calibrated in kNm^{-2}. You'll also encounter non-standard units in the physics course itself – megaparsecs, electronvolts and a.m.u. for example.

In the following ten pairs of quantities, circle the quantity which 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 0.0121×10^{6} N

i. 30×10^{-6} F or 0.003 pF

j. 14000 MHz or 1.4×10^{9} Hz

When you write out the name of a unit in full it is always written completely in lower case letters. For example: the unit of power is the watt (symbol W). In the box above, next to each question write the full name of the SI unit in the question. Bonus points if you find out why some symbols are written using upper case (e.g. N) whereas other unit symbols are written using lower case (e.g. s).

You must bring a working scientific calculator to all of your physics lessons and exams. Your calculator has a button 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. Dealing with vector quantities

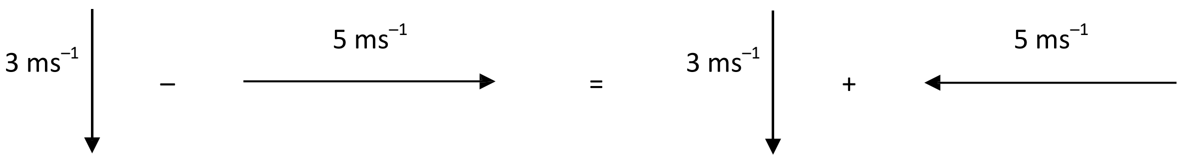
You should already know that a quantity like speed only has a size (e.g. 13 ms^{-1}), but there is another type of quantity (called a vector) that has a size and direction, e.g. a velocity of 13 ms^{-1} *to the left*. You can represent velocities with arrows – the longer the arrow the greater the size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

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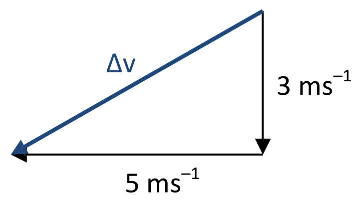

You find Δv by reversing the arrow for the intial velocity and adding this new arrow to the final velocity.

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.

3. 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.

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

or, in symbols

$$\mathbf{F = m\,a}$$

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 × 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 from 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

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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}?

Below is an extensive list of activities you can do before the start of your A levels. This is by no means exhaustive, and there are loads of other examples out there. You do not need to read all the books, watch all the documentaries or listen to all the podcasts. That decision is up to you. However, try to explore lots of different areas of Physics as suggested in order for you to broaden your knowledge. The written work that needs to be done must be on paper with examples of each task. Enjoy!

Reading list (books / academic articles / journals etc)

· What If? by Randall Munroe (Serious Scientific Answers to Absurd Hypothetical Questions)
· A Short History of Nearly Everything by Bill Bryson
· Big Bang: The Most Important Scientific Discovery of All Time and Why You Need to Know About It by Simon Singh
· A Brief History of Time by Stephen Hawking
· The Universe in a Nutshell by Stephen Hawking
· The Making of the Atomic Bomb by Richard Rhodes
· Carrying the Fire: An Astronaut's Journeys by Michael Collins (the Apollo 11 astronaut).
· 13 Things That Don't Make Sense: The Most Intriguing Scientific Mysteries of Our Time by Michael Brooks
· Surely you're joking Mr Feynman by Richard P Feynman and Ralph Leighton.
· Six Easy Pieces: Fundamentals of Physics Explained by Richard P Feynman (or any other book by the same author)

You can read as many of these as you want, but pick just one to write a brief report (half a page max) on it. The main thing I would like to know is, what did you learn from it?

Documentaries

Particle Fever
https://www.youtube.com/watch?v=GR0enyj24es&has_verified=1
Gravity and me
https://www.youtube.com/watch?v=aNeR_fHcQSs
How the Universe works – Black Holes
https://www.youtube.com/watch?v=u88IHVRI13A
Einstein's biggest blunder
https://www.youtube.com/watch?v=Hxr9tkalD8I
The Fantastic Mr Feynman
https://www.youtube.com/watch?v=H9fjhQMsDW4
Inside the Milky Way
https://www.youtube.com/watch?v=rw6TwaqNsYw
The Science of Dr Who
https://www.youtube.com/playlist?list=PLKEzuOOEQvYPEQHJ-nApnOOORvOxEriAf
The Challenger Disaster
https://www.youtube.com/watch?v=DT7Yx5kxYco
Cosmos: A Spacetime Odyssey – Netflix
https://www.youtube.com/watch?v=_erVOAbz420 (trailer)
The Secrets of Light and Energy
https://www.youtube.com/watch?v=TvUb_-Nl58M
The Secrets of Quantum Physics
https://www.youtube.com/watch?v=ISdBAf-ysI0

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Podcasts

The Titanium Physics podcast
http://titaniumphysicists.brachiolopemedia.com/2020/02/01/episode-85-decoherence-not-incoherence-with-ted-leo/
Star Talk with Neil de Grasse Tyson
https://www.startalkradio.net/show/cosmic-queries-theoretical-physics/
The Infinite Monkey Cage with Professor Brian Cox
https://www.bbc.co.uk/programmes/b00snr0w/episodes/downloads
Talk Nerdy
https://soundcloud.com/talk-nerdy/introducing-lifes-little-mysteries
Physics Frontiers
https://physicsfrontiers-rantschler.podomatic.com/

Ask a Spaceman!
https://www.youtube.com/PaulMSutter
The Royal Institution
https://www.youtube.com/user/TheRoyalInstitution

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Written work required

These are the most important skills you should master before the start of your A levels. You need to make notes on, and give examples of, all these skills:

- **Being expert at using standard form.**
- **Knowing how to express answers to a certain number of significant figures.**
- **Knowing the different prefixes, e.g. 10^{-3} = milli.**
- **Learning the GCSE Physics equations in both word and symbol forms.**
- **Being expert at rearranging all GCSE Physics equations.**
- **Knowing the units for all the GCSE Physical quantities, e.g. Energy is measured in joules, or J.**
- **For each GCSE Physics topics, you must know the correct spellings and definitions of key physical terminology, e.g. frequency = the number of wave crests passing a fixed point every second.**
- **Finding links between different areas of Physics, e.g electricity and magnetism, forces and energy, waves and particles etc…**
- **Practical skills (choices of equipment and reasons, accuracy in observations and measurements, identifying sources of error, interpreting results, analysing graphs in as much detail as possible, making conclusions and evaluations).**
- **Practicing writing extended answers (6 mark questions) showing links between different ideas, using correct terminology, showing structure to your explanations…**