



A Level Physics

Summer bridging work

Background maths and problem-solving skills

This work is designed to help prepare you for A-level physics. It covers some of the basic skills that will be used throughout the course. Many of these extend and develop ideas you will have come across at GCSE in science and maths. You should expect to find some parts difficult, but if you persevere you will often find you can do them!

Do your workings and answers to later written questions on paper and hand this in during the first week of teaching in September.

TASK 1:

Part of the summer work will be set using the platform **Isaac Science (isaacscience.org)**. It is free to sign up and the platform will mark your work as you progress.

If you don't have an account already, sign up using this link (or the QR code): <https://isaacscience.org/account?authToken=C83Q97>

If you already have an account please join the Year 11/12 Transition group using code **C83Q97**

You need to click to agree to sharing your data with the physics department staff, so we can see if there are any areas you found difficult once you arrive in September.

Use plenty of scrap paper when doing Isaac Science questions to do your workings. Then type the answer in. Use the Hints if you get the answer wrong the first time and have another try.



Scan to join Year 11/12 Transition !

Task 2: Rearranging equations

Tips: Show your working clearly

When answering physics questions, you need to layout your working clearly showing all the steps. Your final answer should be found at the bottom of your working and should be underlined. Below is an example for you to base your own answer style on.

Question: A white snooker ball with a kinetic energy of 15J collides with a red ball. On impact the white ball stops, transferring all of its KE to the red ball. The mass of the red ball is 120 g. What would be the velocity of the red ball immediately following the collision?

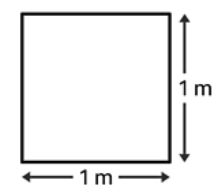
STEPS: Write the relevant Equation → rearrange if necessary → insert values → calculate answer → add the correct unit → rewrite answer to appropriate sig figs

$$\begin{aligned} KE &= \frac{1}{2}mv^2 \quad \therefore \frac{2KE}{m} = v^2 \quad \therefore v = \sqrt{\frac{2 \times 15J}{0.12kg}} \\ &= 15.8 \text{ ms}^{-1} = \underline{16\text{ms}^{-1} (2\text{sf})} \end{aligned}$$

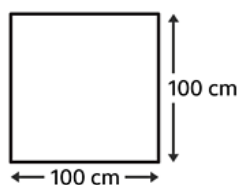
Eight steps to improve the quality of your equations

1. Show all steps
2. Work left to right and top to bottom
3. Rearrange equations before substituting values
4. If a calculation is two step, underline the answer to the first step before proceeding as this may get marks
5. Your writing should be small and neat. Don't scrawl.
6. You should be able to easily check over your working to find mistakes
7. Plan to use the available answer space wisely
8. Try to leave space for correcting mistakes if you go wrong

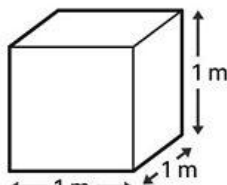
TIP – when converting square and cube units – sketch a quick square or cube and check you have the correct conversion factor!



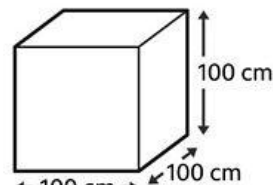
$$1 \text{ m} \times 1 \text{ m} = 1 \text{ m}^2$$



$$100 \text{ cm} \times 100 \text{ cm} = 10,000 \text{ cm}^2$$



$$1 \text{ m} \times 1 \text{ m} \times 1 \text{ m} = 1 \text{ m}^3$$



$$100 \text{ cm} \times 100 \text{ cm} \times 100 \text{ cm} = 1,000,000 \text{ cm}^3$$

Being confident and quick at rearranging equations is an important skill for A-Level physics. The **Unit A1 deck of questions in the Isaac Science work** provides practice at doing this:

https://isaacscience.org/books/physics_skills_19/a1

Task 3: The SI system of units

Scientific measurement depends on standard units – most are Système International (SI) units. You need to know the following six Base Units:

Base units

Physical quantity	Unit	Symbol
Length	metre	m
mass	kilogram	kg
time	second	s

Physical quantity	Unit	Symbol
electric current	ampere	A
temperature difference	Kelvin	K
amount of substance	mole	mol

Derived units

Other quantities are measured in many different units, some with their own name (e.g. the Ohm) and some comprised of a collection of other units (e.g. the metre per second or ms^{-1}). These can all be broken down into Base Units (i.e. they can be derived from Base Units – so they are known as Derived Units). It is helpful to know an equation that can be used to calculate the quantity and use the units to help. (The AQA GCSE formula sheet can be found here for reference: <https://tinyurl.com/5cfhjupe>)

Example: What are the base units for the Joule? I know this is energy and $E=mgh$.

- The unit for mass is 'kg'
- The unit for gravitational field strength is either ' Nkg^{-1} ' or ' ms^{-2} ' – the Newton isn't a base unit so I'll use the unit for acceleration
- The unit for height is 'm'

Units on each side of an equation balance. So:

$$J = \text{kg} \times \text{ms}^{-2} \times \text{m}$$

tidy up the indices to get: $\text{kg m}^2 \text{s}^{-2}$ ← This is the base unit for the Joule

Being able to identify the base units from derived units is required for A-Level physics.

Unit A2 deck of questions in the Isaac Science work provides practice at doing this:

[A2 Derived and Base SI Units — Isaac Science](#)

Unit Prefixes

Prefixes are written in front of units to indicate multiplication or division by multiple

tera	T	1000000000000	10^{12}
giga	G	1000000000	10^9
mega	M	1000000	10^6
kilo	k	1000	10^3
(none)	(none)	1	10^0
milli	m	0.001	10^{-3}
micro	μ	0.000001	10^{-6}
nano	n	0.000000001	10^{-9}
pico	p	0.000000000001	10^{-12}

Being confident using standard form, reducing numbers to fewer significant figures and using unit prefixes are vital skills for A-Level physics.

The **Unit A3 deck of questions in the Isaac Science work** provides practice at doing this:

https://isaacscience.org/question_decks#phys19_a3_r1

Tip: The [ENG] button on your calculator will convert any answer to standard form corresponding to a unit prefix. Press [ENG] again and it will make the unit smaller by 10^3 . Press shift [ENG] or $[\text{ENG}]^{-1}$ and it will make the unit bigger by 10^3 – this is a very useful button when needing to convert units!

The **Unit A4 deck of questions in the Isaac Science work** provides practice converting between units with prefixes:

https://isaacscience.org/questions/phys19_a4_q1?board=phys19_a4

Task 5: Gradients

The gradient of a graph is calculated by choosing two points on a straight line and dividing the vertical change (change in y or 'rise') by the horizontal change (change in x or 'run')

Being able to calculate the gradient from a graph is regularly used in A-Level physics to work out a quantity from practical results plotted on a graph.

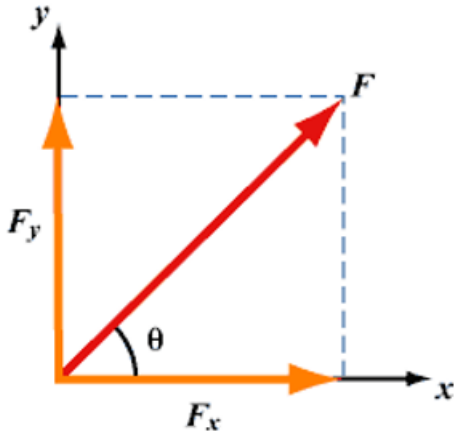
The intercept of a line is the point where it crosses the y axis. This is also sometimes used to determine quantities from practical results.

The **Unit A5 deck of questions in the Isaac Science work** provides practice at using graphs to find gradients and intercepts:

https://isaacscience.org/question_decks#phys19_a5

$$\text{Gradient } (m) = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

Resolving vectors



In A level Physics you will need to work with vectors that act at odd angles. Often the easiest way to deal with this is to convert the diagonal vector into horizontal and vertical components.

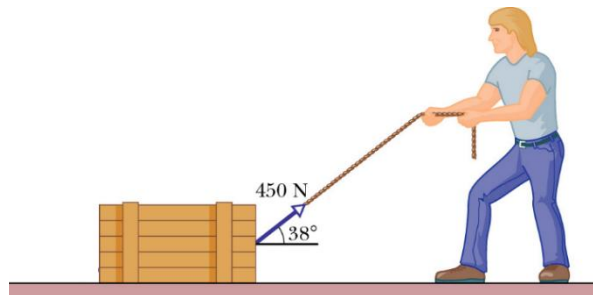
For example, in the case of a force F acting at an angle θ , F can be treated as two forces acting horizontally (F_x) and vertically (F_y). These can be calculated with trigonometry:

Task 6: Mixed Questions - Answer the following questions on a separate piece of paper and show your workings.

(The AQA GCSE formula sheet can be found here for reference:

<https://tinyurl.com/5cfhjupe>)

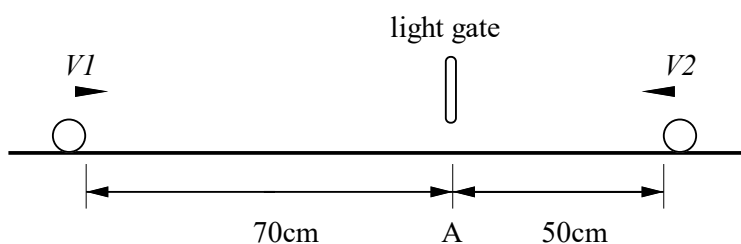
- 1) Calculate the work done in each of the following situations
 - a) A box is pushed 3m along the floor by a horizontal force of 500N (2)
 - a) An electric lift raises 540 kg load through a height of 18.3 metres (2)
 - b) A man uses a rope to pull a box along a floor, as shown. He drags the box 3.0 km (3)



- d) A student adds three 100g slotted masses to a spring of spring constant, $k = 6.0 \text{ Nm}^{-1}$. It extends by 14.0 cm. (4)
- 2) Which of the following are units of power?
 - a) joule second
 - b) watt
 - c) joule second⁻¹
 - d) newton metre second⁻¹
 - e) amp volt

(2)

- 3) In two minutes a rocket gained 370 MJ of kinetic energy and 1300 MJ of gravitational potential energy.
- Find the useful power produced by the rocket engines. (2)
 - In the following 30s the rocket travels at a steady speed of 320 ms^{-1} . Assuming the power of the engines to be constant, calculate the thrust force produced by the engines. (2)
- 4) A 12V electric motor is used to lift a 50g mass through 1.0m. The overall efficiency of this system is 10%.
Whilst in operation it draws a current of 0.25A.
- Find the useful power output of the electric motor. (2)
 - How long does it take the motor to raise the mass 1.0m? (2)
- 5) A bullet travels 300m in 2.60 seconds what is its velocity in:
- m s^{-1}
 - km h^{-1} ?
- 6) An alpha particle covers 2.0 cm travelling at 5% the speed of light (speed of light= $3.0 \times 10^8 \text{ m s}^{-1}$). How long does it take to cover this distance?
- 7) A cyclist is racing on a circular track at an average speed of 8.35 m s^{-1} . She completes three laps in 2 minutes 24.36 seconds. What is the radius of the track?
- 8) Two pool balls are moving towards each other as in the diagram below. At position A is a light gate.



If $V_1 = 0.60 \text{ ms}^{-1}$ and $V_2 = 0.20 \text{ ms}^{-1}$ then

- a) which ball passes through the light gate first?
 - b) at what time?
 - c) at what position do they collide?
 - d) at what time?
- 9) A light-year is the distance light travels in one year. Calculate this distance in metres to 3 significant figures, given that the speed of light is $3.00 \times 10^8 \text{ ms}^{-1}$.
- 10) A horse is cantering at 3.1 m s^{-1} and breaks into a gallop reaching a speed of 5.6 ms^{-1} in 3.5 seconds. Calculate its acceleration.
- 11) A car travelling at 16.0 m s^{-1} , brakes for 3.20 s, decelerating at a rate of 3.125 ms^{-2} . What is its final speed?
- 12) An Olympic diver strikes the water at a speed of 7.2 ms^{-1} , and comes to rest in 1.2 seconds. What is his acceleration?
- 13) A falling ball strikes a floor with a velocity of 4.2 ms^{-1} and rebounds with a velocity of -3.8 ms^{-1} . It is in contact with the floor for 0.12 seconds. What was its acceleration?
- 14) A Porsche is quoted as having a “0-60 time of 4.2 seconds”. This means it accelerates from zero to 60 miles per hour in 4.2 seconds. Given that 1 mile = 1.55 km, calculate its acceleration in ms^{-2}
- 15) At the University of Errors Science Tower, a brick is observed falling past the window of the Physics Laboratory. A quick thinking physics student records its speed as 4.59 ms^{-1} . A moment later it passes the ground floor windows of the Engineering Faculty and an alert engineer records its speed as 12.91 ms^{-1} .
- a) Assuming acceleration due to gravity to be 9.81 ms^{-1} and assuming air resistance to be negligible, how long was the ‘moment’ between these observations?
 - b) By considering its average speed calculate the height between the Physics and the Engineering labs.