



North Halifax Grammar School – A Level Transition Work

A level Physics

Specification

OCR A A-level Physics (H556)

<https://www.ocr.org.uk/Images/171726-specification-accredited-a-level-gce-physics-a-h556.pdf>

Course Overview

Year 1 Subject Content	Year 2 Subject Content
<p>Module 1: Development of practical skills in physics</p> <p>Module 2: Foundations Physics The study of physical quantities and units.</p> <p>Module 3: Forces and Motion The study of Motion; Forces in action; Work, energy and power; Materials; Newton's laws of motion and Momentum.</p> <p>Module 4: Electrons, waves, and photons This unit involves the study of Charge and current; Energy, power and resistance; Electrical circuits; Waves and Quantum physics.</p>	<p>Module 5: Newtonian World and Astrophysics This unit involves the study of Thermal physics; Circular motion; Oscillations; Gravitational fields and Astrophysics.</p> <p>Module 6: Particles and Medical Physics This unit involves the study of Capacitors; Electric fields; Electromagnetism; Nuclear and particle physics and Medical imaging.</p>

Practical Endorsement

There is no coursework component to the course and 15% of the marks for A-level Physics are based on what you learned in your practicals. You will achieve a qualification following the successful completion of twelve practicals throughout the A level course. This is separate to your Physics examination grade.

Recommended reading / revision/ viewing

When you start the course you will be given an exam board specific textbook;

<https://global.oup.com/education/product/9780198352181/?region=uk>

So don't buy this one. You will also get the option to buy the relevant CGP revision guide at a discounted rate.



North Halifax Grammar School – A Level Transition Work

Books: It will help you to stand back and see physics in its wider context, and also to look in more detail at some areas of physics that you may currently know very little about. All of them are written at a level that assumes very little about your prior subject knowledge, but reading them will stretch you into areas that go beyond far beyond A-level. Aim to read a couple of them, there is no need to read them all.

- A Short History of Nearly Everything by Bill Bryson
- Six Easy Pieces: Fundamentals of Physics Explained by Richard P Feynman (or any other book by the same author)
- A Brief History of Time by Stephen Hawking
- Big Bang: The Most Important Scientific Discovery of All Time and Why You Need to Know About It by Simon Singh

Online video clips:

You could spend your whole life watching physics video clips on youtube. No need, however, as minutephysics is all you'll ever really need – and all clips are only a minute long.

<http://www.youtube.com/user/minutephysics>

Review gcse physics and look ahead to A-level with 'GCSE and A-level Physics online'

https://www.youtube.com/channel/UCZzatyx-xC-DI_VVUVHYDYw

Websites:

<http://physicstube.org/>

<http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html>

<https://www.physicsandmathstutor.com/>

<http://i-want-to-study-engineering.org/>



North Halifax Grammar School – A Level Transition Work

Transition work for Physics A level students - Answer on file paper

Moving from GCSE Science to A Level can be a daunting leap. You'll be expected to remember a lot more facts, equations, and definitions, and you will need to learn new maths skills and develop confidence in applying what you already know to unfamiliar situations.

This worksheet aims to give you a head start by helping you:

- to pre-learn some useful knowledge from the first chapters of your A Level course
- understand and practice of some of the maths skills you'll need.

Retrieval questions

You need to be confident about the definitions of terms that describe measurements and results in A Level Physics.

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

Practical science key terms

When is a measurement valid?	when it measures what it is supposed to be measuring
When is a result accurate?	when it is close to the true value
What are precise results?	when repeat measurements are consistent/agree closely with each other
What is repeatability?	how precise repeated measurements are when they are taken by the <i>same</i> person, using the <i>same</i> equipment, under the <i>same</i> conditions
What is reproducibility?	how precise repeated measurements are when they are taken by <i>different</i> people, using <i>different</i> equipment
What is the uncertainty of a measurement?	the interval within which the true value is expected to lie
Define measurement error	the difference between a measured value and the true value
What type of error is caused by results varying around the true value in an unpredictable way?	random error
What is a systematic error?	a consistent difference between the measured values and true values
What does zero error mean?	a measuring instrument gives a false reading when the true value should be zero
Which variable is changed or selected by the investigator?	independent variable
What is a dependent variable?	a variable that is measured every time the independent variable is changed
Define a fair test	a test in which only the independent variable is allowed to affect the dependent variable
What are control variables?	variables that should be kept constant to avoid them affecting the dependent variable



North Halifax Grammar School – A Level Transition Work

Maths skills

1 Measurements

1.1 Base and derived SI units

Units are defined so that, for example, every scientist who measures a mass in kilograms uses the same size for the kilogram and gets the same value for the mass. Scientific measurement depends on standard units – most are *Système International* (SI) units. Every measurement must give the unit to have any meaning. You should know the correct unit for physical quantities.

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

Example:

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

If a car travels 2 metres in 2 seconds:

$$\text{speed} = \frac{2 \text{ metres}}{2 \text{ seconds}} = 1 \frac{\text{m}}{\text{s}} = 1 \text{ m/s}$$

This defines the SI unit of speed to be 1 metre per second (m/s), or 1 m s^{-1} ($\text{s}^{-1} = \frac{1}{\text{s}}$).

Practice questions

1 Complete this table by filling in the missing units and symbols.

Physical quantity	Equation used to derive unit	Unit	Symbol and name (if there is one)
frequency	period ⁻¹	s ⁻¹	Hz, hertz
volume	length ³		–
density	mass ÷ volume		–
acceleration	velocity ÷ time		–
force	mass × acceleration		
work and energy	force × distance		



North Halifax Grammar School – A Level Transition Work

1.2 Significant figures

When you use a calculator to work out a numerical answer, you know that this often results in a large number of decimal places and, in most cases, the final few digits are 'not significant'. It is important to record your data and your answers to calculations to a reasonable number of significant figures. Too many and your answer is claiming an accuracy that it does not have, too few and you are not showing the precision and care required in scientific analysis.

Numbers to 3 significant figures (3 s.f.):

3.62 25.4 271 0.0147 0.245 39 400

(notice that the zeros before the figures and after the figures are *not* significant – they just show you how large the number is by the position of the decimal point).

Numbers to 3 significant figures where the zeros *are* significant:

207 4050 1.01 (any zeros between the other significant figures *are* significant).

Standard form numbers with 3 significant figures:

9.42×10^{-5} 1.56×10^8

If the value you wanted to write to 3.s.f. was 590, then to show the zero was significant you would have to write:

590 (to 3.s.f.) or 5.90×10^2

Practice questions

2 Give these measurements to 2 significant figures:

a 19.47 m b 21.0 s c 1.673×10^{-27} kg d 5 s

3 Use the equation:

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$

to calculate the resistance of a circuit when the potential difference is 12 V and the current is 1.8 mA. Write your answer in k Ω to 3 s.f.

1.3 Uncertainties

When a physical quantity is measured there will always be a small difference between the measured value and the true value. How important the difference is depends on the size of the measurement and the size of the uncertainty, so it is important to know this information when using data.

There are several possible reasons for uncertainty in measurements, including the difficulty of taking the measurement and the resolution of the measuring instrument (i.e. the size of the scale divisions).

For example, a length of 6.5 m measured with great care using a 10 m tape measure marked in mm would have an uncertainty of 2 mm and would be recorded as 6.500 ± 0.002 m.



North Halifax Grammar School – A Level Transition Work

2.4 Powers of ten

When multiplying powers of ten, you must *add* the indices.

So $100 \times 1000 = 100\,000$ is the same as $10^2 \times 10^3 = 10^{2+3} = 10^5$

When dividing powers of ten, you must *subtract* the indices.

So $\frac{100}{1000} = \frac{1}{10} = 10^{-1}$ is the same as $\frac{10^2}{10^3} = 10^{2-3} = 10^{-1}$

But you can only do this when the numbers with the indices are the same.

So $10^2 \times 2^3 = 100 \times 8 = 800$

And you can't do this when adding or subtracting.

$10^2 + 10^3 = 100 + 1000 = 1100$

$10^2 - 10^3 = 100 - 1000 = -900$

Remember: You can only add and subtract the indices when you are multiplying or dividing the numbers, not adding or subtracting them.

Practice questions

6 Calculate the following values – read the questions very carefully!

a $20^6 + 10^{-3}$

b $10^2 - 10^{-2}$

c $2^3 \times 10^2$

d $10^5 \div 10^2$

7 The speed of light is $3.0 \times 10^8 \text{ m s}^{-1}$. Use the equation $v = f\lambda$ (where λ is wavelength) to calculate the frequency of:

a ultraviolet, wavelength $3.0 \times 10^{-7} \text{ m}$

b radio waves, wavelength 1000 m

c X-rays, wavelength $1.0 \times 10^{-10} \text{ m}$.

3 Resolving vectors

3.1 Vectors and scalars

Vectors have a magnitude (size) and a direction. Directions can be given as points of the compass, angles or words such as forwards, left or right. For example, 30 mph east and 50 km/h north-west are velocities.

Scalars have a magnitude, but no direction. For example, 10 m/s is a speed.

Practice questions

1 State whether each of these terms is a vector quantity or a scalar quantity: density, temperature, electrical resistance, energy, field strength, force, friction, frequency, mass, momentum, power, voltage, volume, weight, work done.

2 For the following data, state whether each is a vector or a scalar: 3 ms^{-1} , $+20 \text{ ms}^{-1}$, 100 m NE, 50 km, -5 cm , 10 km S 30° W, $3 \times 10^8 \text{ ms}^{-1}$ upwards, 273°C , 50 kg, 3 A.



North Halifax Grammar School – A Level Transition Work

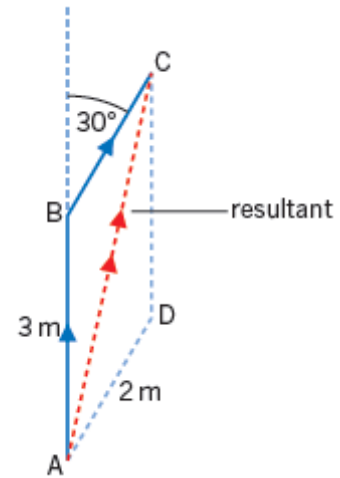
3.2 Drawing vectors

Vectors are shown on drawings by a straight arrow. The arrow starts from the point where the vector is acting and shows its direction. The length of the vector represents the magnitude.

When you add vectors, for example two velocities or three forces, you must take the direction into account.

The combined effect of the vectors is called the resultant.

This diagram shows that walking 3 m from A to B and then turning through 30° and walking 2 m to C has the same effect as walking directly from A to C. AC is the resultant vector, denoted by the double arrowhead.



A careful drawing of a scale diagram allows us to measure these. Notice that if the vectors are combined by drawing them in the opposite order, AD and DC, these are the other two sides of the parallelogram and give the same resultant.

Practice question

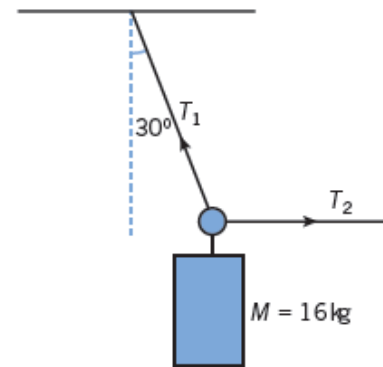
- 3 Two tractors are pulling a log across a field. Tractor 1 is pulling north with force 1 = 5 kN and tractor 2 is pulling east with force 2 = 12 kN. By scale drawing, determine the resultant force.

3.3 Free body force diagrams

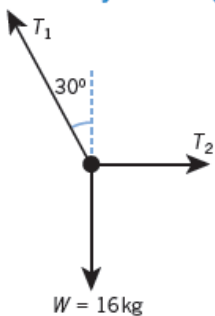
To combine forces, you can draw a similar diagram to the one above, where the lengths of the sides represent the magnitude of the force (e.g., 30 N and 20 N). The third side of the triangle shows us the magnitude and direction of the resultant force.

When solving problems, start by drawing a free body force diagram. The object is a small dot and the forces are shown as arrows that start on the dot and are drawn in the direction of the force. They don't have to be to scale, but it helps if the larger forces are shown to be larger. Look at this example.

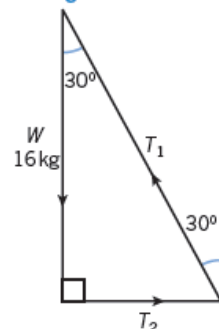
A 16 kg mass is suspended from a hook in the ceiling and pulled to one side with a rope, as shown on the right. Sketch a free body force diagram for the mass and draw a triangle of forces.



Free body force diagram



Triangle of forces



Notice that each force starts from where the previous one ended and they join up to form a triangle with no resultant because the mass is in equilibrium (balanced).



North Halifax Grammar School – A Level Transition Work

Practice questions

- 4 Sketch a free body force diagram for the lamp (**Figure 1**, below) and draw a triangle of forces.
- 5 There are three forces on the jib of a tower crane (**Figure 2**, below). The tension in the cable T , the weight W , and a third force P acting at X . The crane is in equilibrium. Sketch the triangle of forces.

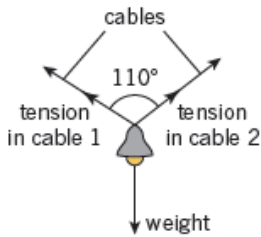


Figure 1

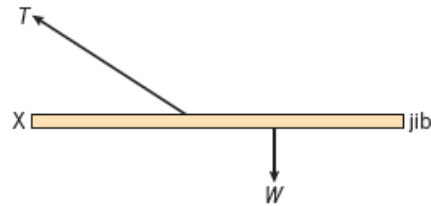


Figure 2

3.4 Calculating resultants

When two forces are acting at right angles, the resultant can be calculated using Pythagoras's theorem and the trig functions: sine, cosine, and tangent.

For a right-angled triangle as shown:

$$h^2 = o^2 + a^2$$

$$\sin \theta = \frac{o}{h}$$

$$\cos \theta = \frac{a}{h}$$

$$\tan \theta = \frac{o}{a}$$

(soh-cah-toa).

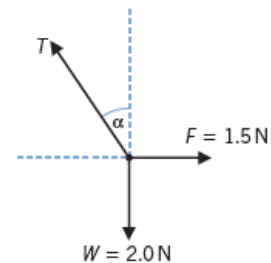
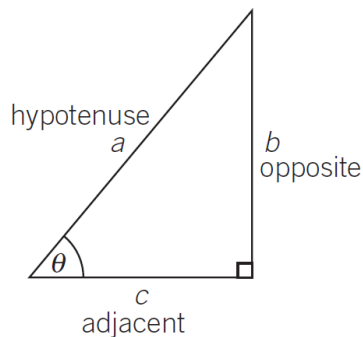


Figure 3

Practice questions

- 6 **Figure 3** shows three forces in equilibrium. Draw a triangle of forces to find T and α .
- 7 Find the resultant force for the following pairs of forces at right angles to each other:
a 3.0 N and 4.0 N **b** 5.0 N and 12.0 N



North Halifax Grammar School – A Level Transition Work

4 Rearranging equations

Sometimes you will need to rearrange an equation to calculate the answer to a question. For example, if you want to calculate the resistance R , the equation:

potential difference (V) = current (A) \times resistance (Ω) or $V = IR$

must be rearranged to make R the subject of the equation:

$$R = \frac{V}{I}$$

When you are solving a problem:

- Write down the values you know and the ones you want to calculate.
- you can rearrange the equation first, and then substitute the values
or
- substitute the values and then rearrange the equation

4.1 Substitute and rearrange

A student throws a ball vertically upwards at 5 m s^{-1} . When it comes down, she catches it at the same point. Calculate how high it goes.

step 1: Known values are:

- initial velocity $u = 5.0 \text{ m s}^{-1}$
- final velocity $v = 0$ (you know this because as it rises it will slow down, until it comes to a stop, and then it will start falling downwards)
- acceleration $a = g = -9.81 \text{ m s}^{-2}$
- distance $s = ?$

Step 2: Equation:

(final velocity)² – (initial velocity)² = 2 \times acceleration \times distance

or $v^2 - u^2 = 2 \times g \times s$

Substituting: $(0)^2 - (5.0 \text{ m s}^{-1})^2 = 2 \times -9.81 \text{ m s}^{-2} \times s$

$0 - 25 = 2 \times -9.81 \times s$

Step 3: Rearranging:

$-19.62 s = -25$

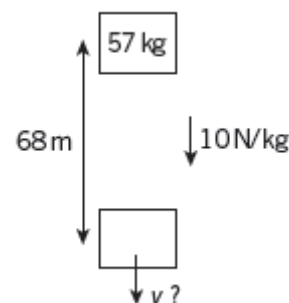
$s = \frac{-25}{-19.62} = 1.27 \text{ m} = 1.3 \text{ m (2 s.f.)}$

Practice questions

- 1 The potential difference across a resistor is 12 V and the current through it is 0.25 A . Calculate its resistance.
- 2 Red light has a wavelength of 650 nm . Calculate its frequency. Write your answer in standard form.
(Speed of light = $3.0 \times 10^8 \text{ m s}^{-1}$)

4.2 Rearrange and substitute

A 57 kg block falls from a height of 68 m . By considering the energy transferred, calculate its speed when it reaches the ground.





North Halifax Grammar School – A Level Transition Work

(Gravitational field strength = 10 N kg^{-1})

Step 1: $m = 57 \text{ kg}$ $h = 68 \text{ m}$ $g = 10 \text{ N kg}^{-1}$ $v = ?$

Step 2: There are three equations:

$$PE = m g h \quad KE \text{ gained} = PE \text{ lost} \quad KE = 0.5 m v^2$$

Step 3: Rearrange the equations before substituting into it.

$$\text{As } KE \text{ gained} = PE \text{ lost, } m g h = 0.5 m v^2$$

You want to find v . Divide both sides of the equation by $0.5 m$:

$$\frac{mgh}{0.5m} = \frac{0.5mv^2}{0.5m}$$

$$2 g h = v^2$$

To get v , take the square root of both sides: $v = \sqrt{2gh}$

Step 4: Substitute into the equation:

$$v = \sqrt{2 \times 10 \times 68}$$

$$v = \sqrt{1360} = 37 \text{ m s}^{-1}$$

Practice question

3 Calculate the specific latent heat of fusion for water from this data:

$4.03 \times 10^4 \text{ J}$ of energy melted 120 g of ice.

Use the equation:

$$\text{thermal energy for a change in state (J)} = \text{mass (kg)} \times \text{specific latent heat (J kg}^{-1}\text{)}$$

Give your answer in J kg^{-1} in standard form.

5 Work done, power, and efficiency

5.1 Work done

Work is done when energy is transferred. Work is done when a force makes something move. If work is done *by* an object its energy decreases and if work is done *on* an object its energy increases.

$$\text{work done} = \text{energy transferred} = \text{force} \times \text{distance}$$

Work and energy are measured in joules (J) and are scalar quantities (see Topic 3.1).

Practice question

1 Calculate the work done when the resultant force on a car is 22 kN and it travels 2.0 km .

2 Calculate the distance travelled when 62.5 kJ of work is done applying a force of 500 N to an object.

5.2 Power

Power is the rate of work done.

It is measured in watts (W) where $1 \text{ watt} = 1 \text{ joule per second}$.

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}} \quad \text{or} \quad \text{power} = \frac{\text{work done}}{\text{time taken}}$$



North Halifax Grammar School – A Level Transition Work

$$P = \Delta W / \Delta t \quad \Delta \text{ is the symbol 'delta' and is used to mean a 'change in'}$$

Look at this worked example, which uses the equation for potential energy gained.

A motor lifts a mass m of 12 kg through a height Δh of 25 m in 6.0 s.

Gravitational potential energy gained:

$$\Delta PE = mg\Delta h = (12 \text{ kg}) \times (9.81 \text{ m s}^{-2}) \times (25 \text{ m}) = 2943 \text{ J}$$

$$\text{Power} = \frac{2943 \text{ J}}{6.0 \text{ s}} = 490 \text{ W (2 s.f.)}$$

Practice questions

- 3 Calculate the power of a crane motor that lifts a weight of 260 000 N through 25 m in 48 s.
- 4 A motor rated at 8.0 kW lifts a 2500 N load 15 m in 5.0 s. Calculate the output power.

5.3 Efficiency

Whenever work is done, energy is transferred and some energy is transferred to other forms, for example, heat or sound. The efficiency is a measure of how much of the energy is transferred usefully.

Efficiency is a ratio and is given as a decimal fraction between 0 (all the energy is wasted) and 1 (all the energy is usefully transferred) or as a percentage between 0 and 100%. It is not possible for anything to be 100% efficient: some energy is always lost to the surroundings.

$$\text{Efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \quad \text{or} \quad \text{Efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

(multiply by 100% for a percentage)

Look at this worked example.

A thermal power station uses 11 600 kWh of energy from fuel to generate electricity. A total of 4500 kWh of energy is output as electricity. Calculate the percentage of energy 'wasted' (dissipated in heating the surroundings).

You must calculate the energy wasted using the value for useful energy output:

$$\text{percentage energy wasted} = \frac{(\text{total energy input} - \text{energy output as electricity})}{\text{total energy input}} \times 100$$

$$\text{percentage energy wasted} = \frac{(11600 - 4500)}{11600} \times 100 = 61.2\% = 61\% \text{ (2 s.f.)}$$



North Halifax Grammar School – A Level Transition Work

Practice questions

- 5 Calculate the percentage efficiency of a motor that does 8400 J of work to lift a load.
The electrical energy supplied is 11 200 J.
- 6 An 850 W microwave oven has a power consumption of 1.2 kW.
Calculate the efficiency, as a percentage.
- 7 Use your answer to question 4 above to calculate the percentage efficiency of the motor. (The motor, rated at 8.0 kW, lifts a 2500 N load 15 m in 5.0 s.)
- 8 Determine the time it takes for a 92% efficient 55 W electric motor take to lift a 15 N weight 2.5 m.