NHGS SIXTH FORM

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
Module 1: Development of practical skills in physics **Module 2: Foundations Physics** The study of physical quantities and units. **Module 3: Forces and Motion** The study of Motion; Forces in action; Work, energy and power; Materials; Newton's laws of motion and Momentum. **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.	**Module 5: Newtonian World and Astrophysics** This unit involves the study of Thermal physics; Circular motion; Oscillations; Gravitational fields and Astrophysics. **Module 6: Particles and Medical Physics** This unit involves the study of Capacitors; Electric fields; Electromagnetism; Nuclear and particle physics and Medical imaging.

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.

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/

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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 *same* person, using the *same* equipment, under the *same* conditions
What is reproducibility?	how precise repeated measurements are when they are taken by *different* people, using *different* 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

Foundations of 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.

What is a physical quantity?	a property of an object or of a phenomenon that can be measured
What are the S.I. units of mass, length, and time?	kilogram (kg), metre (m), second (s)
What base quantities do the S.I. units A, K, and mol represent?	current, temperature, amount of substance
List the prefixes, their symbols and their multiplication factors from pico to tera (in order of increasing magnitude)	pico (p) 10^{-12}, nano (n) 10^{-9}, micro (μ) 10^{-6}, milli (m) 10^{-3}, centi (c) 10^{-2}, deci (d) 10^{-1}, kilo (k) 10^{3}, mega (M) 10^{6}, giga (G) 10^{9}, tera (T) 10^{12}
What is a scalar quantity?	a quantity that has magnitude (size) but *no* direction
What is a vector quantity?	a quantity that has magnitude (size) *and* direction
What are the equations to resolve a force, *F*, into two perpendicular components, F_x and F_y?	$F_x = F\cos\theta$ $F_y = F\sin\theta$
What is the difference between distance and displacement?	distance is a scalar quantity displacement is a vector quantity
What does the Greek capital letter Δ (delta) mean?	'change in'
What is instantaneous speed?	the speed of an object over a very short period of time
What does the gradient of a displacement–time graph tell you?	velocity
How can you calculate acceleration and displacement from a velocity–time graph?	acceleration is the gradient displacement is the area under the graph
What do the letters *suvat* stand for in the equations of motion?	*s* = displacement, *u* = initial velocity, *v* = final velocity, *a* = acceleration, *t* = time taken
Define *stopping distance*	the total distance travelled from when the driver first sees a reason to stop, to when the vehicle stops
Define *thinking distance*	the distance travelled between the moment when you first see a reason to stop to the moment when you use the brake
Define *braking distance*	the distance travelled from the time the brake is applied until the vehicle stops
What does *free fall* mean?	when an object is accelerating under gravity with no other force acting on it

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} ($s^{-1} = \frac{1}{s}$).

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		

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 kΩ 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.

It is useful to quote these uncertainties as percentages.

For the above length, for example,

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{measurement}} \times 100$$

$$\text{percentage uncertainty} = \frac{0.002}{6.500}$$ × 100% = 0.03%. The measurement is 6.500 m ± 0.03%.

Values may also be quoted with absolute error rather than percentage uncertainty, for example, if the 6.5 m length is measured with a 5% error,

the absolute error = 5/100 × 6.5 m = ±0.325 m.

Practice questions

4 Give these measurements with the uncertainty shown as a percentage (to 1 significant figure):

a 5.7 ± 0.1 cm **b** 450 ± 2 kg **c** 10.60 ± 0.05 s **d** 366 000 ± 1000 J

5 Give these measurements with the error shown as an absolute value:

a 1200 W ± 10% **b** 330 000 Ω ± 0.5%

6 Identify the measurement with the smallest percentage error. Show your working.

A 9 ± 5 mm **B** 26 ± 5 mm **C** 516 ± 5 mm **D** 1400 ± 5 mm

2 Standard form and prefixes

When describing the structure of the Universe you have to use very large numbers. There are billions of galaxies and their average separation is about a million light years (ly). The Big Bang theory says that the Universe began expanding about 14 billion years ago. The Sun formed about 5 billion years ago. These numbers and larger numbers can be expressed in standard form and by using prefixes.

2.1 Standard form for large numbers

In standard form, the number is written with one digit in front of the decimal point and multiplied by the appropriate power of 10. For example:

- The diameter of the Earth, for example, is 13 000 km.

13 000 km = 1.3 × 10 000 km = 1.3×10^4 km.

- The distance to the Andromeda galaxy is 2 200 000 light years = 2.2 × 1 000 000 ly = 2.2×10^6 ly.

2.2 Prefixes for large numbers

Prefixes are used with SI units (see Topic 1.1) when the value is very large or very small. They can be used instead of writing the number in standard form. For example:

- A kilowatt (1 kW) is a thousand watts, that is 1000 W or 10^3 W.
- A megawatt (1 MW) is a million watts, that is 1 000 000 W or 10^6 W.
- A gigawatt (1 GW) is a billion watts, that is 1 000 000 000 W or 10^9 W.

Prefix	Symbol	Value
kilo	k	10^3
mega	M	10^6

Prefix	Symbol	Value
giga	G	10^9
tera	T	10^{12}

For example, Gansu Wind Farm in China has an output of 6.8×10^9 W. This can be written as 6800 MW or 6.8 GW.

Practice questions

1 Give these measurements in standard form:

a 1350 W **b** 130 000 Pa **c** 696×10^6 s **d** 0.176×10^{12} C kg^{-1}

2 The latent heat of vaporisation of water is 2 260 000 J/kg. Write this in:

a J/g **b** kJ/kg **c** MJ/kg

2.3 Standard form and prefixes for small numbers

At the other end of the scale, the diameter of an atom is about a tenth of a billionth of a metre. The particles that make up an atomic nucleus are much smaller. These measurements are represented using negative powers of ten and more prefixes. For example:

- The charge on an electron = 1.6×10^{-19} C.
- The mass of a neutron = $0.016\,75 \times 10^{-25}$ kg = 1.675×10^{-27} kg (the decimal point has moved 2 places to the right).
- There are a billion nanometres in a metre, that is 1 000 000 000 nm = 1 m.
- There are a million micrometres in a metre, that is 1 000 000 μm = 1 m.

Prefix	Symbol	Value
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}

Prefix	Symbol	Value
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

Practice questions

3 Give these measurements in standard form:

a 0.0025 m **b** 160×10^{-17} m **c** 0.01×10^{-6} J **d** 0.005×10^6 m **e** 0.00062×10^3 N

4 Write the measurements for question 3a, c, and d above using suitable prefixes.

5 Write the following measurements using suitable prefixes.

a a microwave wavelength = 0.009 m

b a wavelength of infrared = 1×10^{-5} m

c a wavelength of blue light = 4.7×10^{-7} m

2.4 Powers of ten

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

So 100 × 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 3.0×10^8 m s^{-1}. Use the equation $v = f\lambda$ (where λ is wavelength) to calculate the frequency of:

a ultraviolet, wavelength 3.0×10^{-7} m

b radio waves, wavelength 1000 m

c X-rays, wavelength 1.0×10^{-10} m.

3 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*) × resistance (Ω) or $V = I\,R$

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

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

Many physics equations involve more than two terms. When you need to solve for a specific variable, you'll often need to rearrange the equation. The key is to isolate the variable you're looking for on one side of the equation.

Core Principles:

1. **Do the same thing to both sides:** Whatever operation you perform on one side of the equation, you *must* perform the exact same operation on the other side. This ensures the equation remains balanced and true.
2. **Inverse Operations:** To "undo" an operation and move a term, use its inverse:
   - Addition (+) is undone by Subtraction (-)
   - Subtraction (-) is undone by Addition (+)
   - Multiplication (x or implied) is undone by Division (/)
   - Division (/) is undone by Multiplication (x)
3. **Order of Operations (BEDMAS/BODMAS in reverse):** When moving terms, it's often easiest to deal with addition/subtraction terms first, then multiplication/division terms. Think of it as "unwrapping" the variable you want to isolate.
4. **Isolate the term containing the variable first:** Before you can isolate the variable itself, you might need to get the *entire term* that contains it by itself.
5. **Simplify:** After each step, simplify both sides of the equation if possible.

Step-by-Step Strategy:

Let's assume your equation looks something like:

$A=B+C\times D$

And you want to rearrange to find D.

1. **Identify the variable you want to isolate.** (In our example, D)
2. **Identify the terms directly added or subtracted to the term containing your variable.**
   - In $A=B+C\times D$, the term "B" is added to "C×D".
3. **Move any added/subtracted terms to the other side** using the inverse operation.
   - To move "B" (which is positive) to the left side, subtract "B" from both sides: $A-B=B+C\times D-B$
     $A-B=C\times D$
4. **Identify the terms directly multiplied or divided by your variable.**
   - In $A-B=C\times D$, the term "C" is multiplied by "D".
5. **Move any multiplied/divided terms to the other side** using the inverse operation.
   - To move "C" (which is multiplied by D) to the left side, divide both sides by "C": CA−B=CC×D
     CA−B=D
6. **Rewrite if necessary:** It's good practice to write the isolated variable on the left side: D=CA−B

Practice questions:

1) Rearrange $V = IR$ to make R the subject.
2) Rearrange $p = mv$ to make v the subject.
3) Rearrange $p = m/v$ to make m the subject.
4) Rearrange $pV = nRT$ to make V the subject.
5) Rearrange $pV = nRT$ to make n the subject.
6) Rearrange $pV = nRT$ to make T the subject.
7) Rearrange $V = -Gm/r$ to make G the subject.
8) Rearrange $\lambda = ws/D$ to make D the subject.

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

3.1 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 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 $a = g = -9.81$ m s^{-2}
- distance s = ?

Step 2: Equation:

(final velocity)^2 − (initial velocity)^2 = 2 × acceleration × 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 m = 1.3 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 = 3.0×10^8 m s^{-1})

3.2 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.

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

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

Step 2: There are three equations:

PE = $m\,g\,h$ KE gained = PE lost KE = 0.5 $m\,v^2$

Step 3: Rearrange the equations before substituting into it.

As KE gained = PE 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 m s^{-1}

Practice question

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

4.03×10^4 J of energy melted 120 g of ice.

Use the equation:

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

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