A LEVEL PHYSICS

INTRODUCTION TO A LEVEL PHYSICS

The College offers AQA Physics. This contains a broad-based Physics content covering all the major topic areas, and as such is well suited to a wide range of career paths. Assessment is through two written AS Physics papers at the end of the first year (assessing subject theory and analysis of sample practical data) and three written A level Physics papers at the end of the second year (again assessing the subject theory and analysis of sample experimental data, with a Practical Endorsement which assesses practical skills on an ongoing basis throughout the two years of the course). Note that in common with all A levels, the AS grades do not contribute to the final A level grade; this is entirely from the results of the second year exams.

Each week classes will consist of the study of the theory related to a topic area supported by handouts, demonstrations, practical work and IT resources. In addition to this, all students are expected to spend time each week on independent study for this subject for:

- Completion of homeworks consisting application/analysis questions (typically taken from past A level papers), either on paper or using online quizzes
- Completion of a practical write-up; these will contribute to the Practical Endorsement
- Set reading of textbook and handouts
- Time to review/revise the work completed to date and complete revision notes based around the topic checklists in your preferred format (flash cards, posters, etc) and prepare

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FOR TOPIC TESTS/MOCK EXAMS

Revision sessions and mocks will be held prior to examinations, plus topic tests will be set throughout the year to give practice at examination technique and answering questions within set time limits.

First year	*Measurements and their errors*	*Waves*	*Mechanics and materials*
	Use of SI units Limitation of physical measurements Estimation of physical quantities	Progressive and stationary waves Refraction, diffraction and interference	Force, energy and momentum
	Electricity	*Particles and radiation*	*Required practicals*
	Current electricity	Particles Electromagnetic radiation and quantum phenomena	Completion of required practicals as set by exam board. Gaining of competencies for Practical Endorsement.
Second year	*Fields and their consequences*	*Further mechanics and thermal physics*	*Nuclear physics*
	Fields Gravitational fields Electric fields Capacitance Magnetic fields	Periodic motion Thermal physics	Radioactivity Radioactive decay
		Astrophysics	*Required practicals*
		Telescopes Classification of stars Cosmology	Completion of required practicals as set by exam board. Gaining of competencies for Practical Endorsement.

For a full copy of the specification please see ***www.AQA.org.uk***, following the links to GCSE Physics.

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PREPARATION FOR SEPTEMBER

BUILDING ON YOUR CURRENT KNOWLEDGE

In any A level course is little or no 'spare' time and it is important to get off to the best start possible. As such, it will be assumed you will be fully familiar with the scientific and mathematical work you have completed to date. In particular, you should review the following topics over the summer vacation in preparation for your Physics course.

PHYSICS/SCIENCE	MATHEMATICS
Motion and forces Energy Heat and temperature Properties of matter Electricity and circuits Waves, light and the EM spectrum The structure of the atom Nuclear power Practical techniques, practical write-up	Calculator working (including large & small numbers, powers and roots, trigonometric functions, etc.) BODMAS Standard form Decimal places and significant figures Graph plotting & analysis Re-arranging equations Use of brackets (factorisation, expansion) Trigonometry & Pythagoras

SKILLS DEVELOPMENT

Complete the following activities from the Physics skills pack in the Appendix:

1. Read through Appendix A (Rounding numbers) and complete the practice questions in it; bring your work to the the first Physics class in September. This is to develop your mathematical skills

2. Produce a poster on an aspect of Physics which particularly interests you - see Appendix B. This is to develop your research, communication and presentation skills

3. Correct use of units is vital in Physics; a practical result without its unit is useless, and in calculations if the quantities used are not in the correct units the answer will be incorrect. Read through Appendix C (Units and the S.I. system) so that you are familiar with the use of units in A level Physics. In particular, note the section on how units are made bigger and smaller (multiples and sub-multiples). This is to develop your skills for tackling Physics questions and practicals. There will be short test on units in the first week of the course

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APPENDIX A - ROUNDING NUMBERS

The sequence of operations you would go through to round a number is as follows:

1. Count to the right from the first significant figure the number of digits we are going to keep, this is equal to the number of significant figures we are rounding the number to.
   Note: For numbers less than 1, any Os on the left-hand side of the number (including the O) are not significant, they are just giving the number the correct size. E.g. in the number 0.02468, the leftmost significant figure is the 2.

2. Look at the first digit you would be throwing away. If this digit is 4 or less, we ignore it. If it is 5 or more, we must round-up the results - i.e. add 1 to the last digit we are keeping.

3. Write down the digits we are going to keep, putting in as many O's as necessary to keep the number the correct size, e.g. if we were rounding the number 2468 to two significant figures, it would be 2500.
   Note: If the number is in standard form, you won't have to worry about stage (3) above, as the exponent part of the number will not have been altered.

Example: Round the number 45622389.235 to 3 s.f.

Answer: If we are rounding to 3 s.f., the digits we will be keeping are (in bold) 45622389.235

The first digit we will throw away is (in bold) 45622389.235

This digit is less than 4, so we ignore it.

Hence number = 45600000 (to 3 s.f.)

Note: Five O's have been added to keep the number the correct size.

Example: Round the number 0.000457896 to 2 s.f.

Answer: If we are rounding to 2 s.f., the digits we will be keeping are (in bold) 0.000457896

Note: The first 4 O's are not significant, they are there to give the number its correct size; this can clearly be seen if it is written in standard form: 4.57698 x 10-4.

The first digit we will throw away is (in bold) 0.000457896

This digit is more than 5, so we must round up.

Hence number = 0.00046 (to 3 s.f.)

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In calculation questions, which require the correct number of significant figures to be given in the answer, the rule is that the answer is given to the same number of significant figures as the least precise value in the calculation, i.e. the one with the least number of significant figures.

Example: Find the wave velocity v in the following calculation:

$v = f.\lambda$

where wavelength $\lambda = 5{\cdot}00$ mm (to 3 s.f.)

and frequency $f = 6{\cdot}0 \times 10^{10}$ Hz (to 2 s.f.)

Answer: The final answer must be given to 2 s.f., and $5{\cdot}00$ mm $\equiv 5{\cdot}00 \times 10^{-3}$ m

$v = f.\lambda = 6{\cdot}0 \times 10^{10} \times 5{\cdot}00 \times 10^{-3} = 3{\cdot}0 \times 10^{8}$ ms^{-1} (to 2 s.f.)

EXERCISE

Complete the following claculations, rounding off to the correct number of significant figures.

(1) Find the electrical power P in the following equation:

$P = V.I$

where voltage $V = 2{\cdot}577$ V (to 4 s.f.)

and current $I = 0{\cdot}0845$ A (to 3 s.f.)

(2) Find the weight W in the following equation:

$W = m.g$

where mass $m = 0{\cdot}028$ kg

and acceleration $g = 9{\cdot}81$ ms^{-2}

(3) Find the denisty ρ in the following equation:

$$\rho = \frac{m}{V}$$

where mass $m = 0{\cdot}6$ kg

and volume $V = 9{\cdot}444 \times 10^{-5}$ m^3

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(1) 0·218 V (to 3 s.f.) (2 0·27 ms^{-2} (to 2 s.f.) (3) 7100 (to 2 s.f.)

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APPENDIX B - POSTER

Produce a poster on an aspect of Physics which particularly interests you. It should:

- Be A3 size (or two A4 sheets joined together)
- Briefly outline the Physics of the situation
- Contain at least one appropriate scientific image and one appropriate graph
- Have a section listing the sources you used (if this is a textbook give the title, author and date of publication, if a journal or magazine article give the article name, journal/magazine title, issue number and date, and if a website the full web address and the date you accessed it)

Bring the poster into the first Physics session in September; in small groups you will have the opportunity to explain your poster to other students and then it will be displayed within the lab. This is to develop your research, communication and presentation skills.

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APPENDIX C - UNITS AND THE SI SYSTEM.

INTRODUCTION

In all the physical sciences (Physics, Chemistry, Biology and Applied Mathematics), we are concerned with measuring the amounts of various quantities such as mass, velocity, electrical current, etc. and then using these quantities in calculations to find other results. Any measured (or calculated) quantity is made up of two parts: its magnitude, which is simply how big that quantity is, and its unit, which tells you how the quantity was measured.

For example, consider a measurement of the speed of a car. You might find that the car was travelling at 30 miles per hour. So to split this quantity up into its two parts, its magnitude is 30, and its units are miles per hour (implying that the way in which the speed was measured was by finding how many miles the car travelled in one hour). However, you could have measured the car's speed in a different way - one possibility is to measure the number of metres the car travelled in one second. In doing this, you would have found that the magnitude of the car's speed would be different to that measured in miles per hour, because one metre is shorter than one mile and one second is shorter than one hour.

It is vitally important that for all measurements and calculated results you give both the magnitude and the units of the quantity. Again using the car example, if you gave its speed just as 30, with no units, this would be meaningless, as nobody else would know whether you meant 30 miles per hour, 30 metres per second, 30 kilometres per hour, etc. So it is necessary for you to have a knowledge of the standard scientific units, and be able to use them.

THE SI SYSTEM

A standard international system of units has been agreed - the SI system (Systeme International d'Unites), which is built upon the metric system. In this system, there are seven **FUNDAMENTAL QUANTITIES** (which are length, mass, time, electrical current, temperature, amount of a substance and luminous intensity), and the units of any other quantity can be made up by combining the units of these seven fundamental quantities. Each quantity has a name, a symbol (which is simply a 'short-hand' way of writing the name of the quantity), and a unit, with the unit having an abbreviation (which is again just a short-hand way of writing the unit's name.)

THE FUNDAMENTAL QUANTITIES

The seven fundamental quantities and their units are:

Quantity	Symbol	Unit	Unit abbreviation
Length	l or L	metre	m
Mass	M or m	kilogramme	kg
Time	t	second	s
Electrical current	I	ampere	A
Temperature	T	kelvin	K
Amount of a substance	n	mole	mol
Luminous intensity	L	candela	cd

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DERIVED QUANTITIES

These are quantities whose units may be made up from the seven fundamental units, although to simplify their use, many are given their own individual units. The thing to remember is that the units of these quantities are in no way basic or fundamental, but are simply made up from combinations of the true seven fundamental units given above; a selection of these is given below.

Quantity	Symbol	Unit	Unit abbreviation
Area	A	square metre	m^2
Volume	V	cubic metre	m^3
Density	ρ	kilogramme per cubic metre	$kg\ m^{-3}$
Velocity	v	metre per second	$m\ s^{-1}$
Acceleration	a	metre per second per second	$m\ s^{-2}$
Angle	θ	radian	rad
Frequency	f	hertz	Hz
Period	T	second	s
Refractive index	n	No unit	No unit
Charge	Q or q	coulomb	C
Potential difference	PD	volt	V
Resistance	R	ohm	Ω
Resistivity	ρ	ohm metre	Ω m
Force	F	newton	N
Weight	W	newton	N
Moment of a force	M	newton metre	N m
Moment of a couple	T	newton metre	N m
Youngs modulus	E	newton per metre per metre	$N\ m^{-2}$
Work done	W or W.D.	joule	J
Energy	E	joule	J
Potential energy	E_P	joule	J
Kinetic energy	E_K	joule	J
Power	P	watt	W
Atomic number	Z	No unit	No unit
Mass number	A	No unit	No unit
Heat	Q	joule	J
Specific heat capacity	c	joule per kilogramme per kelvin	$J\ kg^{-1}\ K^{-1}$
Latent heat	L	joule	J
Specific latent heat	l	joule per kilogramme	$J\ kg^{-1}$
Pressure	p or P	newton per metre^2 or pascal	$N\ m^{-2}$ or Pa
Momentum	p	kilogramme metre per second	$kg\ m\ s^{-1}$
Electric field strength	E	newton per coulomb or volt per metre	$N\ C^{-1}$ or $V\ m^{-1}$
Capacitance	C	farad	F
Magnetic flux density	B	tesla	T
Magnetic flux	Φ	weber	Wb
Angular velocity	ω	radian per second	$rad\ s^{-1}$
Gravitational constant	G	newton metre^2 per kilogramme^2	$N\ m^2\ kg^{-2}$
Molar gas constant	R	joule per mole per kelvin	$J\ mol^{-1}\ K^{-1}$
Boltzmann constant	k	joule per kelvin	$J\ K^{-1}$

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PREFIXES TO UNITS

Prefixes may be added to units to change their size. There are two types: multiple, which increase the size of the unit, and sub-multiple, which decrease the size of the unit. In the SI system, all prefixes have a name, a symbol, and a value, which must be multiplied with the unit to give the new (prefixed) unit's size.

Table of SI sub-multiples of units.

Prefix	Symbol	Value (to multiply unit by)	
deci	d	10^{-1}	(0·1)
centi	c	10^{-2}	(0·01)
milli	m	10^{-3}	(0·001)
micro	μ	10^{-6}	(0·000001)
nano	n	10^{-9}	(0·000000001)
pico	p	10^{-12}	(0·000000000001)
femto	f	10^{-15}	(0·000000000000001)
atto	a	10^{-18}	(0·000000000000000001)

Table of SI multiples of units.

Prefix	Symbol	Value (to multiply unit by)	
deka	da	10^{1}	(10)
hecto	h	10^{2}	(100)
kilo	k	10^{3}	(1000)
mega	M	10^{6}	(1000000)
giga	G	10^{9}	(1000000000)
tera	T	10^{12}	(1000000000000)

An example of using a sub-multiple is the conversion of metres (m for short) to millimetres (mm for short). The table above shows that the multiplying value for this is 10-3 (0.001), i.e. 1 mm is one thousandth of a metre, and, alternately, there are 1000 mm in a metre. To convert a length given in mm to m, you must divide that length by 1000; to convert a length given in m to mm, you must multiply that length by 1000.

Example: What is the length 2.8 m in mm?

Answer: Length given in mm = length given in m x 1000

length in mm = 2.8 x 1000 = 2800 mm

An example of using a multiple is the conversion of metres to kilometres (km for short). The table above shows that the multiplying value for this is 103(1000), i.e. 1 m is one thousandth of a kilometre, and, alternately, there are 1000 m in a kilometre. To convert a length given in m to km, you must divide that length by 1000; to convert a length given in km to m, you must multiply that length by 1000.

Example: What is the length 2.8 m in km?

Answer: Length given in km = length given in m ÷ 1000

length in km = 2.8 ÷ 1000 = 0.0028 km

One 'rule of thumb' to remember - when converting a quantity's units, the actual size of the quantity is not changing; hence if the unit is getting smaller the magnitude must get bigger (as in the first example above), and if the unit is getting bigger the magnitude must get smaller (as in the second example above).