Physics @ gc

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The Physics Handbook

Contents

The Physics Staff

Introduction

Welcome to Physics at Greenhead College!

This handbook contains a great deal of useful and some very important information on the A-level Physics course so write your name on it and keep it safe. You will need it throughout the course.

The teaching members of the Physics department are Marcus Fascione, Phil Bartlett, Anne Saunders and Ian Yems. The Physics technician is Malcolm Calvert.

We are here to help and support you throughout your course.

Marcus Fascione

Phil Bartlett

Malcolm Calvert

Ian Yems

Anne Saunders

All four Physics teachers have a desk in the Science Resource Centre, this is an open access room which you can use at any time. If we are not in there then try the Physics Prep Room (next to S4) where Malcolm Calvert, the technician is based.

We work as a team, if you need help with any aspect of your Physics please come and ask any one of us. You do not only have to ask your own teacher. In fact many students like to ask somebody different to get a 'different angle' on a problem.

We wish to treat you as **young adults**, on your part you must be prepared to make the effort to come and ask for help in plenty of time for you to hand your work in <u>fully completed</u> by the deadlines.

The Physics Course

The Physics course you will study at Greenhead College is the AQA modular course, syllabus number 6451 (Advanced) or 5451 (Advanced Subsidiary). You will study the following modules:

AS Module 1	*Particles, Radiation and Quantum Phenomena*
AS Module 2	*Mechanics and Molecular Theory*
AS Module 3	*Current Electricity and Elastic Properties of Solids*
A2 Module 4	*Waves, Fields and Nuclear Energy*
A2 Module 5	*Nuclear Instability*
A2 Module 7	*Applied Physics*

There is also a trip to Manchester University on Monday 21st March. The coach and program together costs about £10 and all AS students are expected to attend. (The department will support any student with financial difficulties, please have a chat with your teacher or tutor). Other opportunities are also available during the course, these include the 'Physics School' at Leeds University, The Manchester Physics Experience and a visit to the Engineering Department at Huddersfield University.

There are six units of assessment. Units 1, 2 and 3 comprise the AS assessment and all students will sit these examinations in the summer of the AS year. A-level students will sit the examinations for units 4, 5 and 6 in the summer of the A2 year.

Unit 1	1 hour written paper on module 1
Unit 2	1 hour written paper on module 2
Unit 3	1 hour written paper on module 3 plus internally assessed coursework

(As with most AS subjects, these are usually sat as a one 3 hour session in June of the AS Year)

Unit 4	$1^1/_2$ hour written paper on module 4 (Sat in January of the A2 year)
Unit 7	$1^1/_4$ hour written paper on modules 5 and 7 plus internally assessed coursework (June A2 year)
Unit 10	2 hour written paper (synoptic) on modules 1 – 5 (June A2 year)

See page 14 onwards of this booklet for the course outline, a detailed coursework guide and the full course specification.

In order to help you achieve success the Physics department provides a wide range of resources (see page 6 for details). However it is what **you** actually do in and out of lessons that will ultimately decide whether or not you achieve your full potential. **It is therefore absolutely essential that you take heed of page 4 of this booklet**. We will do our best for you so make sure you do the same for yourself.

We wish you a hard working, interesting and above all enjoyable two years of studying Physics.

What you can expect from us	What we expect from you
We will .... **Provide a friendly and supportive atmosphere for study.** **Set regular assignments which will be marked and returned promptly.** **Give you ample time to complete set work so that you can discuss any difficulties with staff and your peers before the deadline.** **Give you feedback on your progress via written comments, conversation, regular tests and monitoring interviews.** **Ensure members of the Physics staff are available to help you as well as providing help and revision sessions at specific times.** **Provide a wide range of up to date resources to aid your learning and advise you on the best ways to use them.** **Prepare you for the coursework element of the course so that you can approach the practical work with confidence.**	**You should...............** **Display a positive attitude and participate fully in lessons.** **Arrive promptly to lessons.** **Demonstrate a real effort to maintain good standards of work and meet course requirements. Which includes completion of all homework, projects and assignments to set deadlines.** **Give advanced notice of any unavoidable planned absence.** **Write well presented notes in exercise books provided by the department (you must provide file paper and graph paper for homeworks and practical write ups)** **Copy up missing work *immediately* if you are absent, find out what assignments have been set, and hand them in by the due date.** **Seek assistance from Physics staff when you have problems with set work or any other aspect of the course.** **Make sure you are aware of all the resources available in college to help you succeed in the course.** **Regularly read through and supplement your notes.** **Spend 5 hours Physics study time per week additional to lessons.**

Health & Safety

We have a moral obligation to encourage you to develop your own awareness of ensuring that you are working in a safe environment, both for yourselves and for other students & staff. This does not just mean 'not running in a laboratory'! You must 'assess the risk' before commencing any activity, this may be simply, where is your bag? Are there any items blocking a fire escape route? Is an item too heavy to lift? Or *should* you be standing on a stool?
The following is a safety notice will be given to you to stick in your exercise books:

Safety in the Physics Laboratories

Any safety issues you need to be aware of for a specific practical activity will be issued verbally by your teacher and summarised in the risk assessment box on the instruction sheet for that particular activity.

You must also follow the safety rules below **at all times in the laboratory** whether or not practical work is taking place.

1. Coats, bags etc. should never block walkways in the lab or be left on work surfaces. Coat hooks are provided and there is plenty of room under work benches to store bags.

2. Food and drink are not allowed in the lab.

3. Move carefully round the lab. Don't rush.

4. Don't "mess about". This is when accidents tend to happen.

5. Handle any heavy equipment carefully (e.g. large masses, trolley boards).

6. Turn the voltage of power supplies to zero before switching on.

7. Ensure your hands are dry before operating any electrical apparatus.

Resources

The Physics department provides a wide variety of useful resources to help you achieve success in the A-level course. **You can ensure this success by making the most of what is on offer.**

Text books

You are provided with a range of text books which cover the course content. These are useful for supplementing notes given in lessons and for reference if you are having difficulties in understanding a particular topic. They also contain problems, some of which you may be given as set work by your teacher. You should attempt as many additional questions as possible in order to improve your understanding.

Past paper booklets

You are issued with booklets containing relevant questions from past modular examinations. **Please do not write in these as we will collect them in after the examinations to issue to next year's students.**
These booklets are of particular use when revising but you will also be given past questions as set work by your teacher.
Solutions to the past paper questions will be distributed several weeks before the examinations to aid your revision.

Computing Facilities

There are numerous computers available for student use in the Science area. See pages 8 and 9 for full details of the Physics department's I.T. resources.

Extra questions

On the bookcase in the science resource area there are boxes containing Physics and Mathematics tutorials along with extra A-level standard practice questions. See page 7 for further information.

Those students who feel they are coping comfortably with standard A-level problems should accept the **Physics Challenge.** This consists of problems with greater demands and will be of particular interest to prospective Oxbridge students and those considering a degree course in a physics related subject. Also see page 13 for information about the **Further Physics Group**.

The College library

The library has a good selection of Physics related books, journals, videos and CD roms. A complete list of library resources can be found on pages 8 and 9 of this booklet, as well as on the intranet.
We welcome your opinion on any books, videos etc. that are available and will post any written reviews on the notice board and on the Physics intranet pages.
There are also copies of the past paper booklets in the library for reference only.

The Science resource area

This is where you will find your most important resource......**members of the Physics department**. As well as providing specific Physics help sessions there is always a Physics teacher free. We are happy to discuss difficulties with all students whether we teach them or not. This one-on-one interaction is extremely effective at enhancing your understanding so it is vital that you seek help when you are struggling with new concepts. See page 12 for details of help sessions and staff free periods.

Additional questions and notes in the science resource area

Copies of these are available in the boxes on the shelves in the raised section of the science resource area.. Solutions can be found inside the box lids. Below is a list of just some of the sheets which contain summary notes and some problems for you to try. ***These are an extremely valuable resource. Any serious student will regularly check their understanding by attempting extra questions independently.***

	Topic	Module
1	Scalars and vectors	2
2	Turning effects	2
3	Displacement, velocity and acceleration	2
4	Motion in two dimensions	2
5	Newton's laws and linear momentum	2
6	Motion in a circle	4/6C
7	Work, energy and power	2
8	Structure of solids	3
9	Young Modulus	3
10	Current electricity	3
11	Kirchhoff's laws and potential dividers	3
12	E.m.f.; internal resistance; oscilloscopes	3
13	Radioactivity	5
14	Nuclear transformations; radioactive decay	4/5
15	Free and forced vibration; SHM	4
16	Waves	4
17	Diffraction, interference and polarisation	4
18	Magnetic flux density, current and force	4
19	Electromagnetic induction; self induction	4
20	Transformers and a.c. circuits	4
21	The kinetic theory of gases; the gas laws	2
22	Heat flow	2
23	Electric fields	4
24	Gravitational fields	4
25	Thermodynamics	6C

Remember…….. These are not your only source of extra questions.

- Most physics text books contain useful problems with answers.
- You have a folder full of past exam questions.

There are plenty of things to do to fill your 5 hours per week of Physics study time!!

Mathematics Tutorials

1 Indices, standard form and prefixes
2 Approximations and arithmetic mean
3 Logarithms
.4 Solving equations
5 Degrees and radians
6 Graphs
7 Areas and volumes

Additional Maths help sheets

- y = mx + c
- Questions on logs
- Sin, cos and tan practice questions
- Questions involving metric multiples and submultiples

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Library and Resource Area

Physics

BOOKS

Class Numbers

520 ASTRONOMY

530 PHYSICS - textbooks

530.15 MEDICAL PHYSICS

531 MATERIALS

534 ACOUSTICS

535 LIGHT

536 HEAT

537 ELECTRICITY

537.5 ELECTRONICS

539 QUANTUM PHYSICS

REFERENCE

ENCYCLOPAEDIAS, DICTIONARIES, ATLASES, ETC. -

312 REF STATISTICS - national and local statistical data on employment, social conditions, population etc.

NEWSPAPERS & JOURNALS

NEWSPAPERS

Daily Telegraph **Financial Times** **Guardian**

Independent **News(Jang)**

All newspapers have weekly science features.

JOURNALS

Astronomy Now **Economist** (weekly science feature)

Focus **New Scientist** **Physics Review**

All Journals are available for an **OVERNIGHT LOAN.** Current Journals are on display. Please **ask** for back copies.

TOPIC FILES

Cuttings, articles on various topics arranged by class number. eg. 575.1 TF – Genetic Engineering. All Topic files are available for an **OVERNIGHT LOAN**.

VIDEOS

There are currently over 40 videos relevant to Physics. These are shelved with books at the appropriate class number. Videos can be viewed in the Library and Resource Area or they are available for an

OVERNIGHT LOAN.

AUDIO-VISUAL RESOURCES

Financial Times **Guardian**

Independent **Economist**

Available for each year from 1992

CD-ROMS

Advanced Physics Virtual Laboratory

Encyclopaedia Britannica - comprehensive encyclopaedia.

New Scientist - text and graphics from the New Scientist magazine from 1989-2001.

Physics – several useful A-level revision CD-ROMs

For other titles see separate CD-ROM leaflet.

All CD-ROMS are easy to use. Basic instruction leaflets are available for most titles.☺ **Please ask for help.**☺

INTERNET INTRANET

Access the Internet & College Intranet for information on physics related topics. **Newsbank** gives access to a wide range of newspaper articles and is available on the intranet.

OTHER LIBRARIES

Kirklees Public Libraries and the **University Library** contain useful resources. Students may study in these Libraries.

Geenhead College students are entitled to borrow books from the UNIVERSITY LIBRARY.

ASK about the correct procedures for this.

REMEMBER - the **LIBRARY STAFF**, **Mrs. Ros Moors and Mrs. Jean Cliffe** are here to **HELP** you find the information you require.

PLEASE ASK FOR HELP.

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RM June 2004

Using ICT within the department.

Introduction

The college has invested huge sums of money to switch to Windows Office 2003. Your year group will have the benefit of new computers and outstanding ICT facilities

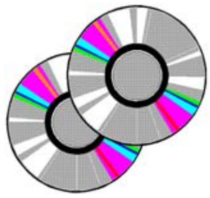
Once you have had an IT induction session you will have a username and password to log on to any networked PC in college. There are many spread around the physics, chemistry areas and in the Science Resources Centre. All of these are connected to Laser and colour printers, with a colour scanner in the Science Resources Centre.

You are free to use any of these computers at any time, as well as those in the IT area (G8, G9, G10 & C10). From these computers you can access the intranet and the internet. Remember the intranet and email system can be accessed from home the easiest way is from the link on the college website's home page: (www.greenhead.ac.uk) You are required to abide by the college code of conduct which will be explained to you during your IT induction.

For all students your username is your college (or exam) number with an 's' in front. If you forget your password please see any member of the ICT staff to reset it. Mr Andy Macdonald is the Network Manager with Richard Lyons and Chris Adams assisting him. They will also assist you if you have problems with logging on and accessing files. The Network Management Office is on the G corridor. Please report any problems so that they can be rectified quickly. **Science students are encouraged to use the science PCs to reduce the pressure on the IT department.**

The college is continually improving the ICT provision and there may have been some improvements over the summer since this was written.

Software available



In addition to the business type packages of Microsoft Office 2003 there are a number of specialist packages. These are:

On the network: (Shortcuts are found in U:data:physics\physics' software)

Albert - this a simulation package installed on the network so you can access it from any computer in college. It consists of 49 simulations some of which will stretch you beyond the A level syllabus. Try these out using the 'simulation help option' within each simulation. Some general instructions on using Albert can be found on the Physics intranet site and worksheets involving Albert will be set throughout the course.

Advancing Physics – This is an electronic text book on every networked PC with software simulations built in, see the Physics intranet for more information.

Focus on Waves & Focus on Fields – These are a more up-to-date set of simulations allowing students to investigate various physics concepts. We also have data logging software which will be used in lessons.

"Painless Physics" - virtual labs. These are new for September 2004 & include a whole host of activities.

These CD's are available in the Library and Resources Area

You will be shown these CD ROMs at some point in your lessons and may be set work which involves them, but feel free to use them beforehand.

Multimedia motion - this a CD ROM simulation package that allows you to complete experiments that you cannot easily do in the lab. It is currently kept either in one of the Physics computers or in the library and you can sign it out and use it on any of the computers in the library. ***Mega Physics CD*** - this is a self tuition package designed for A-level Physics students. ***Maths Tutorial CD*** - a package designed to help you develop those vital mathematical skills! ***Virtual Labs*** - This is a set of three CD ROMs with 35 simulations.

User areas on the network

Once you have logged on, if you click on Explorer you will see your own exclusive work area on G: drive. Only you have access to this area. (G & U network drives are NOT available via the internet).

All shared physics files will be stored on the intranet. You can download spreadsheet data and word files from the intranet server, either at college or from home.

The intranet and the internet

Both of these are accessed through Internet Explorer on the network. The intranet works on the same principles as the internet with Web pages. These are produced by college staff and are held on the college's computer system. The Physics department is currently using its web pages for material additional to the specification. Many of our pages are linked to web sites on the internet so by going through the departmental pages you will be led out to sites on the internet. Of course, you can surf the net directly within Internet Explorer.

You will need an additional username and password for access to the internet/intranet. This is obtained from the IT department once you have signed a contract to agree to the college's code of conduct.

It is intended that students perform some of their own research and the internet is a tool for doing so.

The internet is accessed via a fibre optic link which has a finite capacity. If you are accessing non curriculum sites such as a pop group or a football team, you will preventing another person from legitimately researching curriculum work. Students who are abusing the college facilities will be asked to log out and ultimately blocked from using the internet.

WARNING: All sites visited are logged on the college system; anybody who visits sites deemed to be of a dubious nature may find their access to the internet blocked.

To use the intranet from within college log onto the network, then load Internet Explorer. Select intranet from the icons on the left then "departmental information" followed by "Physics". The buttons along the top of the screen remain in place while you load other pages so you will always be able to return to the Physics home page by clicking on the home button.

Printing

Printers are automatically selected for the room you are in when you logon. You may change the printer, for example to a colour printer. The IT staff will show you how to do this.

Before printing any document you must **insert your name** into the header so that it appears on **every page**. This enables lost work to be returned to the correct student.

Currently there is no charge for printing, as long as it is CURRICULUM work. Please check your work carefully on the screen before you print. Reducing the waste of paper is an important issue for everybody, both for environmental and financial reasons. If you wish to print personal pages then please pay at the Finance office in advance and receive a credit slip. (See IT notices for current prices). Staff will ask to see this credit note if they see you printing what is obviously not curriculum work. Each time you print the cost of your printing so far is displayed. Please be sensible with printing, money wasted here cannot then be spent on other facilities for students.

If you send a file to a printer and it does not come out *do not keep sending it* as it will be in a printer queue somewhere(!). Once the printer comes back on line all your attempts will rush out and you don't really need 10 copies of the same thing!

If you need help with any aspect of using the College's system please ask. If you have any suggestions of how the facilities and content can be improved we would be pleased to hear them.

Staff Timetable and Help Sessions

If you are finding a topic difficult or need help with some questions then please come and ask for help ***from any Physics teacher,*** whether they teach your group or not. Staff are **NOT** teaching a class in the following blocks. Please note that Mrs Saunders teaches both Physics & Maths, as she is part time she is **not** in college on Tuesday morning, all day Wednesday, Thursday afternoon and Friday afternoon.

Time	Period	Monday	Tuesday	Wednesday	Thursday	Friday	Time
8.45	1	F	C	D	B	A	8.45
		Mr Bartlett + Mr Fascione	Mr Yems	Mr Yems is often around	Mrs Saunders + Mr Yems	Mr Bartlett + Mr Fascione	
						C	9.45
9.55	2	E	D	B	F	Mrs Saunders + Mr Yems	
		Mrs Saunders (*Help*)	Mr Yems	on Wednesday	Mr Bartlett + Mr Fascione		
						BREAK	10.45
11.05		BREAK				F	11.05
11.25	3	D	E	C	A	Mr Bartlett + Mr Fascione (*Help*)	
		Mrs Saunders	Mr Yems	mornings to help students	Mr Bartlett (*Help*)		
						D	12.05
12.35		LUNCH				Mrs Saunders + Mr Yems	
						LUNCH	1.05
1.35	4	A	F		E		
						B	1.55
		Mr Bartlett + Mr Fascione	Mr Bartlett + Mr Fascione	Staff not involved in	Mr Yems	Mr Yems	
2.45	5	B	A		C		
						E	2.55
		Mrs Saunders + Mr Yems (*Help*)	Mr Bartlett + Mr Fascione	enrichment will help students	Mr Yems	Mr Yems	
3.55							3.55

In summary, these are the blocks when each member of staff is not teaching a class. They are usually either in the Science Resource area or in the Physics Prep. Room. ***I couldn't find anyone for help is not usually an acceptable excuse for handing in incomplete or late work.***

Some periods are designated help sessions. This does not mean that you can only come for help at these times. It does mean that the particular member of staff will definitely be in the Science Resources Centre ready to offer help.

The Further Physics Group

Are you..........

Finding your Physics assignments fairly straightforward?

Feeling the need to be stretched a little more?

Contemplating a Physics or engineering related subject at university?

Considering taking the Advanced Extension Award in Physics?

Thinking of entering the National Physics Olympiad Competition?

Thinking of applying to do a science or engineering subject at Oxford or Cambridge, or any competitive course?

If the answer to any of the above is yes then the Further Physics Group is probably for you. The group meets regularly at lunchtime in S3 with Mr Bartlett to discuss more challenging Physics problems.

The group is very relaxed, give it a go, if then you do decide it is not for you then so be it, nothing ventured-nothing gained!

You may wish to try some of the "PHYSICS CHALLENGE" sheets from the boxes in the Science Resource Centre…….if you enjoy them why not try the Further Physics Group??

gc Department of Physics ~ AS Year Course Outline

Month	Module	Title	Content
September	**3**	**Elastic properties of solids**	Density; Hooke's law; stress and strain; plastic behaviour, fracture and brittleness; the Young modulus. Uncertainty in experimental measurements.
October / November		**Current Electricity**	Current, p.d and resistance; V-I characteristics; Ohm's law; resistivity; series and parallel resistors; energy and power in circuits; Kirchoff's laws; potential dividers; e.m.f. and internal resistance; alternating currents; the c.r.o.
INTERNALLY ASSESSED PRACTICAL COURSEWORK			
November / December	**1**	**Electromagnetic radiation**	Refraction and refractive index; Snell's law; total internal reflection; fibre optics; photoelectric effect; wave-particle duality.
January / February		**Particles**	Constituents of the atom; Rutherford scattering; particles, photons, antiparticles; weak interaction; pair production; exchange particles; Feynman diagrams; classification - Hadrons and Leptons; properties of quarks and antiquarks.
		Quantum phenomena	Ionisation and excitation; energy levels and line spectra.
March / April	**2**	**Mechanics**	Addition, subtraction and resolution of vectors; equilibrium of forces; moment, couple and torque; principle of moments; centre of mass; displacement, speed, velocity and acceleration; analysis of motion graphs; uniform acceleration formulae; terminal speed; projectiles;
			IT Key Skills Portfolio work (2nd purpose)
			momentum; conservation of momentum; elastic and inelastic collisions; Newton's laws of motion; work, energy and power; conservation of energy; kinetic, potential and heat energy; specific heat capacity and latent heat.
May		**Molecular kinetic theory model**	Ideal gases; equation of state; absolute zero; molecular kinetic energy and temperature; kinetic theory equation for PV; equation for molecular kinetic energy.
June / July	**AS EXAMINATIONS (MODULES 1, 2 AND 3)**		
	A2 TEACHING BEGINS		
	4	**Oscillations**	Graphical and analytical treatment of s.h.m.; simple pendulum and mass on a spring.

gc Department of Physics ~ A2 Year Course Outline

Month	Module	Title	Content
September	INTERNALLY ASSESSED PRACTICAL COURSEWORK		
September	5	**Nuclear instability**	Alpha, beta and gamma radiation; inverse square law for gamma; background radiation; exponential decay and half life; nuclear changes in radioactive decay; use of radiation to probe matter; measurement of nuclear radius.
October	6C	**Rotational Dynamics**	Moment of inertia; rotational kinetic energy; uniform angular acceleration formulae; torque and angular acceleration; conservation of angular momentum; angular impulse; power and frictional couples.
November	6C	**Thermodynamics and engines**	First law of thermodynamics; isothermal, adiabatic, constant pressure and constant volume changes, P-V diagrams; work done in cyclic processes; indicator diagrams for four stroke petrol and diesel cycles; indicated power, output (brake) power and friction power; efficiency.
December / January	4	**Oscillations and Waves**	Free and forced vibrations; resonance; progressive waves; amplitude, frequency, wavelength, speed, phase, path difference; polarisation; superposition; stationary waves; double slit interference; single slit diffraction; diffraction grating.
January	MODULES 5 AND 6 EXAMINATION		
February	4	**Capacitance**	Definition of capacitance; energy stored; charging and discharging graphs; time constant.
March		**Gravitational and electric fields**	Circular motion; Newton's gravitational law; gravitational field strength; gravitational potential; Coulombs law; electric field strength; charged particle beams in electric fields.
April		**Magnetic effects of currents**	Force on a current in a B-field. Force on a moving charged particle; circular paths; flux density, flux and flux linkage; electromagnetic induction; Faraday's and Lenz's laws.
May		**Nuclear applications**	Mass-energy equivalence; mass difference and binding energy; fission and fusion; fusion reactors and safety aspects; production of man-made nuclides
June	A2 EXAMINATIONS (MODULE 4 PLUS SYNOPTIC PAPER)		

Internally Assessed Coursework

Internal assessment of practical skills counts for 12½ % of the A-level Physics course and 15% of the AS course. You will have to complete a maximum of two pieces of assessed coursework in the AS year and two in the A2 year.

Each coursework assignment will test the following practical skills:

Skill A:	**Planning**	**(8 marks)**
Skill B:	**Implementing**	**(8 marks)**
Skill C:	**Analysing Evidence and Drawing Conclusions**	**(8 marks)**
Skill D:	**Evaluating Evidence and Procedures**	**(6 marks)**

In order to gain marks for these skills you must satisfy certain assessment criteria. Full details of these are given on pages 17 to 20.

It is essential that you refer to the assessment grids when planning and writing up coursework

The assessment grids on pages 17 to 20 will probably seem a little daunting at first. **Don't panic!** You will be fully prepared by means of practice assignments so that when the real thing comes you will be full of confidence. **All past students who have followed our advice have performed extremely well in coursework assignments...........you will be no different.**

Coursework Assessment Grids ~ (September 2003)

Skill A Planning

	The candidate can:		AQA Statement	Covered in	**Greenhead Advice**
2	suggest an appropriate experimental plan with some relevant procedures.	A2a	an outline plan or testable hypothesis	4a	One summarising sentence
		A2b	a sketch or partial diagram of the practical set-up	4c	Use standard symbols
		A2c	consideration of safety aspects of the plan.		At least one comment
		A2d	a list of some appropriate apparatus.	4d	
4	design a plan for the investigation or problem to be solved and outline most (if not all) of the appropriate procedures.	A4a	detailed plan or testable hypothesis		A detailed step by step method
		A4b	identification of an appropriate variable	6a	Make a list of possible variables
		A4c	labelled diagram of the full practical set-up and/or a circuit diagram (where appropriate)		Use standard circuit symbols. Label quantities to be measured where appropriate
		A4d	a comprehensive list of apparatus.	6d	Do a 2 column table to include the apparatus specification
6	design a plan for the investigation or problem to be solved, outlining the appropriate experimental procedures in a sensible sequence.	A6a	identification of variable to be kept constant		Pick from the list in A4b
		A6b	number and range of readings to be taken		e.g. 10 readings between 5 & 50 every 5 units
		A6c	logical sequence of readings to be taken		
		A6d	full instrument or apparatus specification. (e.g. instrument ranges)		e.g. a 0 to 5 instrument accurate to ± 0.01 units
8	design a plan for the investigation or problem to be solved, outlining clearly and succinctly the appropriate experimental procedures and providing sound reasons for design choices.	A8a	at least one reason for procedures based on evidence of knowledge and understanding (e.g. why range / number / sequence of readings should give good/more accurate results)		Use calculations to explain why you are not going below your min chosen value and why you are not going above your max chosen value
		A8b	justification for design based on supporting theory (e.g. supporting formulae or calculations)		Include the equation & how you decided what to plot on what axis
		A8c	aspects of the plan based on reasoned predictions **(A2 only)**		What will the graph look like? What will the gradient and intercept be? Roughly what answer do preliminary readings suggest?
		A8d	use of relevant information from secondary sources or preliminary work **(A2 only)**.		Preliminary readings to decide range and methods

Skill B Implementing (September 2003)

	The candidate can:		AQA Statement	Covered in	Greenhead Advice
2	make and record some units given correctly.	B2a	demonstration of the safe and correct use of some equipment	B4a	Nothing you can write here
		B2b	some appropriate readings or observations made		
		B2c	some readings or observations recorded	B4c	all students are expected to obtain these marks!!!
		B2d	two or more correct units used.	B4d	
4	make and record an adequate number of appropriate measurements correctly, with most units given correctly, including the repeat of measurements where appropriate.	B4a	all equipment used safely and correctly		
		B4b	majority of readings accurate and appropriately recorded	B6b	Majority means 75% +
		B4c	sufficient readings taken including, where appropriate, repeat readings		8 to 10 sets of repeated readings,
		B4d	all units correct (except occasional omissions).		Remember to check these!
6	meet the criteria for 4 marks above with measurements made to a suitable degree of precision within the limits set by the apparatus, identify significant source(s) of error.	B6a	readings given to appropriate number of significant figures		The number of decimals places should match the accuracy of the instrument used.
		B6b	readings taken with suitable precision		
		B6c	clear, organised and accurate presentation of results and observations		Column headings should include, quantity and units. All raw and calculated data should be recorded.
		B6d	identification of significant source(s) of error.	D4b	
8	meet the criteria for 6 marks above and discuss appropriate ways to minimise experimental error, and where possible, implement these.	B8a	description of action proposed to minimise errors		Describe clearly the steps you took to keep measurement uncertainties to a minimum.
		B8b	implementation of plan to minimise errors where possible **(A2 only)**.		
		B8c	checks on readings or observations which appear to be inconsistent or suspect **(A2 only)**		Any anomalous data checked or explained. Are repeat readings similar? Do the readings follow a regular pattern?
		B8d	calculation of mean values of repeat readings.		Correctly calculated and quoted to the correct number of significant figures.

Skill C: Analysing Evidence and Drawing Conclusions (September 2003)

	The candidate can:		AQA Statement	Greenhead Advice
2	produce a report of the major aspects of the investigation in a logical sequence, tabulate results as appropriate and process data in preparation for analysis by graphical or other methods of interpretation.	C2a	record of major aspects of the investigation including observations and raw data	
		C2b	demonstration of the use of the equations and/or some calculations	
		C2c	tabulated processed data and/or organised observations	
		C2d	some awareness of how to analyse data or observations (e.g. intention to draw a graph).	
4	meet the criteria for 2 marks above and, in addition, correctly use scientific conventions, including table headings, graph headings and axes, diagrams, labels and significant figures and produce appropriate graph(s).	C4a	data and/or observations processed and organised in a logical sequence	Measured → derived data in columns left to right
		C4b	data presented in appropriate tables with correct headings and units	• Tables MUST be fully boxed • Especially derived data columns
		C4c	appropriate graphs drawn with correct headings and labelled axes	A4 size with the plotted points at least half the scale on each axis. **No title or labels on axis (quantity & units) will limit the C mark to 3.**
		C4d	accurate plotting of points on a graph.	All points should be plotted to within ±1mm.
6	interpret processed data by finding the gradient or intercept of a graph and reach a valid conclusion consistent with the data obtained	C6a	best fit line (or curve) drawn	Do not force the line through the origin if the data does not suggest it.
		C6b	large Δy and Δx shown	Your triangle should be as large as possible
		C6c	correct values read and recorded from graph	You MUST show the values read from the graph to obtain Δx and Δy
		C6d	Δy/Δx calculated or intercept read or formula manipulation	Working here must show ALL stages and be logical.
8	analyse and interpret the results and explain how these support or contradict the original prediction or expectation (when one has been made) and/or explain clearly and succinctly the results in the light of established knowledge and theory, drawing a reasoned conclusion about the whole investigation.	C8a	statement of established theory or knowledge relating to the investigation	Explain how the original equation leads to the graph plotted and how the gradient leads to the final answer.
		C8b	reasoned conclusion or statement about the outcome of the investigation	The value of ….. as found to be ….. should count for b & c
		C8c	final numerical value, relationship with correct significant figures and units where appropriate	
		C8d	explanation of how the results support or contradict the original prediction or expected outcome and established theory or knowledge **(A2 only)**.	How close is your value to the accepted value?(work out the % difference). Link any conclusion back to the original prediction.

	The candidate can:		AQA Statement	Greenhead advice
2	identify some possible sources of errors and anomalies in the experimental evidence and data.	D2a	possible sources of errors	Make a list
		D2b	observations about discrepancies or anomalies in the experimental data	Look at the results table & points on graph, comment that there is not any if this is the case
		D2c	variation in repeat readings or repeated observations indicating an uncertainty in the data	Comment of the spread of readings, if any. Include an extra column in your results table for extra repeated value. Also include a column for the difference between the largest and smallest reading. The average value of this difference gives the uncertainty in the measurement.
		D2d	comment on discrepancies between expected results or outcomes and the experimental evidence.	What is the % difference between your value and the known value? Does the graph produce a straight line and pass through the origin if predicted? (Can be covered with D4d)
4	identify the most significant (or error-sensitive) measurements, make reasonable estimates of the errors in all measurements; use these to assess the suitability of the techniques used and the reliability of the conclusions drawn.	D4a	identification of the most significant measurement(s) (e.g. a value to be **squared** in processing or the measurement of a very small quantity)	Consider the %U of each measurement and how they are combined into the final answer. (Do after D4b)
		D4b	estimate of error of uncertainty in all measurements based on experimental data or evidence	You must calculate the %U for every quantity measured, using the average column, or the average of the **spread of readings**, if applicable - see help sheet on intranet.
		D4c	comment on the suitability of the techniques used	Be specific to *your* methods. Are the %U's too big?
		D4d	comment on the reliability of the conclusions drawn.	**D2d plus:** Are your points close to the line? Does line go through origin if it should? Is the total %U of your measurements small i.e. less than 10%? Look at spread of repeat readings. Does the line tend to curve unexpectedly at high values?
6	identify possible sources of systematic errors and assess the implications of these for the reliability of the outcome of the investigation; discuss clearly and succinctly appropriate ways to minimise experimental error and, where possible, how to implement these and hence improve reliability of final "answer" or conclusions. **There is no 8 mark**	D6a	identification of possible sources of systematic errors in addition to the identified random errors	You must clearly state which errors are random and which are systematic. (See example table on the coursework page of the Physics Intranet)
		D6b	critical analysis of techniques used and associated errors and suggestions for improvement in experimental plan or technique(s) to minimise errors **(A2 only)**	**D4d plus:** Calculate the absolute uncertainty in the final answer. To do this you need to add the %U's of your measured variables (look at the equation and be careful if one of the variables is squared) to obtain the %U in the final answer. Use this to calculate the absolute uncertainty.
		D6c	critical assessment of reliability of conclusions and/or final quantitative "answer" in the light of error-estimates and critical analysis of experimental technique(s) **(A2 only)**	
		D6d	proposals for improvements, or further work, to provide additional or more reliable evidence for the conclusion or to extend the investigation in a different or potentially more successful direction.	Make sure you discuss improving the %U of the most significant measurement. For more reliable evidence look at ways of automating the data collection. Give details & calculate the improved %Uncertainty.

The Course Specification

The following pages contain full details of the specification content for each module. You will find this useful in several ways

1. When revising it will act as a topic checklist.

2. When you finish a topic you should check that the notes you have made cover the syllabus content. This is especially important if you have been absent.

3. By looking at the course outline on pages 14 and 15 you will know when a particular topic is going to be studied. It is a good idea to "get ahead" by doing some preliminary reading and perhaps making some notes **before** the work is covered in class.

Note on equations

You will notice in the specification that some equations are boxed**. *You have to learn all of these***. Some of them you need to be able to ***derive***. All other equations and required data are provided in the examinations on a data sheet.

10

AS Module 1
Particles, Radiation and Quantum Phenomena

Introduction	The two themes explored in this module are those of particles and of electromagnetic radiation and quantum phenomena. The concept of anti-particles is introduced as are quarks and anti-quarks. The particle and the wave models are brought together. Most of this module consists of material from the AS criteria for Physics and develops material studied in the Key Stage 4 science courses.

10.1 Particles

10.1.1	Constituents of the atom	Proton, neutron, electron Charges, relative masses. Atomic mass unit is not required
10.1.2	Evidence for existence of the nucleus, qualitative study of Rutherford scattering	Proton number *Z*, nucleon number *A*, isotopes
10.1.3	Particles, antiparticles and photons	Electron, positron Proton, antiproton Neutrino, antineutrino Photon model of electromagnetic radiation, the Planck constant, $E = hf = \frac{hc}{\lambda}$ Weak interaction, limited to changes in which a proton changes to a neutron or vice versa Pair production; annihilation of a particle and its antiparticle releases energy; the use of $E = mc^2$ is not required Concept of exchange particles to explain forces between elementary particles Simple Feynman diagrams to show how a reaction occurs in terms of particles going in and out and exchange particles: limited to β^- decay, β^+ decay, electron capture, neutrino – neutron collisions, antineutrino – proton collisions and electron – proton collisions
10.1.4	Classification of particles	Hadrons: baryons (proton, neutron) mesons (pion, kaon) Hadrons are subject to the strong nuclear force. Candidates should know that the proton is the only stable baryon into which other baryons eventually decay; in particular the decay of the neutron should be known Leptons: electron, muon, neutrino Candidates will be expected to know baryon and lepton numbers for individual particles and antiparticles

10.1.5	Quarks and antiquarks	Up (u), down (d) and strange (s) quarks only. Properties of quarks: charge, baryon number and strangeness Combinations of quarks and antiquarks are required for baryons (proton and neutron only) and for mesons (pion and kaon only) Change of quark character in β^- decay and β^+ decay Application of the conservation laws for charge, baryon number and strangeness to particle interactions

10.2 Electromagnetic radiation and quantum phenomena

10.2.1	Refraction at a plane surface	Refractive index, *n*; candidates are not expected to recall methods for determining refractive indices Snell's law of refraction $_1n_2 = \frac{\sin\theta_1}{\sin\theta_2} = \frac{c_1}{c_2}$ $_1n_2 = \frac{n_2}{n_1}$ Total internal reflection including calculations of critical angle, θ_c $\sin\theta_c = \frac{1}{n}$ Simple treatment of fibre optics including function of cladding with lower refractive index around central core limited to step index only; candidates should be familiar with modern applications of fibre optics, e.g. endoscopy, communications, etc.
10.2.2	The photoelectric effect	Treatment limited to energy considerations only; the stopping potential experiment is not required; work function ϕ, photoelectric equation $hf = \phi + E_k$
10.2.3	Collisions of electrons with atoms	The electronvolt
	Ionisation, excitation	Understanding of the role of ionisation and excitation in the fluorescent tube; line spectra (e.g. of atomic hydrogen) as evidence of transitions between discrete energy levels
	Energy levels, photon emission	$hf = E_1 - E_2$
10.2.4	Wave-particle duality	Candidates should know that electron diffraction suggests the wave nature of particles and the photoelectric effect suggests the particle nature of electromagnetic waves; details of particular methods of showing particle diffraction are not expected de Broglie wavelength $\lambda = \frac{h}{mv}$

11 AS Module 2
Mechanics and Molecular Kinetic Theory

Introduction

This module contains principally simple mechanics and initial ideas on the molecular kinetic theory model. Most of the module consists of material from the AS criteria for Physics and some topics which have been introduced in Key Stage 4 Science courses.

11.1 Mechanics

11.1.1 Scalars and vectors

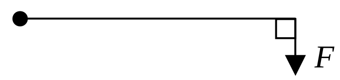
The addition and subtraction of vectors by calculation or scale drawing; calculations limited to two perpendicular vectors
The resolution of vectors into two components at right angles to each other

11.1.2 Conditions for equilibrium for two or three coplanar forces acting at a point

Problems may be solved either by using resolved forces or by using a closed triangle

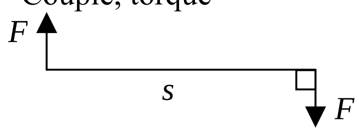
11.1.3 Turning effects

Moment of a force



moment = Fs

Couple, torque



couple = Fs

The principle of moments and its applications in simple balanced situations e.g. see–saw.
The centre of gravity; calculations of the position of centre of gravity of a regular lamina are not expected.

11.1.4 Displacement, speed, velocity and acceleration

$$v = \frac{\Delta s}{\Delta t}$$

$$a = \frac{\Delta v}{\Delta t}$$

11.1.5 Uniform and non-uniform acceleration, representation and interpretation by graphical methods

Interpretation of velocity-time and displacement-time graphs for motion with non-uniform acceleration and uniform acceleration; significance of areas and gradients

Equations for uniform acceleration

$$v = u + at$$

$$s = \left(\frac{u + v}{2}\right)t$$

		$$s = ut + \frac{at^2}{2}$$ $$v^2 = u^2 + 2as$$ Acceleration due to gravity g, terminal speed; detailed experimental methods of measuring g are not required
11.1.6	Independence of vertical and horizontal motion	Calculations involving projectile equations will not be set
11.1.7	Momentum, conservation of linear momentum	Recall and use of $\boxed{p = mv}$ Conservation calculations for elastic and inelastic collisions limited to one dimension. Candidates should have experience of analysing motion using datalogging techniques involving data capture with appropriate sensors e.g. light gates. Candidates will require understanding of the application of the principles of the conservation of linear momentum e.g. space vehicles
11.1.8	Newton's laws of motion	Candidates are expected to know and to be able to apply the three laws in appropriate situations. Force as the rate of change of momentum $$F = \frac{\Delta(mv)}{\Delta t}$$ For constant mass: $F = ma$
11.1.9	Work, energy, power	$W = Fs\cos\theta$ $$P = \frac{\Delta W}{\Delta t} \qquad P = Fv$$
11.1.10	Conservation of energy	Application of the principle of the conservation of energy to determine whether a collision is elastic or inelastic. Application of the conservation of energy to examples involving gravitational potential energy and kinetic energy. Recall and use of $\boxed{\Delta E_p = mg\,\Delta h}$ Recall and use of $\boxed{E_k = \frac{1}{2}mv^2}$
11.1.11	Calculations involving change of energy	$\Delta Q = mc\Delta\theta$, where c is specific heat capacity. $\Delta Q = ml$, where l is specific latent heat

11.2 Molecular kinetic theory model

11.2.1	The equation of state for an ideal gas	Recall and use of $\boxed{pV = nRT}$
11.2.2	The molar gas constant R, The Avogadro constant N_A	Concept of absolute zero of temperature. $T \propto$ average kinetic energy of molecules for an ideal gas
11.2.3	Pressure of an ideal gas	Assumptions leading to and derivation of $$\boxed{pV = \frac{1}{3}Nm\overline{c^2}}$$

11.2.4	Internal energy Relation between temperature and molecular kinetic energy. The Boltzmann constant	Random distribution of energy amongst particles in a body Thermal equilibrium $\frac{1}{2}m\overline{c^2} = \frac{3}{2}kT = \frac{3RT}{2N_A}$

12 AS Module 3
Current Electricity and Elastic Properties of Solids

	Introduction	This module contains principally simple current electricity including alternating currents and the use of the oscilloscope. Some work on elastic properties of solids is also included. Most of this module consists of material from the AS Criteria for Physics.

12.1 Current electricity

12.1.1	Charge, current, potential difference	Electrical current as the rate of flow of charge Recall and use of $\boxed{I = \frac{\Delta Q}{\Delta t}}$ $\boxed{V = \frac{W}{Q}}$
	Resistance	Resistance is defined by $\boxed{R = \frac{V}{I}}$
12.1.2	Current/voltage characteristics	For an ohmic conductor, a semiconductor diode and a filament lamp Candidates should have experience of the use of a current sensor and a voltage sensor with a datalogger to capture data from which to determine $V - I$ curves
12.1.3	Ohm's law	Ohm's law understood as a special case where $I \propto V$
12.1.4	Resistivity ρ	Recall and use of $\boxed{\rho = \frac{AR}{l}}$ Description of the qualitative effect of temperature on the resistance of metal conductors and thermistors. Applications, e.g. temperature sensors
12.1.5	Series and parallel resistor circuits	$R_T = R_1 + R_2 + R_3$ $\quad \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
12.1.6	Energy and power in d.c. circuits	Recall and use of $\boxed{E = VIt}$ $\boxed{P = VI}$ $\boxed{P = I^2R}$ Application, e.g. understanding of high current requirement for a starter motor in a motor car
12.1.7	Kirchhoff's laws	Conservation of charge and energy in simple d.c. circuits The relationships between currents, voltages and resistances in series and parallel circuits; questions will not be set which require the use of simultaneous equations to calculate currents or potential difference
12.1.8	Potential divider	The potential divider used to supply variable p.d. e.g. application as a hi-fi volume control
12.1.9	Electromotive force ϵ Internal resistance r	$\epsilon = \frac{E}{Q}$ $\quad \epsilon = I(R + r)$

12.1.10	Alternating currents	Sinusoidal voltages and currents only; root mean square, peak and peak-to-peak values, for sinusoidal waveforms: $I_{rms} = \frac{I_0}{\sqrt{2}}$ $V_{rms} = \frac{V_0}{\sqrt{2}}$ Application to calculation of mains electricity peak and peak-to-peak voltage values
12.1.11	Oscilloscope	Use of an oscilloscope as a d.c. and a.c. voltmeter, to measure time intervals and frequencies, and to display waveforms

12.2 Elastic properties of solids

12.2.1	Bulk properties of solids	Density ρ. Recall and use of $\rho = \frac{m}{V}$ Hooke's law, elastic limit, experimental investigations Tensile strain and tensile stress Elastic strain energy, breaking stress Derivation of $\textit{energy stored} = \frac{1}{2}Fe$ Description of plastic behaviour, fracture and brittleness and interpretation of simple stress-strain curves
12.2.2	The Young modulus	$\textit{The Young modulus} = \frac{\textit{tensile stress}}{\textit{tensile strain}} = \frac{F}{A}\frac{l}{e}$ One simple method of measurement Use of stress-strain graphs to find the Young modulus and strain energy per unit volume

13 A2 Module 4
Waves, Fields and Nuclear Energy

Introduction	This is the first A2 module building on the key ideas and knowledge covered in AS. The properties of waves are covered, gravitational and electric fields are introduced, as are the magnetic effects of currents. Candidates will also study the practical application of nuclear fission as a source of energy.

13.1 Oscillations and Waves

13.1.1 Simple harmonic motion: graphical and analytical treatments

Characteristic features of simple harmonic motion
Exchange of potential and kinetic energy in oscillatory motion
Understanding and use of the following equations

$$a = -(2\pi f)^2 x$$

$$x = A\cos 2\pi ft$$

$$v = \pm 2\pi f\sqrt{A^2 - x^2}$$

Graphical representations linking displacement, velocity, acceleration , time and energy

Velocity as gradient of displacement/time graph

Simple pendulum and mass-spring as examples and use of the equations

$$T = 2\pi\sqrt{\frac{l}{g}} \qquad T = 2\pi\sqrt{\frac{m}{k}}$$

Candidates should have experience of the use of datalogging techniques in analysing mechanical and oscillatory systems

13.1.2 Free and forced vibration

Qualitative treatment of free and forced vibration

Resonance and the effects of damping

Examples of these effects from more than one branch of Physics e.g. production of sound in a pipe instrument or mechanical vibrations in a moving vehicle

13.1.3 Progressive waves

Oscillation of the particles of the medium

Amplitude, frequency, wavelength, speed, phase, path difference

Recall and use of $\boxed{c = f\lambda}$

13.1.4 Longitudinal waves and transverse waves

Examples including sound and electromagnetic waves
Polarisation as evidence for the nature of transverse waves; applications, e.g. polaroid sunglasses

13.1.5 Superposition of waves, stationary waves

The formation of stationary waves by two waves of the same frequency travelling in opposite directions; no mathematical treatment required

Simple graphical representations of stationary waves, nodes and antinodes on strings and in pipes

13.1.6	Interference	The concepts of path difference and coherence Requirements of two source and single source double-slit systems for the production of fringes The appearance of the interference fringes produced by a double slit system. $\lambda = \frac{ws}{D}$
13.1.7	Diffraction	Appearance of the diffraction pattern from a single slit The plane transmission diffraction grating at normal incidence Optical details of the spectrometer will not be required Derivation of $\boxed{d \sin\theta = n\lambda}$ Applications, e.g. to spectral analysis of light from stars
13.2	Capacitance	
13.2.1	Capacitance	Recall and use of $\boxed{C = \frac{Q}{V}}$
13.2.2	Energy stored by capacitor	Derivation and use of $\boxed{E = \frac{1}{2}QV}$ and interpretation of area under a graph of charge against p.d.
13.2.3	Graphical representation of charging and discharging of capacitors through resistors	*time constant* = *RC* Calculation of time constants including their determination from graphical data
13.2.4	Quantitative treatment of capacitor discharge	$Q = Q_0 e^{-t/RC}$ Candidates should have experience of the use of a voltage sensor and datalogger to plot discharge curve for a capacitor
13.3	Gravitational and electric fields	
13.3.1	Uniform motion in a circle	$\omega = \frac{v}{r}$ $\quad \omega = 2\pi f$ $\quad a = \frac{v^2}{r} = r\omega^2$ where ω is angular speed
13.3.2	Centripetal force equation	Recall and use of $\boxed{F = \frac{mv^2}{r}}$
13.3.3	Gravity, Newton's law, the gravitational constant G	Recall and use of $\boxed{F = -\frac{Gm_1m_2}{r^2}}$ Methods for measuring G are **not** included
13.3.4	Gravitational field strength g	$g = \frac{F}{m}$ $\quad g = -\frac{GM}{r^2}$ (radial field) $g = -\frac{\Delta V}{\Delta r}$
13.3.5	Gravitational potential V	$V = -\frac{GM}{r}$ (radial field) Graphical representations of variations of g and V with r

13.3.6	Motion of masses in gravitational fields	Circular motion of planets and satellites including geo-synchronous orbits
13.3.7	Coulomb's law, permittivity of free space ε_0	Recall and use of $F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q_2}{r^2}$
13.3.8	Electric field strength E	Application, e.g. estimation of forces at closest approach in Rutherford alpha particle scattering $E = \frac{F}{Q}$ $E = \frac{V}{d}$ (uniform field) $E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$ (radial field)
13.3.9	Electric potential V	$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$
13.3.10	Motion of charged particles in an electric field	Trajectory of particle beams
13.3.11	Similarities and differences between electric and gravitational fields	No quantitative comparisons required
13.4	**Magnetic effects of currents**	
13.4.1	Force on a current carrying wire in a magnetic field	$F = BIl$ (field perpendicular to current)
13.4.2	Motion of charged particles in a magnetic field	$F = BQv$ (field perpendicular to velocity) Circular path of particles; application, e.g. charged particles in a cyclotron
13.4.3	Magnetic flux density B, flux Φ flux linkage $N\ \Phi$	$\Phi = BA$, B normal to A
13.4.4	Electromagnetic induction	Simple experimental phenomena, Faraday's and Lenz's laws For a flux change at a uniform rate *magnitude of induced e.m.f.* $= N\frac{\Delta\Phi}{\Delta t}$ Applications, e.g. p.d. between wing-tips of aircraft in flight
13.5.	**Nuclear applications**	
13.5.1	Mass and energy	Simple calculations on nuclear transformations; mass difference; binding energy Atomic mass unit, u Conversion of units; 1u = 931.1 Mev $E = mc^2$ Appreciation that $E = mc^2$ applies to all energy changes Graph of average binding energy per nucleon against nucleon number, A Fission and fusion processes

13.5.2	Induced fission	Induced fission by thermal neutrons Possibility of a chain reaction Critical mass Need for a moderator in thermal reactors Control of the reaction rate Factors influencing choice of material for moderator, control rods and coolant Examples of materials
13.5.3	Safety aspects	Fuel used, shielding, emergency shut-down Production, handling and disposal of active wastes
13.5.4	Artificial transmutation	Production of man-made nuclides and examples of their practical applications, e.g. in medical diagnosis

14

A2 Module 5 (All options)
Common Component
Nuclear Instability

Introduction	This A2 module builds on the ideas introduced in Module 1. Students will gain knowledge and understanding of the present-day views of the particle nature of matter.

14.1 Nuclear instability

14.1.1	Radioactivity	α, β and γ radiation; their properties and experimental identification; applications, e.g. to relative hazards of exposure to humans The experimental investigation of the inverse square law for γ rays $I = k\frac{I_0}{x^2}$ Applications, e.g. to safe handling of radioactive sources Background radiation; its origins and experimental elimination from calculations
14.1.2	Exponential law of decay	Random nature of decay $\frac{\Delta N}{\Delta t} = -\lambda N \quad N = N_0 e^{-\lambda t}$ Half-life and decay constant and their determination from graphical decay data $T_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$ Applications, e.g. relevance to storage of waste radioactive materials; radioactive dating
14.1.3	Variation of N with Z for stable and unstable nuclei	Graph of N against Z for stable and unstable nuclei
14.1.4	Possible modes of decay of unstable nuclei	α, β^+, β^-, nucleon emission, electron capture Changes of Z and A caused by decay and representation in simple decay equations
14.1.5	Existence of nuclear excited states	γ ray emission Application, e.g. use of technetium–99m as a gamma source in medical diagnosis
14.1.6	Probing matter	Scattering as a means of probing matter, including a qualitative discussion of the choice of bombarding radiation or particle, the physical principles involved in the scattering process, the processing and interpretation of data
14.1.7	Nuclear radius	Estimation of radius from closest approach of alpha particles and determination of radius from electron diffraction; knowledge of typical values Dependence of radius on nucleon number $R = r_o A^{\frac{1}{3}}$ derived from experimental data

15 A2 Module 7
Applied Physics

The option offers opportunities for students to reinforce and extend the work of modules PH01, PH02 and PH04 of the previous NEAB syllabus by considering applications in areas of engineering and technology. It embraces rotational dynamics and thermodynamics.

The emphasis should be on an understanding of the concepts and the application of Physics. Questions may be set in novel or unfamiliar contexts, but in all such cases the scene will be set and all relevant information will be given.

15.7 Rotational dynamics

15.7.1 Concept of moment of inertia

$$I = \sum mr^2$$

Expressions for moment of inertia will be given where necessary

15.7.2 Rotational kinetic energy

$$E_k = \tfrac{1}{2} I\omega^2$$

Factors affecting the energy storage capacity of a flywheel
Use of flywheels in machines

15.7.3 Angular displacement, velocity and acceleration

Equations for uniformly accelerated motion:

$$\omega_2 = \omega_1 + \alpha t$$

$$\theta = \omega_1 t + \tfrac{1}{2}\alpha t^2$$

$$\omega_2^2 = \omega_1^2 + 2\alpha\theta$$

$$\theta = \tfrac{1}{2}(\omega_1 + \omega_2)t$$

15.7.4 Torque and angular acceleration

$T = I\alpha$

15.7.5 Angular momentum

angular momentum = $I\omega$

Conservation of angular momentum

Angular impulse = change of angular momentum = Tt

15.7.6 Power

$W = T\theta$ $\quad$ $P = T\omega$

Awareness that, in rotating machinery, frictional couples have to be taken into account

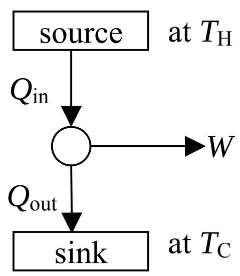
15.8 Thermodynamics and engines

15.8.1 First law of thermodynamics

$$\Delta Q = \Delta U + \Delta W$$

where ΔQ is heat entering the system, ΔU is increase in internal energy and ΔW is work done by the system
At constant pressure $\quad \Delta W = p\Delta V$

15.8.2	Non-flow processes	Isothermal and adiabatic changes, constant pressure and constant volume changes $pV = nRT$ $pV^{\gamma} = constant$ Application of first law of thermodynamics to the above processes
15.8.3	The $p - V$ diagram	Representation of processes on $p - V$ diagram Estimation of work done in terms of area below the graph Expressions for work done are not required except for the constant pressure case, $W = p\Delta V$ Extension to cyclic processes: *work done per cycle = area of loop*
15.8.4	Engine cycles	Understanding of a four-stroke petrol cycle and a Diesel engine cycle, and of the corresponding indicator diagrams; comparison with the theoretical diagrams for these cycles; a knowledge of engine constructional details is not required; where questions are set on other cycles, they will be interpretative and all essential information will be given; indicator diagrams predicting and measuring power and efficiency *input power = calorific value × fuel flow rate* Indicated power as (*area of p – V loop*) = (*no. of cycles/s*) × (*no. of cylinders*) Output or brake power $P = T\omega$ *friction power = indicated power – brake power* Engine efficiency; overall, thermal and mechanical efficiencies
15.8.5	Second Law and engines	Need for an engine to operate between a source and a sink $efficiency = \frac{W}{Q_{in}} = \frac{Q_{in} - Q_{out}}{Q_{in}}$ $maximum\ theoretical\ efficiency = \frac{T_H - T_C}{T_H}$



Reasons for the lower efficiencies of practical engines

Some notes from the Specification

Candidates should be made familiar with the typical 'trigger' words and expressions that examiners use in questions. Some examples are given below although AQA reserves the right to substitute alternative expressions if they make the meaning of a particular question clearer.

Trigger	Meaning	Example
State	Straightforward trigger for expressing a basic principle or law.	State Snell's law and the conditions under which it applies.
Describe	A list of features is required, often with some connections between them, but with the stress principally on factual information.	Describe the principal features of the *nuclear model of the atom* suggested by Rutherford.
Name	Normally, this requires a technical term or equivalent.	Name an example, other than a diode, of a non-ohmic electrical component.
Explain	This generally answers the question 'why?' and often involves the concepts of causality.	Explain how a chain reaction can occur only if the piece of uranium has a certain minimum mass.
Sketch	This normally demands a freehand drawing; in the case of a graph, a simple estimate of the curve is required; unless provided, axes should be correctly labelled.	Sketch below a graph showing how stress and strain are related for a ductile substance and label important features.
Plot	This requires that data should be presented as an appropriate graph on graph paper with points plotted accurately.	Plot a graph of (s/T) on the vertical axis against n on the horizontal axis.
Design	Usually, a candidate is being asked to go beyond factual information to plan a procedure to investigate a phenomenon (often found in Practical Examinations)	Design an experiment that investigates some characteristics of
Calculate	Normally, this requires candidates to show their working and to include appropriate units. Answers should be stated to an appropriate number of significant figures.	The iron ball is pulled back by a horizontal chain so that the suspension rope makes an angle of 30° with the vertical. Calculate the new tension in the suspension rope.

Quality of Written Communication

In each unit paper candidates may be awarded up to two marks for the Quality of Written Communication. Marks are not deducted for poor communication. The criteria for the award of marks for written communication are as follows:

2 marks: Candidates write with almost faultless accuracy (including grammar, spelling and appropriate punctuation); specialist terms are used confidently, accurately and with precision.

1 mark: Candidates write with reasonable and generally accurate expression (including grammar, spelling and appropriate punctuation); specialist terms are used with reasonable facility.

0 marks: Candidates who fail to reach the threshold for the award of one mark.