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Learner Guide

Cambridge IGCSE[®]

Physics

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Cambridge Secondary 2

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How to use this guide

The guide describes what you need to know about your Cambridge IGCSE Physics examination. It will help you to plan your revision programme for the written examinations and will explain what we are looking for in the answers you write. It can also be used to help you to revise by using the tick boxes in Section 4, 'What you need to know', to check what you know and which topic areas of Physics you have covered.

The guide contains the following sections:

Section 1: How will you be tested?

This section will give you information about the different types of theory and practical examination papers that are available.

Section 2: Examination advice

This section gives you advice to help you do as well as you can. Some of the ideas are general advice and some are based on the common mistakes that learners make in exams.

Section 3: What will be tested?

This section describes the areas of knowledge, understanding and skills that we will test you on.

Section 4: What you need to know

This shows the syllabus in a simple way so that you can check

- the topics you need to know about
- how the Extended syllabus (Supplement) differs from the Core syllabus
- details about each topic in the syllabus
- how much of the syllabus you have covered

Section 5: Appendices

This section covers other things you need to know such as:

- symbols, units and definitions of physical quantities
- the importance of the command words we use in examination papers
- information about the mathematical skills you need

Not all the information will be relevant to you. For example, you will need to select what you need to know in Sections 1 and 4 by finding out from your teacher which examination papers you will be taking.

Section 1: How will you be tested?

About the papers

You will be entered for **three** examination papers, **two** theory papers and **one** practical paper.

You will need to ask your teacher which practical paper you are taking. Nearer the time of the examination, you will also need to ask which theory papers you are being entered for. If your teacher thinks that you should enter for the examination based on the Core syllabus, you will take Paper 1, Paper 3 and one of the practical papers (5 or 6). If your teacher thinks that you should enter for the examination based on the Extended syllabus, you will take Paper 2, Paper 4 and one of the practical papers (5 or 6). Whether you take Paper 2 or 3 will depend on the progress your teacher thinks you have made and which paper best suits your particular strengths. You should discuss this with your teacher.

All learners are assessed on practical work. This is by taking either Paper 5 or Paper 6. You should check with your teacher which paper you are to take.

About the theory papers

The table gives you information about the theory papers

Paper number	How long is the paper?	What's in the paper?	What's the % of the total examination?
Paper 1 (Core)	45 minutes	40 multiple-choice questions. You choose one answer you consider correct from four possible answers.	30% (you do either Paper 1 or Paper 2)
Paper 2 (Extended)	45 minutes	40 multiple-choice questions. You choose one answer you consider correct from four possible answers.	30% (you do either Paper 1 or Paper 2)
Paper 3 (Core)	1 hour 15 minutes	Short-answer and structured questions. You should write your answers in the spaces provided. The paper tests topics in the Core syllabus.	50% (you do either Paper 3 or Paper 4)
Paper 4 (Extended)	1 hour 15 minutes	Short-answer and structured questions. You should write your answers in the spaces provided. The paper tests topics in the Extended syllabus.	50% (you do either Paper 3 or Paper 4)

Total 80%

About the practical papers

Twenty percent of the marks for Cambridge IGCSE Physics are for practical work. Practical work is based on experimental skills.

You will do **one** of the practical papers shown in the table. Your teacher will tell you which practical paper you will do.

Paper number and type	How long is the paper?	What's in the test/paper?
Paper 5 Practical Test	1 hour 15 minutes	A practical exam which is supervised by a teacher. There are usually four questions, three of which you will need to use apparatus.
Paper 6 Alternative to Practical	1 hour	A written paper about practical work. There are usually four questions which test the same skill areas as Paper 5.

Total 20%

Practical papers

Here is some more detail about each of the Practical Papers. If you are unsure of anything, ask your teacher.

Experimental skills tested in Paper 5: Practical Test and Paper 6: Alternative to Practical

You may be asked questions on the following experimental contexts:

- measurement of physical quantities such as length or volume or force
- cooling and heating
- springs and balances
- timing motion or oscillations
- electric circuits
- optics equipment such as mirrors, prisms and lenses
- procedures using simple apparatus, in situations where the method may not be familiar to you.

You may be required to do the following:

- use, or describe the use of, common techniques, apparatus and materials, for example ray-tracing equipment or the connection of electric circuits
- select the most appropriate apparatus or method for a task and justify the choice made
- draw, complete or label diagrams of apparatus
- explain the manipulation of the apparatus to obtain observations or measurements, for example:
 - when determining a derived quantity, such as the extension per unit load for a spring
 - when testing/identifying the relationship between two variables, such as between the p.d. across a wire and its length
 - when comparing physical quantities, such as two masses using a balancing method

- make estimates or describe outcomes which demonstrate their familiarity with an experiment, procedure or technique
- take readings from an appropriate measuring device or from an image of the device (for example thermometer, rule, protractor, measuring cylinder, ammeter, stopwatch), including:
 - reading analogue and digital scales with accuracy and appropriate precision
 - interpolating between scale divisions when appropriate
 - correcting for zero errors, where appropriate
- plan to take a sufficient number and range of measurements, repeating where appropriate to obtain an average value
- describe or explain precautions taken in carrying out a procedure to ensure safety or the accuracy of observations and data, including the control of variables
- identify key variables and describe how, or explain why, certain variables should be controlled
- record observations systematically, for example in a table, using appropriate units and to a consistent and appropriate degree of precision
- process data, using a calculator where necessary
- present and analyse data graphically, including the use of best-fit lines where appropriate, interpolation and extrapolation, and the determination of a gradient, intercept or intersection
- draw an appropriate conclusion, justifying it by reference to the data and using an appropriate explanation
- comment critically on a procedure or point of practical detail and suggest an appropriate improvement
- evaluate the quality of data, identifying and dealing appropriately with any anomalous results
- identify possible causes of uncertainty, in data or in a conclusion
- plan an experiment or investigation including making reasoned predictions of expected results and suggesting suitable apparatus and techniques.

Section 1: How will you be tested?

Section 2: Examination advice

This section highlights some common mistakes made by learners. They are collected under various subheadings to help you when you revise a particular topic.

General advice

- Read the questions carefully and fully.
- Look for details that indicate how to answer or the depth of answer required. For example the question 'Describe, in terms of the movement and energies of the water molecules, how evaporation takes place' is allocated two marks on a paper. This shows that you must make two valid points and you must refer to movement and energy of the molecules. So wording such as 'some molecules have more energy than others and these leave the surface' will gain both marks.
- Make sure you are confident with your calculator – particularly using powers of 10.
- Always show your working in calculations so that you can gain marks for your method even if you make a mistake with the final answer.
- Always include units where appropriate.
- Avoid vague descriptions – try to write clearly and concisely using the correct physics terms.
- Use a sharp pencil for graph work, taking care to plot each point with a small, neat cross and to draw a thin best fit line.
- At the end of a calculation ask yourself 'is this answer sensible?'
- Make sure you answer the question set. You will gain no marks for merely repeating the facts given in the question.

Paper 1 and Paper 2 advice

This is the multiple-choice test.

- Work through the paper with care. Do not miss out a question for any reason – you may then start placing your answers in the wrong places.
- Do not attempt to look for any pattern, or any lack of pattern in the answers. In other words, do not worry about how many questions have been answered A, B, C or D and do not worry about the distribution of As, Bs, Cs and Ds.

Paper 3 and Paper 4 advice

These are the papers that test your knowledge and understanding of physics theory and the ability to apply your knowledge to situations described on the paper. The following includes some tips on how to read the questions and advice on particular items in the syllabus that often seem to be poorly understood or applied. (This does not mean that other parts of the syllabus require any less revision of course!).

Reading the questions

- It is very easy when presented with a diagram question to look at the diagram and then try to answer the question. You must read and understand the introductory sentences above the diagram first before trying to answer the question. There may be a part of the question near the end which requires you to use a piece of information that is included in the introductory sentences in your answer.
- Be careful how you answer your questions. An explanation of some physics (even if correct) that does not answer the question set does not score marks.
- If there are three marks available for a calculation, two of the three marks are for showing your working.
- If a question states 'accurately mark' or 'accurately draw', we expect points (e.g. a centre of gravity) to be carefully positioned and lines to be drawn with care using a ruler. In the case of ray diagrams it is expected that rays drawn should pass at least within 1 mm of the relevant point (e.g. principal focus).
- When reading the questions, decide which area of physics you are being asked about. Do not just look at a few words as you may then misunderstand the question. For example a question that mentions heat radiation is not about radioactivity (just because the word 'radiation' is seen). If you are asked for a convection current diagram do not draw a circuit just because the word 'current' is in the question!

Answering the questions

Here are some examples that show the type of understanding that is required to answer questions successfully.

- You must understand the turning effect of a force and that it is called the moment of the force.
- You must be clear about the names given to types of energy and use them appropriately.
- You should know the circuit symbols required for use in describing electrical circuits. The symbol for a fuse is often not known and the symbols for a thermistor and a variable resistor are commonly confused with each other.
- You must know how to connect a voltmeter in parallel with the component across which you are measuring the potential difference.
- You must have a clear understanding of electromagnetic induction. For example, you must know that when a magnet is moved in or out of a solenoid that is part of a circuit, a current will be induced. It is the movement of the magnet in the solenoid that causes the current as its magnetic field lines cut the coil.
- You must understand the difference between mass and weight.
- You must understand basic radioactivity. You should know about the characteristics of the three types of emission (alpha, beta and gamma), half-life and safety precautions.

Paper 5 and Paper 6 advice

You will take one of these papers that test practical physics. There are some particular points that are relevant to answering the questions here.

- When plotting a graph it is important to choose the scales so that the plots occupy more than half of the graph grid. Careless, rushed graph plotting can lose several marks. You should always use a sharp pencil and plot small, neat, accurately placed crosses. Then draw a neat thin best-fit line.
- You should understand that if y is proportional to x then the graph will be a straight line through the origin.

- Diagrams should be drawn with care using a sharp pencil.
- It is important to be able to set up a circuit from a diagram, draw a circuit diagram of a circuit already set up and also to draw a circuit diagram from a written description.
- You need to know that to read the current through a component (e.g. a lamp or a resistor) and the voltage across it, the ammeter is placed in series with the component but the voltmeter must be connected in parallel with the component.
- Column headings in tables of readings must be headed with the quantity and unit as in these examples: I/A, or t/s, or y/m. Graph axes are labelled in the same way.
- Final answers should be given to two or three significant figures.
- When carrying out practical work there are usually measurements that are in some way difficult to take in spite of taking great care. You should comment about these difficulties when asked about precautions taken to improve accuracy.
- You should understand that the control of variables is an important aspect of practical work. You should be able to comment on the control of variables in a particular experiment.
- You should understand the significance of wording such as 'within the limits of experimental accuracy'.
- If you are asked to justify a statement that you have made it must be justified by reference to the readings. A theoretical justification in a practical test will not gain marks.

Section 3: What will be tested?

We take account of the following areas in your examination papers:

- your knowledge (what you remember) and understanding (how you use what you know and apply it to unfamiliar situations)
- how you handle information and solve problems
- your use of experimental skills

These areas of knowledge and skills are called assessment objectives. The theory papers test mainly AO1 (knowledge with understanding) and AO2 (handling information and problem solving). You should note that only half the marks available for AO1 are for simple recall. The purpose of the practical paper is to test AO3 (experimental skill and investigations). Your teacher will be able to give you more information about how each of these is used in examination papers. The table shows you the range of skills you should try to develop.

Assessment objective	What the skill means	What you need to be able to do
AO1 Knowledge with understanding	remembering facts and applying these facts to new situations	Use scientific ideas, facts and laws Know the meaning of scientific terms e.g. centre of mass Know about apparatus and how it works Know about symbols, quantities (e.g. mass and weight) and units (e.g. kg and N) Understand the importance of science in everyday life
AO2 Handling information and problem solving	how you extract information and rearrange it in a sensible pattern and how you carry out calculations and make predictions	Select and organise information from graphs, tables and written text Change information from one form to another e.g. draw graphs. Arrange data and carry out calculations Identify patterns from information given and draw conclusions Explain scientific relationships, e.g. use the moving (kinetic) particle theory to explain ideas about solids, liquids and gases. Make predictions and develop scientific ideas Solve problems
AO3 Experimental skills and investigations	planning and carrying out experiments and recording and analysing information	Set up and use apparatus safely Make observations and measurements and record them Analyse experimental results and suggest how valid they are Plan and carry out your own experiment and describe to what extent your plan worked

Section 3: What will be tested?

Section 4: What you need to know

The following table describes the things you may be tested on in the examination. If you are studying only the Core syllabus (Papers 1 and 3), you will need to refer only to the column headed Core material. If you are studying the Extended syllabus (Papers 2 and 4), you will need to refer to both the Core material and the Extended material columns. If you are unsure about which material to use, you should ask your teacher for advice.

How to use the table

You can use the table throughout your course to check the topic areas you have covered. You can also use it as a revision aid. When you think you have a good knowledge of a topic, you can tick the appropriate box in the checklist column. The main headings in the topic areas are usually followed by the details of what you should know. Test yourself as follows:

- cover up the details with a piece of paper
- try to remember the details
- when you have remembered the details correctly, put a tick in the appropriate box.

If you use a pencil to tick the boxes, you can retest yourself whenever you want by simply rubbing out the ticks. If you are using the table to check which topics you have covered, you can put a tick in the topic column, next to the appropriate bullet point.

The column headed 'Comments' can be used:

- to add further information about the details for each bullet point
- to add learning aids, e.g. simple equations set out in a triangle to help in rearranging the equation
- to highlight areas of difficulty/ things you need to ask your teacher about.

Topic	Core material		Extended material	
	You should be able to:	Checklist	You should be able to:	Checklist
1. General physics 1.1 Length and time	<ul style="list-style-type: none"> Use and describe the use of rules and measuring cylinders to find a length or a volume Use and describe the use of clocks and devices, both analogue and digital, for measuring an interval of time Obtain an average value for a small distance and for a short interval of time by measuring multiples (including the period of a pendulum) 	<p><input type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p>	<ul style="list-style-type: none"> Understand that a micrometer screw gauge is used to measure very small distances 	<p><input type="checkbox"/></p>

Topic	Core material		Extended material	
	You should be able to:	Checklist	You should be able to:	Checklist
1.5.2 Turning effect	<ul style="list-style-type: none"> Describe the moment of a force as a measure of its turning effect and give everyday examples Understand that increasing force or distance from the pivot increases the moment of a force Calculate moment using the product force \times perpendicular distance from the pivot Apply the principle of moments to the balancing of a beam about a pivot 	<input type="checkbox"/> <input type="checkbox"/>	<ul style="list-style-type: none"> Apply the principle of moments to different situations 	<input type="checkbox"/>
1.5.3 Conditions for equilibrium	<ul style="list-style-type: none"> Recognise that, when there is no resultant force and no resultant turning effect, a system is in equilibrium 	<input type="checkbox"/>	<ul style="list-style-type: none"> Perform and describe an experiment (involving vertical forces) to show that there is no net moment on a body in equilibrium 	<input type="checkbox"/>
1.5.4 Centre of mass	<ul style="list-style-type: none"> Perform and describe an experiment to determine the position of the centre of mass of a plane lamina Describe qualitatively the effect of the position of the centre of mass on the stability of simple objects 	<input type="checkbox"/> <input type="checkbox"/>		

Topic	Core material		Extended material	
	You should be able to:	Checklist	Comments	You should be able to:
1.5.5 Scalars and vectors				<ul style="list-style-type: none"> Understand that vectors have a magnitude and direction Demonstrate an understanding of the difference between scalars and vectors and give common examples Determine graphically the resultant of two vectors
1.6 Momentum				<ul style="list-style-type: none"> Understand the concepts of momentum and impulse Recall and use the equation momentum = mass \times velocity, $p = mv$ Recall and use the equation for impulse $Ft = mv - mu$ Apply the principle of the conservation of momentum to solve simple problems in one dimension

Topic	Core material		Extended material	
	You should be able to:	Checklist	You should be able to:	Checklist
1.7.3 Work	<ul style="list-style-type: none"> Demonstrate understanding that work done = energy transferred Relate (without calculation) work done to the magnitude of a force and the distance moved in the direction of the force 	<input type="checkbox"/> <input type="checkbox"/>	<ul style="list-style-type: none"> Recall and use $W = Fd = \Delta E$ 	<input type="checkbox"/>
1.7.4 Power	<ul style="list-style-type: none"> Relate (without calculation) power to work done and time taken, using appropriate examples 	<input type="checkbox"/>	<ul style="list-style-type: none"> Recall and use the equation $P = \Delta E/t$ in simple systems 	<input type="checkbox"/>
1.8 Pressure	<ul style="list-style-type: none"> Recall and use the equation $p = F/A$ Relate pressure to force and area, using appropriate examples Describe the simple mercury barometer and its use in measuring atmospheric pressure Relate (without calculation) the pressure beneath a liquid surface to depth and to density, using appropriate examples Use and describe the use of a manometer 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<ul style="list-style-type: none"> Recall and use the equation $p = h\rho g$ 	<input type="checkbox"/>

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
2.1.3 Evaporation	<ul style="list-style-type: none"> Describe evaporation in terms of the escape of more-energetic molecules from the surface of a liquid Relate evaporation to the consequent cooling of the liquid 	<input type="checkbox"/> <input type="checkbox"/>		<ul style="list-style-type: none"> Demonstrate an understanding of how temperature, surface area and draught over a surface influence evaporation Explain the cooling of a body in contact with an evaporating liquid 	<input type="checkbox"/> <input type="checkbox"/>	
2.1.4 Pressure changes	<ul style="list-style-type: none"> Describe qualitatively, in terms of molecules, the effect on the pressure of a gas of: <ul style="list-style-type: none"> a change of temperature at constant volume a change of volume at constant temperature 	<input type="checkbox"/>		<ul style="list-style-type: none"> Recall and use the equation $pV = \text{constant}$ for a fixed mass of gas at constant temperature 	<input type="checkbox"/>	
2.2 Thermal properties and temperature	<ul style="list-style-type: none"> Describe qualitatively the thermal expansion of solids, liquids, and gases at constant pressure 	<input type="checkbox"/>		<ul style="list-style-type: none"> Explain, in terms of the motion and arrangement of molecules, the relative order of the magnitude of the expansion of solids, liquids and gases 	<input type="checkbox"/>	
2.2.1 Thermal expansion of solids, liquids and gases	<ul style="list-style-type: none"> Identify and explain some of the everyday applications and consequences of thermal expansion 	<input type="checkbox"/>				

Topic	Core material		Extended material		
	You should be able to:	Checklist	You should be able to:	Checklist	
2.2.4 Melting and boiling	<ul style="list-style-type: none"> Describe melting and boiling in terms of energy input without a change in temperature State the meaning of melting point and boiling point Describe condensation and solidification in terms of molecules 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<ul style="list-style-type: none"> Distinguish between boiling and evaporation Use the terms latent heat of vaporisation and latent heat of fusion and give a molecular interpretation of latent heat Define specific latent heat Describe an experiment to measure specific latent heats for steam and for ice Recall and use the equation energy = ml 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments
2.3 Thermal processes	<ul style="list-style-type: none"> Describe experiments to demonstrate the properties of good and bad thermal conductors 	<input type="checkbox"/>	<ul style="list-style-type: none"> Give a simple molecular account of conduction in solids including lattice vibration and transfer by electrons 	<input type="checkbox"/>	
2.3.1 Conduction					
2.3.2 Convection	<ul style="list-style-type: none"> Recognise convection as an important method of thermal transfer in fluids Relate convection in fluids to density changes and describe experiments to illustrate convection 	<input type="checkbox"/> <input type="checkbox"/>			

Topic	Core material		Extended material	
	You should be able to:	Checklist	You should be able to:	Checklist
3. Properties of waves, including light and sound	<ul style="list-style-type: none"> Demonstrate understanding that waves transfer energy without transferring matter 	<input type="checkbox"/>	<ul style="list-style-type: none"> Recall and use the equation $v = f\lambda$ 	<input type="checkbox"/>
3.1 General wave properties	<ul style="list-style-type: none"> Describe what is meant by wave motion as illustrated by vibration in ropes and springs and by experiments using water waves Use the term wavefront Give the meaning of speed, frequency, wavelength and amplitude Distinguish between transverse and longitudinal waves and give suitable examples Describe how waves can undergo: <ul style="list-style-type: none"> – reflection at a plane surface – refraction due to a change of speed – diffraction through a narrow gap Describe the use of water waves to demonstrate reflection, refraction and diffraction 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<ul style="list-style-type: none"> Describe how wavelength and gap size affects diffraction through a gap Describe how wavelength affects diffraction at an edge 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

Topic	Core material		Extended material	
	You should be able to:	Checklist	You should be able to:	Checklist
3.2 Light				
3.2.1 Reflection of light	<ul style="list-style-type: none"> Describe the formation of an optical image by a plane mirror, and give its characteristics Recall and use the law angle of incidence = angle of reflection 	<input type="checkbox"/> <input type="checkbox"/>	<ul style="list-style-type: none"> Recall that the image in a plane mirror is virtual Perform simple constructions, measurements and calculations for reflection by plane mirrors 	<input type="checkbox"/> <input type="checkbox"/>
3.2.2 Refraction of light	<ul style="list-style-type: none"> Describe an experimental demonstration of the refraction of light Use the terminology for the angle of incidence i and angle of refraction r and describe the passage of light through parallel-sided transparent material Give the meaning of critical angle Describe internal and total internal reflection 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<ul style="list-style-type: none"> Recall and use the definition of refractive index n in terms of speed Recall and use the equation $\frac{\sin i}{\sin r} = n$ Recall and use $n = \frac{1}{\sin c}$ Describe and explain the action of optical fibres particularly in medicine and communications technology 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
3.2.3 Thin converging lens	<ul style="list-style-type: none"> Describe the action of a thin converging lens on a beam of light Use the terms principal focus and focal length Draw ray diagrams for the formation of a real image by a single lens Describe the nature of an image using the terms enlarged/same size/diminished and upright/inverted 	<input type="checkbox"/> <input type="checkbox"/>		<ul style="list-style-type: none"> Draw and use ray diagrams for the formation of a virtual image by a single lens Use and describe the use of a single lens as a magnifying glass Show understanding of the terms real image and virtual image 	<input type="checkbox"/> <input type="checkbox"/>	
3.2.4 Dispersion of light	<ul style="list-style-type: none"> Give a qualitative account of the dispersion of light as shown by the action on light of a glass prism including the seven colours of the spectrum in their correct order 	<input type="checkbox"/>		<ul style="list-style-type: none"> Recall that light of a single frequency is described as monochromatic 	<input type="checkbox"/>	

Topic	Core material		Extended material	
	You should be able to:	Checklist	You should be able to:	Checklist
4.2 Electrical quantities	<ul style="list-style-type: none"> State that there are positive and negative charges 	<input type="checkbox"/>	<ul style="list-style-type: none"> State that charge is measured in coulombs 	<input type="checkbox"/>
4.2.1 Electric charge	<ul style="list-style-type: none"> State that unlike charges attract and that like charges repel 	<input type="checkbox"/>	<ul style="list-style-type: none"> State that the direction of an electric field at a point is the direction of the force on a positive charge at that point 	<input type="checkbox"/>
	<ul style="list-style-type: none"> Describe simple experiments to show the production and detection of electrostatic charges 	<input type="checkbox"/>	<ul style="list-style-type: none"> Describe an electric field as a region in which an electric charge experiences a force 	<input type="checkbox"/>
	<ul style="list-style-type: none"> State that charging a body involves the addition or removal of electrons 	<input type="checkbox"/>	<ul style="list-style-type: none"> Describe simple field patterns, including the field around a point charge, the field around a charged conducting sphere and the field between two parallel plates (not including end effects) 	<input type="checkbox"/>
	<ul style="list-style-type: none"> Distinguish between electrical conductors and insulators and give typical examples 	<input type="checkbox"/>	<ul style="list-style-type: none"> Give an account of charging by induction Recall and use a simple electron model to distinguish between conductors and insulators 	<input type="checkbox"/>

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
4.2.2 Current	<ul style="list-style-type: none"> State that current is related to the flow of charge Use and describe the use of an ammeter, both analogue and digital State that current in metals is due to a flow of electrons 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		<ul style="list-style-type: none"> Show understanding that a current is a rate of flow of charge and recall and use the equation $I = Q/t$ Distinguish between the direction of flow of electrons and conventional current 	<input type="checkbox"/> <input type="checkbox"/>	
4.2.3 Electromotive force	<ul style="list-style-type: none"> State that the e.m.f. of an electrical source of energy is measured in volts 	<input type="checkbox"/>		<ul style="list-style-type: none"> Show understanding that e.m.f. is defined in terms of energy supplied by a source in driving charge round a complete circuit 	<input type="checkbox"/>	
4.2.4 Potential difference	<ul style="list-style-type: none"> State that the potential difference (p.d.) across a circuit component is measured in volts Use and describe the use of a voltmeter, both analogue and digital 	<input type="checkbox"/> <input type="checkbox"/>		<ul style="list-style-type: none"> Recall that 1 V is equivalent to 1 J/C 	<input type="checkbox"/>	

Topic	Core material		Extended material		
	You should be able to:	Checklist	You should be able to:	Checklist	
4.6.2 a.c. generator	<ul style="list-style-type: none"> Distinguish between direct current (d.c.) and alternating current (a.c.) 	<input type="checkbox"/>	<ul style="list-style-type: none"> Describe and explain a rotating-coil generator and the use of slip rings Sketch a graph of voltage output against time for a simple a.c. generator Relate the position of the generator coil to the peaks and zeros of the voltage output 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments
4.6.3 Transformer	<ul style="list-style-type: none"> Describe the construction of a basic transformer with a soft-iron core, as used for voltage transformations Recall and use the equation $(V_p/V_s) = (N_p/N_s)$ Understand the terms step-up and step-down Describe the use of the transformer in high-voltage transmission of electricity Give the advantages of high-voltage transmission 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<ul style="list-style-type: none"> Describe the principle of operation of a transformer Recall and use the equation $V_p = I_s V_s$ (for 100% efficiency) Explain why power losses in cables are lower when the voltage is high 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
4.6.6 d.c. motor	<ul style="list-style-type: none"> State that a current-carrying coil in a magnetic field experiences a turning effect and that the effect is increased by: <ul style="list-style-type: none"> – increasing the number of turns on the coil – increasing the current – increasing the strength of the magnetic field 	<input type="checkbox"/>		<ul style="list-style-type: none"> Relate this turning effect to the action of an electric motor including the action of a split-ring commutator 	<input type="checkbox"/>	
5. Atomic physics 5.1 The nuclear atom 5.1.1 Atomic model	<ul style="list-style-type: none"> Describe the structure of an atom in terms of a positive nucleus and negative electrons 	<input type="checkbox"/>		<ul style="list-style-type: none"> Describe how the scattering of α-particles by thin metal foils provides evidence for the nuclear atom 	<input type="checkbox"/>	

Topic	Core material		Extended material	
	You should be able to:	Checklist	You should be able to:	Checklist
5.2.2 Characteristics of the three kinds of emission	<ul style="list-style-type: none"> Discuss the random nature of radioactive emission Identify α, β and γ-emissions by recalling <ul style="list-style-type: none"> their nature their relative ionising effects their relative penetrating abilities (β^+ are not included, β^- particles will be taken to refer to β^-) 	<input type="checkbox"/> <input type="checkbox"/>	<ul style="list-style-type: none"> Describe their deflection in electric fields and in magnetic fields Interpret their relative ionising effects Give and explain examples of practical applications of α, β and γ-emissions 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
5.2.3 Radioactive decay	<ul style="list-style-type: none"> State the meaning of radioactive decay State that during α- or β-decay the nucleus changes to that of a different element 	<input type="checkbox"/> <input type="checkbox"/>	<ul style="list-style-type: none"> Use equations involving nuclide notation to represent changes in the composition of the nucleus when particles are emitted 	<input type="checkbox"/>
5.2.4 Half-life	<ul style="list-style-type: none"> Use the term half-life in simple calculations, which might involve information in tables or decay curves 	<input type="checkbox"/>	<ul style="list-style-type: none"> Calculate half-life from data or decay curves from which background radiation has not been subtracted 	<input type="checkbox"/>
5.2.5 Safety precautions	<ul style="list-style-type: none"> Recall the effects of ionising radiations on living things Describe how radioactive materials are handled, used and stored in a safe way 	<input type="checkbox"/> <input type="checkbox"/>		

Section 5: Appendices

Symbols, units and definitions of physical quantities

You should be able to state the symbols for the following physical quantities and, where indicated, state the units in which they are measured. The list for the Extended syllabus includes both the Core and the Supplement.

You should be familiar with the following multipliers: M mega, k kilo, c centi, m milli.

Core			Supplement		
Quantity	Usual symbol	Usual unit	Quantity	Usual symbol	Usual unit
length	$l, h \dots$	km, m, cm, mm			
area	A	m^2, cm^2			
volume	V	m^3, cm^3			
weight	W	N			
mass	m, M	kg, g	mass	m, M	mg
time	t	h, min, s	time	t	ms
density	ρ	$\text{g}/\text{cm}^3, \text{kg}/\text{m}^3$			
speed	u, v	km/h, m/s, cm/s			
acceleration	a		acceleration	a	m/s^2
acceleration of free fall	g		acceleration of free fall	g	m/s^2
force	F	N			
gravitational field strength	g	N/kg			
			momentum	p	kg m/s
			impulse		N s
moment of a force		N m			
work done	W, E	J, kJ, MJ			
energy	E	J, kJ, MJ			
power	P	W, kW, MW			
pressure	p	N/m^2	pressure	p	Pa
atmospheric pressure		mm Hg			
temperature	θ, T	$^{\circ}\text{C}$			

Core			Supplement		
Quantity	Usual symbol	Usual unit	Quantity	Usual symbol	Usual unit
			thermal capacity (heat capacity)	C	$\text{J}/^\circ\text{C}$
			specific heat capacity	c	$\text{J}/(\text{g } ^\circ\text{C}),$ $\text{J}/(\text{kg } ^\circ\text{C})$
latent heat	L	J			
			specific latent heat	l	$\text{J}/\text{kg}, \text{J}/\text{g}$
frequency	f	Hz, kHz			
wavelength	λ	m, cm			
focal length	f	cm			
angle of incidence	i	degree ($^\circ$)			
angle of reflection, refraction	r	degree ($^\circ$)			
critical angle	c	degree ($^\circ$)			
			refractive index	n	
potential difference/voltage	V	V, mV			
current	I	A, mA			
e.m.f.	E	V			
resistance	R	Ω			
			charge	Q	C

Command words and phrases

We use command words to help you to write down the answer they are looking for. This table explains what each of these words or phrases means and will help you to understand the kind of answer you should write. The list is in alphabetical order. You should bear in mind that the meaning of a term may vary slightly according to how the question is worded.

Command word/phrase	Meaning
Calculate	A numerical answer is needed. You should show any working, especially when there are two or more steps in a calculation. <i>e.g. calculate the refractive index</i>
Deduce	This may be used in two ways: (i) You find the answer by working out the patterns in the information given to you and drawing logical conclusions from them. You may need to use information from tables and graphs and do calculations <i>e.g. deduce what will happen to velocity of the vehicle if ...</i> (ii) You have to refer to a Law or scientific theory or give a reason for your answer <i>e.g. use your knowledge of the kinetic theory to deduce what will happen when ...</i>
Define	You need to state the meaning of something, <i>e.g. define speed</i>
Describe	You need to state the main points about something (using labelled diagrams if it helps you). <i>e.g. describe a rotating-coil generator</i> You may also be asked to describe <ul style="list-style-type: none"> • observations <i>e.g. describe the ways in which a force may change the motion of a body</i> • how to do particular experiments <i>e.g. describe an experiment to determine resistance using a voltmeter and an ammeter</i>
Determine	You are expected to use a formula or method that you know to calculate a quantity. <i>e.g. determine graphically the resultant of two vectors</i>
Discuss	You have to write down points for and against an argument. <i>e.g. discuss the energy loss in cables</i>
Estimate	Suggest an approximate value for a quantity based on reasons and data. You may need to make some approximations. <i>e.g. estimate the volume of a test tube.</i>
Explain	You have to give reasons for your answer OR refer to a particular theory.
Find	This is a general term meaning several similar things such as calculate, measure, determine, etc.
List	Write down a number of separate points. Where the number of points is stated in the question, you should not write more than this number. <i>e.g. list three uses of converging lenses</i>

Command word/phrase	Meaning
Meant (what is meant by the term...)	See 'Understand'
Measure	You are expected to find a quantity by using a measuring instrument. <i>e.g. length (by using a ruler), volume (by using a measuring cylinder)</i>
Outline	State the main points briefly. <i>e.g. outline a method of magnetising an iron bar</i>
Predict	This can be used in two ways: (i) You find the answer by working out the patterns in the information provided and drawing logical conclusions from this. You may need to use information from tables and graphs and do calculations. <i>e.g. predict what will happen to the direction of the resultant force if</i> (ii) It may also mean giving a short answer to a question stating what might happen next. <i>e.g. predict what effect an increase in temperature will have on the resistance.</i>
Sketch	(i) When drawing graphs, this means that you may draw the approximate shape and/or position of the graph BUT you need to make sure that important details, such as the line passing through the origin or finishing at a certain point, are drawn accurately. (ii) When drawing apparatus or other diagrams, a simple line drawing is all that is needed, but you must make sure that the proportions are correct and the most important details are shown. You should always remember to label your diagrams.
State	You should give a short answer without going into any detail. <i>e.g. state the hazards of damaged electrical insulation</i> BUT: 'state the meaning of...' is different. It is more like 'understand'.
Suggest	This may be used in two ways: (i) There may be more than one correct answer. <i>e.g. suggest a precaution to improve the accuracy of the experiment</i> (ii) You are being asked to apply your general knowledge of physics or reasoning skills to a topic area that is not on the syllabus. <i>e.g. applying ideas about moments to the stability of a vehicle</i>
Understand (what do you understand by the term.)	You should (i) define something and (ii) make a more detailed comment about it. The amount of detail depends on the number of marks awarded. <i>e.g. what do you understand by the term total internal reflection</i>

Mathematical skills

This is a checklist of the mathematical skills you need for your physics exam.

Tick each box in the checklist when you know that you have got this skill.

Ask your teacher to explain these skills if you are unsure. The comment column is for extra notes and examples.

You can use a calculator for all the papers. You should make sure that you remove any information from your calculator, if it is programmable.

You can:	Checklist	Comments
<ul style="list-style-type: none"> add, subtract, multiply and divide 	<input type="checkbox"/>	
use: <ul style="list-style-type: none"> averages decimals fractions percentages ratios reciprocals 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
<ul style="list-style-type: none"> use standard notation (notation is putting symbols for numbers e.g. $x = 2$, $y = 5$, atomic mass, $Z = 12$) including both positive and negative indices 	<input type="checkbox"/>	
<ul style="list-style-type: none"> understand significant figures and use them appropriately 	<input type="checkbox"/>	
<ul style="list-style-type: none"> use direct proportion (stepwise increases) use inverse proportion (inverse means turned up side down) 	<input type="checkbox"/> <input type="checkbox"/>	You should know that if you plot a graph of y against x , then a straight line <u>through the origin</u> shows that y is directly proportional to x the inverse of 4 is $\frac{1}{4}$ (= 0.25)
<ul style="list-style-type: none"> use positive, whole number indices in algebraic expressions 	<input type="checkbox"/>	
<ul style="list-style-type: none"> draw charts graphs with line of best fit 	<input type="checkbox"/> <input type="checkbox"/>	You will be given the data
interpret: <ul style="list-style-type: none"> bar graphs pie charts line graphs 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
<ul style="list-style-type: none"> determine the gradient and intercept of a graph 	<input type="checkbox"/>	
<ul style="list-style-type: none"> select suitable scales and axes for graphs 	<input type="checkbox"/>	
<ul style="list-style-type: none"> make approximate evaluations of numerical expressions 	<input type="checkbox"/>	

You can:	Checklist	Comments
recall and use equations for: <ul style="list-style-type: none"> • the area of a rectangle • the area of a triangle • the area of a circle • the volume of a rectangular block • the volume of a cylinder 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	area = length \times width volume = length \times breadth \times height
<ul style="list-style-type: none"> • use a ruler, compasses, protractor and set square 	<input type="checkbox"/>	
understand the meaning of: <ul style="list-style-type: none"> • angle • curve • circle • radius • diameter • circumference • square • parallelogram • rectangle • diagonal 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
<ul style="list-style-type: none"> • solve equations of the form $x = y + z$ and $x = yz$ when two of the terms are known 	<input type="checkbox"/>	
<ul style="list-style-type: none"> • recognise and use clockwise and anticlockwise directions 	<input type="checkbox"/>	
<ul style="list-style-type: none"> • recognise and use points of the compass (N, S, E, W) 	<input type="checkbox"/>	
<ul style="list-style-type: none"> • use sines and inverse sines (Extended syllabus only) 	<input type="checkbox"/>	

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