CAMBRIDGE
International Examinations

Cambridge
IGCSE

Learner Guide

Cambridge IGCSE®
Physics
0625

Cambridge Secondary 2

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How to use this guide

The guide describes what you need to know about your IGSCE 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 tips

This section gives you advice to help you do as well as you can. Some of the tips 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. It is particularly important to realise that most marks are awarded for understanding and skills and only 25% of the total mark is for simple recall.

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?

1.1 The examination Papers you will take

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 (theory), Paper 2 (theory) and one of the practical Papers (4 or 5 or 6). If your teacher thinks that you should enter for the examination based on the Extended syllabus, you will take Paper 1 (theory), Paper 3 (theory) and one of the practical Papers (4 or 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 4 OR Paper 5 OR Paper 6. You should check with your teacher which paper you are to take.

1.2 About the theory Papers

The table gives you information about the theory Papers

Paper number	How long and how many marks?	What's in the Paper?	What's the % of the total examination?
Paper 1	45 minutes	40 multiple choice questions. You choose one answer you consider correct from 4 possible answers.	30%
Paper 2	1¼ hours	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 2 **or** Paper 3)
Paper 3	1¼ hours	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 2 **or** Paper 3)
Practical Paper	see next table	see next table	20%

Total 100%

1.3 About the practical Papers

Twenty percent of the marks for IGCSE Physics are for practical work. Practical work is based only on the Core syllabus.

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 and how many marks?	What's involved?
Paper 4 (coursework)	no fixed time	You design and carry out experiments, which are then marked by your teacher. You will be assessed on 4 skill areas. You need to produce 2 pieces of work for each skill area.
Paper 5 (practical test)	1¼ hours	You do a practical exam which is supervised by a teacher. You will carry out 4 short experiments.
Paper 6 (alternative to practical)	1 hour	You answer a written paper about practical work. There are usually 5 questions which test the same skill areas as Paper 5.

The Practical papers

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

1.3.1 Paper 4 (coursework)

You will carry out several experiments throughout your Physics course, which will be marked by your teacher. Your teacher will mark you on 4 skill areas. What you have to do to get a basic (B), medium (M) or high (H) mark is shown below. You could use a highlighter pen, or underlining, to note the differences between basic, medium and high.

Skill C1: Using apparatus

You follow written instructions to set up and use apparatus correctly. You carry out your work safely.

B: You follow instructions correctly to do a single practical operation e.g. set up a simple circuit and record the current.

You use familiar apparatus, with a little help on points of safety.

M: You follow instructions correctly to do a series of step-by-step practical operations, e.g. set up a circuit and record a series of voltage and current readings.

You use familiar apparatus fairly well, with no help on points of safety.

H: You follow instructions correctly to do a series of step-by-step practical operations, but may need to change one step if things don't work out as you thought, e.g. use a wider range of loads to extend a spring a measurable amount.

You use familiar apparatus very well, with no help on points of safety.

Skill C2: Observing

You make observations and measurements and write them down clearly.

B: You make suitable observations when given some detailed instructions.

You record results correctly when given a detailed table or some help.

M: You make suitable observations when given minimal instructions.

You record results correctly when given an outline table or minimal help.

H: You make suitable observations without help and record results as accurately as the apparatus allows.

You record results correctly without help.

Skill C3: Handling results

You draw graphs and/or perform calculations from your results. You draw conclusions from your results and recognize any results, which do not fit into the pattern.

B: You draw graphs (or do some calculations) from your results when given detailed suggestions.

You draw simple conclusions from your results.

M: You draw graphs (or do some calculations) from your results when given only a little help.

You draw simple conclusions from your results and comment on the patterns shown by the data, e.g. the extension of a spring is proportional to the load.

You comment on results, which do not fit the pattern.

H: You draw graphs (or do some calculations) from your results when given no help.

You draw more general conclusions from your results and comment on the patterns, e.g. the resistance of the wire increases with temperature.

You comment on results which do not fit the pattern and suggest how to deal with them, e.g. repeat a reading.

You suggest what errors there are in your experiment.

Skill C4: Planning and evaluating

You plan your experiment given some basic information from your teacher. You suggest how well your plan worked and modify if necessary.

B: You write a simple plan for your experiment.

You modify your plan after doing several experiments to see which works the best.

M: You write a plan for your experiment, which has a series of logical steps in it.

You modify your plan after doing trial experiments and give reasons why you need to alter your original plan.

If there are two variables (things which can change e.g. length of wire, diameter of wire), you recognise that one variable needs to be changed, while the other is kept the same, e.g. keep the diameter of the wire the same but vary the length.

H: You write a plan for your experiment which has a series of logical and clearly reasoned steps.

You modify your plan after doing trial experiments, give reasons why you need to alter your original plan and suggest to what extent your plan works, and why. You suggest how to deal with unexpected results.

If there are more than two variables, you recognise which needs to be controlled (kept constant) and which needs to be changed.

1.3.2 Paper 5 (Practical test)

You do a practical exam, which is supervised by a teacher. You are given full instructions on the Question Paper, which enable you carry out the experiments, handle the data and draw appropriate conclusions. You may be asked to use the following techniques:

- recording current and potential difference and drawing circuit diagrams
- ray tracing and drawing ray diagrams
- measuring temperature
- balancing (centre of mass and moments)
- stretching of springs
- timing of oscillations

1.3.3 Paper 6 (alternative to practical)

This is a written paper, testing the same skills as Paper 5. You may be asked to:

- record readings from diagrams of apparatus e.g. current readings
- answer questions on the arrangement of apparatus
- complete tables of data
- draw conclusions from information
- answer questions about experimental data
- plot a graph from a table of readings
- interpret information from graphs
- draw ray diagrams
- identify sources of error and suggest improvements in the experiment
- suggest suitable apparatus for investigations

You will need to do plenty of practical work during the course in order to score a good mark on this Paper in the examination.

Section 2: Examination tips

These tips highlight 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 2 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 tips

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.

Papers 2 and 3 tips

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 that a substance melts and freezes at the same temperature and also understand the ice and steam points as used in the calibration of thermometers.
- 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 and be able to explain the concept of terminal velocity.
- You must understand the difference between mass and weight.
- You must be confident in drawing diagrams showing wavefronts as well as those showing rays.
- 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. The difference between nuclear fission and nuclear fusion must also be understood.

Papers 5 and 6 tips

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 2 or 3 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 Objective A (knowledge with understanding) and Assessment Objective B (handling information and problem solving). You should note that only half the marks available for Assessment Objective A are for simple recall. The purpose of the practical Paper is to test Assessment Objective C (experimental skills). 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.

Skill	What the skill means	What you need to be able to do
A: Knowledge with understanding	remembering facts and applying these facts to new situations	1. use scientific ideas, facts and laws 2. know the meaning of scientific terms e.g. centre of mass 3. know about apparatus and how it works 4. know about symbols, quantities (e.g. mass and weight) and units (e.g. kg and N) 5. understand the importance of science in everyday life
B: Handling information and solving problems	how you extract information and rearrange it in a sensible pattern and how you carry out calculations and make predictions	1. select and organize information from graphs, tables and written text 2. change information from one form to another e.g. draw graphs. 3. arrange data and carry out calculations 4. identify patterns from information given and draw conclusions 5. explain scientific relationships, e.g. use the moving (kinetic) particle theory to explain ideas about solids, liquids and gases. 6. make predictions and develop scientific ideas 7. solve problems
C: experimental skills and investigations	planning and carrying out experiments and recording and analysing information	1. set up and use apparatus safely 2. make observations and measurements and record them 3. analyse experimental results and suggest how valid they are 4. plan and carry out your own experiment and describe to what extent your plan worked

Section 4: What you need to know

This is a table, which describes the things you may be tested on in the examination. If you are studying only the Core syllabus (Papers 1 and 2), you will need to refer only to the column headed Core material. If you are studying the Extended syllabus (Papers 1 and 3), 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 you 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	Comments	You should be able to:	Checklist	Comments
General Physics						
Length and time	• Use rules and measuring cylinders to calculate a length or a volume. • Use clocks and stopwatches to measure intervals of time.	☐ ☐		• Use mechanical methods for the measurement of a small distance, including the micrometer screw gauge. • Measure a short interval of time, including the period of a pendulum.	☐ ☐	
Speed, velocity and acceleration	• Define speed and calculate speed from – total distance – total time • Plot and interpret a speed/time graph or a distance/time graph • Recognise from the shape of a speed/time graph when a body is (a) at rest, (b) moving with constant speed, (c) moving with changing speed.	☐ ☐ ☐		• Distinguish between speed and velocity • Recognise linear motion for which the acceleration is constant and calculate the acceleration. • Recognise motion for which the acceleration is not constant.	☐ ☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
	• Calculate the area under a speed/time graph to determine the distance travelled for motion with constant acceleration.	☐		• Describe qualitatively the motion of bodies falling in a uniform gravitational field with and without air resistance (including reference to terminal velocity).	☐	
	• Demonstrate some understanding that acceleration is related to changing speed. • State that the acceleration of free fall for a body near to the Earth is constant.	☐ ☐			☐ ☐ ☐	
Mass and weight	• Show familiarity with the idea of the mass of a body. • State that weight is a force. • Demonstrate understanding that weights (and hence masses) may be compared using a balance.	☐ ☐ ☐		• Demonstrate an understanding that mass is a property which 'resists' change in motion. • Describe, and use the concept of weight as the effect of a gravitational field on a mass.	☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
Density	• Describe an experiment to determine the density of a liquid and the density of a regularly shaped solid and make the necessary calculation.	☐		• Describe the determination of the density of an irregularly shaped solid by the method of displacement and make the necessary calculation.	☐	
Forces						
(a) Effects of forces	• State that a force may produce a change in size and shape of a body. • Plot extension/load graphs and describe the associated experimental procedure. • Describe the ways in which a force may change the motion of a body. • Find the resultant of two or more forces acting along the sameline	☐ ☐ ☐ ☐		• Interpret extension/load graphs. • State Hooke's Law and recall and use the expression $F = kx$. • Recognise the significance of the term 'limit of proportionality' for an extension/load graph. • Recall and use the relation between force,mass and acceleration (including the direction). • Describe, qualitatively, motion in a curved path due to a perpendicular force ($F = mv^2/r$ is not required).	☐ ☐ ☐ ☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(b) Turning effect	• Describe the moment of a force as a measure of its turning effect and give everyday examples. • Describe, qualitatively, the balancing of a beam about a pivot.	☐ ☐		• Perform and describe an experiment (involving vertical forces) to verify that there is no net moment on a body in equilibrium. • Apply the idea of opposing moments to simple systems in equilibrium.	☐ ☐	
(c) Conditions for equilibrium	• State that, when there is no resultant force and no resultant turning effect, a system is in equilibrium.	☐				
(d) Centre of mass	• 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.	☐				

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(e) Scalars and vectors				• Demonstrate an understanding of the difference between scalars and vectors and give common examples. • Add vectors by graphical representation to determine a resultant. • Determine graphically a resultant of two vectors.	☐ ☐ ☐	
Energy, work and power						
(a) Energy	• Demonstrate an understanding that an object may have energy due to its motion or its position, and that energy may be transferred and stored. • Give examples of energy in different forms, including kinetic, gravitational, chemical, strain, nuclear, internal, electrical, light and sound.	☐ ☐		• Recall and use the expressions k.e.= • ½ mv^2 and p.e. = mgh.	☐	
	• Give examples of the conversion of energy from one form to another and of its transfer from one place to another. • Apply the principle of energy conservation to simple examples.	☐ ☐				

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(b) Energy resources	• Distinguish between renewable and non-renewable sources of energy • Describe how electricity or other useful forms of energy may be obtained from: ◦ chemical energy stored in fuel ◦ water, including the energy stored in waves and tides, and the energy stored behind hydroelectric dams ◦ geothermal resources ◦ nuclear fission ◦ heat and light from the Sun (solar cells and solar panels) • Give advantages and disadvantages of each method in terms of cost, reliability, scale and environmental impact • Show an understanding of efficiency	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐		• Show an understanding that • energy is released by • nuclear fusion in the Sun. • Recall and use the equation • efficiency = $\frac{\text{useful energy output}}{\text{energy input}} \times 100\%$	☐ ☐	
(c) Work	• Relate, without calculation, work done to the magnitude of a force and distance moved.	☐		• Describe energy changes in terms of work done. • Recall and use $\Delta W = Fd = \Delta E$.	☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(d) Power	• Relate, without calculation, power to work done and time taken, using appropriate examples.	☐		• Recall and use the equation $P = E/t$ in simple systems.	☐	
Pressure	• Relate, without calculation, 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.	☐ ☐ ☐ ☐		• Recall and use the equation $p = F/A$. • Recall and use the equation $p = h\Delta g$.	☐ ☐	
Thermal Physics						
Simple kinetic molecular model of matter						
(a) States of matter	• State the distinguishing properties of solids, liquids and gases.	☐				

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(b) Molecular model	• Describe qualitatively the molecular structure of solids, liquids and gases. • Interpret the temperature of a gas in terms of the motion of its molecules. • Describe qualitatively the pressure of a gas in terms of the motion of its molecules. • Describe qualitatively the effect of a change of temperature on the pressure of a gas at constant volume. • Show an understanding of the random motion of particles in a suspension as evidence for the kinetic molecular model of matter. • Describe this motion (sometimes known as Brownian motion) in terms of random molecular bombardment.	☐ ☐ ☐ ☐ ☐		• Relate the properties of solids, liquids and gases to the forces and distances between molecules and to themotion of the molecules. • Show an appreciation that massive particles may be moved by light, fast-moving molecules.	☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(c) Evaporation	• Describe evaporation in terms of the escape of more energetic molecules from the surface of a liquid. • Relate evaporation and the consequent cooling.	☐		• Demonstrate an understanding of how temperature, surface area and draught over a surface influence evaporation.	☐	
(d) Pressure changes	• Relate the change in volume of a gas to change in pressure applied to the gas at constant emperature.	☐		• Recall and use the equation pV = constant at constant temperature.	☐	
Thermal properties						
(a) Thermal expansion of solids, liquids and gases	• Describe qualitatively the thermal expansion of solids, liquids and gases. • Identify and explain some of the everyday applications and consequences of thermal expansion. • Describe qualitatively the effect of a change of temperature on the volume of a gas at constant pressure.	☐ ☐ ☐		• Show an appreciation of the relative order of magnitude of the expansion of solids, liquids and gases.	☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(b) Measurement of temperature	• Appreciate how a physical property which varies with temperature may be used for the measurement of temperature and state examples of such properties. • Recognise the need for and identify fixed points. • Describe the structure and action of liquid-in-glass thermometers.	☐		• Demonstrate understanding of sensitivity, range and linearity. • Describe the structure of a thermocouple and show understanding of its use for measuring high temperatures and those which vary rapidly.	☐ ☐	
(c) Thermal capacity	• Relate a rise in temperature of a body to an increase in internal energy. • Show an understanding of the term thermal capacity.	☐ ☐		• Describe an experiment to measure the specific heat capacity of a substance.	☐	
(d) Melting and boiling	• 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.	☐ ☐ ☐		• 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. • Describe an experiment to measure specific latent heats for steam and for ice.	☐ ☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
Transfer of thermal energy						
(a) Conduction	• Describe experiments to demonstrate the properties of good and bad conductors of heat.	☐		• Give a simple molecular account of the heat transfer in solids.	☐	
(b) Convection	• Relate convection in fluids to density changes and describe experiments to illustrate convection	☐				
(c) Radiation	• Identify infra-red radiation as part of the electromagnetic spectrum.	☐		• Describe experiments to show the properties of good and bad emitters and good and bad absorbers of infra-red radiation.	☐	
(d) Consequences of energy transfer	• Identify and explain some of the everyday applications and consequences of conduction, convection and radiation.	☐				

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
Properties of waves, including light and sound						
General wave properties	• Describe what is meant by wave motion as illustrated by vibration in ropes, 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.	☐ ☐ ☐ ☐		• Recall and use the equation $v = f \times \square$. • Interpret reflection, refraction and diffraction using wave theory.	☐ ☐	
	• Describe the use of water waves to show reflection at a plane surface refraction due to a change of speed diffraction produced by wide and narrow gaps.	☐ ☐ ☐				

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
Light						
(a) Reflection	• Describe the formation, and give the characteristics, of the image in a plane mirror. • Use the law angle of incidence = angle of reflection.	☐ ☐		• Perform simple constructions, measurements and calculations.	☐	
(b) Refraction	• 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.	☐ ☐		• Recall and use the definition of refractive index *n* in terms of speed. • Recall and use the equation sin *i*/sin *r* = *n*. • Describe the action of optical fibres particularly in medicine and in communications technology.	☐ ☐ ☐	
	• Give the meaning of critical angle. • Describe internal and total internal reflection.	☐ ☐				

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(c) Converging lenses	• Describe the action of a thin converging lens on a beam of light. • Use the terms principal focus and focal length. • Draw ray diagrams to illustrate the formation of a real image by a single lens.	☐ ☐ ☐		• Draw ray diagrams to illustrate the formation of a virtual image by a single lens. • Use and describe the use of a single lens as a magnifying glass.	☐ ☐	
(d) Dispersion of light	• Give a qualitative account of the dispersion of light as illustrated by the action on light of a glass prism.	☐				
(e) electromagnetic spectrum	• Describe the main features of the electromagnetic spectrum and state that all e-m waves travel with the same high speed *in vacuo* • Describe the role of electromagnetic waves in: – Radio and television communications (radio waves) – Satellite television and telephones (microwaves) – Electrical appliances, remote controllers for televisions and intruder alarms (infrared)	☐ ☐ ☐ ☐ ☐		• State the approximate value of the speed of electromagnetic waves. • Use the term monochromatic.	☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	**Checklist**	**Comments**	**You should be able to:**	**Checklist**	**Comments**
	– Medicine and security (X-rays) – Demonstrate an awareness of safety issues regarding the use of microwaves and X-rays	☐ ☐			☐	
Sound	• Describe the production of sound by vibrating sources. • Describe the longitudinal nature of sound waves. • State the approximate range of audible frequencies. • Show an understanding that a medium is required in order to transmit sound waves. • Describe an experiment to determine the speed of sound in air. • Relate the loudness and pitch of sound waves to amplitude and frequency. • Describe how the reflection of sound may produce an echo.	☐ ☐ ☐ ☐ ☐ ☐ ☐		• Describe compression and rarefaction. • State the order of magnitude of the speed of sound in air, liquids and solids.	☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
Electricity and magnetism						
Simple phenomena of magnetism	• State the properties of magnets. • Give an account of induced magnetism. • Distinguish between ferrous and non-ferrous materials. • Describe methods of magnetisation and of demagnetisation.	☐ ☐ ☐				
	• Describe an experiment to identify the pattern of field lines round a bar magnet. • Distinguish between the magnetic properties of iron and steel. • Distinguish between the design and use of permanent magnets and electromagnets.	☐ ☐ ☐				

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
Electrical quantities						
(a) Electric charge	• Describe simple experiments to show the production and detection of electrostatic charges. • State that there are positive and negative charges. • State that unlike charges attract and that like charges repel. • Describe an electric field as a region in which an electric charge experiences a force. • Distinguish between electrical conductors and insulators and give typical examples.	☐ ☐ ☐ ☐ ☐		• State that charge is measured in coulombs. • State the direction of lines of force and describe simple field patterns, including the field around a point charge and the field between two parallel plates • Give an account of charging by induction. • Recall and use the simple electron model to distinguish between conductors and insulators.	☐ ☐ ☐ ☐	
(b) Current	• State that current is related to the flow of charge. • Use and describe the use of an ammeter.	☐ ☐		• 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.	☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(c) Electro-motive force	• State that the e.m.f. of a source of electrical energy is measured in volts.	☐		• Show understanding that e.m.f. is defined in terms of energy supplied by a source in driving charge round a complete circuit.	☐	
(d) Potential difference	• State that the potential difference across a circuit component is measured in volts. • Use and describe the use of a voltmeter.	☐ ☐				
(e) Resistance	• State that resistance = pd/current and understand qualitatively how changes in p.d. or resistance affect current. • Recall and use the equation $R = V/I$. • Describe an experiment to determine resistance using a voltmeter and an ammeter. • Relate (without calculation) the resistance of a wire to its length and to its diameter.	☐ ☐ ☐ ☐		• Recall and use quantitatively the proportionality between resistance and length of a wire • Recall and use quantitatively the inverse proportionality between resistance and cross-sectional area of a wire.	☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(f) Electrical Energy				• Recall and use the equation $P = IV$ and • $E = Ivt$.	☐	
Electrical circuits						
(a) Circuit diagrams	• Draw and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), lamps, ammeters, voltmeters, magnetising coils, transformers, bells, fuses, relays.	☐		• Draw and interpret circuit diagrams containing diodes and transistors.	☐	
(b) Series and parallel circuits	• Understand that the current at every point in a series circuit is the same. • Give the combined resistance of two or more resistors in series. • State that, for a parallel circuit, the current from the source is larger than the current in each branch. • State that the combined resistance of two resistors in parallel is less than that of either resistor by itself. • State the advantages of connecting lamps in parallel in a lighting circuit.	☐ ☐ ☐ ☐ ☐		• Recall and use the fact that the sum of the p.d.s. across the components in a series circuit is equal to the total p.d.s. across the supply. • Recall and use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit. • Calculate the effective resistance of two resistors in parallel.	☐ ☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(c) Action and use of circuit components	• Describe the action of a variable potential divider (potentiometer). • Describe the action of thermistors and light dependent resistors and show understanding of their use as input transducers. • Describe the action of a capacitor as an energy store and show understanding of its use in time delay circuits. • Describe the action of a relay and show understanding of its use in switching circuits.	☐ ☐ ☐ ☐		• Describe the action of a diode and show understanding of its use as a rectifier. • Describe the action of a transistor as an electrically operated switch and show understanding of its use in switching circuits. • Recognise and show understanding of circuits operating as light sensitive switches and temperature operated alarms (using a relay or a transistor).	☐ ☐ ☐	
(d) Digital electronics				• Explain and use the terms digital and analogue. • State that logic gates are circuits containing transistors and other components. • Describe the action on NOT, AND, OR, NAND and NOR gates. • Design and understand simple digital circuits combining several logic gates. • State and use the symbols for logic gates.	☐ ☐ ☐ ☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
Dangers of electricity	• State the hazards of (i) damaged insulation (ii) overheating of cables (iii) damp conditions. • Show an understanding of the use of fuses and circuit-breakers.	☐ ☐				
Electromagnetic effects						
(a) Electromagnetic induction	• Describe an experiment which shows that a changing • magnetic field can • induce an e.m.f. in a circuit.	☐		• State the factors affecting the magnitude of an induced e.m.f. • Show understanding that the direction of an induced e.m.f. opposes the change causing it.	☐ ☐	
(b) a.c generator	• Describe a rotating-coil generator and the use of slip rings. • Sketch a graph of voltage output against time for a simple a.c. generator.	☐ ☐				

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(c) Transformer	• Describe the construction of a basic iron-cored transformer as used for voltage transformations. • Recall and use the equation $(V_p/V_s) = (N_p/N_s)$. • Describe the use of the transformer in high-voltage transmission of electricity. • Give the advantages of high voltage transmission	☐ ☐ ☐ ☐		• Describe the principle of operation of a transformer. • Recall and use the equation $V_pI_p = V_sI_s$ (for 100% efficiency). • Explain why energy losses in cables are lower when the voltage is high	☐ ☐ ☐	
(d) The magnetic effect of a current	• Describe the pattern of the magnetic field due to currents in straight wires and in solenoids. • Describe applications of the magnetic effect of current, including the action of a relay.	☐ ☐		• State the variation of the strength of the magnetic field over the parts of the patterns • Describe the effect on the magnetic field of changing the magnitude and direction of the current.	☐ ☐	
(e) Force on a current-carrying conductor	• Describe an experiment to show that a force acts on a current-carrying conductor in a magnetic field, including the effect of reversing (i) the current, (ii) the direction of the field.	☐		• Describe an experiment to show the corresponding force on beams of charged particles. • State and use the relative directions of force, field and current.	☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(f) d.c. motor	• State that a current-carrying coil in a magnetic field experiences a turning effect and that the effect is increased by increasing the number of turns on the coil. • Relate this turning effect to the action of an electric motor.	☐ ☐		• Describe the effect of increasing the current.	☐	
Cathode ray oscilloscopes						
(a) Cathode rays	• Describe the production and detection of cathode rays. • Describe their deflection in electric fields. • State that the particles emitted in thermionic emission are electrons.	☐ ☐ ☐				
(b) Simple treatment of cathode-ray oscilloscope				• Describe in outline the basic structure, and action, of a cathode-ray oscilloscope (detailed circuits are *not* required). • Use and describe the use of a cathode-ray oscilloscope to display waveforms.	☐ ☐	

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
Atomic physics						
Radioactivity						
(a) Detection of radioactivity	• Show awareness of the existence of background radioactivity. • Describe the detection of α-particles, β-particles and γ-rays.	☐ ☐				
(b) Characteristics of the three kinds of emission	• State that radioactive emissions occur randomly over space and time. • State, for radioactive emissions: (i) their nature (ii) their relative ionising effects (iii) their relative penetrating abilities.	☐ ☐ ☐ ☐ ☐		• Describe their deflection in electric fields and magnetic fields. • Interpret their relative ionising effects.	☐ ☐	
(c) Radioactive decay	• State the meaning of radioactive decay, using equations (involving words or symbols) to represent changes in the composition of the nucleus when particles are emitted.	☐				
(d) Half-life	• Use the term half-life in simple calculations which might involve information in tables or decay curves.	☐				

Topic	Core material			Extended material		
	You should be able to:	Checklist	Comments	You should be able to:	Checklist	Comments
(e) Safety precautions	• Describe how radioactive materials are handled, used and stored in a safe way.	☐				
The nuclear atom						
(a) Atomic model	• Describe the structure of an atom in terms of a nucleus and electrons.	☐		• Describe how the scattering of alpha-particles by thin metal foils provides evidence for the nuclear atom.	☐	
(b) Nucleus	• Describe the composition of the nucleus in terms of protons and neutrons. • Use the term proton number (= atomic number), Z, use the term nucleon number (= mass number), A, use the term nuclide and nuclide notation ${}^{A}_{Z}X$	☐ ☐				
(c) Isotopes				• Use the term isotope • Give and explain examples of practical applications of isotopes	☐ ☐	

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. You should be able to define those items indicated by an asterisk (*) The list for 'Extended' includes both the Core and the Supplement.

Core			Supplement		
Quantity	**Symbol**	**Unit**	**Quantity**	**Symbol**	**Unit**
length	*l, h ...*	km, m, cm, mm			
area	*A*	m^2, cm^2			
volume	*V*	m^3, cm^3			
weight	*W*	N			N*
mass	*m, M*	kg, g			mg
time	*t*	h, min, s			ms
density*		g/cm^3, kg/m^3			
speed*	*u, v*	km/h, m/s, cm/s			
acceleration	*a*		acceleration*		m/s^2
acceleration of freee fall	*g*				
force	*F, P ...*	N	force*		N*
			moment of a force*		N m
work done	*W, E*	J	work done by a force*		J*
energy	*E*	J			J*, kw h*
power	*P*	W	power*		W*
pressure	*p, P*		pressure*		Pa*, N/m^2
			atmospheric pressure		millibar

Core			Supplement		
Quantity	**Symbol**	**Unit**	**Quantity**	**Symbol**	**Unit**
temperature	θ, T	*C			
specific heat capacity	c	J/(g °C), J/(kg °C)	specific heat capacity*		
latent heat	L	J	specific latent heat*	l	J/kg, J/g
			frequency*	f	Hz
			wavelength*	λ	m, cm
focal length	f				
angle of incidence	i	degree (°)	refractive index	n	
angle of reflection, refraction	r	degree (°)			
critical angle	c	degree (°)			
potential difference/ voltage	V	V, mV	potential difference*		V*
current	I	A, mA	current*		
			charge		C, A s
e.m.f.	E	V	e.m.f.*		
resistance	R	Ω			

Command words and phrases used in physics papers

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.

Calculate	A numerical answer is needed. You should show any working, especially when there are two or more steps in a calculation. *e.g. calculate the refractive index*
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 *e.g. deduce what will happen to velocity of the vehicle if ….* (ii) You have to refer to a Law or scientific theory or give a reason for your answer *e.g. use your knowledge of the kinetic theory to deduce what will happen when ……*
Define	You need to state the meaning of something *e.g. define speed*
Describe	You need to state the main points about something (using labelled diagrams if it helps you). *e.g. describe a rotating-coil generator* You may also be asked to describe • observations *e.g. describe the ways in which a force may change the motion of a body* • how to do particular experiments *e.g. describe an experiment to determine resistance using a voltmeter and an ammeter*
Determine	You are expected to use a formula or method that you know to calculate a quantity. *e.g. Determine graphically the resultant of two vectors*
Discuss	You have to write down points **for** and **against** an argument *e.g. discuss the energy loss in cables*
Estimate	Suggest an approximate value for a quantity based on reasons and data. You may need to make some approximations. *e.g. estimate the volume of a test tube.*
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. *e.g. list **three** uses of converging lenses*

Meant (what is meant by the term…)	See 'Understand'
Measure	You are expected to find a quantity by using a measuring instrument *e.g. length (by using a ruler), volume (by using a measuring cylinder)*
Outline	State the main points briefly *e.g. outline a method of magnetising an iron bar*
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. *e.g. predict what will happen to the direction of the resultant force if ….* (ii) It may also mean giving a short answer to a question stating what might happen next *e.g. predict what effect an increase in temperature will have on the resistance.*
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 *e.g. state the hazards of damaged electrical insulation* 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. *e.g. suggest a precaution to improve the accuracy of the experiment* (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 *e.g. applying ideas about moments to the stability of a vehicle*
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. *e.g. what do you understand by the term total internal reflection*

The mathematical skills you need

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
• add, subtract, multiply and divide	☐	
Use: • averages • decimals • fractions • percentages • ratios • reciprocals	 ☐ ☐ ☐ ☐ ☐ ☐	
• recognise standard notation (notation is putting symbols for numbers e.g. $x = 2$, $y = 5$, atomic mass, $Z = 12$) • use standard notation	☐ ☐	
• use direct proportion (stepwise increases) • use inverse proportion (inverse means turned up side down)	☐ ☐	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 ¼ (= 0.25)
• use numbers to the 'power of 10' e.g. $1 \times 10^2 = 100$	☐	Your calculator will often show number to the power of 10 when you do calculations. Do not worry too much though – your calculator does the work for you.
• draw charts • graphs with lne of best fit	☐ ☐	You will be given the data
interpret: • bar graphs • pie charts • line graphs	 ☐ ☐ ☐	
• select suitable scales and axes for graphs	☐	
• make approximations	☐	

You can:	Checklist	Comments
use the formulas: • area = length × width • volume = length × breadth × height • use and convert metric units into one another	☐ ☐ ☐	e.g. 100 cm = 1 m 1000 g = 1 kg
• use a ruler, compasses, protractor and set square	☐	
understand the meaning of: • angle • curve • circle • radius • diameter • square • parallelogram • rectangle • diagonal • horizontal • vertical	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	
• solve equations of the form $x = yz$ when two of the terms are known	☐	
• recognise and use points of the compass (N, S, E, W)	☐	

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