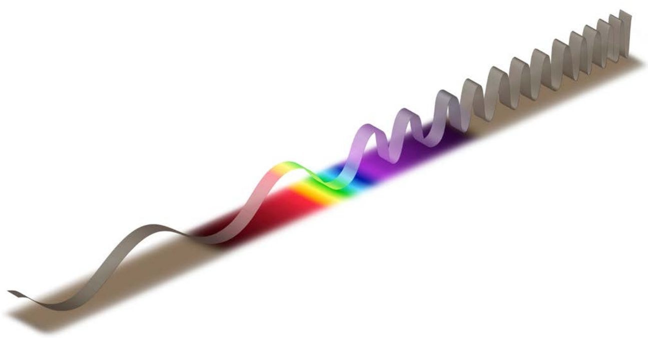
Cambridge Assessment International Education

Interactive

Learner Guide

Cambridge O Level Physics 5054

For examination from 2023



Version 2

Cambridge Pathway

In order to help us develop the highest quality resources, we are undertaking a continuous programme of review; not only to measure the success of our resources but also to highlight areas for improvement and to identify new development needs.

We invite you to complete our survey by visiting the website below. Your comments on the quality and relevance of our resources are very important to us.

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Contents

About this guide

This guide explains what you need to know about your Cambridge O Level Physics course and examinations.

It will help you to:

- ✓ understand what skills you should develop by taking this Cambridge O Level course
- ✓ understand how you will be assessed
- ✓ understand what we are looking for in the answers you write
- ✓ plan your revision programme
- ✓ revise, by providing revision tips and an interactive revision checklist (Section 4).

The aims of this syllabus are to enable you to:

- acquire scientific knowledge and understanding of scientific theories and practice
- develop a range of experimental skills, including handling variables and working safely
- use scientific data and evidence to solve problems and discuss the limitations of scientific methods
- communicate effectively and clearly, using scientific terminology, notation and conventions
- understand that the application of scientific knowledge can benefit people and the environment
- enjoy science and develop an informed interest in scientific matters which support further study.

Section 1: Syllabus content - what you need to know about

This section gives you an outline of the syllabus content for this course. Ask your teacher for more detail about each topic. You can also find more detail in the Revision checklists of this guide.

There are six main units in this syllabus which you will study:

1. Motion, forces and energy
2. Thermal physics
3. Waves
4. Electricity and magnetism
5. Nuclear physics
6. Space physics

Make sure you always check the latest syllabus, which is available at www.cambridgeinternational.org

Section 2: How you will be assessed

You will be assessed at the end of the course using three components:

- Paper 1: Multiple Choice
- Paper 2: Theory
- Paper 3: Practical Test or Paper 4: Alternative to Practical

Find out from your teacher which components you will be taking, and when you will be taking them.

Components at a glance

This table summarises the key information about each examination paper. You can find details and advice on how to approach each component in the 'About each paper' sub-section.

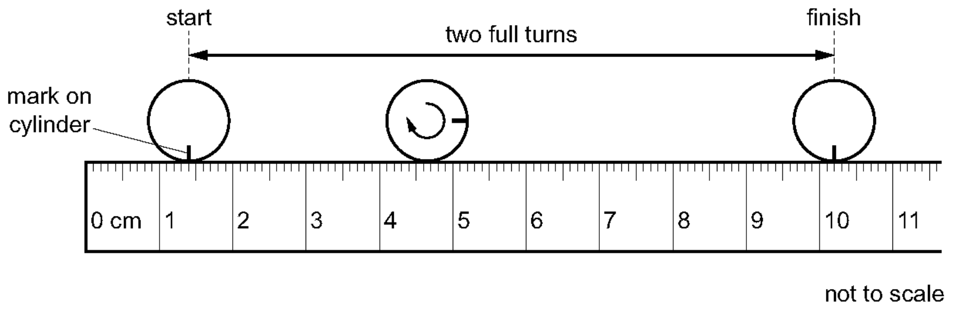
Component	Time and marks	Details	Percentage of qualification
Paper 1: Multiple Choice	1 hour 40 marks	40 four-choice multiple-choice questions. Questions will be based on the full subject content. Tests assessment objectives AO1 and AO2. Externally assessed.	30%
Paper 2: Theory	1 hour 45 minutes 80 marks	Short-answer and structured questions. Questions will be based on the full subject content. Tests assessment objectives AO1 and AO2. Externally assessed.	50%
Paper 3: Practical Test	1 hour 30 minutes 40 marks	Questions will be based on the experimental skills listed in the syllabus. Tests assessment objective AO3 in a practical context. Externally assessed.	20%
Paper 4: Alternative to Practical	1 hour 40 marks	Questions will be based on the experimental skills listed in the syllabus. Tests assessment objective AO3 in a written paper. Externally assessed.	20%

About each paper

Paper 1: Multiple Choice

Each of the 40 multiple choice questions you will answer has four choices.

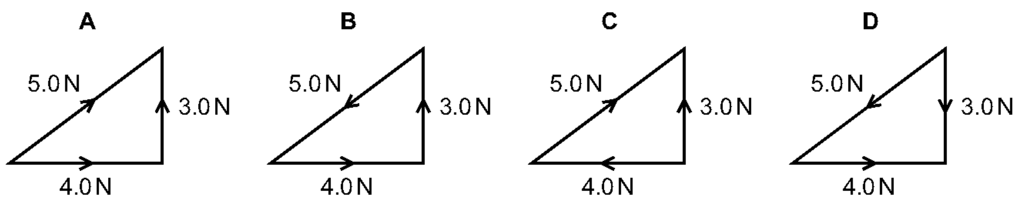
1 A small cylinder is rolled along a ruler and completes two full turns as shown in the diagram.



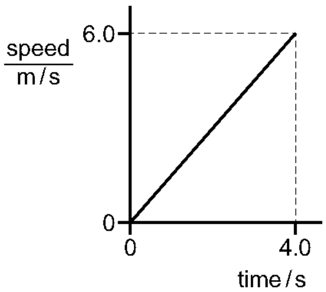
What is the circumference of the cylinder?

A 4.4 cm **B** 5.1 cm **C** 8.8 cm **D** 10.2 cm

2 Which diagram shows the vector addition of a 4.0 N force and a 3.0 N force?



3 The diagram shows the speed-time graph for an object moving with constant acceleration.



What is the distance travelled in the first 4.0 s?

A 0.67 m **B** 1.5 m **C** 12 m **D** 24 m

Paper 2: Theory

For Paper 2, all questions are compulsory and there are no separate sections.

9 Fig. 9.1 shows the main parts of a nuclear reactor.

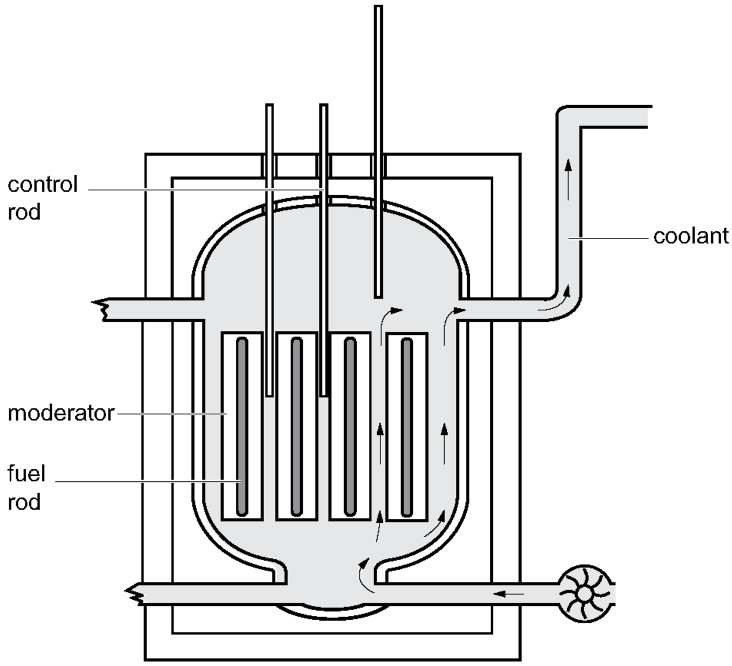


Fig. 9.1

(a) The fuel rod contains uranium-235, which can undergo nuclear fission.

Describe the process of nuclear fission that occurs in the fuel rod.

Your description should include the role of neutrons in the process.

....

....

....

....

....

.... [3]

(b) Explain what happens as a control rod is moved out of the reactor core.

....

.... [2]

Paper 3: Practical Test and Paper 4: Alternative to Practical

Both Paper 3 and Paper 4 include a planning question. It will be a 6-mark question focusing solely on the experimental skill of planning. The planning question will be identical in both papers.

4 A student places a small metal container inside a larger metal container, as shown in Fig. 4.1. There is an air gap between the two containers. The student investigates the effect of the size of the air gap on the rate of cooling of hot water.

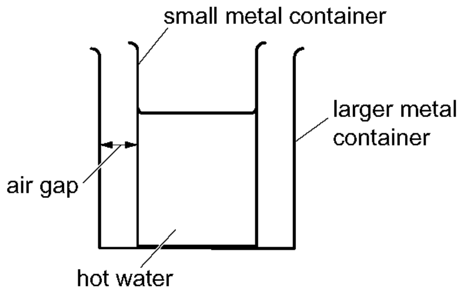


Fig. 4.1

Plan an experiment to investigate the effect of the size of the air gap between the small metal container and larger metal containers on the rate of cooling of hot water.

The following apparatus is available:

a small metal container
a number of metal containers of different diameters (all larger than the small container)
a thermometer
a stopwatch
a measuring cylinder
a supply of hot water.

You can also use other apparatus and materials that are usually available in a school laboratory.

You are **not** required to do this investigation.

In your plan, you should:

- explain briefly how to carry out the investigation
- state the key variables to control
- draw a table, or tables, with column headings, to show how to display your readings (you are **not** required to enter any readings in the table)
- explain how to use your readings to reach a conclusion.

A diagram is **not** required but you may draw one if it helps your explanation.

Section 3: What skills will be assessed

The areas of knowledge, understanding and skills that you will be assessed on are called **assessment objectives** (AO).

The examiners take account of the following skills areas (assessment objectives) in the question papers:

- Knowledge with understanding
- Handling information and problem-solving
- Experimental skills and investigations

It is important that you know the different weightings (%) of the assessment objectives, as this affects how the examiner will assess your work. For example, assessment objective 1 (AO1 Knowledge with understanding) is worth 63% of the total marks in Paper 1 and Paper 2, and AO2 Handling information and problem-solving covers the remaining 37%. However, in Paper 3 and Paper 4, only AO3 Experimental skills and investigations is assessed.

Assessment objectives (AO)	What does the AO mean?	What do you need to be able to do?
AO1 Knowledge with understanding	Remembering facts and applying these facts to new situations	You should be able to demonstrate knowledge and understanding of: • scientific phenomena, facts, laws, definitions, concepts and theories • scientific vocabulary, terminology and conventions (including symbols, quantities and units) • scientific instruments and apparatus, including techniques of operation and aspects of safety • scientific and technological applications with their social, economic and environmental implications.
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	You should be able, in words or using other written forms of presentation (i.e. symbolic, graphical and numerical) to: • locate, select, organise and present information from a variety of sources • translate information from one form to another • manipulate numerical and other data • use information to identify patterns, report trends and form conclusions • present reasoned explanations for phenomena, patterns and relationships • make predictions based on relationships and patterns • solve problems, including some of a quantitative nature.
AO3 Experimental skills and investigations	Planning and carrying out experiments and recording and analysing information	You should be able to: • demonstrate knowledge of how to select and safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate) • plan experiments and investigations • make and record observations, measurements and estimates • interpret and evaluate experimental observations and data • evaluate methods and suggest possible improvements.

Section 4: Revision

This advice will help you revise and prepare for the examinations. It is divided into general advice for all papers and more specific advice for Paper 1, Paper 2, Paper 3 and Paper 4.

Use the tick boxes ☐ to keep a record of what you have done, what you plan to do or what you understand.

General advice

Before the examination

☐ Find out when the examinations are and plan your revision so you have time to revise. Create a revision timetable and divide it into sections to cover each topic.

☐ Find out how long each paper is, how many questions you have to answer, how many marks there are for each question, and work out how long you have for each question.

☐ Find out the choices you have on each paper, make sure you know how many sections there are and which sections you should answer from.

☐ Know the meaning of the command words used in questions and how to apply them to the information given. Look at past examination papers and highlight the command words and check what they mean.

☐ Make revision notes. Try different styles of notes.

☐ Work for short periods then have a break. Revise small sections of the syllabus at a time.

☐ Test yourself by writing out key points, redrawing diagrams, etc.

☐ Make sure you define, scientific terms accurately.

☐ Definitions must not reuse the words to be defined.

☐ Make your own dictionary or draw up a glossary of key terms for each section of the syllabus.

☐ Practise drawing clear, simple, neat, fully-labelled diagrams

☐ Learn to spell scientific terms correctly.

☐ Have a look at past questions so that you are clear of what to expect in an examination.

☐ Look at mark schemes to help you to understand how the marks are awarded for each question.

In the examination

☐ Read the instructions carefully and answer the right number of questions from the right sections.

☐ Do not answer more questions than are needed, as this will not gain you more marks in the examination.

☐ Plan your time according to the marks for each question. For example, a question worth three marks requires less time and a shorter answer than one worth 10 marks. If a question has several parts, then the parts with more marks will need more time and more developed answers.

☐ 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.

☐ Do not leave out questions or parts of questions. Remember, no answer means no mark.

☐ Read each question very carefully.

- Identify the command words – you could underline or highlight them.
- Identify the other key words and perhaps underline them too.
- Try to put the question into your own words to understand what it is really asking.

- [ ] Read all parts of a question before starting your answer. Think carefully about what is needed for each part. You will not need to repeat material.
- [ ] Look very carefully at the resource material you are given.
  - Read the title, key, axes of graphs, etc. to find out exactly what it is showing you.
  - Look for dates, scale, and location.
  - Try using coloured pencils or pens to pick out anything that the question asks you about.
- [ ] **Answer the question.** This is very important!

  Use your knowledge and understanding.

  Do not just write all you know, only write what is needed to answer the question.
- [ ] Plan your answers. Clear, concise, well-ordered, well-argued, well-supported answers get more marks than long, rambling, muddled, repetitious answers. Quality is better than quantity.
- [ ] Use scientific terms in your answers as much as possible.
- [ ] Use the resource material given in the question to support your answer.
- [ ] 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.
- [ ] Make sure your writing is clear and easy to read. It is no good writing a brilliant answer if the examiner cannot read it!

Paper 1 advice

- [ ] 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 2 advice

- [ ] 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!
- [ ] 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 3 and Paper 4 advice

- [ ] 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.

Revision checklists

In the next part of this guide we have provided some revision checklists. These include information from the syllabus that you should revise. They don't contain all the detailed knowledge you need to know, just an overview. For more detail see the syllabus and talk to your teacher.

The table headings are explained below:

Topic	You should be able to	R	A	G	Comments
These are the topics you will study	Content in the syllabus you need to cover	You can use the tick boxes to show when you have revised an item and how confident you feel about it. R = RED means you are really unsure and lack confidence; you might want to focus your revision here and possibly talk to your teacher for help. A = AMBER means you are reasonably confident but need some extra practice. G = GREEN means you are very confident. As your revision progresses, you can concentrate on the RED and AMBER items in order to turn them into GREEN items. You might find it helpful to highlight each topic in red, orange or green to help you prioritise.			You can: • Add further information of your own. • add learning aids, such as rhymes, poems or word play • pinpoint areas of difficulty you need to check further with your teacher or textbooks • include reference to a useful resource

Note: the tables below cannot contain absolutely everything you need to know, but it does use examples wherever it can.

1 Motion, forces and energy

Topic	You should be able to	R	A	G	Comments
1.1 Physical quantities and measurement techniques					
1	Describe how to measure a variety of lengths with appropriate precision using tapes, rulers and micrometers (including reading the scale on an analogue micrometer)	☐	☐	☐	
2	Describe how to use a measuring cylinder to measure the volume of a liquid or finding the volume of a solid by displacement	☐	☐	☐	
3	Describe how to measure a variety of time intervals using clocks and digital timers	☐	☐	☐	
4	Determine an average value for a small distance and for a short interval of time by measuring multiples (including the period of a pendulum)	☐	☐	☐	
5	Understand that a scalar quantity has magnitude (size) only and that a vector quantity has magnitude and direction	☐	☐	☐	
6	Know that the following quantities are scalars: distance, speed, time, mass, energy, temperature and pressure	☐	☐	☐	
7	Know that the following quantities are vectors: displacement, force, weight, velocity, acceleration, momentum, electric field strength and gravitational field strength	☐	☐	☐	
8	Determine, by calculation or graphically, the resultant of two vectors at right angles	☐	☐	☐	
1.2 Motion					
1	Define speed as distance travelled per unit time and velocity as change in displacement per unit time	☐	☐	☐	
2	Recall and use the equation $\text{speed} = \frac{\text{distance}}{\text{time}}$ $v = \frac{s}{t}$	☐	☐	☐	
3	Recall and use the equation $\text{average speed} = \frac{\text{total distance travelled}}{\text{total time taken}}$	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
4	Define acceleration as change in velocity per unit time; recall and use the equation $\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$ $a = \frac{\Delta v}{\Delta t}$				
5	State what is meant by and describe examples of uniform acceleration and non-uniform acceleration				
6	Know that a deceleration is a negative acceleration and use this in calculations				
7	Sketch, plot and interpret distance–time and speed–time graphs				
8	Determine from the shape of a distance–time graph when an object is: a. at rest b. moving with constant speed c. accelerating d. decelerating				
9	Determine from the shape of a speed–time graph when an object is: a. at rest b. moving with constant speed c. moving with constant acceleration d. moving with changing acceleration				
10	State that the acceleration of free-fall g for an object near to the surface of the Earth is approximately constant and is approximately 9.8 m/s^2				
11	Calculate speed from the gradient of a distance–time graph				
12	Calculate the area under a speed–time graph to determine the distance travelled for motion with constant speed or constant acceleration				
13	Calculate acceleration from the gradient of a speed–time graph				

Topic	You should be able to	R	A	G	Comments
1.3 Mass and weight					
1	State that mass is a measure of the quantity of matter in an object at rest relative to the observer				
2	State that the mass of an object resists change from its state of rest or motion (inertia)				
3	Know that weights, and therefore masses, may be compared using a beam balance or equal-arm balance				
4	Describe how to determine mass using an electronic balance				
5	Describe how to measure weight using a force meter				
6	Define gravitational field strength as force per unit mass; recall and use the equation gravitational field strength = $\frac{\text{weight}}{\text{mass}}$ $g = \frac{W}{m}$ and know that this is equivalent to the acceleration of free fall				
7	State that a gravitational field is a region in which a mass experiences a force due to gravitational attraction				
1.4 Density					
1	Define density as mass per unit volume; recall and use the equation density = $\frac{\text{mass}}{\text{volume}}$ $\rho = \frac{w}{v}$				
2	Describe how to determine the density of a liquid, of a regularly shaped solid and of an irregularly shaped solid which sinks in a liquid (volume by displacement), including appropriate calculations				
1.5 Forces					
1.5.1 Balanced and unbalanced forces					
1	Identify and use different types of force, including weight (gravitational force), friction, drag, air resistance, tension (elastic force), electrostatic force, magnetic force, thrust (driving force) and contact force				

Topic	You should be able to	R	A	G	Comments
2	Identify forces acting on an object and draw free-body diagram(s) representing the forces				
3	State Newton's first law as 'an object either remains at rest or continues to move in a straight line at constant speed unless acted on by a resultant force'				
4	State that a force may change the velocity of an object by changing its direction of motion or speed				
5	Determine the resultant of two or more forces acting along the same straight line				
6	Recall and use the equation resultant force = mass × acceleration $F = ma$				
7	State Newton's third law as 'when object A exerts a force on object B, then object B exerts an equal and opposite force on object A'				
8	Understand that Newton's third law describes pairs of forces of the same type acting on different objects				
1.5.2 Friction					
1	Describe friction as a force that may impede motion and produce heating				
2	Understand the motion of objects acted on by a constant weight or driving force, with and without drag (including air resistance or resistance in a liquid)				
3	Explain how an object reaches terminal velocity				
4	Define the thinking distance, braking distance and stopping distance of a moving vehicle				
5	Explain the factors that affect thinking and braking distance including speed, tiredness, alcohol, drugs, load, tyre surface and road conditions				
1.5.3 Elastic deformation					
1	Know that forces may produce a change in size and shape of an object				

Topic	You should be able to	R	A	G	Comments
2	Define the spring constant as force per unit extension; recall and use the equation spring constant = $\frac{\text{force}}{\text{extension}}$ $k = \frac{F}{x}$	☐	☐	☐	
3	Sketch, plot and interpret load–extension graphs for an elastic solid and describe the associated experimental procedure	☐	☐	☐	
4	Define and use the term 'limit of proportionality' for a load–extension graph and identify this point on the graph (an understanding of the elastic limit is **not** required)	☐	☐	☐	
1.5.4 Circular motion					
1	Describe qualitatively motion in a circular path due to a force perpendicular to the motion as: a. speed increases if force increases, with mass and radius constant b. radius decreases if force increases, with mass and speed constant c. an increased mass requires an increased force to keep speed and radius constant ($F = \frac{mv^2}{r}$ is **not** required)	☐	☐	☐	
1.5.5 Turning effect of forces					
1	Describe the moment of a force as a measure of its turning effect and give everyday examples	☐	☐	☐	
2	Define the moment of a force as moment = force × perpendicular distance from the pivot; recall and use this equation	☐	☐	☐	
3	State and use the principle of moments for an object in equilibrium	☐	☐	☐	
4	Describe an experiment to verify the principle of moments	☐	☐	☐	
1.5.6 Centre of gravity					
1	State what is meant by centre of gravity	☐	☐	☐	
2	Describe how to determine the position of the centre of gravity of a plane lamina using a plumb line	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
3	Describe qualitatively the effect of the position of the centre of gravity on the stability of simple objects				
1.6 Momentum					
1	Define momentum as mass x velocity; recall and use the equation $p = mv$				
2	Define impulse as force x change in time; recall and use the equation Impulse = $F\Delta t = \Delta(mv)$				
3	Apply the principle of the conservation of momentum to solve simple problems in one dimension				
4	Define resultant force as the change in momentum per unit time; recall and use the equation resultant force = $\frac{\text{change in momentum}}{\text{time taken}}$ $F = \frac{\Delta p}{\Delta t}$				
1.7 Energy, work and power					
1.7.1 Energy					
1	State that energy may be stored as kinetic, gravitational potential, chemical, elastic (strain), nuclear, electrostatic, magnetic and internal (thermal)				
2	Describe how energy is transferred between stores during events and processes, including examples of transfer by forces (mechanical work done), electrical currents (electrical work done), heating, and by electromagnetic, sound and other waves				
3	Know the principle of the conservation of energy and apply this principle to the transfer of energy between stores during events and processes				
4	Recall and use the equation for kinetic energy $E_k = \frac{1}{2} mv^2$				
5	Recall and use the equation for the change in gravitational potential energy $\Delta E_p = mg\Delta h$				

Topic	You should be able to	R	A	G	Comments
1.7.2 Work					
1	Recall and use the equation work done = force × distance moved in the direction of the force $W = Fd$	☐	☐	☐	
1.7.3 Energy resources					
1	List renewable and non-renewable energy sources	☐	☐	☐	
2	Describe how useful energy may be obtained, or electrical power generated, from a. chemical energy stored in fossil fuels b. chemical energy stored in biofuels c. biofuels/biomass d. hydroelectric resources e. solar radiation f. nuclear fuel g. geothermal resources h. wind i. tides j. waves in the sea including references to a boiler, turbine and generator where they are used	☐	☐	☐	
3	Give advantages and disadvantages of each method limited to whether it is renewable, when and whether it is available, and its impact on the environment	☐	☐	☐	
1.7.4 Efficiency					
1	Define efficiency as: a. (%) efficiency = $\frac{\text{(useful energy output)}}{\text{(total energy output)}}$ (×100%) b. (%) efficiency = $\frac{\text{useful power output}}{\text{total power output}}$ (×100%) and recall and use these equations	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
1.7.5 Power					
1	Define power as work done per unit time and also as energy transferred per unit time; recall and use the equations a. $\text{power} = \frac{\text{work done}}{\text{time taken}}$ $P = \frac{W}{t}$ b. $\text{power} = \frac{\text{energy transferred}}{\text{time taken}}$ $P = \frac{\Delta E}{t}$	☐	☐	☐	
1.8 Pressure					
1	Define pressure as force per unit area; recall and use the equation $\text{pressure} = \frac{\text{force}}{\text{area}}$ $p = \frac{F}{A}$	☐	☐	☐	
2	Describe how pressure varies with force and area in the context of everyday examples	☐	☐	☐	
3	State that the pressure at a surface produces a force in a direction at right angles to the surface and describe an experiment to show this	☐	☐	☐	
4	Describe how the height of a liquid column in a liquid barometer may be used to determine the atmospheric pressure	☐	☐	☐	
5	Describe, quantitatively, how the pressure beneath the surface of a liquid changes with depth and density of the liquid	☐	☐	☐	
6	Recall and use the equation for the change in pressure beneath the surface of a liquid change in pressure = density × gravitational field strength × change in height $\Delta p = \rho g \Delta h$	☐	☐	☐	

2 Thermal physics

Topic	You should be able to	R	A	G	Comments
2.1 Kinetic particle model of matter					
2.1.1 States of matter					
1	Know the distinguishing properties of solids, liquids and gases	☐	☐	☐	
2	Know the terms for the changes in state between solids, liquids and gases	☐	☐	☐	
2.1.2 Particle model					
1	Describe, qualitatively, the particle structure of solids, liquids and gases, relating their properties to the forces and distances between particles and to the motion of the particles (atoms, molecules, ions and electrons)	☐	☐	☐	
2	Describe the relationship between the motion of molecules and temperature, including the idea that there is a lowest possible temperature (–273 °C), known as absolute zero, where the particles have least kinetic energy	☐	☐	☐	
3	Describe the pressure and the changes in pressure of a gas in terms of the forces exerted by particles colliding with surfaces, creating a force per unit area	☐	☐	☐	
4	Explain qualitatively, in terms of particles, the relationship between: a. pressure and temperature at constant volume b. volume and temperature at constant pressure c. pressure and volume at constant temperature	☐	☐	☐	
5	Recall and use the equation p1V1 = p2V2, including a graphical representation of the relationship between pressure and volume for a gas at constant temperature	☐	☐	☐	
2.2 Thermal properties and temperature					
2.2.1 Thermal expansion of solids, liquids and gases					
1	Explain applications and consequences of thermal expansion in the context of common examples, including the liquid-in-glass thermometer	☐	☐	☐	
2	Explain, in terms of the motion and arrangement of particles, the thermal expansion of solids, liquids and gases, and state the relative order of magnitudes of the expansion of solids, liquids and gases	☐	☐	☐	
3	Convert temperatures between kelvin and degrees Celsius; recall and use the equation T (in K) = θ (in °C) + 273	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
2.2.2 Specific heat capacity					
1	Know that a rise in the temperature of an object increases its internal energy				
2	Describe an increase in temperature of an object in terms of an increase in the average kinetic energies of all of the particles in the object				
3	Define specific heat capacity as the energy required per unit mass per unit temperature increase; recall and use the equation $\text{specific heat capacity} = \dfrac{\text{change in energy}}{\text{mass x change in temperature}}$ $c = \dfrac{\Delta E}{m\Delta\theta}$				
4	Describe experiments to measure the specific heat capacity of a solid and of a liquid				
2.2.3 Melting, boiling and evaporation					
1	Describe melting, solidification, boiling and condensation in terms of energy transfer without a change in temperature				
2	Know the melting and boiling temperatures for water at standard atmospheric pressure				
3	Describe the differences between boiling and evaporation				
4	Describe evaporation in terms of the escape of more-energetic particles from the surface of a liquid				
5	Describe how temperature, surface area and air movement over a surface affect evaporation				
6	Explain how evaporation causes cooling				
7	Describe latent heat as the energy required to change the state of a substance and explain it in terms of particle behaviour and the forces between particles				

Topic	You should be able to	R	A	G	Comments
2.3 Transfer of thermal energy					
2.3.1 Conduction					
1	Describe experiments to distinguish between good and bad thermal conductors				
2	Describe thermal conduction in all solids in terms of atomic or molecular lattice vibrations and also in terms of the movement of free (delocalised) electrons in metallic conductors				
2.3.2 Convection					
1	Explain convection in liquids and gases in terms of density changes and describe experiments to illustrate convection				
2.3.3 Radiation					
1	Describe the process of thermal energy transfer by infrared radiation and know that it does not require a medium				
2	Describe the effect of surface colour (black or white) and texture (dull or shiny) on the emission, absorption and reflection of infrared radiation				
3	Describe how the rate of emission of radiation depends on the surface temperature and surface area of an object				
4	Describe experiments to distinguish between good and bad emitters of infrared radiation				
5	Describe experiments to distinguish between good and bad absorbers of infrared radiation				
2.3.4 Consequences of thermal energy transfer					
	Explain everyday applications using ideas about conduction, convection and radiation, including: a. heating objects such as kitchen pans b. heating a room by convection c. measuring temperature using an infrared thermometer d. using thermal insulation to maintain the temperature of a liquid and to reduce thermal energy transfer in buildings				

3 Waves

Topic	You should be able to	R	A	G	Comments
3.1 General properties of waves					
1	Know that waves transfer energy without transferring matter				
2	Describe what is meant by wave motion as illustrated by vibrations in ropes and springs and by experiments using water waves				
3	Describe the features of a wave in terms of wavefront, wavelength, frequency, crest (peak), trough, amplitude and wave speed				
4	Define the terms: a. frequency as the number of wavelengths that pass a point per unit time b. wavelength as the distance between two consecutive, identical points such as two consecutive crests c. amplitude as the maximum distance from the mean position				
5	Recall and use the equation wave speed = frequency × wavelength $v = f\lambda$				
6	Know that for a transverse wave, the direction of vibration is at right-angles to the direction of the energy transfer, and give examples such as electromagnetic radiation, waves on the surface of water, and seismic S-waves (secondary)				
7	Know that for a longitudinal wave, the direction of vibration is parallel to the direction of the energy transfer, and give examples such as sound waves and seismic P-waves (primary)				
8	Describe how waves can undergo: a. reflection at a plane surface b. refraction due to a change of speed c. diffraction through a narrow gap				
9	Describe how wavelength and gap size affects diffraction through a gap				

Topic	You should be able to	R	A	G	Comments
10	Describe the use of a ripple tank to show: a. reflection at a plane surface b. refraction due to a change in speed caused by a change in depth c. diffraction due to a gap d. diffraction due to an edge				
11	Describe how wavelength affects diffraction at an edge				
3.2 Light					
3.2.1 Reflection of light					
1	Define and use the terms normal, angle of incidence and angle of reflection				
2	Describe an experiment to illustrate the law of reflection				
3	Describe an experiment to find the position and characteristics of an optical image formed by a plane mirror (same size, same distance from mirror as object and virtual)				
4	State that for reflection, the angle of incidence is equal to the angle of reflection and use this in constructions, measurements and calculations				
3.2.2 Refraction of light					
1	Define and use the terms normal, angle of incidence and angle of refraction				
2	Define refractive index n as $n = \frac{\sin i}{\sin r}$; recall and use this equation				
3	Describe an experiment to show refraction of light by transparent glass blocks of different shapes				
4	Define the terms critical angle and total internal reflection; recall and use the equation $n = \frac{1}{\sin c}$				
5	Describe experiments to show internal reflection and total internal reflection				
6	Describe the use of optical fibres, particularly in telecommunications, stating the advantages of their use in each context				

Topic	You should be able to	R	A	G	Comments
3.2.3 Thin lenses					
1	Describe the action of thin converging and thin diverging lenses on a beam of light				
2	Define and use the terms focal length, principal axis and principal focus (focal point)				
3	Draw ray diagrams to illustrate the formation of real and virtual images of an object by a converging lens and know that a real image is formed by converging rays and a virtual image is formed by diverging rays				
4	Define linear magnification as the ratio of image length to object length; recall and use the equation $\text{linear magnification} = \frac{\text{image length}}{\text{object length}}$				
5	Describe the use of a single lens as a magnifying glass				
6	Draw ray diagrams to show the formation of images in the normal eye, a short-sighted eye and a long-sighted eye				
7	Describe the use of converging and diverging lenses to correct long-sightedness and short-sightedness				
3.2.4 Dispersion of light					
1	Describe the dispersion of light as illustrated by the refraction of white light by a glass prism				
2	Know the traditional seven colours of the visible spectrum in order of frequency and in order of wavelength				
3.3 Electromagnetic spectrum					
1	Know the main regions of the electromagnetic spectrum in order of frequency and in order of wavelength				
2	Know that the speed of all electromagnetic waves in: a. a vacuum is 3.0×10^8 m/s b. air is approximately the same as in a vacuum				

Topic	You should be able to	R	A	G	Comments
3	Describe the role of the following components in the stated applications: a. radio waves – radio and television communications, astronomy b. microwaves – satellite television, mobile (cell) phone, Bluetooth, microwave ovens c. infrared – household electrical appliances, remote controllers, intruder alarms, thermal imaging, optical fibres d. visible light – optical fibres in medical uses, photography, vision e. ultraviolet – security marking, detecting counterfeit bank notes, sterilising water f. X-rays – hospital use in medical imaging, security scanners, killing cancerous cells, engineering applications such as detecting cracks in metal g. gamma rays – medical treatment in detecting and killing cancerous cells, sterilising food and medical equipment, engineering applications such as detecting cracks in metal				
4	Describe the damage caused by electromagnetic radiation, including: a. excessive exposure causing heating of soft tissues and burns b. ionising effects caused by ultraviolet (skin cancer and cataracts), X-rays and gamma rays (cell mutation and cancer)				
3.4 Sound					
1	Describe the production of sound by vibrating sources				
2	Describe the longitudinal nature of sound waves and describe compressions and rarefactions				
3	State the approximate range of frequencies audible to humans as 20 Hz to 20 000 Hz				
4	Explain why sound waves cannot travel in a vacuum and describe an experiment to demonstrate this				
5	Describe how changes in amplitude and frequency affect the loudness and pitch of sound waves				
6	Describe how different sound sources produce sound waves with different qualities (timbres), as shown by the shape of the traces on an oscilloscope				
7	Describe an echo as the reflection of sound waves				

Topic	You should be able to	R	A	G	Comments
8	Describe simple experiments to show the reflection of sound waves				
9	Describe a method involving a measurement of distance and time for determining the speed of sound in air				
10	Know that the speed of sound in the air is approximately 330-350 m/s				
11	Know that, in general, sound travels faster in solids than in liquids and faster in liquids than in gases				
12	Define ultrasound as sound with a frequency higher than 20 kHz				
13	Describe the uses of ultrasound in cleaning, prenatal and other medical scanning, and in sonar (including calculation of depth or distance from time and wave speed)				

4 Electricity and magnetism

Topic	You should be able to	R	A	G	Comments
4.1 Simple magnetism and magnetic fields					
1	Describe the forces between magnetic poles and between magnets and magnetic materials, including the use of the terms north pole (N pole), south pole (S pole), attraction and repulsion, magnetised and unmagnetised				
2	Describe induced magnetism				
3	State the difference between magnetic and non-magnetic materials				
4	State the differences between the properties of temporary magnets (made of soft iron) and the properties of permanent magnets (made of steel)				
5	Describe a magnetic field as a region in which a magnetic pole experiences a force				
6	Describe the plotting of magnetic field lines with a compass or iron filings and the use of a compass to determine the direction of the magnetic field				
7	Draw the pattern and direction of the magnetic field lines around a bar magnet				
8	State that the direction of the magnetic field at a point is the direction of the force on the N pole of a magnet at that point				

Topic	You should be able to	R	A	G	Comments
9	Know that the relative strength of a magnetic field is represented by the spacing of the magnetic field lines				
10	Describe uses of permanent magnets and electromagnets				
4.2 Electrical quantities					
4.2.1 Electric charge					
1	State that there are positive and negative charges and that charge is measured in coulombs				
2	State that unlike charges attract and like charges repel				
3	Describe experiments to show electrostatic charging by friction				
4	Explain that charging of solids by friction involves only a transfer of negative charge (electrons)				
5	Describe an electric field as a region in which an electric charge experiences a force				
6	State that the direction of an electric field line at a point is the direction of the force on a positive charge at that point				
7	Describe simple electric field patterns, including the field: a. around a point charge b. around a charged conducting sphere c. between two oppositely charged parallel conducting plates (end effects will **not** be examined)				
8	State examples of electrical conductors and insulators				
9	Describe an experiment to distinguish between electrical conductors and insulators				
10	Recall and use a simple electron model to explain the difference between electrical conductors and insulators				

Topic	You should be able to	R	A	G	Comments
4.2.2 Electric current					
1	Define electric current as the charge passing a point per unit time; recall and use the equation $\text{electric current} = \frac{\text{charge}}{\text{time}}$ $I = \frac{Q}{t}$	☐	☐	☐	
2	Describe electrical conduction in metals in terms of the movement of free electrons	☐	☐	☐	
3	Know that current is measured in amps (amperes) and that the amp is given by C / s	☐	☐	☐	
4	Know the difference between direct current (d.c.) and alternating current (a.c.)	☐	☐	☐	
5	State that conventional current is from positive to negative and that the flow of free electrons is from negative to positive	☐	☐	☐	
6	Describe the use of ammeters (analogue and digital) with different ranges	☐	☐	☐	
4.2.3 Electromotive force and potential difference					
1	Define e.m.f. (electromotive force) as the electrical work done by a source in moving a unit charge around a complete circuit; recall and use the equation $\text{e.m.f.} = \frac{\text{work done (by a source)}}{\text{charge}}$ $E = \frac{W}{Q}$	☐	☐	☐	
2	Define p.d. as the work done by a unit charge passing through a component; recall and use the equation $\text{p.d.} = \frac{\text{work done (by a component)}}{\text{charge}}$ $V = \frac{W}{Q}$	☐	☐	☐	
3	Know that e.m.f. and p.d. are measured in volts and that the volt is a joule per coulomb (V = J / C)	☐	☐	☐	
4	Describe the use of voltmeters (analogue and digital) with different ranges	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
5	Calculate the total e.m.f. where several sources are arranged in series				
6	State that the e.m.f of identical sources connected in parallel is equal to the e.m.f. of one of the sources				
4.2.4 Electric circuits					
1	Recall and use the equation resistance = $\frac{\text{p.d.}}{\text{current}}$ $R = \frac{W}{I}$				
2	Describe an experiment to determine resistance using a voltmeter and an ammeter and do the appropriate calculations				
3	Recall and use, quantitatively, for a wire, the direct proportionality between resistance and length, and the inverse proportionality between resistance and cross-sectional area				
4	State Ohm's Law, including reference to constant temperature				
5	Sketch and explain the current–voltage graphs of a resistor of constant resistance, a filament lamp and a diode				
6	Describe the effect of temperature increase on the resistance of a resistor, such as the filament in a filament lamp				
4.3 Electric circuits					
4.3.1 Circuit diagrams and circuit components					
1	Draw and interpret circuit diagrams with cells, batteries, power supplies, generators, oscilloscopes, potential dividers, switches, resistors (fixed and variable), heaters, thermistors (NTC only), light-dependent resistors (LDRs), lamps, motors, ammeters, voltmeters, magnetising coils, transformers, fuses, relays, diodes and light-emitting diodes (LEDs), and know how these components behave in the circuit				

Topic	You should be able to	R	A	G	Comments
4.3.2 Series and parallel circuits					
1	Recall and use in calculations, the fact that: a. the current at every point in a series circuit is the same b. the sum of the currents into a junction in a parallel circuit is equal to the sum of the currents that leave the junction c. the total p.d. across the components in a series circuit is equal to the sum of the individual p.d.s across each component d. the p.d. across an arrangement of parallel resistances is the same as the p.d. across one branch in the arrangement of the parallel resistances				
2	Calculate the combined resistance of two or more resistors in series				
3	Calculate the combined resistance of two resistors in parallel				
4	Calculate current, voltage and resistance on parts of a circuit or on the whole circuit				
4.3.3 Action and use of circuit components					
1	Describe the action of negative temperature coefficient (NTC) thermistors and light-dependent resistors and explain their use as input sensors				
2	Describe the action of a variable potential divider				
3	Recall and use the equation for two resistors used as a potential divider $\frac{R_1}{R_2} = \frac{V_1}{V_2}$				
4.4 Practical electricity					
4.4.1 Uses of electricity					
1	State common uses of electricity, including heating, lighting, battery charging and powering motors and electronic systems				
2	State the advantages of connecting lamps in parallel in a lighting circuit				
3	Recall and use the equation power = current × voltage $P = IV$				

Topic	You should be able to	R	A	G	Comments
4	Recall and use the equation energy = current × voltage × time $E = IVt$				
5	Define the kilowatt-hour (kW h) and calculate the cost of using electrical appliances where the energy unit is the kW h				
4.4.2 Electrical safety					
1	State the hazards of: a. damaged insulation b. overheating cables c. damp conditions d. excess current from overloading of plugs, extension leads, single and multiple sockets when using a mains supply				
2	Explain the use and operation of trip switches and fuses and choose appropriate fuse ratings and trip switch settings				
3	Explain what happens when a live wire touches a metal case that is earthed				
4	Explain why the outer casing of an electrical appliance must be either non-conducting (double insulated) or earthed				
5	Know that a mains circuit consists of a live wire (line wire), a neutral wire and an earth wire and explain why a switch must be connected to the live wire for the circuit to be switched off safely				
6	Explain why switches, fuses and circuit breakers are wired into the live conductor				
4.5 Electromagnetic effects					
4.5.1 Electromagnetic induction					
1	Describe an experiment to demonstrate electromagnetic induction				
2	State that the magnitude of an induced e.m.f. is affected by: a. the rate of change of the magnetic field or the rate of cutting of magnetic field lines b. the number of turns in a coil				

Topic	You should be able to	R	A	G	Comments
3	State and use the fact that the effect of the current produced by an induced e.m.f. is to oppose the change producing it (Lenz's Law) and describe how this law may be demonstrated				
4.5.2 The a.c. generator					
1	Describe a simple form of a.c. generator (rotating coil or rotating magnet) and the use of slip rings and brushes where needed				
2	Sketch a graph of e.m.f. against time for a simple a.c. generator and relate the position of the generator coil to the peaks, troughs and zeros of the e.m.f.				
4.5.3 Magnetic effect of a current					
1	Describe the pattern of the magnetic field due to currents in straight wires and in solenoids and state the effect on the magnetic field of changing the magnitude and direction of the current				
2	Describe how the magnetic effect of a current is used in relays and loudspeakers and give examples of their application				
4.5.4 Forces on a current-carrying conductor					
1	Describe experiments to show the force on a current-carrying conductor in a magnetic field and on a beam of charged particles in a magnetic field, including the effect of reversing: a. the current b. the direction of the field				
2	Recall and use the relative directions of force, magnetic field and current				
3	Describe the magnetic field patterns between currents in parallel conductors and relate these to the forces on the conductors (excluding the Earth's field)				
4.5.5 The d.c. motor					
1	Know that a current-carrying coil in a magnetic field experiences a turning effect and that the turning effect is increased by increasing: a. the number of turns on the coil b. the current c. the strength of the magnetic field				
2	Describe the operation of an electric motor, including the action of a split-ring commutator and brushes				

Topic	You should be able to	R	A	G	Comments
4.5.6 The transformer					
1	Describe the structure and explain the principle of operation of a simple iron-cored transformer	☐	☐	☐	
2	Use the terms primary, secondary, step-up and step-down	☐	☐	☐	
3	Recall and use the equation $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ where p and s refer to primary and secondary	☐	☐	☐	
4	State the advantages of high-voltage transmission and explain why power losses in cables are smaller when the voltage is greater	☐	☐	☐	
4.6 Uses of an oscilloscope					
1	Describe the use of an oscilloscope to display waveforms (the structure of any oscilloscope is **not** required)	☐	☐	☐	
2	Describe how to measure p.d.s and short intervals of time with an oscilloscope using the Y-gain and timebase	☐	☐	☐	

5 Nuclear physics

Topic	You should be able to	R	A	G	Comments
5.1 The nuclear model of the atom					
5.1.1 The atom					
1	Describe the structure of the atom in terms of a positively charged nucleus and negatively charged electrons in orbit around the nucleus	☐	☐	☐	
2	Describe how the alpha-particle scattering experiment provides evidence for: a. a very small nucleus surrounded by mostly empty space b. a nucleus containing most of the mass of the atom c. a nucleus that is positively charged	☐	☐	☐	
5.1.2 The nucleus					
1	Describe the composition of the nucleus in terms of protons and neutrons	☐	☐	☐	
2	Describe how atoms form positive ions by losing electrons or negative ions by gaining electrons	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
3	Define the terms proton number (atomic number), Z and nucleon number (mass number), A and be able to calculate the number of neutrons in a nucleus	☐	☐	☐	
4	Explain the term nuclide and use the nuclide notation $^{A}_{Z}X$	☐	☐	☐	
5	Explain what is meant by isotope and state that an element may have more than one isotope	☐	☐	☐	
5.2 Radioactivity					
5.2.1 Detection of radioactivity					
1	Describe the detection of alpha-particles (α-particles) using a cloud chamber or spark counter and the detection of beta-particles (β-particles) (β-particles will be taken to refer to β–) and gamma radiation (γ-radiation) by using a Geiger-Müller tube and counter	☐	☐	☐	
2	Use count rate measured in counts/s or counts/minute	☐	☐	☐	
3	Know what is meant by background radiation	☐	☐	☐	
4	Know the sources that make a significant contribution to background radiation including: a. radon gas (in the air) b. rocks and buildings c. food and drink d. cosmic rays	☐	☐	☐	
5	Use measurements of background radiation to determine a corrected count rate	☐	☐	☐	
5.2.2 The three types of emission					
1	Describe the emission of radiation from a nucleus as spontaneous and random in direction	☐	☐	☐	
2	Describe α-particles as two protons and two neutrons (helium nuclei), β-particles as high-speed electrons from inside the nucleus and γ-radiation as high-frequency electromagnetic waves	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
3	State for α-particles, β-particles and γ-radiation: a. their relative ionising effects b. their relative penetrating powers	☐	☐	☐	
4	Describe the deflection of α-particles, β-particles and γ-radiation in electric fields and magnetic fields	☐	☐	☐	
5.2.3 Radioactive decay					
1	Know that radioactive decay is a change in an unstable nucleus that can result in the emission of α-particles or β-particles and/or γ-radiation and know that these changes are spontaneous and random	☐	☐	☐	
2	Use decay equations, using nuclide notation, to show the emission of α-particles, β-particles and γ-radiation	☐	☐	☐	
5.2.4 Fission and fusion					
1	Describe the process of fusion as the formation of a larger nucleus by combining two smaller nuclei with the release of energy, and recognise fusion as the energy source for stars	☐	☐	☐	
2	Describe the process of fission when a nucleus, such as Uranium-235 (U-235), absorbs a neutron and produces daughter nuclei and two or more neutrons with the release of energy	☐	☐	☐	
3	Explain how the neutrons produced in fission create a chain reaction and that this is controlled in a nuclear reactor, including the action of coolant, moderators and control rods	☐	☐	☐	
5.2.5 Half-life					
1	Define the half-life of a particular isotope as the time taken for half the nuclei of that isotope in any sample to decay; recall and use this definition in calculations, which may involve information in tables or decay curves	☐	☐	☐	
2	Describe the dating of objects by the use of ^{14}C	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
3	Explain how the type of radiation emitted and the half-life of the isotope determine which isotope is used for applications including: a. household fire (smoke) alarms b. irradiating food to kill bacteria c. sterilisation of equipment using gamma rays d. measuring and controlling thicknesses of materials with the choice of radiations used linked to penetration and absorption e. diagnosis and treatment of cancer using gamma rays	☐	☐	☐	
5.2.6 Safety precautions					
1	State the effects of ionising radiations on living things, including cell death, mutations and cancer	☐	☐	☐	
2	Explain how radioactive materials are moved, used and stored in a safe way, with reference to: a. reducing exposure time b. increasing distance between source and living tissue c. use of shielding to absorb radiation	☐	☐	☐	

6 Space physics

Topic	You should be able to	R	A	G	Comments
6.1 Earth and the Solar System					
6.1.1 The Earth					
1	Know that: a. the Earth is a planet that orbits the Sun once in approximately 365 days b. the orbit of the Earth around the Sun is an ellipse which is approximately circular c. the Earth rotates on its axis, which is tilted, once in approximately 24 hours d. it takes approximately one month for the Moon to orbit the Earth e. it takes approximately 500 s for light from the Sun to reach the Earth	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
2	Define average orbital speed from the equation $v = \frac{2\pi r}{T}$ where r is the average radius of the orbit and T is the orbital period; recall and use this equation				
6.1.2 The Solar System					
1	Describe the solar system as containing: a. one star, the Sun b. the eight named planets and know their order from the Sun c. minor planets that orbit the Sun, including dwarf planets such as Pluto and asteroids in the asteroid belt d. moons, that orbit the planets e. smaller Solar System bodies, including comets and natural satellites				
2	Analyse and interpret planetary data about orbital distance, orbital duration, density, surface temperature and uniform gravitational field strength at the planet's surface				
3	Know that the strength of the gravitational field a. at the surface of a planet depends on the mass of the planet b. around a planet decreases as the distance from the planet increases				
4	Know that the Sun contains most of the mass of the Solar System and that the strength of the gravitational field at the surface of the Sun is greater than the strength of the gravitational field at the surface of the planets				
5	Know that the force that keeps an object in orbit around the Sun is due to the gravitational attraction of the Sun				
6	Know that the strength of the Sun's gravitational field decreases and that the orbital speeds of the planets decrease as the distance from the Sun increases				

Topic	You should be able to	R	A	G	Comments
6.2 Stars and the Universe					
6.2.1 The Sun as a star					
1	Know that the Sun is a star of medium size, consisting mostly of hydrogen and helium, and that it radiates most of its energy in the infrared, visible and ultraviolet regions of the electromagnetic spectrum				
2	Know that stars are powered by nuclear reactions that release energy and that in stable stars the nuclear reactions involve the fusion of hydrogen into helium				
6.2.2 Stars					
1	State that: a. galaxies are made up of many billions of stars b. the Sun is a star in the galaxy known as the Milky Way c. other stars that make up the Milky Way are much further away from the Earth than the Sun is from the Earth d. astronomical distances can be measured in light-years, where one light-year is the distance travelled in a vacuum by light in one year				
2	Describe the life cycle of a star: a. a star is formed from interstellar clouds of gas and dust that contain hydrogen b. a protostar is an interstellar cloud collapsing and increasing in temperature as a result of its internal gravitational attraction c. a protostar becomes a stable star when the inward force of gravitational attraction is balanced by an outward force due to the high temperature of the star d. all stars eventually run out of hydrogen as fuel for the nuclear reaction e. most stars expand to form red giants and more massive stars expand to form red supergiants when most of the hydrogen in the centre of the star has been converted to helium f. a red giant from a less massive star forms a planetary nebula with a white dwarf at its centre g. a red supergiant explodes as a supernova, forming a nebula containing hydrogen and new heavier elements, leaving behind a neutron star or a black hole at its centre h. the nebula from a supernova may form new stars with orbiting planets				

Topic	You should be able to	R	A	G	Comments
6.2.3 The Universe					
1	Know that the Milky Way is one of many billions of galaxies making up the Universe and that the diameter of the Milky Way is approximately 100 000 light-years	☐	☐	☐	
2	Describe redshift as an increase in the observed wavelength of electromagnetic radiation emitted from receding stars and galaxies	☐	☐	☐	
3	Know that the light from stars in all distant galaxies shows redshift and that the further away the galaxy, the greater the observed redshift and the faster the galaxy's speed away from the Earth	☐	☐	☐	
4	Describe qualitatively how redshift provides evidence for the Big Bang theory	☐	☐	☐	

Section 5: Useful websites

TThe resources listed below will help you to revise and study for your Cambridge IGCSE physics course.

These resources have not been through the Cambridge quality assurance process but have been found suitable for use with various parts of the syllabus. This list includes website links providing direct access to internet resources. Cambridge is not responsible for the accuracy or content of information contained in these resources. The inclusion of a link to an external website should not be understood to be an endorsement of that website or the site's owners (or their products/services).

https://www.bbc.co.uk/bitesize

https://www.falstad.com/mathphysics.html

https://www.mathsisfun.com/physics/index.html

https://phet.colorado.edu

https://www.physicsclassroom.com

https://spark.iop.org

https://www.stem.org.uk

You can find a resource list, including endorsed resources to support Cambridge O Level Physics on our public website [here]

Endorsed resources have been written to be closely aligned to the syllabus they support, and have been through a detailed quality assurance process. All textbooks endorsed by Cambridge International for this syllabus are the ideal resource to be used alongside this Learner Guide.

In addition to reading the syllabus, you should refer to the past and specimen papers.

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