Learner Guide

Cambridge O Level

Cambridge O Level Physics

5054

For examination from 2016

Cambridge Secondary 2

CAMBRIDGE International Examinations

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Contents

How to use this guide

The guide describes what you need to know about your Cambridge O Level 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 theory and practical examination papers.

Section 2: Examination advice

This section gives you advice to help you do as well as you can. Some of the ideas are general advice and some are based on the common mistakes that candidates 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 approximately 30% of the total mark is for simple recall.

Section 4: What you need to know

This shows the syllabus content so that you can check:

- which topics you need to know about
- details about each topic area in the syllabus
- how much of the syllabus you have covered.

Section 5: Useful websites

- some useful websites that you might use.

Section 6: 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.

Before you start:

Check with your teacher which practical paper you will be taking (Paper 3 or Paper 4).

Both of these papers are described in Section 1 and Section 3. You only need to read about one of them.

The theory papers are the same for everyone and the theory is detailed in Section 2.

Section 1: How will you be tested?

About the papers

You will be entered for **three** examination papers: **two** theory papers and **one** practical paper. You will take Paper 1 Multiple Choice, Paper 2 Theory and either Paper 3 Practical Test or Paper 4 Alternative to Practical.

You need to ask your teacher which practical paper you are taking.

About the theory papers

The table gives you information about the theory papers.

Paper number and type	How long and how many marks?	What's in the paper?	What's the % of the total examination?
Paper 1 Multiple Choice	1 hour (40 marks)	40 multiple-choice questions	27.6
Paper 2 Theory	1¾ hours (75 marks)	Short answer and structured questions	51.7

Here is some more information about each paper.

Paper 1 Multiple Choice

You have to choose one of the four possible answers in each question.

The multiple-choice questions cover the entire syllabus, apart from Section 25 on Electronic Systems.

Paper 2 Theory

All answers are written in the spaces provided on the actual question paper.

There are two sections.

Section A contains short structured questions where you may have to write a few words or sentences or make a calculation. You must answer all the questions.

Section B has three longer questions. Each question is worth 15 marks. You must answer **two** of the three questions, so take your time to read them carefully before choosing which questions to answer.

Questions on Section 25 (Electronic Systems) will always be optional.

About the practical papers

Just over 20 per cent of the marks for Cambridge O Level Physics are for practical work.

You will do **one** of the practical papers shown in the table, either Paper 3 or Paper 4. Your teacher will tell you which practical paper you will do.

Paper number and type	How long and how many marks?	What's invovled?
Paper 3 Practical Test	2 hours (30 marks)	You do a practical exam which is supervised by a teacher
Paper 4 Alternative to Practical	1 hour (30 marks)	You answer a written paper about practical work.

Here is some more detail about the practical papers. If you are unsure of anything, ask your teacher.

EITHER

Paper 3 Practical Test

You do a practical exam, which is supervised by a teacher. You will carry out four short experiments.

Section A contains three short questions and lasts 1 hour. **Section B** contains one question that takes 1 hour.

You are given instructions, which enable you to carry out the experiments. You will take readings and record them in a table. You need to use a sensible number of figures and give the unit in the heading. You will usually draw a graph and make some conclusions, commenting upon accuracy and on how to improve the experiment.

You may be asked to use the following techniques, amongst others:

- 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.

Your experience of practical work during the course should enable you to handle the apparatus. Your teacher will be able to give you more examples and explain how to take readings and analyse the data.

OR

Paper 4 Alternative to Practical

This is a written paper, testing the same skills as Paper 3. There are usually four questions which test practical procedures in the physics laboratory.

You may be asked to:

- record readings from diagrams of apparatus, e.g. reading current from an ammeter
- 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 advice

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

General advice

- Thorough and careful revision is the best way to prepare for a physics examination.
- Make your revision productive by making it interesting and fun. Make notes, revision cards or mind maps. Revision should be an active process, i.e. you should be 'doing things', not just sitting and reading a book.
- Don't try to learn it all in one go! Take regular breaks and review what you have learnt regularly.
- Learning equations is essential; put them on small pieces of paper and stick them somewhere you will see them every morning.
- Revise with a friend so you can test each other or try explaining the physics of a topic to a friend – as if you were a teacher!
- Working through past paper questions is the best way to complete your revision. This helps you to know the type and style of questions to expect in the examination.
- Try timed questions so you can learn to answer quickly.
- Get your answers checked so you know you are correct!
- In Cambridge O Level Physics examinations you have to be able to complete a variety of tasks; always read the question carefully to make sure you have understood what you are expected to do.

Spelling

- The spelling of technical terms is important, so make sure your writing is legible as well as spelt correctly.
- Some words are very similar, such as *reflection* and *refraction*, *fission* and *fusion*. If we cannot tell which one you have written, then you will lose the mark. Make a list of technical terms and definitions in each section of the syllabus, checking the spellings carefully.

Descriptive answers

In descriptive answers, you should:

- Check the number of marks available and make sure you give sufficient points.
- Plan your answer first so that you don't repeat yourself or contradict yourself.
- Read your answer through carefully afterwards to check you have not missed out important words.
- Read the question again to check you have answered the question asked.
- Use sketches and diagrams wherever you can to help your explanation.
- Add labels when referring to a diagram, e.g. *point X*, so that you can refer to it easily in your explanation. This can save many words and much confusion.

Numerical answers

In numerical answers, you should:

- Quote any formulae you are going to use and show clearly all the steps in your working. It may be tempting to use your calculator and just write down the answer, but if you write down one figure wrongly then you may lose all the marks for the calculation. If we can see the formula and the numbers you have used then you will lose only a little credit. Some questions ask for a formula to be quoted; even if you get the right answer, failure to quote the formula will lose you a mark.
- Check the units are consistent, e.g. if the distance is given in km and the speed in m/s, then you must convert the km to m.
- Be careful when you are converting minutes and seconds: 1 minute 30 seconds is not 1.3 minutes and 150 seconds is not 1.5 minutes. These are common mistakes, so always double check any conversion of units of time.
- State the answer clearly at the end.
- Give your answer as a decimal to an appropriate number of significant figures. Don't leave your answer as a fraction unless specifically asked to do so.
- Check that you have given the unit of your final answer.
- Look at your final answer and see that it is reasonable. If you have calculated the cost of using an electrical appliance such as a kettle for a few minutes and found it to be hundreds of dollars, then check the powers of ten in your calculation.

Graphs

Plotting graphs can be tested in Papers 2, 3 or 4.

When drawing graphs, you should:

- Remember to label the axes with both quantity (e.g. distance or d) and unit (e.g. metres or m). Then write it as distance/metres or even just *d*/m.
- Make sure the axes are the correct way round. You are usually told, for example, to plot distance on the *x*-axis, so make sure you know that *x* is the horizontal axis!
- Make the scales go up in sensible amounts, i.e. 0, 5, 10… or 0, 2, 4… but not 0, 3, 6… or 0, 7, 14…
- Make sure that the plotted points fill at least half the graph paper. This means if you can double the scale and still plot all the points then you should double the scale.
- Check if you have been told to start the scales from the origin. If not, then think carefully about where to start the axes.
- When you are told to start the axes from a certain point (e.g. $x = 1$, $y = 20$) you must do so. You will lose a mark if you use a different point (e.g. the origin).
- Use a sharp pencil to plot the points and draw the line.
- Plot the points carefully. It is best to use small neat crosses. Every point will be checked by the examiner, and you will lose the mark if any are wrongly plotted.
- Draw either a straight line or a smooth curve. In physics we never join the dots!
- Your line may not go through all the points – especially in the practical papers.
- Remember that a best fit line (curve or straight) should have some points above and some points below the line.

When taking readings from a graph, you should:

- Draw a large triangle when measuring the gradient of a line. It must be at least half the length of the line. Top tip: draw a triangle the full size of the graph! It is best to show the numbers on the sides of the triangle when finding the gradient.
- Always use points on the line, not your plotted points, when calculating the gradient.
- Draw a tangent to find the gradient of a curve. Make sure it is at the right place on the curve. Again, use a large triangle.
- Make sure you read the scales correctly when reading a value from a graph. It may be that they are in mA rather than A or km rather than m.

When describing the shape of a graph, remember that:

- **directly proportional** means a straight line *through the origin*.
  There are two ways to check if quantities are directly proportional:
  - doubling one quantity will cause the other to double
  - dividing one by the other will give the same result

    i.e. if two quantities *F* and *L* are directly proportional then if you find several values of ***F*/*L*** they should be the same
- if the straight line does not go through the origin, then it is just called a **linear graph**
- **inverse relationship** means increasing one quantity will cause the other to decrease
- if doubling one quantity causes the other to halve, then they are **inversely proportional**.
  This can also be checked by:
  - multiplying the two quantities together will give the same result

    i.e. if two quantities *F* and *L* are inversely proportional then if you find several values of $\boldsymbol{F} \times \mathbf{L}$ they should be the same.

Section 3: What will be tested?

We test you on three assessment objectives:

AO1 your knowledge (what you remember) and understanding (how you use what you know and apply it to unfamiliar situations)

AO2 how you handle information and solve problems

AO3 your experimental skills

The theory papers test AO1 and AO2.

You should note that approximately 65% of the marks are for AO1 and of these only about half of these are for simple recall.

The practical papers test AO3.

The table shows you the range of skills you should try to develop.

Assessment objective	What this means	Whatyou need to be able to do
AO1 Knowledge with understanding	remembering facts and applying these facts to new situations	• Use scientific ideas, facts and laws • Know the meaning of scientific terms, e.g. centre of mass • Know equations and definitions • Use simple equations, e.g. speed = distance/time • Know about apparatus and how it works • Know about symbols, quantities (e.g. mass and weight) and units (e.g. kg and N)
AO2 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	• Select and organise information from graphs, • tables and written text • Change information from one form to another, e.g. draw graphs • Arrange data and carry out calculations • Identify patterns from information given and draw conclusions • Explain scientific relationships, e.g. use the moving (kinetic) particle theory to explain ideas about solids, liquids and gases • Make predictions and develop scientific ideas • Solve problems

AO3 Experimental skills and investigations	planning and carrying out experiments, recording and analysing information	• Follow instructions to set up and use apparatus safely • Make observations and measurements and record them with regard to precision, accuracy and units • Analyse experimental results • Plan and carry out an experiment describing any problems and suggesting improvements

Section 4: What you need to know

The following table describes the things you may be tested on in the examination.

The main headings in the topic areas are usually followed by the details of what you need to know.

How to use the table

You can use the table throughout your course to check the topic areas you have covered.

There is no need to start at the beginning. Use it when you finish a section of your course to make sure that you understand what you should be able to do.

When you think you have a good knowledge of a topic, you can tick the appropriate box in the checklist column.

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.

You can also use it as a revision aid at the end of the course to find out any weaknesses or areas you need to do some work on or ask your teacher about.

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 show areas of difficulty/things you need to ask your teacher about.

There are six major **themes** in the table:

General Physics

Newtonian Mechanics

Energy and Thermal Physics

Waves

Electricity and Magnetism

Atomic Physics.

Each **theme** contains a number of **sections**. The 27 sections cover the whole syllabus. Each section contains a number of **topics** and the table lists what you should be able to do in each topic.

You should note that questions on Section 25, Electronic Systems, only appear in Paper 2 and are always set as an alternative within a question.

Your teacher may have chosen not to cover this section in your course. In that case you should not need to learn that topic.

Do, however, make sure that you understand Section 24, Introductory Electronics.

Topic	You should be able to:	Checklist	Comments
THEME 1	**General Physics**		
1. Physical quantities, units and measurements			
Scalars and vectors	• define the terms *scalar* and *vector* • find the resultant of two vectors by a graphical method • know which of the following are scalars and which are vectors: distance, displacement, length, speed, velocity, time, acceleration, mass and force	☐ ☐ ☐	
Measurement techniques	• describe how to measure different lengths with suitable accuracy using tapes, rules, micrometers, and calipers (the use of a vernier scale is **not** required) • describe how to measure different time intervals using clocks and stopwatches	☐ ☐	
Units and symbols	• recognise and use the SI system of units – your teacher will have more information	☐	
THEME 2	**Newtonian Mechanics**		
2. Kinematics			
Speed, velocity and acceleration	• state what is meant by speed • state what is meant by velocity • calculate average speed using *average speed = distance travelled/time taken* • state what is meant by uniform acceleration • calculate acceleration using *acceleration = change in velocity/time taken* • explain what is meant by non-uniform acceleration	☐ ☐ ☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
Graphical analysis of motion	• plot and use distance-time graphs. • plot and use speed-time graphs. • recognise the shape of a speed-time graph for a body: at rest, moving with uniform speed moving with uniform acceleration moving with non-uniform acceleration • calculate the area under a speed-time graph to find the distance travelled by a body moving with constant speed or constant acceleration	☐ ☐ ☐ ☐	
Free-fall	• state that the acceleration of free-fall for a body near to the Earth is constant • know that it is about 10 m/s^2 • describe in words the motion of bodies falling without air resistance • describe in words the motion of bodies falling with air resistance • explain how a body reaches terminal velocity	☐ ☐ ☐ ☐ ☐	
3. Dynamics			
Balanced and unbalanced forces	• state Newton's third law • describe the effect of balanced and unbalanced forces on a body • describe the ways in which a force may change the motion of a body • do calculations using the equation *force = mass × acceleration*	☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
Friction	• explain the effects of friction on the motion of a body • describe how the following affect friction between the wheels of a vehicle and the road: tyre surface road conditions (including skidding) braking force • describe how these change the: braking distance thinking distance stopping distance of a vehicle	☐ ☐ ☐	
Circular motion	• describe in words how objects move in a circular path due to a constant force perpendicular to the direction of travel • apply ideas about circular motion to: electrostatic forces on an electron in an atom, gravitational forces on a satellite, the motion of planets in the solar system	☐ ☐	
4. Mass, weight and density			
Mass and weight	• state that mass is a measure of the amount of substance in a body • state that mass of a body resists change from its state of rest or motion • calculate weight from the equation *weight = mass × gravitational field strength* • explain that weights, and therefore masses, may be compared using a balance • describe how to measure mass and weight by using suitable balances	☐ ☐ ☐ ☐ ☐	
Gravitational fields	• state that a gravitational field is a region in which a mass experiences a force due to gravitational attraction	☐	

Topic	You should be able to:	Checklist	Comments
Density	• describe how to use a measuring cylinder to measure the volume of a liquid or solid. • describe how to determine the density of: a liquid a regularly shaped solid an irregularly shaped solid which sinks in water (volume by displacement) • do calculations using the equation *density = mass/volume*	☐ ☐ ☐	
5. Turning effect of forces			
Moments	• describe the moment of a force in terms of its turning effect • describe simple everyday examples of moments • state the principle of moments for a body in equilibrium • do calculations using *moment of a force =* *force × perpendicular distance from the pivot* • do calculations using the principle of moments • describe how to verify the principle of moments	☐ ☐ ☐ ☐ ☐ ☐	
Centre of mass	• describe how to find the position of the centre of mass of a plane lamina	☐	
Stability	• describe in words the effect of the position of the centre of mass on the stability of simple objects	☐	
6. Deformation			
Elastic deformation	• state that a force may produce a change in size and shape of a body • plot and use extension-load graphs for an elastic solid • describe an experiment to measure the extension produced by different loads for an elastic solid • know what is meant by the 'limit of proportionality' for an elastic solid • calculate extensions for an elastic solid using extension is directly proportional to load	☐ ☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
7. Pressure			
Pressure	• define the term pressure in terms of force and area • do calculations using the equation *pressure = force/area* • explain how pressure varies with force and area in a range of everyday examples	☐ ☐ ☐	
Pressure changes	• describe how the height of a liquid column may be used to measure the atmospheric pressure • explain in words how the pressure beneath a liquid surface changes with depth and density of the liquid in simple everyday examples • do calculations using the equation *pressure = hρg* • describe how a manometer is used to measure pressure differences • describe and explain the transmission of pressure in hydraulic systems • describe the workings of: the hydraulic press, hydraulic brakes on vehicles • describe how changing the pressure applied to a gas at constant temperature causes a change in volume • do calculations using $p_1V_1 = p_2V_2$	☐ ☐ ☐ ☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
THEME 3	**Energy and Thermal Physics**		
8. Energy sources and transfer of energy			
Energy forms	• list the different forms of energy • give examples in which each form occurs • state the principle of the conservation of energy • apply this principle to the conversion of energy from one form to another • state that kinetic energy $E_k = ½ mv^2$ • state that potential energy $E_P = mgh$ • do calculations using these equations	☐ ☐ ☐ ☐ ☐ ☐ ☐	
Major sources of energy	• list renewable and non-renewable energy sources • describe the energy conversions taking place when using the following energy sources: – chemical/fuel energy (re-grouping of atoms) – hydroelectric generation (emphasising the mechanical energies involved) – solar energy (nuclei of atoms in the Sun) – nuclear energy – geothermal energy – wind energy • explain how nuclear fusion releases energy • explain how nuclear fission releases energy • describe the generation of electricity and draw a block diagram of the process from fuel input to electricity output • discuss the environmental issues associated with power generation	☐ ☐ ☐ ☐ ☐	
Work	• calculate work done from the equation *work = force × distance moved in direction of the force*	☐	

Topic	You should be able to:	Checklist	Comments
Efficiency	• calculate the efficiency of an energy conversion using the equation $efficiency = \frac{energy\ converted\ to\ the\ required\ form}{total\ energy\ input}$ • discuss the efficiency of energy conversions in common use, particularly those giving electrical output • discuss the usefulness of energy output from a number of energy conversions	☐ ☐ ☐	
Power	• calculate power from the equation *power = work done/time taken*	☐	
9. Transfer of thermal energy			
Conduction	• describe how to distinguish between good and bad conductors of heat • describe heat transfer in solids by the movement of molecules • describe heat transfer in solids by the movement of free electrons	☐ ☐ ☐	
Convection	• describe convection in fuids using density changes	☐	
Radiation	• describe how heat is transferred by radiation • describe how to distinguish between good and bad emitters of infra-red radiation • describe how to distinguish between good and bad absorbers of infra-red radiation	☐ ☐ ☐	
Total transfer	• describe how heat is transferred to or from buildings and rooms • state the important methods of thermal insulation of buildings • describe how these important methods insulate the buildings	☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
10. Temperature			
Principles of thermometry	• explain how a physical property which varies with temperature may be used for the measurement of temperature • state examples of such properties • explain the need for fixed points • state what is meant by the ice point and steam point • discuss the features: sensitivity range linearity of thermometers	☐ ☐ ☐ ☐ ☐	
Practical thermometers	• describe the structure and action of liquid-in-glass thermometers (including clinical) • describe the structure and action of a thermocouple thermometer • explain the use of a thermocouple thermometer for measuring high temperatures and those which vary rapidly	☐ ☐ ☐	
11. Thermal properties of matter			
Specific heat capacity	• describe a rise in temperature of a body as an increase in its internal energy (random thermal energy) • define the terms heat capacity • define the term specific heat capacity • calculate heat transferred using the equation *thermal energy =* *mass × specific heat capacity × change in temperature*	☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
Melting and boiling	• describe melting/solidification and boiling/condensation as a transfer of energy without a change in temperature • state the meaning of melting point • state the meaning of boiling point • explain the difference between boiling and evaporation • define the term latent heat • define the term specific latent heat • explain latent heat by writing about molecules • calculate heat transferred in a change of state using the equation *thermal energy = mass × specific latent heat*	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	
Thermal expansion of solids, liquids and gases	• describe in words the thermal expansion of solids, liquids and gases • describe the relative order of magnitude of the expansion of solids, liquids and gases • list and explain some of the everyday applications and consequences of thermal expansion • describe in words how a change of temperature affects the volume of a gas at constant pressure	☐ ☐ ☐ ☐	
12. Kinetic model of matter			
States of matter	• state the properties of solids, liquids and gases	☐	
Molecular model	• describe in words the molecular structure of solids, liquids and gases • link the properties of solids, liquids and gases to: the forces between the molecules the distances between molecules the motion of the molecules • describe how changing the temperature affects the motion of molecules • explain the pressure of a gas in terms of the motion of its molecules	☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
Evaporation	• describe evaporation in terms of the escape of more energetic molecules from the surface of a liquid • describe how evaporation is affected by: temperature surface area draught over the surface • explain that evaporation causes cooling	☐ ☐ ☐	
THEME 4	**Waves**		
13. General wave properties			
Describing wave motion	• describe what is meant by a wave motion • describe the use of: ropes springs ripple tanks to demonstrate wave motions	☐ ☐	
Wave terms	• state what is meant by a *wavefront* • define the terms: *speed* *frequency* *wavelength* *amplitude* • do calculations using *velocity* = *frequency* × *wavelength* • describe a transverse wave • describe a longitudinal wave • explain the differences between transverse and longitudinal waves	☐ ☐ ☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
Wave behaviour	• describe how a ripple tank is used to show: – reflection at a plane surface – refraction due to a change of speed • describe simple experiments to show the reflection of sound waves • describe a simple experiment to show the refraction of sound wave	☐ ☐ ☐	
14. Light			
Reflection of light	• define the following terms: *normal* *angle of incidence* *angle of reflection* • describe an experiment to illustrate the law of reflection • describe an experiment to find the position of an image formed by a plane mirror • describe the properties of the image produced by a plane mirror • know that the angle of incidence is equal to the angle of reflection and • use this in drawing diagrams and calculations	☐ ☐ ☐ ☐ ☐ ☐	
Refraction of light	• define the following: *angle of incidence* *angle of refraction* *refractive index* • describe experiments to show refraction of light through glass blocks • do calculations using the equation $\sin i / \sin r = n$ • define the terms: *critical angle* *total internal reflection* • do calculations using the equation $\sin c = 1/n$ • describe experiments to show total internal reflection • describe how optical fibres are used in telecommunications and • state the advantages of their use	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
Thin converging and diverging lenses	• describe the action of thin converging lenses on a beam of light • describe the action of thin diverging lenses on a beam of light • define the term focal length • draw ray diagrams to show the formation of real and virtual images of an object by a converging lens • draw ray diagrams to show the formation of a virtual image by a diverging lens • define the term linear magnification • draw scale diagrams to determine the focal length of a converging lens needed for particular values of magnification • describe the use of a single lens: as a magnifying glass in a camera n a projector in a photographic enlarger • draw ray diagrams to show how the image is formed by a magnifying glass: in a camera in a projector in a photographic enlarger • draw ray diagrams to show the formation of images in the normal eye: a short-sighted eye a long-sighted eye • describe the correction of short-sight • describe the correction of long-sight	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	
15. Electromagnetic spectrum			
Dispersion of light	• describe the dispersion of light by a glass prism. • state the colours of the spectrum • explain how the colours are related to frequency and wavelength	☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
Properties of electromagnetic waves	• state that all electromagnetic waves travel with the same high speed in air • know that the speed is 3×10^8 m/s • list the components of the electromagnetic spectrum • describe the important features of each component of the electromagnetic spectrum	☐ ☐ ☐ ☐	
Applications of electromagnetic waves	• discuss how each component is used: – radiowaves in radio and television communications – microwaves in satellite television and in telephones – infra-red in household electrical appliances: in television controllers in intruder alarms – light in optical fibres: in medical uses in telephone cables – ultra-violet in sunbeds in fluorescent tubes in sterilisation – X-rays in hospitals for medical imaging in hospitals for killing cancerous cells in engineering for detecting cracks in metal objects – gamma rays in hospitals for killing cancerous cells, in engineering for detecting cracks in metal objects	☐	

Topic	You should be able to:	Checklist	Comments
16. Sound			
Sound waves	• describe the production of sound by vibrating sources • explain why sound waves are longitudinal • explain what is meant by *compressions* and *rarefactions* • state the approximate range of audible frequencies • explain sound waves need a medium, and • describe an experiment to demonstrate this • explain how the loudness of a sound wave depends on its amplitude • explain how the pitch of sound waves depends on its frequency • describe how the reflection of sound may produce an echo • explain what is meant by the *quality* (timbre) of a sound wave • describe what affects the quality (timbre) of sound waves, and • describe how these can be shown on a cathode ray oscilloscope (c.r.o.)	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	
Speed of sound	• describe a simple method of measuring the speed of sound in air, and • explain how the speed is calculated from the measurements • state approximate magnitude of the speeds of sound in air in liquids in solids	☐ ☐ ☐	
Ultrasound	• define *ultrasound* • describe the uses of ultrasound: in cleaning in detecting flaws (quality control) in pre-natal scanning	☐ ☐	

Topic	You should be able to:	Checklist	Comments
THEME 5	**Electricity and Magnetism**		
17. Magnetism and electromagnetism			
Laws of magnetism	• know that magnets have N (north) and S (south) poles • state that unlike poles attract and like poles repel	☐ ☐	
Magnetic properties of matter	• state the differences between magnetic, non-magnetic and magnetised materials • describe an electrical method of magnetisation • describe an electrical method of demagnetisation • explain what is meant by a permanent magnet • know that steel behaves as a permanent magnet • describe uses of permanent magnets • explain what is meant by a temporary magnet • know that iron behaves as a temporary magnet • describe uses of temporary magnets • explain what is meant by induced magnetism • describe how to plot magnetic field lines with a plotting compass • explain what is meant by magnetic screening • explain the choice of material for magnetic screening • describe the use of magnetic materials in a computer hard disk drive	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	
Electromagnetism	• describe the pattern of the magnetic field due to: currents in straight wires currents in solenoids • state the effect on the magnetic field of changing: the magnitude of the current the direction of the current • describe uses of electromagnets in: relays circuit-breakers loudspeakers	☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
18. Static electricity			
Laws of electrostatics	• know that there are positive and negative charges • state that unlike charges attract and like charges repel	☐ ☐	
Principles of electrostatics	• describe experiments to show electrostatic charging by friction • explain that charging of solids involves a movement of electrons • know that charge is measured in coulombs • describe an electric field as a region in which an electric charge experiences a force • state the direction of lines of force (electric field lines) • describe simple electric field patterns • describe the separation of charges by induction • explain the differences between electrical conductors and insulators • give examples of electrical conductors • give examples of electrical insulators • explain what is meant by 'earthing' a charged object	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	
Applications of electrostatics	• describe examples where charging could be a problem, e.g. lightning • describe examples where charging is helpful, e.g. photocopier, electrostatic precipitator	☐ ☐	
19. Current electricity			
Current	• state that a current is a flow of charge • know that current is measured in amperes • do calculations using the equation *charge* = *current* × *time* • describe the use of an ammeter with different ranges	☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
Electromotive force (e.m.f.)	• explain that e.m.f. is the energy converted by a power supply (e.g. cell) in moving a unit charge around a circuit • state that e.m.f. is work done/charge • calculate the total e.m.f. when several power supplies are arranged in series, and • describe how this is used in the design of batteries • explain the advantage of making a battery from several power supplies arranged in parallel	☐ ☐ ☐ ☐ ☐	
Potential difference (p.d.)	• know that p.d. is measured in volts • explain that the p.d. is measured across a circuit component • explain that the p.d. across a component is the work done when a unit charge passes through the component • state that the volt is given by J/C • describe the use of a voltmeter with different ranges	☐ ☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
Resistance	• know that *resistance = p.d./current* • do calculations using the equation *resistance = voltage/current* • describe an experiment to measure the resistance of a metallic conductor using a voltmeter and an ammeter • state Ohm's Law • explain that Ohm's Law is only obeyed by a resistor at constant temperature • do calculations with the relationships for a wire: *resistance is directly proportional to length* *resistance is inversely proportional to cross-sectional area* • calculate the total resistance of several resistors: in series in parallel • sketch current/voltage graphs for: resistor filament lamp • describe the effect of temperature increase on the resistance of: a resistor a filament lamp • describe how the resistance of a light-dependent resistor varies with the intensity of light	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
20. D.C. circuits			
Current and potential difference in circuits	• know the circuit symbols for: power sources (cell, battery or a.c. mains) switches (closed and open) esistors (fixed and variable) light dependent resistors thermistors. lamps ammeters voltmeters magnetising coils bells fuses relays light-emitting diodes rectifying diodes. • draw circuits containing these components	☐ ☐	
Series and parallel circuits	• state that the current at every point in a series circuit is the same • state that the sum of the p.d.s in a series circuit is equal to the p.d. across the whole circuit • state that the current from the source is the sum of the currents in the separate branches of a parallel circuit • do calculations on the whole circuit, recalling and using formulae including $R = V/I$ and these for potential differences in series, resistors in series and resistors in parallel	☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
21. Practical electricity			
Uses of electricity	• describe the use of electricity in: heating lighting motors • do calculations using the equations *power* = *voltage* × *current* *energy* = *voltage* × *current* × *time* • calculate the cost of using electrical appliances where the energy unit is the kW h	☐ ☐ ☐	
Dangers of electricity	• state the hazards of: damaged insulation overheating of cables damp conditions	☐	
Safe use of electricity in the home	• describe the use of: fuses circuit breakers • explain what is meant by: fuse ratings circuit breaker settings • explain the need for: earthing metal cases double insulation • state the meaning of the terms: *live* *neutral* *earth* • describe how to wire a mains plug • explain why switches, fuses and circuit breakers are always placed in the live conductor	☐ ☐ ☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
22. Electromagnetism			
Force on a current-carrying conductor	• describe experiments to show the force on: a current-carrying conductor in a magnetic field a beam of charged particles in a magnetic field • describe the effect on the force of: reversing the current reversing the direction of the field • state the relative directions of force, field and current: (use of Fleming's left hand rule) • describe the magnetic field patterns between currents in parallel conductors • use the magnetic field patterns to find the direction of the forces on the wires	☐ ☐ ☐ ☐ ☐	
The d.c. motor	• explain how a current-carrying coil in a magnetic field experiences a turning effect • describe the effect of: increasing the number of turns on the coil increasing the current • describe how this turning effect is used in an electric motor • explain why a split-ring commutator is used in a simple motor • describe the effect of winding the coil onto a soft-iron cylinder	☐ ☐ ☐ ☐ ☐	
23. Electromagnetic induction			
Principles of 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 the induced e.m.f. • know that the direction of a current produced by an induced e.m.f. opposes the change producing it (Lenz's Law) • describe a simple demonstration of Lenz's Law	☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
The a.c. generator	• describe a simple form of a.c. generator (rotating coil or rotating magnet) • explain the purpose of slip rings (where needed) • sketch a graph of voltage output against time for a simple a.c. generator	☐ ☐ ☐	
The transformer	• describe the structure of a simple iron-cored transformer • describe the operation of a simple iron-cored transformer • state the advantages of high voltage transmission • compare underground power transmission with overhead lines in terms of: environmental impact cost	☐ ☐ ☐ ☐	
24. Introductory electronics			
Thermionic emission	• state that electrons are emitted by a hot metal filament • explain that to allow the electrons to flow requires both: high positive potential very low gas pressure • describe the deflection of an electron beam by: electric fields magnetic fields • state that the flow of electrons (electron current) is from negative to positive • know that the flow of electrons is in the opposite direction to conventional current	☐ ☐ ☐ ☐ ☐	
Simple treatment of cathode-ray oscilloscope (c.r.o.)	• describe in outline the basic structure of a c.r.o. • describe in outline the action of a c.r.o. • describe the use of a c.r.o.: to display waveforms to measure p.d.s. to measure short intervals of time	☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
Action and use of circuit components	• describe the resistor colour code • explain how the resistor colour code can easily be used to label very large and very small resistances • explain why widely different values of resistance are needed in different types of circuit • explain why we need to use resistors with very different power ratings • describe the action of a thermistor • explain the use of a thermistor as an input sensor • describe the action of a light-dependent resistor • explain the use of a light-dependent resistor as an input sensor • describe the action of a variable potential divider (potentiometer) • describe the action of a diode in passing current in one direction only • describe the action of a light-emitting diode in passing current in one direction only and emitting light • describe the action of a capacitor as a charge store • explain how a capacitor is used in time delay circuits • describe the action of a relay • explain how relays are used in switching circuits • describe circuits operating as: light-sensitive switches temperature operated alarms (using a relay or other circuits)	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
25. Electronic systems (Note this topic is optional. Questions are always set as alternatives.)			
Switching and logic circuits	• describe the action of an npn transistor as an electrically operated switch • explain the use of an npn transistor in switching circuits. • state in words and in truth table form, the action of the following logic gates: AND OR NAND NOR NOT (inverter). • state the symbols for the logic gates listed above	☐ ☐ ☐ ☐	
Bistable and astable circuits	• describe the use of a bistable circuit • know that bistable circuits exhibit the property of memory • describe the use of an astable circuit (pulse generator) • describe how the frequency of an astable circuit is related to the values of the resistive and capacitative components	☐ ☐ ☐ ☐	
THEME 6	**Atomic Physics**		
26. Radioactivity			
Detection of radioactivity	• describe the detection of: alpha-particles beta-particles gamma-rays	☐	
Characteristics of the three types of emission	• explain what is meant by *radioactive decay* • for each radioactive emission, state: the nature their relative ionising effect their relative penetrating power • state and explain the random emission of radioactivity in direction and time • describe the deflection of radioactive emissions in: electric fields magnetic fields	☐ ☐ ☐ ☐	

Topic	You should be able to:	Checklist	Comments
Nuclear reactions	• explain what is meant by fusion • explain what is meant by fission • describe with the aid of a block diagram one type of fission reactor for use in a power station • describe star formation and explain how energy is produced by fusion	☐ ☐ ☐ ☐	
Half-life	• explain what is meant by *half-life* • do calculations based on half-life using: information in tables decay curves	☐ ☐	
Uses of radioactive isotopes including safety precautions	• describe how radioactive materials are: handled used stored in a safe way • explain how the choice of a radioactive material for a particular use depends on: the type of radiation emitted the half-life • describe the origins and effect of background radiation • describe the dating of objects by the use of ^{14}C	☐ ☐ ☐ ☐	
27. The nuclear atom			
Atomic model	• describe the structure of the atom in terms of nucleus and electrons • describe how the Geiger–Marsden alpha-particle scattering experiment provides evidence for the nuclear atom	☐ ☐	

Topic	You should be able to:	Checklist	Comments
Nucleus	• describe the composition of the nucleus in terms of protons and neutrons • define the terms: *proton number* (atomic number), Z *nucleon number* (mass number), A • explain the term nuclide • use the nuclide notation ${}^{A}_{Z}X$ in equations where radioactive decay causes the nucleus to change • define the term isotope • explain, using nuclide notation, how one element may have a number of isotopes	☐ ☐ ☐ ☐ ☐ ☐	

Section 5: Useful websites

You may find the websites below useful in your revision or if you want extra help. The syllabus covered in the website does not always match the Cambridge O Level syllabus, so choose carefully.

www.physics.org
An Institute of Physics site. If you have a burning question, you will be directed to other relevant websites.

http://www.bbc.co.uk/education/subjects/zpm6fg8
A BBC website dedicated to revision and simple testing.

www.gcse.com/physics.htm
A useful site that deals with many topics in an interesting way.

www.s-cool.co.uk/gcse/physics
Basic theory and online testing.

www.gcsescience.com
Basic theory and online testing that might help revision.

Section 6: 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 familiar with the following multipliers: M mega, k kilo, c centi, m milli.

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
mass	*m*, *M*	kg, g, mg
time	*t*	h, min, s, ms
density	ρ	g/cm^3, kg/m^3
speed	*u*, *v*,	km/h, m/s, cm/s
acceleration	*a*	m/s^2
acceration of free fall	*g*	m/s^2
force	*F*, *P* …	N
gravitational field strength	*g*	N/kg
moment of force		Nm
work done	*W*, *E*	J
energy	*E*	J, kWh
power	*P*	W
pressure	*p*, *P*	Pa, N/m^2
temperature	θ, *t*, *T*	°C
heat capacity	*C*	J/°C
specific heat capacity	*c*	/(kg°C), J/(g°C)
latent heat	*L*	J
specific latent heat	*l*	J/kg, J/g
frequency	*f*	Hz
wavelength	λ	m, cm
focal length	*f*	m, cm
angle of incidence	*i*	degree (°)
angles of reflection, refraction	*r*	degree (°)

Quantity	Symbol	Unit
critical angle	*c*	degree (°)
refractive index	*n*	
potential difference / voltage	*V*	V, mV
current	*I*	A, mA
charge	Q	C
e.m.f.	*E*	V
resistance	*R*	Ω

Command words and phrases

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

Command word/phrase	Meaning
Calculate	A numerical answer is needed. Show your working, especially when there are two or more steps in a calculation.
Deduce	This may be used in two ways: • 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 the velocity of the vehicle if …* • 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	A formal statement of a quantity is required. You can sometimes give a defining equation, e.g. speed = d/t, as long as you state what the symbols are that you use in your equation, in the example given d = distance, t = time.
Describe	Try to set out a logical sequence that allows the reader to follow the main points about something. You may use labelled diagrams if you find it easier, *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 must write down points **for** and **against** an argument, *e.g. discuss the supply of energy with a nuclear power station.*

Command word/phrase	Meaning
Estimate	Give 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 must give reasons for your answer **or** refer to a particular theory.
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.
Measure	You are expected to find a quantity by using a measuring instrument, *e.g. length by using a ruler, or angle by using a protractor*.
Outline	State the main points briefly, *e.g. outline a method of magnetising an iron bar*.
Predict	This can be used in two ways: • 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 …* • It may also mean stating what might happen next e.g. predict what effect an increase in temperature will have on the resistance.
Sketch	When drawing graphs, this means that you draw the approximate shape and/or position of the graph. 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. When drawing apparatus or other diagrams, a simple line drawing is all that is needed, but make sure that the proportions are correct and the most important details are shown. Always label diagrams.
State	You should give a short answer without going into any detail or explanation.
Suggest	This may be used in two ways: • There may be more than one correct answer, *e.g. suggest a precaution to improve the accuracy of the experiment*. • You are being asked to apply your general knowledge of physics or reasoning skills to a topic area that is not directly on the syllabus, *e.g. applying ideas about moments to the stability of a vehicle*.
What is meant by/What do you understand by	You should define something and also make a more detailed comment about it, *e.g. what do you understand by the term total internal reflection*.

Cambridge International Examinations
1 Hills Road, Cambridge, CB1 2EU, United Kingdom
tel: +44 1223 553554 fax: +44 1223 553558
email: info@cie.org.uk www.cie.org.uk