Welcome to GCSE success

Key features

Use This Book to Help You Revise
This book is intended to help you prepare for your GCSE examination in Physics. It is not intended to replace a textbook but to supplement it. It is written to help you revise and prepare for an examination and assumes that you have started a GCSE course. If there are topics that you have never studied, refer to a good textbook and carefully read and make notes on the relevant chapter. One good, concise and easy-to-read text for this purpose is Mastering Physics, published by Macmillan. We wish you all the best in your studies and in your examinations. Good luck!

John Keighley

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Stephen Doyle

Stephen Doyle

Pithy summary of the essentials

At the beginning of each chapter there is a pithy summary of the essential physics that you need to know. Spend time in becoming thoroughly familiar with the material in these sections.

Real questions – real self check

- Each chapter contains real GCSE questions with model answers. Carefully studying these will help you to revise as well as showing you how to set out your answers in an examination.
- At the end of the worked examples there is a section called 'Examination Questions'. Do these questions without looking at the answers provided. Make sure you really grasp the principles and the basic physics contained in these questions.

Look!

The very latest physics

- microwave ovens
- optical fibres
- the greenhouse effect
- the ozone layer

Good design

for effective revision

Topic

WJEC & NEAB	ULEAC Syll A	ULEAC Syll B	MEG	Topic	MEG Salters'	MEG Nuffield	SEG	NICCEA
✓	✓	✓	✓	Non-renewable fuels (Fossil and nuclear fuels)	✓	✓	✓	✓
✓	✓	✓	✓	Greenhouse effect	✓	✓	✓	✓
✓	✓	✓	✓	Renewable resources (Solar, geothermal, tidal, wind, hydroelectric, biomass)	✓	✓	✓	✓
✓	✓	✓	✓	Origins of the Earth's energy	✓	✓	✓	✓
✓	✓	✓	✓	Storing energy	✓	✓	✓	✓

Syllabus analysis
Ensures you only do the topics you need – no more, no less

Chapter breakdown
Shows you in detail what is covered in the chapters

Revision

points for passing

1 Check your syllabus

Make sure that your teacher has not missed anything out from the syllabus and that your notes are not incomplete because you were away and have not copied them up. For effective revision you need a complete set of notes. Set about checking your notes against a recent copy of the syllabus which may be obtained from the addresses in the acknowledgements. Use a friend's notes or a textbook to fill in any of the gaps.

2 Use the book and your notes together

Use this book as a tool with your notes. The book's aim is to help you pass the exam by giving you practice in the way questions should be answered. Although notes are included in each chapter, these are only brief and are intended only to jog your memory about the topic. You will need to use this book in conjunction with your notes and the textbook you use.

3 Revision tips

Pace yourself when revising. Most people make the mistake of leaving their revision to the last couple of weeks before the exam. It is a good idea to prepare yourself a realistic revision timetable and try to stick to it. The important thing is to develop a routine.

4 Short bursts

Short sessions of revision are much more effective than a long stretch; try to do your revision in a quiet room away from any distractions.

5 Ask yourself questions

Be active in your revision. Ask yourself questions all the time – for example, 'Do I know how to perform the experiment to verify Hooke's Law for a spring?' You can do this in any spare moment. You could also ask friends or relatives to help you.

6 Exam question practice

Study the worked examples, since these have been designed to help you build up your knowledge and give advice about how questions should be answered.

Use this book by trying the examination questions at your particular tier and then checking your answer against the supplied one. Don't worry that your answer is different sometimes, because some questions can have a wide range of possible answers and the one supplied is only one of them.

7 Understanding better

People remember more if they write things down. You can do this, but try to avoid copying out your notes again.

How to tackle the questions

Topic guide

- 1 How to tackle different types of examination questions
[Calculations; Multiple choice questions; Short answer or structured questions; Free response type questions; Practical coursework]
- 2 A few important points
- 3 Some maths help
[Using mathematical equations; Graphs; Significant figures; Powers of ten; Conversion of units; Solidus and negative index notation]

1 How to tackle different types of examination questions

Calculations

You will not obtain full marks for a calculation unless you start by stating the physical principles involved and show the steps by which you arrive at the answer. You will lose marks in an examination if your answers to calculations consist of numbers without any indication of the reasoning by which you arrive at them. Remember it is a physics examination and not an arithmetic examination! The physics of the question must be clearly stated. Unless the answer is a ratio it will have a unit, so you *must always remember to state the unit*.

You may find it helpful before starting a calculation to ask yourself:

- 1 What am I being asked to calculate?
- 2 Which principle, law or formula needs to be used?
- 3 What units am I going to use?

A further hint worth remembering is that an apparently complex problem involving many items of data may often be clarified using a simple diagram.

A numerical answer must not have more significant figures than any number used in the calculation (see section 3 (page viii): 'Significant figures').

Example of a calculation

A uniform plank of wood 3 m long is pivoted at its mid-point and used as a see-saw. Jean, who weighs 400 N, sits on one end. Where must John, who weighs 600 N, sit if the see-saw is to balance?

To answer this question first draw a diagram showing the plank and the forces acting on it.

All the relevant information is shown on the diagram. We need to calculate the distance x metres so that the see-saw is balanced. The physical principle must first be stated, i.e. for a body in equilibrium:

Anticlockwise moment about a point = clockwise moment about the same point.

We now use this equation. Taking moments about the pivot

$$(600 \text{ N} \times x) = (400 \text{ N} \times 1.5 \text{ m})$$

$$x = \frac{400 \text{ N} \times 1.5 \text{ m}}{600 \text{ N}}$$

$$x = 1 \text{ m}$$

John must sit 1 m from the mid-point on the opposite side to Jean.

Always check your answer at the end to ensure that it is physically reasonable. Had you got an answer to the above question of 3 m, then you should at once realise that this is unreasonable (John would be off the end of the see-saw!), and look back to discover where you have made a mistake. *And don't forget to put a unit after the answer.*

Multiple choice questions

Multiple choice questions are no longer part of most GCSE physics examinations. Check with a recent copy of the examination syllabuses to see if they form part of your examination. If all the questions have to be attempted, do not waste valuable time reading through the paper before you start. Start at question 1 and work steadily through the paper. If you come to a difficult question which you can't answer, miss it out and come back to it at the end. If you spend a lot of time thinking about questions which you don't find particularly easy, you may find yourself short of time to do some easier questions which are at the end of the paper.

When possible it is helpful to try to answer the question without first looking at the responses. This can reduce the chance of 'jumping to the wrong conclusions'. When you have found the response you think is correct, if time allows, check the other responses to see why they are incorrect.

When you have worked through the paper in this way, return to the questions you found difficult the first time through, but leave until the very end any questions about which you have little or no idea. In the closing minutes of the examination, if you still have not answered all the questions, sprint to the finish by guessing, if necessary.

As examination boards do not deduct marks for wrong answers it is essential that you answer every question. If you are not sure which of the choices is the correct answer try to eliminate one or two of the alternative answers, and, if necessary, guess which of the remaining alternatives is correct.

If you have to alter an answer, ensure that the previous one has been completely rubbed out. Only one answer for each question must appear on the answer sheet.

Example of a multiple choice question

In the circuit shown in the diagram the high-resistance voltmeter reads 12.0 V, and the ammeter reads 600 mA. The value of the resistance marked R is

- A 7200 Ohm B 72 Ohm C 20 Ohm D 7.2 Ohm
E 0.02 Ohm

Solution

[We use the equation in chapter 12, section 1, which defines resistance, namely

$$R = \frac{\text{potential difference across object (volts)}}{\text{current through object (amperes)}}$$

The ammeter reading is 600 mA = 0.6 A

$$R = \frac{12 \text{ V}}{0.6 \text{ A}} = 20 \text{ Ohm.}]$$

Answer C

Short answer or structured questions

In this type of question most examining boards leave space for the answer to be written on the question paper. The amount of space left will be a guide to the length of answer that is required, as will the number of marks indicated by the question. It doesn't follow that if you don't fill all the space up you haven't answered the question correctly. But if five lines are left for the answer, and you have only written on one line, or if you can't possibly get your answer on five lines, then you certainly ought to have another think about the answer.

Example of a short answer or structured question

A system of pulleys is used to raise a load of 9 N through 2 m. The effort of 2 N needed to do this moves through 12 m. What is

- the potential energy gained by the load
- the work done by the effort
- the efficiency of the system?

Solution

- Work done on load = force $\times$ distance =
9 N $\times$ 2 m = 18 J
Potential energy gained by load = 18 J
- Work done by effort = force $\times$ distance
= 2 N $\times$ 12 m = 24 J
- Efficiency = $\frac{\text{work out}}{\text{work in}} = \frac{18 \text{ J}}{24 \text{ J}} = \frac{3}{4}$
= 0.75 or 75%

(If you have problems understanding the answer, refer to chapter 3.)

Free response type questions

These are likely to be met in the optional papers taken by those seeking the highest grades. Make sure you attempt the full number of questions you have to answer.

If you are asked to describe an experiment you must normally draw a diagram of the apparatus or the relevant circuit diagram. A labelled diagram saves time, as information shown on the diagram need not be repeated in words. You should state clearly exactly what readings are taken, remembering that readings should be repeated as a check whenever possible. Finally mention any precautions necessary to obtain an accurate result.

Avoid saying vaguely at the end 'the result is calculated from the readings'. You must state exactly how it is calculated.

If the answer involves drawing a graph, be sure to label the axes and choose a scale so that the graph covers most of the paper.

Use the indicated mark scheme as a guide to the length of answer required.

Example of a free response type question

- (a) Describe an experiment you would perform in order to measure the average power a girl can develop over a period of a few seconds. (8 marks)

- (b) A car of weight 6000 N climbs a hill 1 km long which raises the car a vertical distance of 50 m. The driver maintains a constant speed of 25 m/s while he travels up the hill.
- How long does it take him to reach the top of the hill? (2 marks)
 - What is the gain in gravitational potential energy of the car when it reaches the top of the hill? (4 marks)
 - Neglecting frictional forces, what is the power developed by the car as it climbs the hill? (2 marks)
- (c) Outline the main energy changes which take place as the car climbs the hill. (4 marks)

Solution

- (a) Leg muscle power may be measured by running up a flight of steps and measuring the time it takes with a stopwatch. Start the watch as the girl starts to climb the stairs and stop it when she reaches the top. Suppose that the average of three runs is 6 s. Measure the total vertical height of the stairs by using a ruler to measure the average height of each step and multiply by the number of steps to get the total vertical height. If this height is 5 m and the weight of the person, found by using bathroom scales, is 720 N, then

$$\text{Work done in 6 s} = 720 \text{ N} \times 5 \text{ m} = 3600 \text{ J}$$

$$\text{Power} = \frac{\text{work done}}{\text{time taken}} \quad [\text{see chapter 4, section 4}]$$

$$\frac{3600 \text{ J}}{6 \text{ s}} = 600 \text{ W}$$

[The important thing in answering this question is to state clearly what must be measured: (1) the weight of the person, using bathroom scales; (2) the vertical height of the staircase, using a metre rule; (3) the time to climb the stairs, using a clock, taking the average of a number of runs. You must also show how to calculate her power.]

- (b) (i) The car travels 1 km (1000 m) at 25 m/s; hence

$$\text{Time taken} = \frac{1000 \text{ m}}{25 \text{ m/s}} = 40 \text{ s}$$

$$\begin{aligned} \text{(ii) Gravitational potential energy gained} \\ &= \text{weight} \times \text{vertical height raised} \\ &= 6000 \text{ N} \times 50 \text{ m} = 300\,000 \text{ J} \end{aligned}$$

$$\begin{aligned} \text{(iii) Power} &= \frac{\text{work done}}{\text{time taken}} \\ &= \frac{300\,000 \text{ J}}{40 \text{ s}} = 7500 \text{ W} \end{aligned}$$

- (c) The chemical energy of the fuel becomes heat energy in the engine cylinders, which eventually becomes gravitational potential energy of the car together with heat energy in the atmosphere as a result of frictional forces.

Practical coursework

Some points to bear in mind are:

- Follow any instructions carefully step by step. Read each instruction twice to ensure that you have understood it.
- Take great care in reading an instrument. Record each reading accurately, carefully, systematically and clearly. When reading a horizontal scale with a pointer above it, make sure your eye is vertically above the pointer as you take the reading. Don't forget to put the **unit**. Whenever you read a scale, make sure you have carefully thought through the value of each of the small divisions on the scale. Remember to correct for zero errors (for example, make sure a spring balance reads zero before you hang a weight from it). When reading multiscale instruments, be careful to read the correct scale.
- Present your readings clearly. Tabulate them neatly (don't forget the **unit**) and present them graphically whenever possible. Choose a suitable scale for the graph (i.e. 1 large square = 1 unit) and don't forget to label the axes. Take great care over plotting the points. Don't join them with short straight lines but draw the best smooth curve or straight line through them.

- 4 Repeat all the readings and take the average. Be particularly careful to check any unexpected reading.
- 5 If you have to take the temperature of a liquid which is being heated, you must stir the liquid well before taking the temperature.
- 6 Be aware of the accuracy of any readings. For example, when reading a ruler marked in centimetres, you can only read it to the nearest 0.1 cm.
- 7 It is important to select the most appropriate apparatus. For example, if you need to measure a current of about 0.009 A (9 mA) and you have the choice of two ammeters, one reading 0–10 mA and the other 0–1 A, you should choose the 0–10 mA one.
- 8 You will need to know how to use, among other things, a measuring cylinder, a balance for measuring mass, a spring balance, a stopwatch, a thermometer, a voltmeter, an ammeter and a CRO.
- 9 You will be required to:
 - (a) devise an investigation, select and set up suitable apparatus;
 - (b) take precautions necessary for obtaining an accurate result;
 - (c) show your skills at observation and measurement;
 - (d) analyse and process data;
 - (e) draw conclusions from your observations and readings.
- 10 Be prepared to criticise your own work. State your conclusion clearly, and whenever possible state a concise relationship between variables.

2 A few important points

- 1 Read the question carefully before you write anything. Make sure you know exactly what the question is asking.
- 2 Answer the question precisely as asked. Note carefully the phrase used in the question. For example, 'explain', 'define', 'state', 'derive' and 'describe' all mean different things and are meant to be taken literally.
- 3 Try to pace yourself during the exam. Your aim should be to complete the paper with enough time to check through at the end.
So keep an eye on the clock and make sure you do not spend too much time on any one question. On the other hand, do make sure that you don't miss out the last parts of an easy question, because you are anxious to press on and finish the paper.
- 4 Set your work out neatly and clearly. Examiners are human and if they have done many hours of marking, they are likely to be far more sympathetic if your work is well set out and easy to follow.
- 5 Make sure you are familiar with the style of question set by your particular examining board and the length of time allowed for each question (syllabuses and past

papers may be obtained from the addresses given in the Acknowledgements).

- 6 Don't spend a lot of time on a multiple choice question or a short answer question with which you are having difficulty. Leave that question and come back to it later if you have time.

3 Some maths help

Using mathematical equations

Equations help us to relate certain quantities. The usefulness of the equation is extended if it can be rearranged. There are three helpful rules for rearranging an equation.

The plus/minus rule

A symbol or number may be moved from one side of an equation to the other provided the sign in front of the symbol or number is changed. That is, a 'plus' item on one side becomes a 'minus' item on the other side and vice versa. For example:

$$X = Y + 30$$

$$X - Y = 30 \text{ or } X - 30 = Y$$

The diagonal rule

An item may be moved diagonally across an equals sign. For example, if

$$\frac{A}{B} = \frac{C}{D}$$

then the arrows show possible moves, so that

$$\frac{A}{B \times C} = \frac{1}{D} \text{ or } \frac{A}{C} = \frac{B}{D} \text{ or } \frac{D}{B} = \frac{C}{A}$$

The 'do unto others' rule

Whatever is done on one side of the equation must be done to the other side. For example:

if $A = B$ then $A^2 = B^2$ (both sides have been squared)

if $C = \frac{1}{D}$ then $\frac{1}{C} = D$ (both sides have been inverted)

But if $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ then $R \neq R_1 + R_2$

($\neq$ means 'does not equal')

The **whole** of each side must be inverted, i.e.

$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{1}{\frac{R_2 + R_1}{R_1 R_2}} = \frac{R_1 R_2}{R_1 + R_2}$$

Graphs

Choose easy scales, such as one large square to represent 1, 2 or 5 units (or multiples of 10 of these numbers). Avoid scales where one large square is 3, 4, 6, 7, 8 or 9 units. If each large square is, say, 3 units, then a small square is 0.3 units and this makes the plotting of the graph much more difficult. Usually the spread of readings along the two axes should be about the same and they should cover most of the page. For example, on the graph shown below on the horizontal scale 2 small squares represent 1 second, and on the vertical scale 1 small square represents 2 m/s.

It is important to remember to label the axes and to put a title at the top of the page. In physics most relationships are either straight lines or smooth curves, so it is not correct to join adjacent points together by short straight lines. You must decide whether the relationship is a straight line or a curve, and then draw either the best straight line through the points or a smooth curve.

Significant figures

A useful rule to remember is that you must never give more significant figures in the answer than the number of

significant figures given in the least precise piece of data. For example, if a cube of side 2.0 cm has a mass of 71.213 g, then we may calculate the density by using the equation

$$\text{Density} = \frac{\text{mass}}{\text{volume}} \quad [\text{see chapter 1 section 3}]$$

$$= \frac{71.213 \text{ g}}{8.0 \text{ cm}^3} = 8.901625 \text{ g/cm}^3$$

according to my calculator! But the side was only given to two significant figures and we may not give the answer to more than two significant figures, i.e. 8.9 g/cm³ (we certainly do not know the density to the nearest millionth of a g/cm³!). The answer should be written 8.9 g/cm³.

A problem arises when the examiners use whole numbers without a decimal point and expect you to take them as exact. In the above calculation, if the side were given as 2 cm we may only strictly give the answer to one significant figure, i.e. 9 g/cm³. If you are in doubt in such a calculation, work the calculation to, say, three significant figures and then give the answer to one significant figure.

Powers of ten

100 may be written as 10² 1000 = 10³

$\frac{1}{10}$ may be written as 10⁻¹ $\frac{1}{100} = 10^{-2}$ $\frac{1}{1000} = 10^{-3}$

$\frac{1}{100\,000} = 10^{-5}$

Conversion of units

1 m² = 100 cm × 100 cm = 10⁴ cm²

so 5 N/cm² = 5 × 10⁴ N/m² = 50 kN/m²

1 m³ = 100 cm × 100 cm × 100 cm = 10⁶ cm³

so 1 g/cm³ = 10⁶ g/m³ = 1000 kg/m³

Therefore to convert g/cm³ to kg/m³ we multiply by 1000.

Solidus and negative index notation

Make sure you are familiar with the notation used by your examination board. Most boards use the solidus for GCSE examinations, i.e. m/s and kg/m³. But m/s may be written ms⁻¹ and kg/m³ may be written kgm⁻³.

Exam Board Addresses

For syllabuses and past papers contact the Publications office at the following addresses:

Northern Examinations and Assessment Board (NEAB)

12 Harter Street
MANCHESTER M1 6HL
Tel 0161 952 1170
Fax 0161 273 7572

Welsh Joint Education Committee (WJEC)

245 Western Avenue
Llandaff
CARDIFF CF5 2YX
Tel 01222 265112
Fax 01222 575987

(There is a shop at the above address and the hours of opening are 9.30am to 5.30pm, Monday to Friday.)

Midland Examining Group (MEG)

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Fax 0223 460278

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Northern Ireland Council for the Curriculum, Examinations and Assessment (NICCEA)

29 Clarendon Road
BELFAST BT1 3BG
Tel 01232 261200
Fax 01232 261234

Scottish Examinations Board (SEB) [Use this address for the ordering of syllabuses]

Ironmills Road
DALKEITH
Midlothian EH22 1LE
Tel 0131 636 6601

or recent papers from the SEB's agent

Robert Gibson and Sons Ltd
17 Fitzroy Place
GLASGOW G3 75F
Tel 0141 248 5674

Remember to check your syllabus number with your teacher!

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Physics GCSE

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