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IGCSE Physics

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Introduction

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Introduction

Welcome to your IGCSE Physics course. This introduction will serve as a guide to what you can expect from the course, and it will show you how to plan your study effectively. Take the time to read this Introduction thoroughly before you start the lessons.

The course is designed to prepare students for examination in the **Edexcel IGCSE Physics specification (4PHO).** Please make sure you refer to the current issue of the specification.

The Course

In combination with other suitable IGCSE entry subjects, the course is an ideal preparation for those who wish to go on to study Physics at AS and A2 level.

If you have some background in Physics then you will find that some of the lessons touch upon things that you have encountered before, but the course is designed to be fully understandable by those who have little or no previous background in science. There is some overlap with our Year 9 Physics course, for instance.

The course is designed to develop (1) a broad understanding of physical facts, concepts and principles, (2) skills in physical investigation and (3) an ability to evaluate the benefits and drawbacks of modern scientific developments.

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Practical Work

The practical work described at various places in this course is to help to develop your skills for the practical-based components of the theory exams. You should try to carry out this work yourself; if you can undertake some of it at home, or have the opportunity to perform supervised laboratory work in the course of your studies, this will be a great help. Three of the lessons are devoted to the development of practical skills, and there is a very useful Appendix at the back of the textbook (pages 218-226), and the course pack to help you further.

NB. The exam will include written questions on practical-based study, so you should make sure that you have studied these lessons carefully and have carried out some of the experiments yourself.

Textbook

The textbook that is referred to throughout this course is

Brian Arnold, Steve Woolley and Penny Johnson, *Edexcel IGCSE Physics Student Book* (2009, Pearson Educational Ltd, ISBN 978 0 435966 90 4)

You will need a copy of *Edexcel IGCSE Physics* throughout the course; you can buy a copy through the Oxford Open Learning website. The textbook is referred to in almost every lesson and provides excellent coverage of the material. By using the textbook and the course together you will be fully prepared for the examinations at the end.

You should not need other books during the course, but you may like to look in other science books from time to time. If you feel that you would like to use a revision guide before the examination, you should ask your tutor which one they recommend.

Arrangement of Lessons

The lessons are planned so that all the material and preparation required for both examination papers, Physics Paper 1 and Physics Paper 2, is covered by the seven modules of the course. Topics that will be examined only in Paper 2 are given in **bold type** in the lesson aims at the beginning of each lesson.

The seven course modules are:

Module 1: Forces and Motion
Module 2: Electricity
Module 3: Waves
Module 4: Energy Resources and Energy Transfer
Module 5: Solids, Liquids and Gases
Module 6: Magnetism and Electromagnetism
Module 7: Radioactivity and Particles

You are advised to do the modules in order, as the content has been written to enable you to develop your knowledge and skills as you progress through the lessons.

Lesson Contents and Textbook References

Introductory Lesson: Using Numbers in Physics

Module 1 – Forces and Motion		
Lesson	*Title*	*Textbook pages*
1	Speed, Distance and Time	1 -10
2	Forces **TMA A**	12-16, 23-26, 28-29, 39-40
3	Friction and Momentum	16-18, 26-31, 34-39
4	Investigative Skills A: Experimental Design	234 - 236
5	Turning and Stretching	18-20, 42-58
6	Astronomy **TMA B**	49-56

Module 2 – Electricity		
Lesson	*Title*	*Textbook pages*
7	Electrical Appliances	59 - 65
8	Static Electricity **TMA C**	66 - 72
9	Electrical Circuits 1: Current and Voltage	74 - 80
10	Electrical Circuits 2: Resistance	82 - 88
11	Investigative Skills B: Interpretation **TMA D**	236 - 241

Module 3 – Waves		
Lesson	*Title*	*Textbook pages*
12	Properties of Waves	91 - 98
13	The Electromagnetic Spectrum	99 –106
14	Light	107 - 116
15	Sound	118 - 125
16	Investigative Skills C: Taking a Reading **TMA E**	235

Module 4 – Energy Resources and Energy Transfer		
Lesson	*Title*	*Textbook pages*
17	Energy Transfers	127 - 132
18	Thermal Energy	133 - 141
19	Work and Power **TMA F**	142 - 149
20	Energy Resources and Electricity Generation	150 - 159

Module 5 – Solids, Liquids and Gases		
Lesson	*Title*	*Textbook pages*
21	Density and Pressure **TMA G**	162 - 168
22	Solids, Liquids and Gases	169 - 176

Module 6 – Magnetism and Electromagnetism		
Lesson	*Title*	*Textbook pages*
23	Magnetism **TMA H**	179 - 186
24	Electric Motors and Electromagnetic Induction	187 - 195

Module 7 – Radioactivity and Particles		
Lesson	*Title*	*Textbook pages*
25	Atoms and Radioactivity **TMA I**	199 - 207
26	Radiation and Half-life	209 - 215
27	Applications of Radioactivity	216 - 224
28	Atomic Theory and Nuclear Fission **TMA J** **TMA K – Mock Exam paper 1** **TMA L – Mock Exam paper 2**	226 - 231

Appendices		
	A: Electrical circuit symbols	242
	B: Physical Quantities and Units	245
	C: Formulae and Relationships	243 - 244

Internet Resources

In many lessons of the course, references to internet sites are given. These have been carefully selected to illustrate points in the lesson and to provide additional activities. These are an important tool in your understanding of your Physics course and you should make every effort to view them and use the activities that they contain. If you do not have an internet connection at home, consider building in regular trips to a library or internet café as part of your study schedule.

There are two ways of finding the correct webpage:

- type in the full webpage address given in the text
- search using the search phrase given in the text.

When you type in either the address or the search phrase, it is important that you do not make typing errors, or miss out words. The search phrases have been carefully tested to bring the required website to the top of the list of sites returned by the search engine. If you cannot see the site you need on the first page of websites listed, you should try retyping the phrase and searching again. If you still have a problem, ask your tutor for help. But it is inevitable that some webpages will disappear altogether without warning!

The Structure within each Lesson: how to study

Front Page

The front page of each lesson shows:

- The title.
- **Aim(s)** for the lesson. These set out what you should know, and be able to do, after working through the lesson. Keep these aims in mind while reading the lesson material. Aims printed in **bold** will not be examined in Paper 1, but will appear in Paper 2.
- **Context**. This tells you which sections of Edexcel course specification are covered by the lesson.
- **Reading**. This tells you which pages of your textbook cover the same ground as the lesson. Reading them will help to reinforce what you have learned from the course notes.

Lesson Notes

The body of the lesson, from the heading "Introduction" onwards, contains the subject material to be mastered. Read these notes carefully several times until you feel that you have thoroughly understood the theory involved.

Then tackle the reading from the textbook. This will deal with some of the topics in greater detail than the notes. As with the notes, you will probably need to read some of the passages in the textbook several times.

The Textbook CD and Answers Download

Textbook CD

When you acquire your textbook it will either have a CD attached, or will have instructions about how you can obtain the CD. The CD contains a copy of the textbook with additional resources for most pages. You may need your invoice number for the textbook in order to obtain the CD. If you do not understand how to use the CD you should ask your tutor.

If you are taking the IGCSE exam in one year, you may find it better to leave the interactive pages on the CD until you start your revision. If you are taking your exam over two years, then you might spend time on the interactive resources as you progress through this course, or leave them for revision.

Textbook questions

After each chapter in the textbook there are questions. You are recommended to try these as part of your study of the chapter. So that you have some questions to practise when you revise, you might like to work on alternate questions when you first study the chapter, e.g. try odd-numbered questions, leaving even-numbered questions for revision. You will get a spread of topics if you tackle odd and even questions, rather than only those at the start of the set of questions. Organise your answers so they are easy to refer back to; for example, use a separate notebook and write down the textbook page number as well as the question number next to your answer.

Textbook answers

These are available for downloading at

http://www.edexcel.com/resources/pages/viewItem.aspx?item=320

If you have difficulty finding the download on www.edexcel.com please ask your tutor to help you.

Activities

Activities are placed in the notes at relevant points. They are indicated as follows:

Activity 7	Make a list giving examples of situations in which friction operates. Record the effect friction has and state whether it is an advantage or a disadvantage.
	

The pencil symbol indicates that you should make your own notes in the space provided.

Self-Assessment Tests

When you feel that you have mastered all of the topics in the lesson, and have completed the activities, tackle the Self-Assessment test (SAT). This is to be found at the end of the lesson, unless it concludes with a TMA (see below). The answers to the SAT are found right at the end of the lesson.

Ask your tutor if there is a question in the SAT you do not understand, but do *not* send your self-assessment answers to your tutor.

Tutor-marked Assignments

After every two or three lessons there is a Tutor-Marked Assignment (TMA). Most of these are in IGCSE examination style. These tests will thoroughly test your understanding of the previous few lessons. You should send your answers to each TMA to your tutor, and you will then receive a marked script together with a set of suggested answers.

Some students may opt to tackle TMAs under timed conditions as examination practice. However, they are intended to check your understanding, so it can be helpful also to look back at the lessons.

Revision

Do **not** leave all your revision until the end of the course. You will need to revise thoroughly for your examination, but frequent revision throughout the course is helpful. Plan your revision sensibly and re-read as much as you feel necessary if your knowledge is beginning to fade.

If you intend to revise all the work after studying the lessons, you should allow at least two months of concentrated study for revision and past papers. You can find past exam papers on the Edexcel website (see below).

Coursework

The IGCSE Physics course does not contain coursework. However the skills involved in designing, carrying out and interpreting scientific investigations are tested in both of the written exam papers, and account for 20-25% of the overall mark. These skills are addressed directly in Lessons 4, 11 and 16, but you will also practise them throughout the course. Read any experimental detail covered in the notes or textbook carefully, and think about how you would do any practical work mentioned.

Checking the Specification/Syllabus

This course has been written to cover the contents of the **Edexcel Physics 4PH0** syllabus, which is available to download at

http://www.edexcel.com/quals/igcse/int-gcse11/physics/Pages/default.aspx

Click on "Specification" and then download "Specification and Sample assessment Material: First Examination June 2013". Make sure you do **not** download "Specification – Issue 3" by mistake. You will need an Adobe Acrobat® reader on your computer to download this material. This can be downloaded for free at:

http://get.adobe.com/uk/reader

In the specification, you should look in particular at:

- The Qualification Content on pages 3 -22
- The Assessment Objectives on page 24-25

NB. Please make sure that you look at the current issue of the specification.

You should check the specification throughout the course, so either keep a copy on your computer or print it out.

The Examination

The examination you will sit consists of two papers. There is no separate practical exam and no practical coursework component; testing of practical skills is built into both of the theory papers. You will be asked practical-based questions as part of your written exam.

Physics Paper 1 Paper code: 4PH0/1P

This is a two-hour examination paper. The total number of marks is 120, two thirds of the overall total. The paper examines all of the Specification content *except* those items printed in **bold** (see also in the lesson Aims and Context), and all of the assessment objectives.

Physics Paper 2 Paper code: 4PH0/2P

This is a one-hour examination paper. The total number of marks is 60, one third of the overall total. This paper examines all of the Specification content, *including* those items printed in **bold** (see also in the lesson Aims and Context), and all of the assessment objectives.

You can see an example of both papers, and the mark-schemes used in marking them, at the end of the file which contains the specification.

In both papers there will be a range of compulsory short-answer, structured questions, which gradually increase in difficulty to ensure accessibility for less-able students, as well as to stretch more-able students.

In both papers, students may be required to perform calculations, draw graphs and describe, explain and interpret physical phenomena. Some of the question content will be deliberately unfamiliar to students: these questions are designed to assess data-handling skills and the ability to apply physical principles in unfamiliar situations.

The IGCSE qualification is graded on an eight-point scale from A* to G. Students whose level of achievement is below the minimum standard for Grade G will receive an unclassified U. Where a candidate is unclassified, this will not be recorded on the IGCSE certificate.

If you do not have access to the Internet, it is possible to buy a paper copy of the specification from Edexcel. The contact details are:

Edexcel Publications
Adamsway
Mansfield
Notts NG18 4FN

Tel: 01623 467 467
Fax: 01623 450 481
Email: publication.orders@edexcel.com

Past Papers

At the time of writing, some past exam papers for the previous issue of the specification are available for download from the Edexcel website at:

http://www.edexcel.com/quals/igcse/int-gcse11/physics/Pages/default.aspx

Follow the link "Question paper". You may use these for exam practice, but please do not send them to your tutor for marking.

A pair of mock examinations, marked by your tutor, are provided at the end of this course.

Tiering and Assessment

The Edexcel IGCSE Physics examination is not tiered. This means that all abilities are tested in the same examination.

Your Tutor

You have a lot of resources to help you in your studies: your course file, your textbook, the interactive CD, internet resources and your tutor. You should make good use of your tutor to help you with any difficulties that you may have during the course.

And finally ... good luck with your studies!

Marian Green and Philip West

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IGCSE Physics

Using Number in Physics

Introductory Lesson

Using Numbers in Physics

Aims

By the end of this introductory lesson you should be able to:

- use decimals rather than fractions
- use a calculator
- rearrange formulae
- handle different units
- work with numbers in standard form

Context

To make a good start with this course, it helps if you have a good mathematical background. This introductory lesson will help you see whether you have the necessary skills or whether additional work is required.

No additional reading is required.

Oxford Open Learning

Using Numbers in Physics

In Physics we study the basic properties of matter and energy by measuring things like length, time, mass and force, and giving them numbers. Giving things numbers enables us to describe their behaviour more exactly. It is more exact to say that a ball weighs “357 grams” than to say it is “quite heavy”, or that a journey took “23 seconds” than that it was “very short”.

Because Physics uses numbers it involves the use of some maths, and this is a very brief guide to the maths you will need. Please re-read it while working on each lesson until you are familiar with the contents. Ask your tutor if you find it difficult to understand.

The guide has five sections:

1. decimals and fractions
2. using a calculator
3. rearranging formulae
4. handling units
5. standard form

Decimals and Fractions

In Physics, we always use decimals rather than fractions. So use 0.5 instead of ½, and 0.003 instead of 3/1000.

Using a Calculator

You are allowed to use a calculator in Physics exams, in fact it is encouraged, so buy one to use during the lessons and exams now. A simple one costing a few pounds is fine, but you need to have a “sin” or “sine” button on its keyboard: ask your tutor if you need help on choosing one.

Do not rely on the calculator on your mobile phone or laptop, because you will not be able to take it into the exam room – buy a separate one.

Using a calculator makes arithmetic easy, but it has two pitfalls:

1. It is very easy to enter the wrong number, or press the wrong button, by mistake. To guard against this, always work out an approximate answer in your head and check the calculator answer against it.

   For example, if the sum is 3,130 ÷ 9.89, the answer is approximately 3000 ÷ 10 = 300. So if you get a calculator answer of 26 or 92,735,118 you know you have made a mistake!

2. The calculator display often gives you an answer with too many figures. For example, if you try the above sum your calculator gives you an answer of 316.48129. Unfortunately, if you just copy this down, your answer will be marked wrong. This is because you are claiming your answer is accurate to the nearest 0.00001, which it usually isn't.

In Physics you quote your answer to about the same number of significant figures as was found in the numbers you fed into your sum. This means the number of places, starting from the left, until you run out of numbers or hit just zeros. 3,130 and 9.89 both have three significant figures, so the best answer is 316, not 316.48129 (8 significant figures) or 300 (1 significant figure) or 316.48 (5 significant figures).

The last number in your answer may need to be rounded up or down. Round it down if the next figure is 4 or less; round it up if it is 5 or more. So 27.4236 should be rounded down to 27.4, while 27.4511 should be rounded up to 27.5.

Rearranging Formulae

A formula is an equation with an "equals" sign, where the things on the left and the right are equal. For example, a formula we will meet in Lesson One is:

distance = speed × time

This means that if the speed is 6 and the time is 9, the distance will be 6 × 9 = 54.

A list of the formulae you will eventually need to know is given at Appendix C at the back of your file.

If we are given the distance and the speed, and need to find the time, we have to rearrange the formula. To do this, divide both sides by the speed. This produces the revised formula:

$$\frac{distance}{speed} = \frac{speed \times time}{speed}$$

We can now cancel out the "speed" on the top and bottom on the right hand side, which gives:

$$\frac{distance}{speed} = time$$

So if the distance is 27 and the speed is 9, the time will be $27 \div 9 = 3$.

Similarly, going back to the original formula, if we divide both sides by time we get:

$$\frac{distance}{time} = speed$$

The basic rule for handling formulae is: whatever you do to one side, you must also do to the other side. It is OK to multiply both sides by anything, or divide both sides by anything, but you must do the same thing to both sides.

Handling Units

Things we measure and give numbers to in Physics are called **quantities**, and most quantities are measured in **units**. For example, you can't say that the distance around a running track is "400", it is 400 *metres*. And you can't say the time taken to run it is "53", but 53 *seconds*. Distance and time are quantities, and their units are metres and seconds.

S.I. units

Unfortunately, there are often many different units in use for the same quantity. E.g. length may be measured in metres, feet, furlongs or paces. To overcome this, scientists have agreed on an official set of units to use, called the **S.I. units** (which stands for Système Internationale in French). The most important of these are the **kilogram** (for mass), the **metre** (for length) and the **second** (for time). A complete list of the S.I. units used in the course is given at Appendix B at the back of your file.

To make writing units quicker, each is given an official abbreviation. For kilograms it is **kg**, for metres it is **m**, and for seconds it is **s**. Please note four things:

- the abbreviations are "case sensitive", so you *must* write "m", not "M" for metres. "M" is also used in Physics, but it means something different
- the abbreviations are *not* followed by a full stop (unless they are at the end of a sentence), so 53m is correct, while 53m. is wrong
- no gap is left between the number and the unit, so 91s is correct, while 91 s is wrong
- no "s" is added to make a unit plural, so 1kg and 17kg are both correct, but 17kgs is wrong (it means 17 kilogram-seconds)

Big and small units

Bigger and smaller versions of each official unit are often needed, and they are found by multiplying and dividing repeatedly by 1000. So for length we have:

- millimetres (mm) which are $1/1000^{th}$ of a metre
- micrometres (μm) which are $1/1000^{th}$ of a millimetre
- nanometres (nm) which are $1/1000^{th}$ of a micrometre

while in computing, whose basic unit of information is the byte (B), we have:

- kilobytes (kB) which are 1000 bytes
- megabytes (MB) which are 1000 kilobytes
- gigabytes (GB) which are 1000 megabytes
- terabytes (TB) which are 1000 gigabytes

Milli- (m), micro- (μ), nano- (n), kilo- (k), mega (M), giga- (G) and tera- (T) are all official symbols which can be added to any unit. So we can have nanoseconds (ns) and kilometres (km) and so on. Note that some are capital letters (e.g. M and G)

while some are small letters (e.g. m and n), while one is the Greek letter "mu" (μ).

Note that, strangely, the basic S.I. unit for mass is the kilogram (kg) which is 1000 grams (1000g).

A few other big and small units are also used, such as the centimetre (cm) for length which is $1/100^{th}$ of a metre. But older units such as "feet" or "miles" for length, "pounds" for weight, and "degrees Fahrenheit" (°F) are no longer used in science.

Standard Form

In Physics we often have to write very big or very small numbers, and "standard form" is a way to write them which avoids using too many zeros.

For example:

- 3,600,000 can be written as 3.6×10^6
- 457,000,000,000 can be written as 4.57×10^{11}

In standard form you always:

- start with a number with only one figure before the decimal place
- follow this by "times" (×)
- then write 10 to the "power" of the number of places you need to move the decimal point to get the number written out in full

If the number is smaller than 1, the same rules apply. But because you need to move the decimal point in the other direction the "power" becomes negative. So:

- 0.03 is written 3×10^{-2}
- 0.000000732 is written 7.32×10^{-7}

Notice that the power is one *more* than the number of zeros after the decimal point when the number is written in full.

Conclusion

If you've read this far for the first time, you will probably have a bad case of mathematical indigestion! Don't worry. Just start off on Lesson One, where many of these ideas are used, and come back to this guide to reinforce your knowledge whenever you start work on a new lesson.

If you get confused, consult your tutor. And enjoy using your numbers!