Section B exam guide & Derivations

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## BREAKDOWN OF THE EXAM PAPER

|  |  |  |  |
| --- | --- | --- | --- |
| Total number of marks: 400 | | | |
| **Section A** | **Marks** | **(%)** | **Resource** |
| *Questions 1, 2, 3, 4*  *Answer 3 Questions from 4* | 40 marks each  Total = 120 | 10% each  Total = 30% | See booklet entitled  ***Section A: Questions and Solutions*** |
|  |  |  |  |
|  | | | |
| **Section B** | **Marks** | **(%)** | **Resource** |
| *Questions 5, 6, 7, 8, 9, 10, 11, 12*  *Answer 5 Questions from 8* | 56 marks each  Total = 280 | 14% each  Total = 70% | See booklet entitled ***Question 5’s***  See booklets containing all the questions on each topic at HL and OL (plus solutions for HL questions) |

All resources above can be accessed from the *Revision* section of *thephysicsteacher.ie* website.

**Section B: The following should be your ‘banker’ questions**

* Question 5: 10 short questions covering the whole course: answer any 8
* Question 12: 4 separate questions, also from any section of the course: answer any 2
* **Question 10: Particle Physics – but only if it comes up. It was a full question every year from 2002 – 2015 but then just appeared as half a question 12 (d) in 2016 and 2017 and back to a full question in 2018.**
* You now need to pick 2 questions from the remaining 5 - even you can do this.

**Do I need to study *Mechanics*?**

You need to cover all the mandatory experiments in *Mechanics* (see *Section A* booklet) and also the short questions in *Mechanics* if you intend doing Question 5 (see *Question 5’s* booklet), but beyond that you could probably get away with not studying the long questions.

I think this is reasonable given that the *Mechanics* questions can be fairly difficulty, particularly if maths i not your strong point.

On the other hand if you’re looking for an *A* then you really must cover everything. And anyway, all the *Mechanics* questions (plus solutions) are covered in the *Mechanics* revision document. And like all other topics you should notice that the questions tend to repeat themselves after a while.

Also, if you’re studying Applied Maths the *Mechanics* question should be much more straightforward.

**Do I need to study *Electricity*?**

With the exception of *Static Electricity* and *Capacitance* (which are both short and come up regularly), the reasoning here is the same as for **Mechanics**.

**Why you can avoid *Mechanics* and *Electricity*.**

***Remember that if you’re planning to answer question 5 (Short Questions) and Question 10 Particle Physics) then you only need to answer another 2 questions from those below. You should be able to see for yourself that every year since 2002 there were at least two full questions available on the topic below, and some years there was even a choice within this.***

But just to repeat; if looking for an *A* or a *B* grade you should really cover all topics on the course.

Note:

A full question in Section B is 56 marks or 14% of your overall mark.

Therefore half a question represents 7% and 1½ questions would be 21 % (see the way I just did that?)

BREAKDOWN OF SECTION B BY PERCENTAGE OF THE OVERALL PAPERThe % mark represents what this topic typically represents, but this obviously varies from year to year

|  |  |  |
| --- | --- | --- |
|  | | |
| **Geometrical Optics,**  **Waves, Sound, Light** | 21% | 2018 Question 7, 11  2017 Question 7, 9 {first half}, 12 (c)  2016 Question 11 {first half}, 12 (c) {most of this question}  2015 Question 9, 12 (b) 2014 Question 7, 12 (b) {plus ½ of no. 10 – mixed in with Resistance}  2013 Question 7, 12(b)  2012 Question 7, 12 (b)  2011 Question 8, 12(b)  2010 Question 7, 11, 12 (c)  2009 Question 7, 12 (c)  2008 Question 9, 12 (b)  2007 Question 7, 12 (b)  2006 Question 7  2005 Question 7, 12 (c)  2004 Question 12 (b)  2003 Question 7  2002 Question 7, 12 (b) |
| **Static Electricity and Capacitance** | 7% | 2018 Question 12 (c)  2017 - -  2016 Question 12 (b)  2015 Question 8 2014 Question 9  2013 Question 12 (c)  2012 --  2011 Question 9  2010 Question 12(d)  2009 Question 9  2008 Question 12 (d)  2007 Question 8  2006 Question 12 (b)  2005 Question 10  2004 Question 8  2003 Question 12 (c)  2002 Question 11 |
| **Electromagnetic induction** | 7% | 2018 Question 9 {half}  2017 Question 8 {last part only}  2016 Question 10  2015 Question 11 2014 --  2013 appeared as small parts of various questions  2012 --  2011 --  2010 --  2009 --  2008 Question 8  2007 Question 12 (c)  2006 Question 11 {5/8 of a long question}  2005 Question 12 (b)  2004 Question 12 (c)  2003 Question 12 (d)  2002 Question 12 (c) |
| **The electron** | 14% | 2018 Question 12 (d)  2017 Question 10  2016 Question 11 (second half)  2015 Question 7 2013 --  2012 Question 12 (d)  2011 --  2010 Question 9  2009 Question 8  2008 Question 11{5/8 of a long question}  2007 --  2006 Question 12 (d)  2005 Question 12 (d)  2004 Question 9  2003 Question 9  2002 Question 9 |
| **Nuclear physics** | 7% | 2018 Question 8, 12 (b)  2017 Question 12 (b)  2016 Question 12 (a)  2015 Question12 (d) 2014 Question 8  2013 Question 9  2012 Question 8  2011 Question 12 (d)  2010 Question 12 (b)  2009 Question 12 (d)  2008 Question 12 (c)  2007 Question 12 (d)  2006 Question 8  2005 Question 8  2004 --  2003 Question 11  2002 Question 12 (d) |

## BREAKDOWN OF TIME

**How much time per question?**

The exam is 3 hours long (180 minutes) and you need to do 8 questions (3 from Section A and 5 from Section B).

Rule of thumb: spend 20 minutes (approx) on every question (even though Section B questions are slightly more marks than Section A).

8 × 20 = 160 minutes = 2 hrs 40 minutes.

* Section A: Total time one hour.

5 minutes to read over and pick your three questions, then 20 minutes for each question.

* Section B: 90 minutes for 5 questions.

5 minutes to read over and pick your five questions, then 20 minutes each.

* 10 minutes at the end to read over your paper.

Obviously you’re not going to stick religiously to this time-scheme, but it is useful to at least have it in mind and perhaps write it down as soon as you start. It can also be useful to regard picking questions / looking over questions as a sort of ‘break’ from the main job of answering questions, so ration it out appropriately.

## HOW TO REVISE

Avoid the temptation of merely reading over a topic and then considering that topic ‘done’. This must surely be the single greatest distinguishing factor in separating the ‘A’ student from the ‘C’ student. I should know; I was always in the latter category.

In tackling the Leaving Cert Physics paper, the preparation that you put in beforehand is vital.

For a start, you must know all the basic material:

* Experiments
* Definitions
* Formulae
* Derivations
* Demonstrations
* Applications
* Units
* Symbols

Most of these are dealt with individually in this booklet. Others (like the experiments) are available in a separate booklet.

**Primacy-Recency effect:** When given a list of items to memorise, people are most likely to remember the most recent items first, then the items at the beginning, followed lastly by the items in the middle. So if learning definitions, formulae etc make sure to jumble up the order when going back over them.

Do a little often.

Sleep is essential. Try to maintain the same sleeping pattern before and during the exam period. If you really want to try to survive on three hours sleep then wait until the drinking frenzy that follows the exams.

Before leaving a topic ask yourself: “What did I learn?” then jot down the key points.

This can increase retention by up to 50%.

Be comfortable with calculator exercises including scientific notation.

This is a written paper and your revision should reflect this.

Set aside a specific amount of time to cover a given topic, then quickly sketch a web or mind-map, cross-referencing all the concepts, definitions, experiments and formulae that you can think of (you may be surprised by how much you know).

When using mind-maps try to avoid using straight lines – your brain prefers curves!

Highlight any aspect that you need further work on.

Spend no more than ten minutes on this exercise.

Now check the syllabus to see what you (and possibly the teacher – don’t be afraid to remind me!) have left out.

This helps to highlight the concepts that you are least familiar with, and hopefully helps you to avoid one of the greatest pitfalls in revision; namely spending too much time going over what you already know or the topics which you prefer.

It is important that you attempt to answer past examination questions, preferably in the allotted time.

Doing so gives you a ‘feel’ for questions, how they were asked and what is expected in an answer.

However, when you have done this a few times, you may find that your time is better spent simply summarising answers rather than answering them in full.

The aim here again is to differentiate what is known well from what is not known. Writing the answer out in point form, or perhaps with a diagram and a short note, is the best way of doing this.

Remember to take regular (short) breaks, and *every* time you go back, spend a little time revising what you have just covered.

This is the most important, but I suspect least practiced, area of revision.

It may seem like you’re not making progress, but trust me it’s worth it (I wish I had been told this when I was studying; maybe I wouldn’t have had to repeat so many exams).

Working for 40-minute periods enables you to retain more of the material you are learning *while* you are learning it.

Equally important, however, is the retention of material *after* a learning period. This falls off rapidly with time.

Indeed *after 24 hours you will lose 80% of what you have learned unless you revise it with that time-span!*

Such a revision need take no more than 5 or 10 minutes.

To reinforce it even more, you should revise the topic again after a week.

Admittedly, all this requires organisation, but it will be worth it if you can achieve it.

**Revising Definitions**

To check whether or not you know your definitions, write them out and then (and only then) compare it to your notes or marking scheme.

If it’s different and you’re not sure whether you would get full marks for your answer, ask me.

You may well be surprised to find that you would lose half the marks for an apparently irrelevant phrase that you thought was just tagged on at the end, e.g. ‘at constant temperature’.

Obviously there is limited benefit to just copying a definition out of a textbook and assuming that this means you know it.

**Golden rule**

The question isn’t asking you what ‘might’ the definition of refraction be – it’s asking you what *is* the definition of refraction. So don’t waffle.

**Revising Section A Questions**

The best strategy here is to go over the experiments from past papers, you will quickly notice how repetitive they become.

You will invariably be asked to draw a labelled diagram, to describe how you obtained values for the different variables, to mention any relevant precautions and possibly to graph the data. See the Section A booklet for more details.

## EXAM TECHNIQUE: SECTION B

The most popular questions and also those which usually yield the highest marks:

* Question 5: do 8 from 10
* Question 12: do 2 from 4
* Question 10: Particle physics
* This leaves 2 more questions to be answered from 5

**Question 5: 10 parts – do 8**

Attempt all parts – it’s not unusual to find that you did much better than expected in one part and much worse than expected in another, therefore it makes sense to have a reserve question, even if you think it’s of poor quality (once it doesn’t take a disproportionate amount of time).

If you are looking for an A grade make sure you know all the relevant formulae and definitions before you tackle this question.

**Question 10 (a): Particle Physics**

There will almost certainly be a question on Particle Physics (although there’s no rule which says there has to be one, and it doesn’t have to be Question 10 either).

If it does come up it will appear together with the ‘Applied Electricity’ option [Question 10 (b)], but you can ignore this unless you have prepared for it by yourself.

**Experiment Question in Section B**

One of the questions in this section may require a description of an experiment although no detailed graph will be required.

In describing the experiment ensure to include the following:

* A labelled diagram of the experimental set-up, including all essential apparatus. The first step in the procedures should then be “we set up the apparatus as shown in the diagram”.
* A description of how to obtain values for both sets of variables
* A description of what needs to be adjusted to give a new set of data
* Reference to a relevant formula, graph etc

**Comprehension Question**

There will probably be one question which is very general in nature.

This may seem easy but because it is non-mathematical in nature it can be hard to pick up top marks.

Because it’s like a comprehension question it’s not always clear what information the question is looking for.

In my opinion this question suits students looking for a D or C grade as there is not a whole lot of physics knowledge required to pick up 50/60%, but the questions can often be too vague to enable a student picking up full marks.

**The Rest**

The format for the remaining questions generally require some or all of the following:

* Definition(s)
* Derivation of a formula
* Applications of a given concept
* Mathematical problem

It is important to note that for a given question some or all of the bullet points above can be asked.

The definition at the beginning usually sets the scene for the question. Knowing this can help you to approach the mathematical part with greater confidence.



## POINTS TO WATCH OUT FOR / COMMON MISTAKES

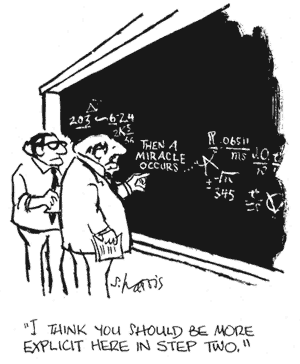
* Many questions require a specific phrase; avoid the temptation of putting things in your own words if a standard phrase exists. You check for this when revising by constantly cross-referencing your answers to past papers with their associated marking scheme. In particular ensure that your answer reads like a proper English sentence; if not then you won’t get full marks, despite having the relevant correct phrase embedded in it.
* Think logically: Does your answer *look* right? e.g. a current of 1,000 amps is not reasonable, nor is a focal length of 1,000 metres. If converting from kilometres to metres should your number get bigger or smaller? Why?
* It is noticeable that many students often miss out on an A1 due to mis-reading a question or (more commonly) not noticing a question or definition. This isn’t helped by the exams commission refusing to number each sub-question. But there’s nothing you can do about that now. Just make sure that you read, re-read and then read again each question before *and after* you have attempted it.
* Giving an *example* of something (e.g. for resonance) is not the same as giving an *application* of it.
* An *expression* is not the same as an *equation*, which in turn is not the same as a *statement*.
* When giving definitions, watch out for short phrases at the end such as "*at constant temperature*", or "*if no external forces act*". Quite often the main part of the definition can be very long but still only merit the same amount of marks (three) as the bit that gets tagged on at the end. This is particularly important if you are giving a formula as an answer to a definition; the temptation is to think that it can all be represented mathematically.
* When giving a formula as an answer to a definition, remember to explain all symbols.
* Similarly if are asked for a definition and you're unsure how something should be phrased, write it both ways - you should only get marked on the best one.
* You may see the first part of a question as difficult and straight away write off the question - not a good idea.
* If you're unsure how much to write for a given question, look at the marking scheme.
* Definition of units – know how to express them in terms of their associated formulae, e.g. to define the newton refer to the F = ma equation).
* Ensure that you know how to use your calculator - don’t buy one on the day (or even the week) beforehand. And make sure you can switch back from radians to degrees in case someone has accidentally put it on *radians* to begin with (or even worse – *grads*; who uses those things and why are they available on school calculators?).
* Ask for Maths tables and be familiar with what information is available.
* When giving a formula as an answer to a definition, remember to explain all symbols.
* Remember to include the relevant unit at the end of a maths question – you may not lose many marks but it is unforgivable because you almost definitely know what the unit is. It’s also unforgivable because if you were in my class you will have spent two years losing half marks every time you left out in one of my tests and omitting it now would only serve to illustrate that you have learnt nothing in my class. In my opinion you should be heavily punished for this in the exam itself. After all if the required answer is 2 cm and you leave your answer as 2 it merely begs the question; is it 2 cm, 2 miles or 2 bananas?
* Question: *Name two devices that contain capacitors*.

‘Radios and cameras’ is probably too general to be accepted as an answer.

A safer answer would be ‘rectifiers’ (used to convert a.c. to d.c.) or ‘in flashguns in cameras’.

* Question: *What is meant by the capacitance of a capacitor?*

The answer requires a definition of *capacitance*, not some vague, waffly, hand-wavy essay (so why don’t they just ask you to define *capacitance*? I don’t know).



# DERIVATIONS

1. ***v = u + at s = ut + ½ at2  v2 = u2 + 2as***
2. **Show that F = ma is a special case of Newton’s Second Law**
3. **v = r ω**

****

1. **Relationship between Periodic Time and Radius for a Satellite in Orbit:**
2. **Show that any object that obeys Hooke’s Law will also execute SHM**
3. **nλ = d Sin θ**
4. **Resistors in series and in parallel**
5. **F = Bqv**

***s = ut + ½ at2***

***v2 = u2 + 2as***

***v = u + at***

**Three Equations of Motion**

**** ⇒ v = u + at

Vaverage =  But v = u + at ⇒ Vaverage = 

Vaverage = **** ⇒ s = Vaverage(t) ⇒ s = **** (t)

⇒ s = ut + ½ at2

v = u + at ⇒ v2 = u2 + 2uat + (at)2 {multiply out both sides}  
  
We can rewrite this as *v2 = u2 + 2a(ut + ½ at2)* {because *2a(ut + ½ at2)* = 2uat + (at)2}  
   
Now sub in *s = ut + ½ at2* ⇒ *v2 = u2 + 2as*

**To Show that F = ma is a special case of Newton’s Second Law**

*Use Newton’s second law to establish the relationship: force = mass × acceleration*

From Newton II: Force is proportional to the rate of change of momentum

Force ∝ rate of change of momentum

F ∝ (mv – mu)/t

F ∝ m(v-u)/t

F ∝ ma

F = k (ma)

F = ma

We define θ (in radians) as s/r:



Divide both sides by t:



But ω = θ/t and v = s/t:



Cross-multiply to get:



**v = r ω**

**Relationship between Periodic Time and Radius for a Satellite in Orbit**

****

We compare two formulae which we have for *force*:

1. The first is the *Universal Gravitational* *Force* formula: 
2. The second is the *Centripetal Force* formula: ****
3. Equate both forces (because both equations apply to satellite motion)
4. Cancel one ‘m’ from both sides
5. Replace the d2 in the first formula with r2 and cancel one ‘r’ both sides



1. You now have *Equation (1)*

{**You must be familiar with using this equation as it gets asked a lot**}

1. Now v = velocity = Distance/Time.
2. Distance in this case is the circumference of a circle (2πR for circular satellite orbits)
3. ⇒  ⇒  *Equation (2)*

Equating Equations (1) and (2) we get 

**To show that any object that obeys Hooke’s Law will also execute SHM**

[2007] Derive the relationship between the acceleration of a sphere undergoing SHM and its displacement from the fixed point.

So we start with the equation for Hooke’s Law; F ∝ -s ⇒ F = -k s

But F = ma ⇒ ma = -k s

Now divide both sides by m ⇒ a = - s



This is equivalent to the equation for S.H.M. where the constant ω2 in this case is k/m.

**nλ = d Sin θ**



From the diagram we can see that:

1. For constructive interference to occur, the extra path length that the top ray travels must be an integer number of wavelengths (**nλ)** {Eqn (1)}
2. Using trigonometry, this extra path length is equal to **d sin θ,** where d is the slit width {Eqn (2)}

Equating (1) and (2) gives us **nλ = d Sin θ**

**Resistors in series and in parallel**

***\*\*\*\* Put in relevant diagrams \*\*\*\****

**RTotal = R1 + R2**

**Resistors in Series\***

Derivation:

For resistors in series VTotal = V1 + V2

But V = IR (Ohm’s Law)

⇒ I RTotal = I R1 + I R2 (We can now cancel the I’s because the current is the same for resistors in series)

⇒ RTotal = R1 + R2



**Resistors in Parallel\***

Derivation:

For resistors in parallel ITotal = I1 + I2

But I = V/R (Ohm’s Law)

⇒ V/RT = V/R1 + V/R2 (But we can cancel the V’s because the voltage is the same for resistors in parallel)

⇒ 1/RTotal = 1/R1 + 1/R2

**F = Bqv**

*l*

Consider a section of conductor of length *l* through which a current *I* is flowing.

If *q* is the charge which carries the current in this section of the conductor, then:

*I* = *q/t*, (remember q = It (**Q**u**IT**?) where tis the time it takes the charge *q* to travel a distance *l)*.

The average velocity with which the charge flows is given by *v* = *l*/*t*, i.e. *l* = *vt*.

Substituting into the primary equation which we have for force (F = BIL),we get

F = B × q/t × vt

i.e. *F* = *Bqv*

