Leaving Cert Physics Revision Booklet

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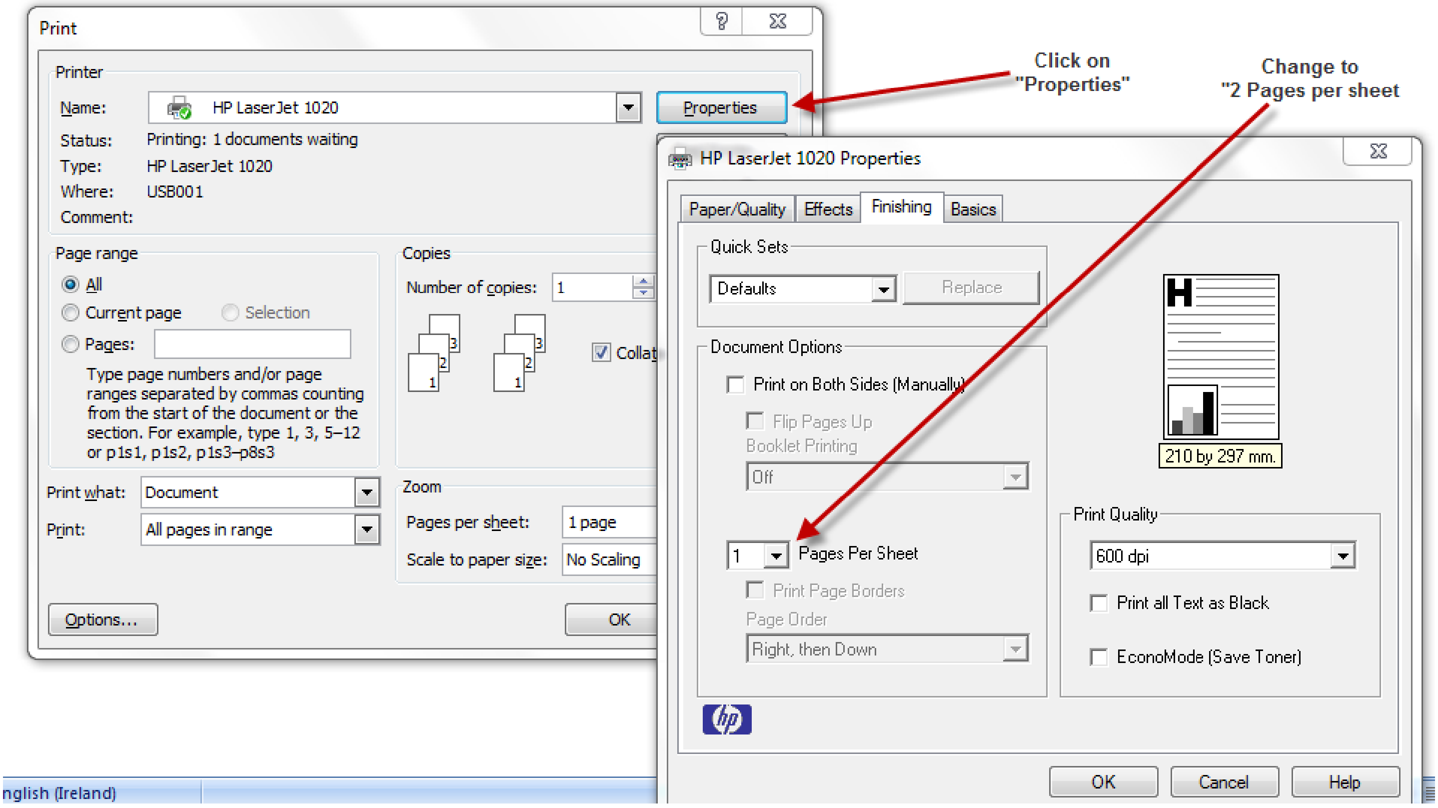
This booklet is 30 pages long
Please do not print out all 30 pages

Use the functions in your printer options to print 2 pages onto 1.
If photocopying for students then please also use the 'print back-to-back' option on the photocopier.



And yes I know this instruction is taking up a page, but this page was going to be left blank anyway for formatting purposes.
Smartass

How to get 100% in your Leaving Cert Physics exam (without really trying)

Breakdown of the exam itself

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. It's a little on the long side, but because it comes up every year the questions are very repetitive.
- 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?)

Section B		
Geometrical Optics, Waves, Sound, Light	21%	2012 no. 7, 12 (b) 2011 no.8, 12(b) 2010 no.7, 11, 12 (c) 2009 no.7, 12 (c) 2008 no.9, 12 (b) 2007 no. 7, 12 (b) 2006 no.7 2005 no.7, 12 (c) 2004 12 (b) 2003 no.7 2002 no. 7, 12 (b)
Static Electricity and Capacitance	7%	2012 -- 2011 no.9 2010 12 (d) 2009 no.9 2008 12 (d) 2007 no.8 2006 12 (b) 2005 no.10 2004 no.8 2003 12 (c) 2002 no.11
Electromagnetic Induction	7%	2012 -- 2011 -- 2010 -- 2009 -- 2008 no.8 2007 12 (c) 2006 no.11 {5/8 of a long question} 2005 12 (b) 2004 12 (c) 2003 12 (d) 2002 12 (c)
The Electron	14%	2012 12 (d) 2011 -- 2010 no.9 2009 no.8 2008 no.11{5/8 of a long question} 2007 -- 2006 12 (d) 2005 12 (d) 2004 no.9 2003 no.9 2002 no.9
Nuclear Physics	7%	2012 no.8 2011 12 (d) 2010 12 (b) 2009 12 (d) 2008 12 (c) 2007 12 (d) 2006 no.8 2005 no.8 2004 -- 2003 no.11 2002 12 (d)

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.

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.

EXAM TECHNIQUE: SECTION A

You must know all mandatory experiments inside out

You will be given a set of results and will be asked to do some of the following:
1. Draw a labelled diagram.
2. Explain how the values were obtained.
3. To calculate some quantity (e.g. Specific Heat Capacity) or to verify a Law (e.g. Conservation of Momentum, Snell's Law etc).
4. Some shorter questions on sources of error, precautions etc in relation to the performance of the experiment.
5. At least one of the questions will require a graph to be drawn. In such cases the slope of the graph will usually have to be calculated. The significance of the slope of the graph is determined by comparing it to a relevant formula (which links the two variables on the graph).

Note

The data given will frequently have to be modified in some way (e.g. you may need to square one set of values or find the reciprocal etc) before the graph is drawn. This modification is determined by comparing it to the relevant formula which links the two variables.

When revising Section A make sure that you can do each of the following for every experiment:
- Draw a labelled diagram of the experimental set-up, ***including all essential apparatus***.
  The first step in the procedures should then read "we set up the apparatus as shown in the diagram".
- Describe how to obtain values for both sets of variables
- Describe what needs to be adjusted to give a new set of data
- Say what goes on the graph, and which variable goes on which axis
- Know how to use the slope of the graph to obtain the desired answer (see below).
- List two or three precautions; if you are asked for two precautions, give three - if one is incorrect it will simply be ignored.
- List two or three sources of error.

Misc Points
- The graph question is usually well worth doing.
- Learn the following line off by heart as the most common source of error: "parallax error associated with using a metre stick to measure length / using a voltmeter to measure volts etc".
- Make sure you understand the concept of percentage error; it's the reason we try to ensure that what we're measuring is as large as possible.
- There is a subtle difference between a precaution and a source of error – know the distinction.
- When asked for a precaution do not suggest something which would result in giving no result, e.g. "Make sure the power-supply is turned on" (a precaution is something which could throw out the results rather than something which negates the whole experiment).
- *To verify Joule's Law* does not involve a Joulemeter
- *To verify the Conservation of Momentum* – the second trolley must be at rest.
- *To verify the laws of equilibrium* - the phrase 'spring balance' is not acceptable for 'newton-metre'.
- *To measure the Focal length of a Concave Mirror or a Convex Lens.*

  Note that when given the data for various values of u and v, you must calculate a value for f in each case, and only then find an average. (As opposed to averaging the u's and the v's and then just using the formula once to calculate f). Apparently the relevant phrase is "an average of an average is not an average".

DRAWING THE GRAPH

- You *must* use graph paper and fill at least THREE QUARTERS OF THE PAGE.

- Use a scale which is easy to work with i.e. the major grid lines should correspond to natural divisions of the overall range.

- LABEL THE AXES with the quantity being plotted, including their units.

- Use a sharp pencil and mark each point with a dot, surrounded by a small circle (to indicate that the point is a data point as opposed to a smudge on the page.

- Generally all the points will not be in perfect line – this is okay and does not mean that you should cheat by putting them all on the line. Examiners will be looking to see if you can draw a best-fit line – you can usually make life easier for yourself by putting one end at the origin. The idea of the best-fit line is to imagine that there is a perfect relationship between the variables which should theoretically give a perfect straight line. Your job is to guess where this line would be based on the available points you have plotted.

- Buy a TRANSPARENT RULER to enable you to see the points underneath the ruler when drawing the best-fit line. Make that a LONG transparent ruler. See next point.

- BE VERY CAREFUL drawing a line if your ruler is too short to allow it all to be drawn at once. Nothing shouts INCOMPETENCE more than two lines which don't quite match.

- DO NOT JOIN THE DOTS if a straight line graph is what is expected. Make sure that you know in advance which graphs will be curves.

- Note that examiners are obliged to check that each pint is correctly plotted, and you will lose marks if more than or two points are even slightly off.

- When calculating the slope choose two points that are far apart; usually the origin is a handy point to pick (but only if the line goes through it).

- When calculating the slope DO NOT TAKE DATA POINTS FROM THE TABLE of data supplied (no matter how tempting!) UNLESS the point also happens to be on the line.
  If you do this you will lose beaucoup des marks and can kiss goodbye any chance of an A grade.
  Do you understand *why* you cannot do this?

WHAT GOES ON WHAT AXIS?

Option one

To show one variable is proportional to another, the convention is to put the *independent* variable on the x–axis, and the *dependant* variable on the y-axis, (from y = fn (x), meaning y is a function of x). The independent variable is the one which you control.

Option two

If the slope of the graph needs to be calculated then we use a difference approach, one which often contradicts option one, but which nevertheless must take precedence. In this case we compare a formula (the one which connects the two variables in question) to the basic equation for a line: y = mx.

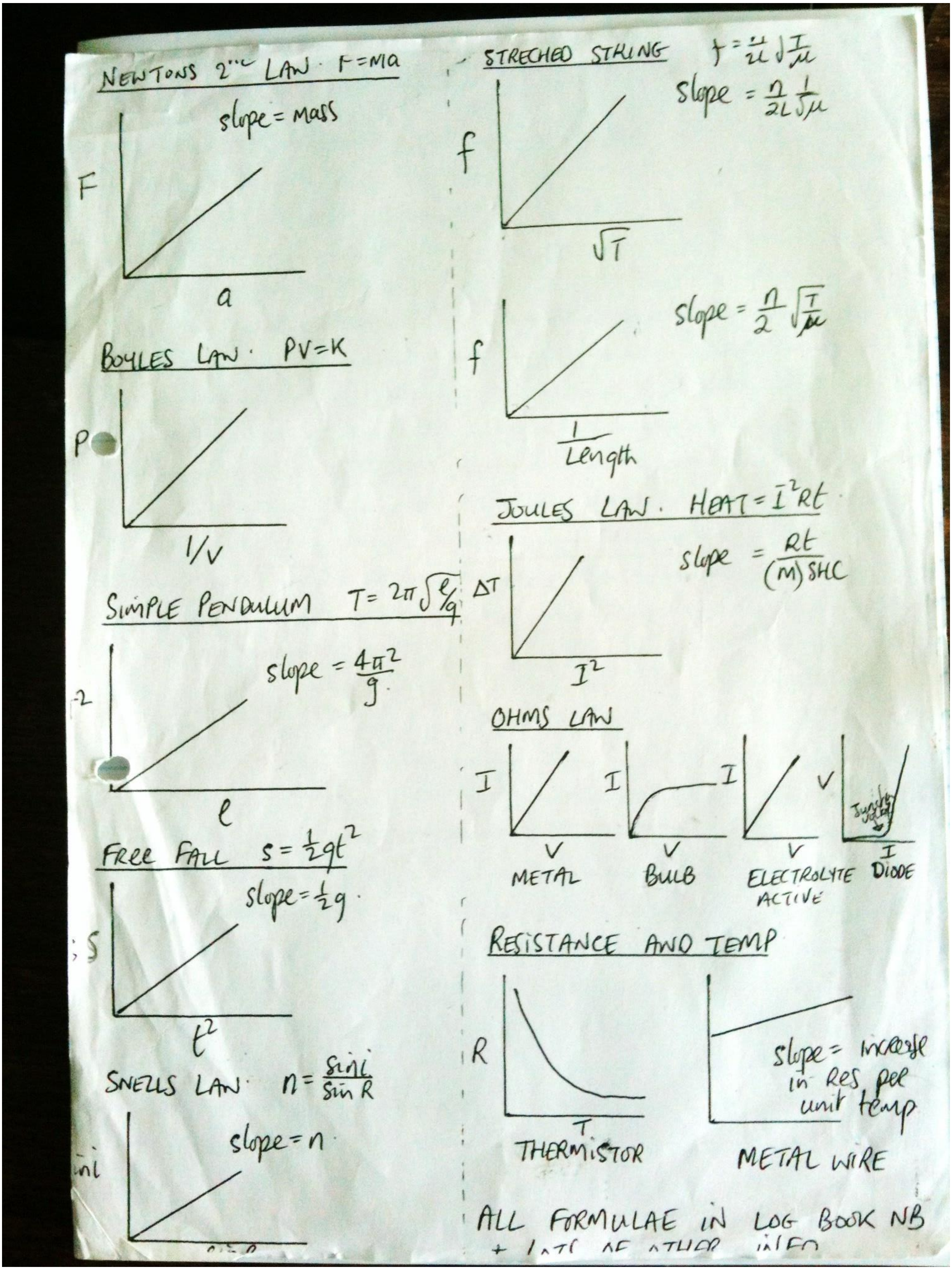
See if you can work out what goes on what axis for each of the following examples (they get progressively trickier):

1. To Show Force is proportional to Acceleration
2. Ohm's Law
3. Snell's Law
4. Acceleration due to gravity by the method of free-fall
5. Acceleration due to gravity using a Pendulum

There is usually a follow-up question like the following;
"Draw a suitable graph on graph paper and explain how this verifies Snell's Law".
There is a standard response to this;
"The graph of *Sin i* against *Sin r* resulted in a straight line through the origin (allowing for experimental error), showing *Sin i* is directly proportional to *Sin r*, and therefore verifying Snell's Law".

If you are asked any questions to do with the information in the table, you are probably being asked to first find the slope of the graph, and use this to find the relevant information.

SUMMARY OF THE GRAPHS



EXPERIMENT QUESTIONS (SECTION A) BY YEAR

Experiment Title	12	11	10	09	08	07	06	05	04	03	02
Concave Mirror						3					
Convex Lens	2			2						3	
Refractive Index			3					3			
Verify F = Ma			1								
g by free-fall				1					1		
Conservation of Momentum		1						1			
Simple Pendulum	1				1		1				
Calibration Curve											
Specific Heat Capacity						2					
Latent Heat of Vapourisation			2					2		2	
Latent Heat of Fusion					2						2
Boyle’s Law		2								1	
Laws of Equiblibrium						1					1
Speed of Sound							3				
Natural Frequency and Length	3								3		
Natural Frequency and Tension				3					3		3
Wavelength of Light		3			3		2		2		
Joule’s Law							4			4	
Ohm’s Law											
V I for a Filament Bulb								4			
V I for copper sulphate		4									4
Semiconductor Diode	4					4					
R versus Temp for a Metal					4						
R versus Temp for Thermistor			4								
Resistivity				4					4		

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).

- Use the syllabus extracts in my chapter notes to double to check that you (and I) have everything covered.

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).
$8 \times 20 = 160$ 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.

SYMBOLS AND UNITS

Note:
All ***units*** are spelled out using lower case, e.g. newtons, joules, volts, kilogram.
Symbols of units that derive from *the name of a physicist* are all uppercase e.g. J, V etc. while symbols for all other units remain lowercase, e.g. the symbol for the kilogram is kg.

Check that you know these by covering over all but the first column.

Let me know if I've missed any.

Mechanics

Quantity	Symbol	Unit	Symbol	Equation
Area	a	metres squared	m^2	
Volume	v	metres cubed	m^3	
Mass	m	kilogram	kg	
Density	ρ	kilogram per metre cubed	$kg\ m^{-3}$	**ρ = m/v**
Displacement	s	metre	m	
Velocity	v	metre per second	$m\ s^{-1}$	**v = d/t**
Acceleration	a	metre per second squared	$m\ s^{-2}$	
Force	f	newton	N	**F = ma**
Momentum	ρ		$kg\ m\ s^{-1}$	**ρ = mv**
Pressure	p	pascal	Pa	**p = F/a**
Moment of a force		newton metre	N m	
Torque (couple)	T	newton metre	N m	**T = F x d**
Energy	E / Q / W	joule	J	
Work	W	joule	J	**W = F s**
Power	P	watt	W	**P = W/t**
Angle	θ (“theta”)	radian	rad	
Angular velocity	ω (“omega”)	radian per second	rad/sec	**ω = θ/t**

Heat and Temperature

Quantity		**Symbol**		**Unit**		**Symbol**		**Equation**
Heat Capacity		C		joule per kelvin		J/K		**$Q = c\ (\triangle\theta)$**
Specific Heat Capacity		c				J/kg/K		**$Q = mc\triangle\theta$**
Latent Heat		l		joule per kilogram		J/kg		**$Q = ml$**

Waves, Sound and Light

Quantity		**Symbol**		**Unit**		**Symbol**		**Equation**
Frequency		f		hertz		Hz		
Wavelength		λ (“lamda”)		metres		m		
Velocity		v (or c for light)		metre per second		m/s		**$v = f\lambda$**
Intensity		I		watts per metre squared		W/m^2		**S.I. = P/A**
Sound Intensity Level				decibels		dB		

Electricity

Quantity	Symbol	Unit	Symbol	Equation
Charge	Q	coulomb	C	
Electric Field Strength	E	newtons per coulomb	N/C	**E = F/Q**
Potential Difference ("voltage")	V	volts	V	**W = V Q**
Capacitance	C	farads	F	**C = Q/V**
Current	I	amperes (amps)	A	**I = Q/t**
Power	P	watt	W	**P = VI**
Resistance	R	ohm	Ω	R = V/I
Resistivity	ρ	ohm-metre	Ω m	**ρ = RA /l**
Magnetic Flux Density	B	tesla	T	**F = BIL**
Magnetic Flux	ϕ Psi ("sigh")	weber	W	**ϕ = BA**
Half-Life	$T_{1/2}$	second		**$T_{1/2}$ = 0.693/λ**

EQUATIONS

Many of the maths questions on the Leaving Cert Physics paper rely on you being able to quickly recall short equations.
And yes I know that these are all in the new log tables, but if you are looking for an *A* or *B* grade then you don't have time to go searching.
The variables have deliberately not been arranged in the order in which they would appear in the formula (because that would just be too easy).

To test yourself, cover the third column and see if you can come up with the relevant equation given the information in the second column.

If you come across any equations which I have omitted, please let me know and I will update the list.

Hangman takes on a new dimension if you can include equations by allowing spaces for division, power s(e.g. ^2) etc.

Mechanics

	Variables	Equation
Equations of Motion		$v = u + at$ $s = ut + ½ at^2$ $v^2 = u^2 + 2as$
Force, Mass and Momentum	acceleration, force, mass	$F = ma$
	weight , mass	$W = mg$
	velocity, mass, momentum	$\rho = mv$
Conservation of Momentum		$m_1 u_1 + m_2 u_2 = m_1 v_3 + m_2 v_4$
Pressure	area, pressure, force	$P = F/A$
	density, height, pressure	$P = \rho gh$
Boyle's Law		$P_1V_1= P_2V_2$
Newton's Law of Gravitation	gravitational force between two masses	$F_g = \frac{Gm_1m_2}{d^2}$
***g* at different heights**	acceleration due to gravity and distance above a planet	$g = GM/ d^2$
Moment of a force	distance, moment, force	Moment = Force x distance
Torque	force, distance, torque	T = F x d (between forces)
Work, Energy	force, work, displacement	$W = F s$
Kinetic Energy	velocity, mass energy	$E_k = ½ mv^2$
Potential Energy	height, mass, energy	$E_p = mgh$
Conservation of Energy		$mgh = ½ mv^2$
Power	time, power work	$P = W/t$

Percentage Efficiency		Power Out / Power In x 100/1
Circular Motion	time, angular velocity, theta	$\omega = \theta/t$
	linear velocity, angular velocity, radius	$v = r\omega$
	acceleration, angular velocity, radius,	$a = r\omega^2$
	linear velocity, radius, acceleration	$a = v^2/r$
	force, angular velocity, radius, mass	$F = mr\omega^2$
	mass, linear velocity, radius, force,	$F = mv^2/r$
	mass of planet, acceleration due to gravity, radius of satellite	$g = GM/R^2$
	mass of a planet, radius, periodic tiime	$T^2 = \frac{4\pi^2 R^3}{GM}$
Hooke's Law	extension, restoring force	$F = -k\ s$
S.H.M.	acceleration and displacement	$a = -\omega^2\ s$
	periodic time and angular velocity	$T = 2\pi/\omega$
	frequency and periodic time	$T = 1/f$
Simple Pendulum		$T = 2\pi \sqrt{l/g}$

Waves, Sound, Light

Mirrors	image distance, magnification, Object distance	$M = \frac{v}{u}$
	image height, magnification, object height	$M = \frac{image\_Hgt}{object\_Hgt}$
	image distance, magnification, object distance	$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$
Refraction		$\frac{Sin\_i}{Sin\_r} = consant$
	real and apparent depth	$\frac{real\_depth}{apparent\_depth} = \bigcap$
	reversing direction and critical angle	$x \bigcap y = \frac{1}{y \bigcap x}$
	refractive index and speeds	$\frac{C1}{C2} = \bigcap$
	refractive index and critical angle	$\bigcap = \frac{1}{SinC}$
Lenses	image distance, mag, object distance	$M = \frac{v}{u}$
	image height, mag, object height	$M = \frac{image\_Hgt}{object\_Hgt}$
	image distance, magnification, object distance	$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$
	power, focal length	$P = \frac{1}{f}$
	Addition of powers	$P_{Total} = P_1 + P_2$
Waves	Wavelength, velocity, frequency	$v = f \lambda$
Doppler Effect		$f' = \frac{fc}{c \pm u}$
	Area, Power, S Intensity	S.I. = Power / Area
	Tension, Frequency, Length	$f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$
Wavelength of light		$n\lambda = d \sin \theta$
Diffraction Grating Formula	Distance between slits on a diffraction grating	$d = 1/n$

Electricity

	Variables	Equation
Static Electricity	Coulomb's Law	F = $\frac{1}{4\pi\varepsilon}\ \frac{Q_1Q_2}{d^2}$
	Relative Permittivity	$\varepsilon = \varepsilon_r\ \varepsilon_o$
	Electric Field Intensity	E = F/Q
	Electric Field Strength	F = $\frac{Q}{4\pi\varepsilon\_d^2}$
Potential Difference	Charge, Voltage, Work	W = QV
Capacitance	Charge, Potential difference, Capacitance	C= Q/V
	Area, Capacitance Distance	C = εA/d
	Work/energy, Voltage Capacitance	W = ½ CV^2
	Current, Charge, Time	I = Q/t Q = It
	Power, Current, Voltage	P = VI
Ohm's Law		$R = \frac{V}{I}$ V = IR
	Resistivity	R = ρl/A
	Wheatstone Bridge	$\frac{R_1}{R_2} = \frac{R_3}{R_4}$
	Current, Time Energy, Resistance,	Heat = I^2Rt
Joule's Law	Current, Power, Res	Power = I^2R
	Current, Length, Force, Mag field density	F = BIL
	Force, Charge, velocity, Mag field density,	F = Bqv
	Magnetic Flux Density, Area, Magnetic Flux	$\phi = BA$
	Induced emf	E = - N (dϕ/dt)
	V_{rms}, Maximum voltage	$V_{rms} = V_{max}/(\sqrt{2})$
	I_{rms}, Maximum current	$I_{rms} = I_{max}/(\sqrt{2})$
Transformer		$\frac{Vi}{Vo} = \frac{Np}{Ns}$

Modern Physics

	Variables	Equation	Year
Force on an electron		$mv^2/r = Bev$	
	Potential energy and Kinetic energy of electron	$eV = ½ mv^2$	
Photoelectric Effect		$hf = \phi + ½mv^2$	
	Frequency, Energy of a photon	$E = hf$	
	Wavelength, Energy of a photon	$E = hc/\lambda$	
	Decay rate, Decay constant Number of atoms	$dn/dt = \lambda N$	
	Half life, Decay constant	$T_{1/2} = 0.693/\lambda$	
	Energy, Mass	$E = mc^2$	
		$H_1^1 + Li_3^7 \rightarrow He_2^4 + He_2^4$ + K.E.	
Pair Production		γ rays $\rightarrow e^- + e^+$ + K.E.	
Particle Annihilation		$e^- + e^+ \rightarrow 2\gamma$ + K.E.	

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**
4. **Relationship between Periodic Time and Radius for a Satellite in Orbit:** $T^2 = \frac{4\pi^2 R^3}{GM}$
5. **Show that any object that obeys Hooke's Law will also execute SHM**
6. **nλ = d Sin θ**
7. **Resistors in series and in parallel**
8. **F = Bqv**

Three Equations of Motion

v = u + at

$$a = \frac{v-u}{t} \quad \Rightarrow \quad v = u + at$$

s = ut + ½ at²

$V_{average} = \frac{u+v}{2}$ But v = u + at $\Rightarrow$ $V_{average} = \frac{u+u+at}{2}$

$V_{average} = \frac{displacement(s)}{time(t)}$ $\Rightarrow$ $s = V_{average}(t)$ $\Rightarrow$ $s = \frac{u+u+at}{2}(t)$

$\Rightarrow$ $s = ut + \frac{1}{2}at^2$

v² = u² + 2as

v = u + at $\Rightarrow$ $v^2 = u^2 + 2uat + (at)^2$ {multiply out both sides}

We can rewrite this as $v^2 = u^2 + 2a(ut + \frac{1}{2}at^2)$ {because $2a(ut + \frac{1}{2}at^2) = 2uat + (at)^2$}

Now sub in $s = ut + \frac{1}{2}at^2$ $\Rightarrow$ $v^2 = u^2 + 2as$

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 $\propto$ rate of change of momentum

$$F \propto (mv - mu)/t$$

$$F \propto m(v-u)/t$$

$$F \propto ma$$

$$F = k\,(ma)$$

$$F = ma$$

v = r ω

We define θ (in radians) as s/r: $\theta = \frac{s}{r}$

Divide both sides by t: $\frac{\theta}{t} = \frac{s}{tr}$

But $\omega = \theta/t$ and $v = s/t$: $\omega = \frac{v}{r}$

Cross-multiply to get: $v = r\omega$

$$T^2 = \frac{4\pi^2 R^3}{GM}$$

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: $F_g = \frac{Gm_1m_2}{d^2}$
2. The second is the *Centripetal Force* formula: $F_c = \frac{mv^2}{r}$
3. Equate both forces (because both equations apply to satellite motion)
4. Cancel one 'm' from both sides
5. Replace the d^2 in the first formula with r^2 and cancel one 'r' both sides
6. You now have $\frac{GM}{R} = v^2$ *Equation (1)*

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

7. Now v = velocity = Distance/Time.
8. Distance in this case is the circumference of a circle (2πR for circular satellite orbits)
9. $\Rightarrow$ $v = \frac{2\pi R}{T}$ $\Rightarrow$ $v^2 = \frac{4\pi^2 R^2}{T^2}$ *Equation (2)*

Equating Equations (1) and (2) we get $T^2 = \frac{4\pi^2 R^3}{GM}$

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.

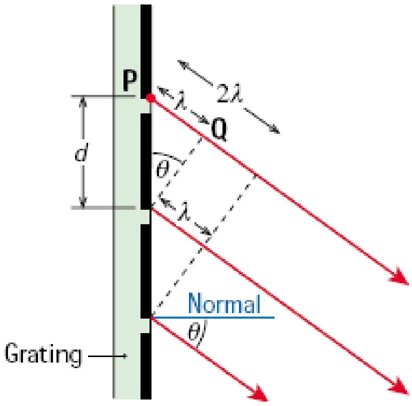
So we start with the equation for Hooke's Law; $F \propto -s$ $\Rightarrow$ $F = -k\,s$

But F = ma $\Rightarrow$ $ma = -k\,s$

Now divide both sides by m $\Rightarrow$ $a = -\frac{k}{m} s$

This is equivalent to the equation for S.H.M. where the constant ω^2 in this case is k/m.

$n\lambda = d \sin\theta$



From the diagram we can see that:

(i) For constructive interference to occur, the extra path length that the top ray travels must be an integer number of wavelengths (**$n\lambda$**) {Eqn (1)}

(ii) Using trigonometry, this extra path length is equal to **$d \sin\theta$,** where d is the slit width {Eqn (2)}

Equating (1) and (2) gives us **$n\lambda = d \sin\theta$**

Resistors in series and in parallel

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

Resistors in Series*

$R_{Total} = R_1 + R_2$

Derivation:

For resistors in series $V_{Total} = V_1 + V_2$

But $V = IR$ (Ohm's Law)

$\Rightarrow$ $I R_{Total} = I R_1 + I R_2$ (We can now cancel the I's because the current is the same for resistors in series)

$\Rightarrow$ $R_{Total} = R_1 + R_2$

Resistors in Parallel*

$$\frac{1}{R_{Total}} = \frac{1}{R_1} + \frac{1}{R_2}$$

Derivation:

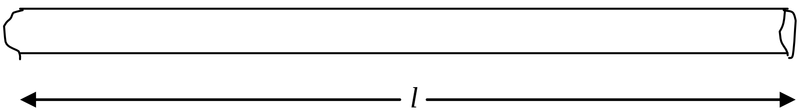
For resistors in parallel $I_{Total} = I_1 + I_2$

But $I = V/R$ (Ohm's Law)

$\Rightarrow$ $V/R_T = V/R_1 + V/R_2$ (But we can cancel the V's because the voltage is the same for resistors in parallel)

$\Rightarrow$ $1/R_{Total} = 1/R_1 + 1/R_2$

$F = Bqv$



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 (**QuIT**?) where t is 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

$$F = B \times q/t \times vt$$

i.e. $F = Bqv$