The external assessment

You will be assessed on two papers that contribute 80% of your final grade (the other 20% comes from Internal Assessment). You are allowed a calculator on both papers.

	SL	HL
Paper 1	1 hour 30 minutes Part A: 25 multiple choice questions Part B: Data-based questions Weight: 36%	2 hours Part A: 40 multiple choice questions Part B: Data-based questions Weight: 36%
Paper 2	1 hour 30 minutes Short and long questions Weight: 44%	2 hours 30 minutes Short and long questions Weight: 44%
IA	Weight: 20%	Weight: 20%

Paper 1

Part A: Multiple choice questions

- It is important to read the question carefully! Some questions are complex. They use scientific and everyday terminology that may be similar or that has more than one meaning. Make sure you have understood the relevant meaning of all the words in the question.
- Often, most (or all) of the four options may be correct statements. Choose the option that answers the question and **not** one that is merely a correct statement. For example, when compressing a gas, the molecules collide more frequently with each other, but that does not explain *why* the pressure goes up.
- Do not spend too much time on any one question. Remember that these are supposed to be questions that you can answer quickly. Long algebraic or arithmetical calculations are unnecessary in this paper, and if you cannot get the answer quickly, the chances are you will not get it even if you spend a long time on the question.
- If you cannot choose the correct answer, see if you can eliminate options that are clearly wrong.
- Sometimes you can choose the correct answer just by checking the units of the answer. For example, if you are asked for a force, your chosen answer must have units of force.
- Guess the answer as a last resort.

Multiple choice questions include lots of 'ratio problems'. You should master ways to solve them. Typical examples include:

A particle starts from rest with constant acceleration. After travelling a distance d, its speed is v. What is its speed after travelling an additional distance d?

The formula giving speed in terms of distance is $v^2 = 2ad$, that is, $v = \sqrt{2ad}$. We need to find v when $d \to 2d$. Then $v' = \sqrt{2a2d} = \sqrt{2} \times \sqrt{2ad} = \sqrt{2} \times v$.

The force between two point masses is F. The separation is doubled. What is the new force?

The formula giving force is $F = \frac{Gm_1m_2}{r^2}$. Here $r \to 2r$, which means that $r^2 \to 4r^2$.
So, $F' = \frac{Gm_1m_2}{4r^2} = \frac{1}{4}\frac{Gm_1m_2}{r^2} = \frac{F}{4}$.

The length and radius of a wire are both doubled. What happens to the resistance of the wire?

The formula giving resistance is $R = \rho\frac{L}{A}$. Here $L \to 2L$; $r \to 2r$, which means that $A \to 4A$ (since $A = \pi r^2$).
So, the new resistance is $R' = \rho\frac{2L}{4A} = \frac{1}{2}\rho\frac{L}{A} = \frac{R}{2}$.

Two identical resistors are connected in series to a cell of negligible internal resistance. The power dissipated in the circuit is P. What is the power dissipated when the two resistors are connected in parallel?

The question asks for power. Write a formula for power in the first circuit: $P = \frac{E^2}{2R}$, since the total resistance is $2R$. Now go to the second circuit, write a formula for the new power, and try to relate it to the old power:
$P' = \frac{E^2}{\frac{R}{2}} = 2 \times \frac{E^2}{R} = 4 \times \frac{E^2}{2R} = 4P$.

A source of sound produces waves of amplitude A. The intensity a distance d away is 9 mW m^{-2}. The amplitude is tripled. How far away should an observer be placed so that they hear the same intensity?

You must know that intensity is $I \propto \frac{A^2}{d^2}$. Here $A \to 3A$ so that $A^2 \to 9A^2$, so for intensity to stay the same we need $d^2 \to 9d^2$. This means $d \to 3d$.

Part B: Data-based questions

- Remember that a 'line' of best fit is not necessarily a straight line.
- If you need to find the gradient of a straight line, draw the biggest triangle possible.

Paper 2

- Read the questions carefully and answer what is being asked. Perfect answers to questions that are not being asked do not gain you any marks.
- Pay attention to the command terms (described later). This determines the amount of detail required in the answer. If the question says 'state', a simple sentence will do without any explanation. An essay-type answer is not required. If the question says 'explain' or 'discuss', a lot of detail is required. Feel free to answer the question in your own way and in your own words. But do not overdo it by including extra and irrelevant information. The examiner may (but most likely will not) deduct points if you say something that is incorrect or contradictory to things mentioned elsewhere.
- You will save time by not repeating the question in your answer.
- Pay attention to the number of lines allotted to each question; this also gives a good indication of how much is expected in your answer.
- Watch your significant figures; round numbers at the end and not in the intermediate stages of a calculation.
- Do not forget to include units for your final answer.
- Know your calculator well. The examination room is not the place to learn how to use a calculator.
- Know the definitions of key terms well. If you have to use an equation instead of a definition, do so, but remember to define all the symbols appearing in the equation.
- Pay special attention to the axes of graphs. Often, the units for a quantity are expressed with a power of 10. So, if the x co-ordinate of a point is 2.0 but the axis is labeled / × 10^{-3} m, the value you use is $x = 2.0 \times 10^{-3}$ m.
- You may be used to solving numerical questions by using the NSolve facility of your calculator. Let the examiner know that you have done so, and write down the equation you put into NSolve for the examiner to see. Using NSolve can be difficult: make sure you are confident that you know how it works.

Command terms for physics

In examinations, questions begin with specific terms known as command terms. These command terms dictate the amount and type of detail required in the answers.The number of marks allocated to each question or question part indicate how many separate points you have to make to answer fully answer.

Assessment objective 1

Command term	Definition
Draw	Represent by means of a labelled, accurate diagram or graph, using a pencil. Use a straight-edged ruler for straight lines. Draw diagrams to scale. Correctly plot points on graphs (if appropriate) and join them in a straight line or smooth curve. Draw the forces on the body. • arrows to represent correct direction of forces • length of arrows to indicate relative magnitude of forces • correct labeling of nature of each force.
State	Give a specific name, value or other brief answer without explanation or calculation. State what is meant by binding energy. • mentions definition of binding energy.

Assessment objective 2

Command term	Definition
Annotate	Add brief notes to a diagram or graph. Annotate the diagram to show the position of nodes and antinodes.
Calculate	Obtain a numerical answer showing the relevant stages in the working. Calculate the tension force at position X.
Describe	Give a detailed account. Describe how the spectrum of a black body may be used to find its temperature. • mentions peak wavelength • mentions Wien's law.
Estimate	Obtain an approximate value. Estimate the time our sun will spend on the main sequence. • uses energy released per fusion reaction • finds number of reactions needed to produce given luminosity • calculates time to use up a certain fraction of the mass.

Command term	Definition
Identify	Select from a number of possibilities. Identify the main factor determining the evolution of a star.
Outline	Give a brief descriptive summary of a sequence of processes without going into details. Outline the evolutionary stages of a star of one solar mass. • leaves main sequence when hydrogen is exhausted • moves to red giant phase • explodes as a planetary nebula • core forms a white dwarf.

Assessment objective 3

Command term	Definition
Analyse	Produce a method that will enable correct conclusions to be drawn from an experiment or observations. Analyse the data in the table in order to find the value of the elementary charge. • explain why we must look for common divisors of the data • explain how choice of least common divisor is made.
Deduce	Reach a conclusion from the available evidence. Deduce that the separation of the stars will decrease. • uses the formula for total energy • realizes that the energy will get more negative • deduces the separation must decrease.
Determine	Obtain the only possible answer. Determine the period of oscillations from graph of acceleration versus displacement. • recognize gradient as $-\omega^2$ • find gradient using large triangle • get period from ω.
Discuss	Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Present opinions or conclusions clearly and support them with appropriate evidence. Discuss how Young's two-slit experiment provides support to the idea that light is a wave. • fringes imply constructive and destructive interference • this cannot be explained in terms of material particles • interference is a wave phenomenon.

Command term	Definition
Explain	Give a detailed account based on the laws of physics in order to understand a particular phenomenon or observation. Explain why the intensity of sound at P will be a maximum. • mentions interference • mentions path difference • condition for a maximum.
Predict	Calculate the numerical outcome of an experiment or argue to a conclusion of what the outcome might be. Predict the mass of lead that will be formed in the alpha decay of polonium-210 after 2 minutes. • number of decays in 2 minutes using radioactive law • mass of a lead atom • multiplication to get answer.
Show	Step-by-step process in which parts of a calculation or derivation are clearly evident and are connected. Show that the maximum horizontal distance R travelled by a projectile is given by $R = \frac{2v^2 \sin\theta \cos\theta}{g}$. • time of travel • formula for horizontal distance • manipulation to get answer.
Suggest	Produce a series of arguments pointing to the explanation of a phenomenon or observation, model, theory or hypothesis. Suggest why large stable nuclei have more neutrons than protons. • mentions forces acting in a nucleus • mentions the effect of the forces on binding • mentions range of the forces • need to dilute the protons.