Learner Guide

Cambridge International AS & A Level

Cambridge International AS & A Level Mathematics

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How to use this guide

This guide describes what you need to know about your Cambridge International AS and A Level Mathematics examination.

It will help you plan your revision programme and it will explain what we are looking for in your answers. It can also be used to help you revise, by using the topic lists in Section 4 to check what you know and which topic areas you have covered.

The guide contains the following sections.

Section 1: How will you be tested?

This section will give you information about the different examination papers that are available.

Section 2: Examination advice

This section gives you advice to help you do as well as you can. Some of the ideas are general advice and some are based on the common mistakes that learners make in exams.

Section 3: What will be tested?

This section describes the areas of knowledge, understanding and skills that you will be tested on.

Section 4: What you need to know

This section shows the syllabus content in a simple way so that you can check:

- what you need to know about each topic;
- how much of the syllabus you have covered.

Not all the information in this checklist will be relevant to you.

You will need to select what you need to know in Sections 1, 2 and 4 by finding out from your teacher which examination papers you are taking.

Section 5: Useful websites

Section 1: How will you be tested?

About the examination papers

This syllabus is made up of seven units: three of them are Pure Mathematics units (P1, P2 and P3), two are Mechanics units (M1 and M2) and two are Probability and Statistics units (S1 and S2). Each unit has its own examination paper.

You need to take two units for the Cambridge International AS Level qualification or four units for the full Cambridge International A Level qualification. The table below shows which units are compulsory and which are optional, and shows also the weighting of each unit towards the overall qualification.

You will need to check with your teacher which units you will be taking.

Certification title	Compulsory units	Optional units
Cambridge International AS Level Mathematics	P1 (60%)	P2 (40%) or M1 (40%) or S1 (40%)
Cambridge International A Level Mathematics	P1 (30%) and P3 (30%)	M1 (20%) and S1 (20%) or M1 (20%) and M2 (20%) or S1 (20%) and S2 (20%)

The following combinations of units are possible.

AS Level

- P1 and P2
- P1 and M1
- P1 and S1

A Level

- P1, P3, M1 and S1
- P1, P3, M1 and M2
- P1, P3, S1 and S2

If you are taking the full A Level qualification, you can take the examination papers for all four units in one session, or alternatively you can take two of them (P1 and M1 or P1 and S1) at an earlier session for an AS qualification and then take your other two units later.

The AS Level combination of units P1 and P2 **cannot** be used as the first half of a full A Level qualification, so you should not be taking P2 if you intend to do the full Cambridge International A Level Mathematics qualification.

About the papers

Once you have checked with your teacher which units you are doing you can use the table below to find basic information about each unit.

All units are assessed by a written examination, externally set and marked. You must answer all questions and all relevant working must be clearly shown. Each paper will contain both shorter and longer questions, with the questions being arranged approximately in order of increasing mark allocation (i.e. questions with smaller numbers of marks will come earlier in the paper and those with larger numbers of marks will come later in the paper.)

Units P1 and P3 will contain about 10 questions and the other units about 7 questions.

Component	Unit name	Total marks	Duration	Qualification use
Paper 1	P1 Pure Mathematics 1	75	1 hour 45 mins	AS Level Mathematics A Level Mathematics
Paper 2	P2 Pure Mathematics 2	50	1 hour 15 mins	AS Level Mathematics
Paper 3	P3 Pure Mathematics 3	75	1 hour 45 mins	A Level Mathematics
Paper 4	M1 Mechanics 1	50	1 hour 15 mins	AS Level Mathematics A Level Mathematics
Paper 5	M2 Mechanics 2	50	1 hour 15 mins	A Level Mathematics
Paper 6	S1 Probability and Statistics 1	50	1 hour 15 mins	AS Level Mathematics A Level Mathematics
Paper 7	S2 Probability and Statistics 2	50	1 hour 15 mins	A Level Mathematics

Section 2: Examination advice

How to use this advice

This section highlights some common mistakes made by learners. They are collected under various subheadings to help you when you revise a particular topic or area.

General advice

- You should give numerical answers correct to three significant figures in questions where no accuracy is specified, except for angles in degrees when one decimal place accuracy is required.
- To achieve three-figure accuracy in your **answer** you will have to work with at least *four* figures in your working throughout the question. For a calculation with several stages, it is usually best to use all the figures that your calculator shows; however you do not need to write all these figures down in your working.
- Giving too many significant figures in an answer is not usually penalised. However, if the question *does* specify an accuracy level then you must keep to it for your final answer, and giving too many significant figures here *will* be penalised.
- There are some questions which ask for answers in exact form. In these questions you must *not* use your calculator to evaluate answers. Exact answers may include fractions, square roots and constants such as p, for example, and you should give them in as simple a form as possible.
- You are expected to use a scientific calculator in all examination papers. Computers, graphical calculators and calculators capable of algebraic manipulation are not permitted.
- Make sure you check that your calculator is in degree mode for questions that have angles in degrees, and in radian mode when you require or are given angles in radians.
- You should always show your working, as marks are usually awarded for using a correct method even if you make a mistake somewhere.
- It is particularly important to show **all** your working in a question where there is a given answer. Marks will not be gained if the examiner is not convinced of the steps in your working out.
- Read questions carefully. Misreading a question can cost you marks.
- Write clearly. Make sure all numbers are clear, for example make sure your '1's don't look like '7's.
- If you need to change a word or a number, or even a sign (+ to – for example) it is best to cross out and re-write it. Don't try to write over the top of your previous work. If your alteration is not clear you will not get the marks.
- When an answer is given (i.e. the question says 'show that…'), it is often because the answer is needed in the next part of the question. So a given answer may mean that you can carry on with a question even if you haven't been able to obtain the answer yourself. When you need to use a given answer in a later part of a question, you should **always** use the result exactly as given in the question, even if you have obtained a different answer yourself. You should **never** continue with your own wrong answer, as this will lead to a further loss of marks.
- Make sure you are familiar with all the standard mathematical notation that is expected for this syllabus. Your teacher will be able to advise you on what is expected.

- Although there is no choice of questions in any of the Cambridge International AS and A Level papers, you do not have to answer the questions in the order they are printed in the question paper. You don't want to spend time struggling on one question and then not have time for a question that you could have done and gained marks for.
- Check the number of marks for each question/part question. This gives an indication of how long you should be spending. Part questions with only one or two marks should not involve you doing complicated calculations or writing long explanations. You don't want to spend too long on some questions and then run out of time at the end. A rough guide is that a rate of 'a mark a minute' would leave you a good amount of time at the end for checking your work and for trying to complete any parts of questions that you hadn't been able to do at first.
- As long as you are not running out of time, don't 'give up' on a question just because your working or answers are starting to look wrong. There are always marks available for the method used. So even if you have made a mistake somewhere you could still gain method marks.
- Don't cross out anything until you have replaced it – even if you know it's not correct there may still be method marks to gain.
- There are no marks available for just stating a method or a formula. The method has to be applied to the particular question, or the formula used by substituting values in.
- Always look to see if your answer is 'reasonable'. For example if you had a probability answer of 1.2, you would know that you had made a mistake and you would need to go back and check your solution.
- Make sure that you have answered everything that a question asks. Sometimes one sentence asks two things (e.g. 'Show that … and hence find …') and it is easy to concentrate only on the first request and forget about the second one.
- Check the formula book before the examination. You must be aware which formulas are given and which ones you will need to learn.
- Make sure you practise lots of past examination papers so that you know the format and the type of questions. You could also time yourself when doing them so that you can judge how quickly you will need to work in the actual examination.
- Presentation of your work is important – don't present your solutions in the examination in double column format.
- Make sure you know the difference between three significant figures and three decimal places, and make sure you round answers rather than truncate them.

Advice for P1, P2 and P3

- Make sure you know all the formulas that you need (even ones from Cambridge IGCSE). If you use an incorrect formula you will score no marks.
- Check to see if your answer is required in exact form. If this is the case in a trigonometry question exact values of sin 60°, etc. will need to be used.
- Make sure you know the exact form for sin 60°, etc. They are not in the formula booklet.

Additional advice for P2 and P3

- Calculus questions involving trigonometric functions use values in radians, so make sure your calculator is in the correct mode if you need to use it.

Advice for M1 and M2

- When using a numerical value for '*g*' you must use $10\,\text{m}\,\text{s}^{-2}$ (unless the question states otherwise).
- Always draw clear force diagrams when appropriate, whether the question asks for them or not.
- Make sure you are familiar with common words and phrases such as 'initial', 'resultant', and know the difference between 'mass' and 'weight'. Go through some past examination papers and highlight common words and phrases. Make sure you know what they mean.

Advice for S1 and S2

- Questions that ask for probabilities must have answers between 0 and 1. If you get an answer greater than 1 for a probability you should check your working to try to find the mistake.
- Answers for probabilities can often be given as either fractions or decimals. For answers in decimal form, it is important that you know the difference between three significant figures and three decimal places. For example 0.03456 to three significant figures is 0.0346, but to three decimal places is 0.035. A final answer of 0.035 would not score the accuracy mark as it is not correct to the level of accuracy required.
- Sometimes you may be asked to answer 'in the context of the question'. This means that you cannot just give a 'textbook' definition that could apply to any situation; your answer must relate to the situation given in the question. So, for example, you should not just say 'The events must be independent', but 'The scores when the die is thrown must be independent' or 'The times taken by the people must be independent of each other' or whatever it is that the question is about.
- When answering a question about a normal distribution, it is useful to draw a diagram. This can prevent you from making an error; e.g. if you are finding a probability, a diagram will indicate whether your answer should be greater than or less than 0.5.

Additional advice for S2

- When carrying out a hypothesis test, you should always state the conclusion in the context of the question. You should not state conclusions in a way that implies that a hypothesis test has *proved* something; e.g. it is better to say 'There is evidence that the mean weight of the fruit has increased' than 'The test shows that the mean weight of the fruit has increased'.
- When calculating a confidence interval, it may not always be sensible to apply the usual 'three significant figure' rule about accuracy. For example, if an interval for a population mean turns out to be (99.974, 100.316), it makes no sense to round each end to 100, and you should give two or three decimal places in a case like this, so that the *width* of the interval is shown with reasonable accuracy.

Section 3: What will be tested?

The full syllabus, which your teacher will have, says that the assessment covers ‘technique with application’.

This means that you will be tested both on your knowledge of all the mathematical topics, methods, etc. that are set out in the syllabus content, and also on your ability to apply your knowledge in solving problems.

The syllabus also lists five ‘assessment objectives’ that set out the kinds of thing that examination questions will be designed to test.

These assessment objectives indicate that:

- you need to be familiar with all the usual notation and terminology used in your units, as well understanding the mathematical ideas
- you need to work accurately, e.g. in solving equations, etc.
- you may have to decide for yourself how to go about solving a problem, without being told exactly what procedures you need to use
- you may need to use more than one aspect of your knowledge to solve a problem
- your work needs to be clearly and logically set out.

You should ask your teacher if you require more detailed information on this section.

Section 4: What you need to know

This section has a table for each of the seven units. Each table lists the things you may be tested on in the examination for that unit.

How to use the table

You can use the table throughout your mathematics course to check the topic areas you have covered.

You can also use it as a revision aid. You can go through the list at various stages in the course, and put:

- a RED dot against a topic if you are really unsure
- an ORANGE dot if you are fairly sure of the topic, but need some further practice
- a GREEN dot if you are fully confident.

As you progress through the course and prepare for the examination you should be giving yourself more and more green dots!

Remember that we are looking for you to **know** certain skills and facts **and** to be able to **apply** these in different situations.

It is therefore important to learn the facts and practise the skills first, in isolation; but then you need to find more complex questions that use the skills you are learning, so that you can practise applying what you have learnt to solving problems. Working through past examination papers is invaluable here.

You will see that the syllabus has been divided into 'skills', 'knowledge', and 'application'. However, you should remember that each skill and knowledge item could be tested in questions requiring use of that particular skill or knowledge in a situation that may not be specifically mentioned here.

Pure Mathematics 1: Unit P1

Topic	Skill	Knowledge	Application	Checklist
Quadratics	Complete the square Find discriminant Solve quadratic equations Solve linear and quadratic inequalities Solve by substitution a pair of simultaneous equations one linear and one quadratic		Locate vertex of graph Sketch graph of quadratic Use in connection with the number of real roots Recognise and solve equations that can be put into quadratic form Solve problems, e.g. involving the intersection of a line and a curve	
Functions	Find range of a given function Find fg(x) for given f and g Identify one-one functions Find inverse of one-one function	Understand terms: function, domain and range one-one function, inverse function composition of functions Understand how the graphs of a one-one function and its inverse are related	Sketch graphs of a one-one function and its inverse Restrict a domain to ensure that a function is one-one	
Coordinate geometry	Given end points of a line: find the length find the gradient find the mid-point Find equation of a line, e.g. using 2 points on it, or 1 point and the gradient	Gradients of parallel lines are equal Perpendicular gradients: $m_1m_2 = -1$ Know the forms $y = mx + c$ and $y - y_1 = m(x - x_1)$ Understand the relationship between a graph and its equation	Use these relationships in solving problems Interpret and use linear equations Solve problems that relate points of intersection of graphs to solution of equations (including the correspondence between a line being a tangent to curve and an equation having a repeated root)	

Pure Mathematics 1: Unit P1

Topic	Skill	Knowledge	Application	Checklist
Circular measure	Convert between radians and degrees Use formulae $s = r\theta$ and $A = \frac{1}{2}r^2\theta$ to calculate arc length and sector area	Definition of a radian	Solve problems involving arc lengths and areas of sectors and segments	
Trigonometry	Sketch and recognise graphs of the sine, cosine and tangent functions (angles of any size, degrees or radians) Solve trig equations giving all solutions in specified interval	Know exact values for sin, cos, tan of 30°, 45°, 60° Understand notation $\sin^{-1}x$, $\cos^{-1}x$, $\tan^{-1}x$ as denoting principal values Identities: $\frac{\sin\theta}{\cos\theta} = \tan\theta$ $\sin^2\theta + \cos^2\theta = 1$	Use trigonometric graphs Use exact values of related angles e.g. cos 150° Use these identities, e.g. to prove other identities or to solve equations	
Vectors	Add and subtract vectors, and multiply a vector by a scalar Find magnitude of a vector and the scalar product of two vectors	Standard vector notations Meaning of terms: unit vector displacement vector position vector	Geometrical interpretation Use scalar products to find angles and to solve problems involving perpendicular lines	
Series	Expand $(a + b)^n$ for positive integer n Find: nth term of AP sum of AP nth term GP sum of GP sum to infinity of convergent GP	Notation $n!$ and $\binom{n}{r}$ Recognise arithmetic progressions and geometric progressions Condition for convergence of geometric progression	Use arithmetic progression and/or geometric progression formulae in solving problems	

Pure Mathematics 1: Unit P1

Topic	Skill	Knowledge	Application	Checklist
Differentiation	Differentiate x^n for rational n, together with constant multiples, sums and differences of functions Use the chain rule on composite functions Find stationary points and identify maximum/minimum	Understand gradient of a curve Notation $\frac{dy}{dx}, \frac{d^2y}{dx^2}, f'(x), f''(x)$	Apply differentiation to: gradients tangents and normals increasing/decreasing functions connected rates of change Use information about stationary points to sketch graphs	
Integration	Integrate $(ax + b)^n$ (rational $n \neq -1$) together with constant multiples, sums and differences. Evaluate definite integrals	Integration as reverse differentiation	Use integration to solve problems involving finding a constant of integration Solve problems involving: area under a curve area between two curves volume of revolution about one of the axes	

Pure Mathematics 2: Unit P2

Topic	Skill	Knowledge	Application	Checklist
Assumed knowledge		Content of unit P1 is assumed, and may be required in solving problems on P2 topics		
Algebra	Solve modulus equations and inequalities, including use of: $\lvert a\rvert = \lvert b\rvert \Leftrightarrow a^2 = b^2$ $\lvert x - a\rvert < b \Leftrightarrow a - b < x < a + b$ Carry out algebraic polynomial division	Meaning of $\lvert x\rvert$ Meaning of quotient and remainder Factor and remainder theorems	Use of theorems in finding factors, solving polynomial equations, finding unknown coefficients etc.	
Logarithmic and exponential functions	Solve equations of form $a^x = b$ and corresponding inequalities	Relationship between logarithms and indices Laws of logarithms Definition and properties of e^x and $\ln x$	Use of laws, e.g. in solving equations Use graphs of e^x and $\ln x$ Transformation to linear form, and use of gradient and intercept	

Pure Mathematics 2: Unit P2

Topic	Skill	Knowledge	Application	Checklist
Trigonometry		The sec, cosec and cot functions and their relationship to cos, sin and tan Identities: $\sec^2 \theta = 1 + \tan^2 \theta$ $\operatorname{cosec}^2 \theta = 1 + \cot^2 \theta$ Expansions of: $\sin(A \pm B)$ $\cos(A \pm B)$ $\tan(A \pm B)$ Formulae for: $\sin 2A$ $\cos 2A$ $\tan 2A$	Use properties and graphs of all six trig functions for angles of any magnitude Use of these in evaluating and simplifying expressions, and in solving equations, including expressing $a \sin \theta + b \cos \theta$ in the forms $R \sin(\theta \pm \alpha)$ and $R \cos(\theta \pm \alpha)$	
Differentiation	Differentiate e^x and ln x, sin x, cos x and tan x, together with constant multiples, sums, differences and composites Differentiate products and quotients Parametric differentiation Implicit differentiation		Applications of differentiation include all those in unit P1	

Pure Mathematics 2: Unit P2

Topic	Skill	Knowledge	Application	Checklist
Integration	Integrate: • e^{ax+b} • $(ax+b)^{-1}$ • $\sin(ax+b)$ • $\cos(ax+b)$ • $\sec^2(ax+b)$ Trapezium rule		Carry out integrations using appropriate trig identities Applications of integration include all those in unit P1 Use of sketch graphs to identify over/under estimation	
Numerical solution of equations	Locate root graphically or by sign change Carry out iteration $x_{n+1} = F(x_n)$	Idea of sequence of approximations which converge to a root of an equation, and notation for this Understand relation between iterative formula and equation being solved	Find approximate roots to a given degree of accuracy	

Pure Mathematics 3: Unit P3

Topic	Skill	Knowledge	Application	Checklist
Assumed knowledge		Content of unit P1 is assumed, and may be required in solving problems on P3 topics		
Algebra	Solve modulus equations and inequalities, including use of: $\lvert a \rvert = \lvert b \rvert \Leftrightarrow a^2 = b^2$ $\lvert x - a \rvert < b \Leftrightarrow a - b < x < a + b$ Carry out algebraic polynomial division Find partial fractions	Meaning of $\lvert x \rvert$ Meaning of quotient and remainder Factor and remainder theorems Know appropriate forms of partial fractions for denominators: $(ax + b)(cx + d)(ex + f)$ $(ax + b)(cx + d)^2$ $(ax + b)(x^2 + c^2)$ Expansion of $(1 + x)^n$ for rational n and $\lvert x \rvert < 1$	Use of theorems in finding factors, solving polynomial equations, finding unknown coefficients etc Use of first few terms, e.g. for approximations Dealing with $(a + bx)^n$	
Logarithmic and exponential functions	Solve equations of form $a^x = b$ and corresponding inequalities	Relationship between logarithms and indices Laws of logarithms Definition and properties of e^x and $\ln x$	Use of laws, e.g. in solving equations Use graphs of e^x and $\ln x$ Transformation to linear form, and use of gradient and intercept	

Pure Mathematics 3: Unit P3

Topic	Skill	Knowledge	Application	Checklist
Trigonometry		The sec, cosec and cot functions and their relationship to cos, sin and tan Identities: $\sec^2\theta = 1 + \tan^2\theta$ $\operatorname{cosec}^2\theta = 1 + \cot^2\theta$ Expansions of: $\sin(A \pm B)$ $\cos(A \pm B)$ $\tan(A \pm B)$ Formulae for: $\sin 2A$ $\cos 2A$ $\tan 2A$	Use properties and graphs of all six trig functions for angles of any magnitude Use of these in evaluating and simplifying expressions, and in solving equations, including expressing $a\sin\theta + b\cos\theta$ in the forms $R\sin(\theta \pm \alpha)$ and $R\cos(\theta \pm \alpha)$	
Differentiation	Differentiate e^x and $\ln x$, $\sin x$, $\cos x$ and $\tan x$, together with constant multiples, sums, differences and composites Differentiate products and quotients Parametric differentiation Implicit differentiation		Applications of differentiation include all those in unit P1	

Pure Mathematics 3: Unit P3

Topic	Skill	Knowledge	Application	Checklist
Integration	Integrate: • e^{ax+b} • $(ax+b)^{-1}$ • $\sin(ax+b)$ • $\cos(ax+b)$ • $\sec^2(ax+b)$ Integrate by means of decomposition into partial fractions Recognise and integrate $\frac{k\mathrm{f}'(x)}{\mathrm{f}(x)}$ Integration by parts Integration by substitution Trapezium rule		Carry out integrations using: • appropriate trig identities • partial fractions Applications of integration include all those in unit P1 Use of sketch graphs to identify over/under estimation	
Numerical solution of equations	Locate root graphically or by sign change Carry out iteration $x_{n+1} = \mathrm{F}(x_n)$	Idea of sequence of approximations which converge to a root of an equation, and notation for this Understand relation between iterative formula and equation being solved	Find approximate roots to a given degree of accuracy	

Pure Mathematics 3: Unit P3

Topic	Skill	Knowledge	Application	Checklist
Vectors	Find: • the angle between two lines • the point of intersection of two lines when it exists • the vector equation of a line • the perpendicular distance from a point to a line Find: the equation of a plane the angle between two planes the perpendicular distance from a point to a plane	Understand $\mathbf{r} = \mathbf{a} + t\mathbf{b}$ as the equation of a straight line Understand $ax + by + cz = d$ and $(\mathbf{r} - \mathbf{a}).\mathbf{n} = 0$ as the equation of a plane	Determine whether two lines are parallel, intersect or are skew Use equations of lines and planes to solve problems, including: • finding the angle between a line and a plane • determining whether a line lies in a plane, is parallel to it, or intersects it • finding the point of intersection of a line and a plane when it exists • finding the line of intersection of two non-parallel planes	
Differential equations	Form a differential equation from information about a rate of change Solve a first order differential equation by separating variables	General and particular solutions	Use initial conditions and interpret solutions in context	
Complex numbers	Add, subtract, multiply and divide two complex numbers in cartesian form Multiply and divide two complex numbers in polar form Find the two square roots of a complex number Illustrate equations and inequalities as loci in an Argand diagram	Meaning of terms: real and imaginary parts modulus and argument conjugate cartesian and polar forms Argand diagram	Equality of complex numbers Roots in conjugate pairs Geometrical interpretation of conjugation, addition, subtraction, multiplication and division	

Mechanics 1: Unit M1

Topic	Skill	Knowledge	Application	Checklist
Trigonometry knowledge required		$\sin(90° - \theta) \equiv \cos\theta$ $\cos(90° - \theta) \equiv \sin\theta$ $\tan\theta \equiv \dfrac{\sin\theta}{\cos\theta}$ $\sin^2\theta + \cos^2\theta \equiv 1$		
Forces and equilibrium	Identify forces acting Find and use components and resultants Equilibrium of forces Use 'smooth' contact model	Forces as vectors Meaning of terms: contact force normal component frictional component limiting friction limiting equilibrium coefficient of friction smooth contact Newton's third law	Use conditions for equilibrium in problems involving finding forces, angles, etc. Limitations of 'smooth' contact model Use $F = \mu R$ and $F \leqslant \mu R$ as appropriate in solving problems involving friction Use this law in solving problems	

Mechanics 1: Unit M1

Topic	Skill	Knowledge	Application	Checklist
Kinematics of motion in a straight line	Sketch displacement-time and velocity-time graphs	Distance and speed as scalars, and displacement, velocity, acceleration as vectors (in one dimension) Velocity as rate of change of displacement, and acceleration as rate of change of velocity Formulae for motion with constant acceleration	Use of positive and negative directions for displacement, velocity and acceleration Interpret graphs and use in solving problems the facts that: area under *v-t* graph represents displacement gradient of *s-t* graph represents velocity gradient of *v-t* graph represents acceleration Use differentiation and integration to solve problems involving displacement, velocity and acceleration Use standard *SUVAT* formulae in problems involving motion in a straight line with constant acceleration	

Mechanics 1: Unit M1

Topic	Skill	Knowledge	Application	Checklist
Newton's laws of motion		Newton's second law Meaning of terms: mass weight	Use Newton's laws in problems involving motion in a straight line under constant forces Use the relationship between mass and weight Solve constant acceleration problems involving weight: • particle moving vertically • particle moving on an inclined plane • two particles connected by a light string passing over a smooth pulley	
Energy, work and power	Calculate work done by constant force	Concepts of gravitational potential energy and kinetic energy, and formulae mgh and $\frac{1}{2}mv^2$ Power as rate of working $P = Fv$	Solve problems involving the work-energy principle, and use conservation of energy where appropriate Use the relationship between power, force and velocity with Newton's second law to solve problems about acceleration etc.	

Mechanics 2: Unit M2

Topic	Skill	KnowledgwA	Application	Checklist
Assumed knowledge		Content of unit M1 is assumed, and may be required in solving problems on M2 topics		
Motion of a projectile	Use horizontal and vertical equations of motion Derive the cartesian equation of the trajectory	Constant acceleration model	Limitations of constant acceleration model Solve problems, e.g. finding: the velocity at a given point or instant the range the greatest height Use the trajectory equation to solve problems, including finding the initial velocity and angle of projection	
Equilibrium of a rigid body	Locate centre of mass of a single uniform body: using symmetry using data from formula list Calculate the moment of a force Locate centre of mass of a composite body using moments	Concept of centre of mass Conditions for equilibrium	Solve equilibrium problems, including toppling/sliding	
Uniform motion in a circle		Concept of angular speed $v = r\omega$ Acceleration is towards centre	Use of $\omega^2 r$ or v^2/r as appropriate in solving problems about a particle moving with constant speed in a horizontal circle	

Mechanics 2: Unit M2

Topic	Skill	KnowledgwA	Application	Checklist
Hooke's law		Meaning of terms: modulus of elasticity elastic potential energy	Use of $T = \frac{\lambda x}{l}$ and $E = \frac{\lambda x^2}{2l}$ in solving problems involving elastic string or springs, including those where considerations of work and energy are needed	
Linear motion under a variable force	Use $\frac{dv}{dt}$ or $v\frac{dv}{dx}$ as appropriate in applying Newton's second law	$v = \frac{dx}{dt}$ and $a = \frac{dv}{dt} = v\frac{dv}{dx}$	Set up and solve differential equations for problems where a particle moves under the action of variable forces	

Probability and Statistics 1: Unit S1

Topic	Skill	Knowledge	Application	Checklist
Representation of data	Select suitable ways of presenting raw data Construct and interpret: • stem and leaf diagram • box & whisker plots • histograms • cumulative frequency graphs Estimate median and quartiles from cumulative frequency graph Calculate mean and standard deviation using: • individual data items • grouped data • given totals Σx and Σx^2 • given $\Sigma(x-a)$ and $\Sigma(x-a)^2$	Measures of central tendency: mean, median, mode Measures of variation: • range • interquartile range • standard deviation	Discuss advantages and/ or disadvantages of particular representations Calculate and use these measures, e.g. to compare and contrast data Solve problems involving means and standard deviations	
Permutations and combinations		Meaning of terms: • permutation • combination • selection • arrangement	Solve problems involving selections Solve problems about arrangements in a line including those with: • repetition • restriction	

Probability and Statistics 1: Unit S1

Topic	Skill	Knowledge	Application	Checklist
Probability	Evaluate probabilities by: • counting events in the sample space • calculation using permutations and combinations Use addition and multiplication of probabilities as appropriate Calculate conditional probabilities	Meaning of terms: • exclusive events • independent events • conditional probability	Solve problems involving conditional probabilities, e.g. using tree diagrams	
Discrete random variables	Construct a probability distribution table Calculate E(X) and Var(X) For the binomial distribution: • calculate probabilities • use formulae np and npq	Notation B(n, p)	Recognise situations where the binomial distribution is a suitable model, and solve problems involving binomial probabilities	
The normal distribution	Use normal distribution tables	Idea of continuous random variable, general shape of normal curve and notation N(μ, σ^2) Condition for B(n, p) to be approximated by N(np, npq)	Use of the normal distribution as a model Solve problems involving a normal distribution, including: finding probabilities finding μ and/or σ Solve problems involving the use of a normal distribution, with continuity correction, to approximate a binomial distribution	

Probability and Statistics 2: Unit S2

Topic	Skill	Knowledge	Application	Checklist
Assumed knowledge		Content of unit S1 is assumed, and may be required in solving problems on S2 topics		
The Poisson distribution	Calculate Poisson probabilities	Notation Po(μ) Mean and variance of Po(μ) Conditions for random events to have a Poisson distribution Conditions for B(n, p) to be approximated by Po(np) Conditions for Po(μ) to be approximated by N(μ, μ)	Use the Poisson distribution as a model, and solve problems involving Poisson probabilities Solve problems which involve approximating binomial probabilities using a Poisson distribution and/or approximating Poisson probabilities using a normal distribution with continuity correction	

Probability and Statistics 2: Unit S2

Topic	Skill	Knowledge	Application	Checklist
Linear combinations of random variables		For a random variable X: $E(aX + b) = aE(X) + b$ $Var(aX + b) = a^2Var(X)$ For random variables X and Y: $E(aX + bY) = aE(X) + bE(Y)$ For independent X and Y: $Var(aX + bY) = a^2Var(X) + b^2Var(Y)$ For a normal variable X: $aX + b$ has a normal distribution For independent normal variables X and Y: $aX + bY$ has a normal distribution For independent Poisson variables X and Y: $X + Y$ has a Poisson distribution	Solve problems using results about combinations of random variables	
Continuous random variables	Use a density function to find: probabilities the mean the variance	Understand the concept of a continuous random variable. Properties of a density function: always non-negative total area is 1	Solve problems using density function properties	

Probability and Statistics 2: Unit S2

Topic	Skill	Knowledge	Application	Checklist
Sampling and estimation	Calculate unbiased estimates of population mean and variance Determine a confidence interval for a population mean (normal population or large sample) Determine a confidence interval for a population proportion (large sample)	Meaning of terms: sample population Need for randomness in sampling Use of random numbers for sampling Idea of sample mean as a random variable Distribution of sample mean from a normal population, and for a large sample from any population	Explain why a given sampling method may be unsatisfactory Solve problems involving the use of $\overline{X} \sim N(\mu, \sigma^2/n)$, including appropriate use of the Central Limit theorem Interpret confidence intervals and solve problems involving confidence intervals	
Hypothesis tests	Formulate hypotheses for a test Carry out a test of the value of p in a binomial distribution, using either binomial probabilities directly or a normal approximation, as appropriate Carry out a test of the mean of a Poisson distribution, using either Poisson probabilities directly or a normal approximation, as appropriate Carry out a test of a population mean where: • the population is normal with known variance • the sample size is large Calculate probabilities of Type I and Type II errors in the above tests	Concept of a hypothesis test Meaning of terms: • one-tail and two-tail • null and alternative hypotheses • significance level • rejection (or critical) region • acceptance region • test statistic • Type I and Type II errors	Relate the results of tests to the context and interpret Type I and Type II error probabilities	

Section 5: Useful websites

The websites listed below are useful resources to help you study for your Cambridge International AS and A Level Mathematics. The sites are not designed specifically for the 9709 syllabus, but the content is generally of the appropriate standard and is mostly suitable for your course.

www.s-cool.co.uk/a-level/maths
This site covers some Pure Maths and Statistics topics, but not Mechanics. Revision material is arranged by topics, and includes explanations, revision summaries and exam-style questions with answers.

www.examsolutions.co.uk
This site has video tutorials on topics in Pure Maths, Mechanics and Statistics. There are also other resources, including examination questions (from UK syllabuses) with videos of worked solutions.

www.bbc.co.uk/bitesize/higher/maths
This site has revision material and test questions covering some Pure Maths topics only.

www.cimt.plymouth.ac.uk
This site contains resources, projects, and publications, and is intended for both learners and teachers. The main items relevant to AS and A Level revision are the course materials and the interactive 'A-level Audits', which you can access from the 'Resources' option; these both cover Pure Maths, Mechanics and Statistics. The course materials are textbook style notes on selected topics, and can be found by following the Mathematics Enhancement Programme (MEP) link. The 'audits' are online tests containing questions of progressive difficulty, and can be found by following the Test and Audits link.

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