3.3 Unit AS 2: Applied Mathematics

This unit, which assumes knowledge of Unit AS 1, covers the applied content of AS Mathematics and is compulsory for both AS and A level Mathematics. The unit addresses aspects of both mechanics (50% of the assessment) and statistics (50% of the assessment). It assesses modelling and the application of mathematics. The unit is assessed by a 1 hour 15 minute external examination, with 5–10 questions worth 70 raw marks. The examination has two sections: Section A assesses mechanics and Section B assesses statistics. Students answer all questions in both sections.

The statistical content of this unit should be taught through the use and interrogation of a large data set. The examination tests students' ability to:

- interpret real data presented in summary or graphical form; and
- use data to investigate questions arising in real contexts.

Students should be familiar with methods of presenting data, including frequency tables for ungrouped and grouped data, box plots and stem-and-leaf diagrams. They should also be familiar with mean, mode and median as summary measures of location of data. We will not set questions that directly test students' ability to construct such tables and diagrams and calculate such measures, but students will be expected to interpret and draw inferences from them.

Section A: Mechanics

Content	Learning Outcomes
Quantities and units in mechanics	Students should be able to: • demonstrate understanding of and use fundamental quantities and units in the SI system: length, time and mass; • demonstrate understanding of and use derived quantities and units: velocity, acceleration, force and weight;
Kinematics	• demonstrate understanding of and use the language of kinematics: position, displacement, distance travelled, velocity, speed and acceleration; and • demonstrate understanding of, use and interpret graphs in kinematics for motion in a straight line: – displacement against time and interpretation of gradient; and – velocity against time and interpretation of gradient and area under the graph.

Content	Learning Outcomes
Kinematics (cont.) **Forces and Newton's laws**	Students should be able to: • demonstrate understanding of and use the formulae for constant acceleration for motion in a straight line; • demonstrate understanding of and use the constant acceleration formulae in two dimensions using vectors; • demonstrate understanding of and use Newton's first law and the concept of a force; • resolve forces in two dimensions; • demonstrate understanding of and use addition of forces to find the resultant of a system of forces; • demonstrate understanding of and use Newton's second law, including forces given as 2D vectors; • demonstrate understanding of and use the gravitational acceleration, g, and its value in SI units to varying degrees of accuracy; • demonstrate understanding of and use weight and motion in a straight line under gravity; • demonstrate understanding of and use Newton's third law; • demonstrate understanding of and use Newton's second and third laws to solve problems involving connected particles; • solve problems involving equilibrium of forces on a particle; • demonstrate understanding of and use the $F \leq \mu R$ model of friction; • demonstrate understanding of and use the coefficient of friction; • solve problems involving the motion of a body on a rough surface; and • solve problems involving limiting friction and statics.

Section B: Statistics

Content	Learning Outcomes
Statistical sampling	Students should be able to: • demonstrate understanding of and use the terms population and sample; • use samples to make informal inferences about the population; • demonstrate understanding of and use sampling techniques, including simple random sampling and stratified sampling; • select or critique sampling techniques in the context of solving a statistical problem, including understanding that different samples can lead to different conclusions about the population;
Data presentation and interpretation	• interpret diagrams for single-variable data, including understanding that area in a histogram represents frequency and connections to probability distributions; • interpret measures of central tendency and variation, including standard deviation and variance; • calculate standard deviation and variance of a population or sample, including from summary statistics; • interpret scatter diagrams and regression lines for bivariate data, including recognition of scatter diagrams that include distinct sections of the population (excluding calculations involving regression lines); • demonstrate understanding of informal interpretation of correlation; • calculate and interpret the product-moment correlation coefficient; • demonstrate understanding that correlation does not imply causation; and • recognise and interpret possible outliers in data sets and statistical diagrams.

Content	Learning Outcomes
Data presentation and interpretation (cont.)	Students should be able to: • select or critique data presentation techniques in the context of a statistical problem; • clean data, including dealing with missing data, errors and outliers;
Probability	• demonstrate understanding of and use the addition and multiplication laws; • demonstrate understanding of and use the following concepts: – mutually exclusive events; – exhaustive events; and – statistical dependence and independence; • calculate combined probabilities of up to three events, using tree diagrams, Venn diagrams and two-way tables;
Statistical distributions	• demonstrate understanding of and use the binomial distribution as an example of a discrete probability distribution; • calculate probabilities using the binomial distribution; and • link binomial probabilities to the binomial expansion and tree diagrams.