2.2 AS UNIT 2

Unit 2: Applied Mathematics A
Written examination: 1 hour 45 minutes
15% of A level qualification (37.5% of AS qualification)
75 marks

Candidates will be expected to be familiar with the knowledge, skills and understanding implicit in Unit 1.

The paper will comprise two sections:

Section A: Statistics (40 marks)

Section B: Mechanics (35 marks)

The total assessment time of 1 hour 45 minutes can be split between Section A and Section B as candidates deem appropriate.

The subject content is set out on the following pages. There is no hierarchy implied by the order in which the content is presented, nor should the length of the various sections be taken to imply any view of their relative importance.

Topics	Guidance
STATISTICS	
2.2.1 Statistical Sampling	
Understand and use the terms 'population' and 'sample'. Use samples to make informal inferences about the population. Understand and use sampling techniques, including simple random sampling, systematic sampling and opportunity 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.	

Topics	Guidance
2.2.2 Data presentation and interpretation	
Interpret diagrams for single-variable data, including understanding that area in a histogram represents frequency. Connect to probability distributions.	Learners should be familiar with box and whisker diagrams and cumulative frequency diagrams. Qualitative assessment of skewness is expected and the use of the terms symmetric, positive skew or negative skew
Interpret scatter diagrams and regression lines for bivariate data, including recognition of scatter diagrams which include distinct sections of the population. (Calculations of coefficients of regression lines are excluded.) Understand informal interpretation of correlation. Understand that correlation does not imply causation.	Equations of regression lines may be given in a question and learners asked to make predictions using it. Use of the terms positive, negative, zero, strong and weak is expected.
Interpret measures of central tendency and variation, extending to standard deviation. Be able to calculate standard deviation, including from summary statistics.	Measures of central tendency: mean, median, mode. Measures of central variation: variance, standard deviation, range, interquartile range.
Recognise and interpret possible outliers in data sets and statistical diagrams. Select or critique data presentation techniques in the context of a statistical problem. Be able to clean data, including dealing with missing data, errors and outliers.	Use of $Q_1 - 1.5 \times IQR$ and $Q_3 + 1.5 \times IQR$ to identify outliers.

Topics	Guidance
2.2.3 Probability	
Understand and use mutually exclusive and independent events when calculating probabilities. Link to discrete and continuous distributions.	To include the multiplication law for independent events: $P(A \cap B) = P(A)\,P(B)$.
Use Venn diagrams to calculate probabilities.	Use of set notation and associated language is expected. To include the generalised addition law: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$. Conditional probability will not be assessed in this unit.
2.2.4 Statistical distributions	
Understand and use simple, discrete probability distributions. Understand and use, • the binomial distribution, as a model • the Poisson distribution, as a model • the discrete uniform distribution, as a model (Calculation of mean and variance of discrete random variables is excluded.)	To include using distributions to model real world situations and to comment on their appropriateness.
Calculate probabilities using • the binomial distribution. • the Poisson distribution. • the discrete uniform distribution.	Use of the binomial formula and tables / calculator. Use of the Poisson formula and tables / calculator Use of the formula for the discrete uniform distribution.

Topics	Guidance
Select an appropriate probability distribution for a context, with appropriate reasoning, including recognising when the binomial, Poisson or discrete uniform model may not be appropriate.	
2.2.5 Statistical hypothesis testing	
Understand and apply the language of statistical hypothesis testing, developed through a binomial model: null hypothesis, alternative hypothesis, significance level, test statistic, 1-tail test, 2-tail test, critical value, critical region, acceptance region, *p*-value.	The *p*-value is the probability that the observed result or a more extreme one will occur under the null hypothesis H_0. For uniformity, interpretations of a *p*-value should be along the following lines: $p < 0{\cdot}01$; there is very strong evidence for rejecting H_0. $0{\cdot}01 \leq p \leq 0{\cdot}05$; there is strong evidence for rejecting H_0. $p > 0{\cdot}05$; there is insufficient evidence for rejecting H_0.
Conduct a statistical hypothesis test for the proportion in the binomial distribution and interpret the results in context. Understand that a sample is being used to make an inference about the population and appreciate that the significance level is the probability of incorrectly rejecting the null hypothesis.	
Interpret and calculate Type I and Type II errors, and know their practical meaning.	

Topics	Guidance
MECHANICS	
2.2.6 Quantities and units in mechanics	
Understand and use fundamental quantities and units in the S.I. system; length, time and mass.	
Understand and use derived quantities and units: velocity, acceleration, force, weight.	
2.2.7 Kinematics	
Understand and use the language of kinematics: position, displacement, distance travelled, velocity, speed, acceleration.	
Understand, use and interpret graphs in kinematics for motion in a straight line: displacement against time and interpretation of the gradient; velocity against time and interpretation of the gradient and the area under the graph	Learners may be expected to sketch displacement-time and velocity-time graphs.
Understand, use and derive the formulae for constant acceleration for motion in a straight line.	To include vertical motion under gravity. Gravitational acceleration, g. The inverse square law for gravitation is not required and g may be assumed to be constant, but learners should be aware that g is not a universal constant but depends on location. The value 9·8 ms^{-2} can be used for the acceleration due to gravity, unless explicitly stated otherwise.
Use calculus in kinematics for motion in a straight line.	To include the use of $v = \frac{dr}{dt}$, $a = \frac{dv}{dt} = \frac{d^2r}{dt^2}$, $r = \int v\,dt$, $v = \int a\,dt$, where v, a and r are given in terms of t.

Topics	Guidance
2.2.8 Forces and Newton's laws	
Understand the concept of a force. Understand and use Newton's first law.	
Understand and use Newton's second law for motion in a straight line (restricted to forces in two perpendicular directions or simple cases of forces given as 2-D vectors).	
Understand and use weight and motion in a straight line under gravity; gravitational acceleration, g, and its value in S.I. units to varying degrees of accuracy. (The inverse square law for gravitation is not required and g may be assumed to be constant, but learners should be aware that g is not a universal constant but depends on location.)	Forces will be constant and will include weight, normal reaction, tension and thrust. To include problems involving lifts. The value $9{\cdot}8\ ms^{-2}$ can be used for the acceleration due to gravity, unless explicitly stated otherwise.
Understand and use Newton's third law. Equilibrium of forces on a particle and motion in a straight line (restricted to forces in two perpendicular directions or simple cases of forces given as 2-D vectors) Applications to problems involving smooth pulleys and connected particles.	Problems involving particles connected by strings passing over smooth, fixed pulleys or pegs; one particle will be freely hanging and the other particle may be (i) freely hanging, (ii) on a smooth, horizontal plane.
2.2.9 Vectors	
Calculate the magnitude and direction of a vector and convert between component form and magnitude/direction form.	
Use vectors to solve problems in context, including forces.	Does not include kinematics problems.