2.4 A2 UNIT 4

Unit 4: Applied Mathematics B
Written examination: 1 hour 45 minutes
25% of A level qualification
80 marks

Candidates will be expected to be familiar with the knowledge, skills and understanding implicit in Unit 1, Unit 2 and Unit 3.

The paper will comprise two sections:

Section A: Statistics (40 marks)

Section B: Differential Equations and Mechanics (40 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	
2.4.1 Probability	
Understand and use conditional probability, including the use of tree diagrams, Venn diagrams and two-way tables.	
Understand and use the conditional probability formula: $P(A \cap B) = P(A)\,P(B\|A) = P(B)\,P(A\|B)$.	
Modelling with probability, including critiquing assumptions made and the likely effect of more realistic assumptions.	

Topics	Guidance
2.4.2 Statistical distributions	
Understand and use the continuous uniform distribution and Normal distributions as models. Find probabilities using the Normal distribution. Link to histograms, mean, standard deviation, points of inflection and the binomial distribution.	 Use of calculator / tables to find probabilities. Linear interpolation in tables will **not** be required.
Select an appropriate probability distribution for a context, with appropriate reasoning, including recognising when the continuous uniform or Normal model may not be appropriate.	The distributions from which the selection can be made are: Discrete: binomial, Poisson, uniform Continuous: Normal, uniform
2.4.3 Statistical hypothesis testing	
Understand and apply statistical hypothesis testing to correlation coefficients as measures of how close data points lie to a straight line and be able to interpret a given correlation coefficient using a given *p*-value or critical value. (The calculation of correlation coefficients is excluded.)	Learners will be expected to state hypotheses in terms of ρ, where ρ represents the population correlation coefficient.
Conduct a statistical hypothesis test for the mean of a Normal distribution with known, given or assumed variance, and interpret the results in context.	Learners should know and be able to use the result that if $X \sim \mathrm{N}(\mu, \sigma^2)$ then $\overline{X} \sim \mathrm{N}\left(\mu, \frac{\sigma^2}{n}\right)$ (The proof is excluded.)

Topics	Guidance
DIFFERENTIAL EQUATIONS AND MECHANICS	
2.4.4 Trigonometry	
Use trigonometric functions to solve problems in context, including problems involving vectors, kinematics and forces.	Contexts may include, for example, wave motion as well as problems in vector form which involve resolving directions and quantities in mechanics.
2.4.5 Differentiation	
Construct simple differential equations in context (contexts may include kinematics, population growth and modelling the relationship between price and demand).	To include contexts involving exponential growth and decay.
2.4.6 Integration	
Evaluate the analytical solution of simple first order differential equations with separable variables, including finding particular solutions.	Questions will be set in context. Separation of variables may require factorisation involving a common factor.
Interpret the solution of a differential equation in the context of solving a problem, including identifying limitations of the solution; includes links to kinematics.	

Topics	Guidance
2.4.7 Quantities and units in mechanics	
Understand and use derived quantities and units for moments.	
2.4.8 Kinematics	
Extend, use and derive the formulae for constant acceleration for motion in a straight line to 2 dimensions using vectors.	
Extend the use of calculus in kinematics for motion in a straight line to 2 dimensions using vectors.	To include the use of $\mathbf{v}=\frac{\mathrm{d}\mathbf{r}}{\mathrm{d}t}$, $\mathbf{a}=\frac{\mathrm{d}\mathbf{v}}{\mathrm{d}t}=\frac{\mathrm{d}^2\mathbf{r}}{\mathrm{d}t^2}$, $\mathbf{r}=\int \mathbf{v}\,\mathrm{d}t$, $\mathbf{v}=\int \mathbf{a}\,\mathrm{d}t$, where $\mathbf{v}$, $\mathbf{a}$ and $\mathbf{r}$ are given in terms of t.
Model motion under gravity in a vertical plane using vectors; projectiles.	To include finding the speed and direction of motion of the projectile at any point on its path. The maximum horizontal range of a projectile for a given speed of projection. In examination questions, learners may be expected to derive the general form of the formulae for the range, the time of flight, the greatest height or the equation of path. In questions where derivation of formulae has not been requested, the quoting of these formulae will **not** gain full credit. Questions will **not** involve resistive forces.

Topics	Guidance
2.4.9 Forces and Newton's laws	
Extend Newton's second law to situations where forces need to be resolved (restricted to two dimensions).	
Resolve forces in two dimensions. Understand and use the equilibrium of a particle under coplanar forces.	
Understand and use addition of forces; resultant forces; dynamics for motion in a plane.	
Understand and use the $F \leq \mu R$ model for friction. The coefficient of friction. The motion of a body on a rough surface. Limiting friction and statics.	Forces will be constant and will include weight, friction, normal reaction, tension and thrust. To include motion on an inclined plane. The motion of particles connected by strings passing over smooth, fixed pulleys or pegs; one particle will be freely hanging and the other particle may be on an inclined plane.
2.4.10 Moments	
Understand and use moments in simple static contexts.	To include parallel forces only.
2.4.11 Vectors	
Understand and use vectors in three dimensions.	To include the use of the unit vectors $\mathbf{i}$, $\mathbf{j}$ and $\mathbf{k}$.
Use vectors to solve problems in context, including forces and kinematics.	Questions will not involve the scalar product.