Knowledge Organiser A Level Mathematics

Unit:	Quantities and Units in Mechanics
Year:	12

Purpose of Unit:

- To introduce to the mechanics section of the A level

Key Learning/Knowledge:

- Quantities and units in mechanics

Key Skills:

- To know and use the language for mechanics modelling assumptions
- Units used in mechanics
- Converting to SI units

Key Vocabulary and meanings:

Model- a mathematical system which enables a problem to be solved

Light- has negligible mass

Static- not moving

Rigid- doesn't bend

Thin- has negligible thickness

Smooth- no friction between the surface and object

Rough- friction to be considered

Particle- dimensions are negligible so mass or object is at a point. Air resistance and rotational forces can be ignored

Rod- a long, thin, straight object

Lamina- a thin, two dimensional surface with mass distributed evenly across it's flat surface

Uniform body- mass is distributed evenly, so acts at the centre of mass

Light string- neglible mass and equal tension

Inextensible string- a string that does not stretch

Scalar- has magnitude only and is always positive. E.g. distance, speed, time, mass.

Vector- a quantity with magnitude and direction. E.g. velocity, acceleration

Links to prior knowledge/learning:
Converting between units of mass, volume and length.
Compound measures
Plotting and interpreting graphs

Cross Curricular link/ World Issues
Simplifying real world problems using the assumptions

Knowledge Organiser A Level Mathematics

Unit: Data Presentation and Interpretation **Year:** 12

Purpose of Unit:

- To learn and embed the data presentation and interpretation content for the Statistics part of the A level.

Key Learning/Knowledge:	Key Vocabulary and meanings:
 - To be able to calculate measures of location, mean, median and mode - To be able to calculate measures of variation, standard deviation, variance, range and interpercentile range - To be able to interpret and draw inferences from summary statistics - Be able to clean data, including dealing with missing data, errors and outliers - Interpret diagrams for single-variable data, including understanding that area in a histogram represents frequency - Interpret scatter diagrams and regression lines for bivariate data, including recognition of scatter diagrams which include distinct sections of the population (calculations involving regression lines are excluded) - Understand informal interpretation of correlation - Understand that correlation does not imply causation - Recognise and interpret possible outliers in data sets and statistical diagrams - Select or critique data presentation techniques in the context of a statistical problem	**Mean-** The Arithmetic Mean is the average of the numbers: a calculated "central" value of a set of numbers **Median-** The "middle" of a sorted list of numbers. This can be found from group data using **linear interpolation.** **Mode-** The most common value of a set of data. A set of data can have more than one mode. **Variance-** A measure of how spread out numbers are. **Standard deviation-** also a measure of how spread out numbers are. This is the square root of the variance. **Skewness-** When data has a "long tail" on one side or the other, so it is not symmetrical. **Interquartile range-** Also a measure of how spread out the data is. This is the difference between the upper and lower quartiles.
Key Skills: - Calculating averages - Interpreting data - Representing data - Correlation	

Links to prior knowledge/learning:
GCSE Data Handling

Cross Curricular link/ World Issues:
Large data set
Subjects such as psychology and the sciences also use advanced data handling skills.

Knowledge Organiser A Level Mathematics

Unit: Statistical Distributions
Year: 12

Purpose of Unit:

- To be able to find and use statistical probability distributions

Key Learning/Knowledge:	Key Vocabulary and meanings:
- Understand and use simple, discrete probability distributions including the Binomial Distribution - Use the Binomial Distribution as a model - Calculate probabilities using the Binomial Distribution	**Binomial distribution-** has two possible outcomes **Uniform distribution-**all outcomes have the same probability of success **Discrete random variable-** a set of possible values from an experiment
Key Skills: - Fractions, decimals and percentages - Probability - Quadratics - Independent and mutually exclusive events	**Cumulative-** running total

Links to prior knowledge/learning:
- Area under a curve
- GCSE Probability
- Using inequality symbols

Cross Curricular link/ World Issues
Probability experiments e.g. tossing a coin
Psychology
Sports

Knowledge Organiser A Level Mathematics

Unit: Constant acceleration
Year: 12

Purpose of Unit:

- To introduce constant acceleration

Key Learning/Knowledge:	Key Vocabulary and meanings:
	Velocity- the rate of change of displacement
	Acceleration- the rate of change of velocity
• Distance-time and velocity time graphs	**SUVAT equations-**
• SUVAT equations	

Key Skills:

- Drawing and interpreting distance-time and velocity-time graphs
- Deciding which SUVAT equation is appropriate for the given problem
- Using SUVAT equations
- Vertical motion under gravity

$$v = u + at$$

$$v^2 = u^2 + 2as$$

$$s = ut + \frac{1}{2}at^2$$

$$s = vt - \frac{1}{2}at^2$$

$$s = \frac{1}{2}(u+v)t$$

s – displacement
u – initial velocity
v – final velocity
a – acceleration
t - time

Acceleration due to gravity- in maths we use 9.8m/s²

Links to prior knowledge/learning:
Converting between SI and compound units (in previous unit)
Substitution into formulae
Changing the subject of a formula
Plotting and interpreting graphs in context

Cross Curricular link/ World Issues
This unit overlaps with the Physics A level.

Knowledge Organiser A Level Mathematics

Unit: **Hypothesis Testing**	
Year: 12	

Purpose of Unit:

- To perform hypothesis tests on the binomial distribution

Key Learning/Knowledge:	**Key Vocabulary and meanings:**
 - Setting up hypothesis tests - One tailed tests - Two tailed tests - Critical regions	 **Null hypothesis-** the hypothesis that there is no significant difference between the specified populations.
Key Skills: - Finding binomial probabilities - Using inequality symbols	**Alternate hypothesis-** claims that there is a difference between the specified populations. **Significance level-** a measure of the strength of the evidence that must be present in your sample before rejecting the null hypothesis. **Critical region-** a set of values for the test statistic for which the null hypothesis is rejected

Links to prior knowledge/learning:
Previous unit on statistical distributions

Cross Curricular link/ World Issues
Hypothesis testing is used in real-life situations such as election polling
Biology, Psychology, Maths at degree level

Knowledge Organiser A Level Mathematics

Unit: **Statistical Sampling**	
Year: 12	

Purpose of Unit:

- To know and use statistical sampling methods and be introduced to the large data set

Key Learning/Knowledge:	Key Vocabulary and meanings:
• Sampling methods • Large data set	**Population-** whole set of items that could be sampled **Census-** observations taken from the entire population **Sample-** observations taken from a subset of the population **Sampling unit-** one individual observation set from the population **Sampling frame-** a numbered (or named) list of individual sampling units **Strata-** a subset of the population **Simple random sampling-** every item has an equal chance of being chose e.g. random number generator **Quota sampling-** non-random sample is taken to fill predetermined categories **Opportunity sampling-** a non-random sample from available sampling units **Stratified sampling-**random samples are taken proportionally from mutually exclusive groups **Systematic sampling-**items are chosen at regular intervals from a sampling frame **Quantitative data-** numerical values **Qualitative data-** non-numerical values **Continuous data-** variables that can take any value. Measured. **Discrete data-** variables that can only take specific values. Counted.
Key Skills: • To know and use 'population' and 'sample' • Use samples to make inferences about a population • To understand and use techniques including simple random, systematic, opportunity, quota and stratified sampling • To critique sampling methods in context • To familiarise with the large data set	

Links to prior knowledge/learning:
GCSE data handling

Cross Curricular link/ World Issues
Psychology and sociology also use sampling methods

Knowledge Organiser A Level Mathematics

Unit: Forces and Newton's Laws
Year: 12

Purpose of Unit:

- To know and use Newton's laws of motion

Key Learning/Knowledge:	Key Vocabulary and meanings:
- 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 - Understand and use Newton's third law - Equilibrium of forces on a particle and motion in a straight line - Application to problems involving smooth pulleys and connected particles	**Force** – a push or pull upon an object resulting from the object's interaction with another object
Key Skills: - Draw force diagrams and calculate resultant forces - Calculate resultant forces by adding vectors - Form and solve equations using Newton's second law, $F = ma$ - Apply Newton's second law to vector forces and acceleration - Solve problems involving connected particles	**Mass** - a measure of how much matter is in an object **Acceleration** – the rate of change of velocity **Tension** – the pulling force transmitted through a string, cable, or similar object **Equilibrium** – the state of an object if all forces on it are balanced and therefore it's velocity does not change over time **Particle** – object of negligible dimensions. The mass of the object is concentrated at a single point, air resistance and rotational forces can be ignored

Links to prior knowledge/learning:
- GCSE Calculating resultant vectors
- GCSE Trigonometry
- A-Level Modelling assumptions
- GCSE/A-Level Simultaneous Equations
- GCSE/A-Level physics Equations of motion

Cross Curricular link/ World Issues

- A-Level physics
- Design Technology
- Engineering

Knowledge Organiser A Level Mathematics

Unit: Probability Year: 12	
Purpose of Unit: • To learn probability content for Year 12	
Key Learning/Knowledge: • Probability	**Key Vocabulary and meanings:** **Mutually exclusive-** Mutually exclusive events cannot happen at the same time **Independent-** Independent events do not affect eachother. $P(A) \times P(B) = P(A \cap B)$
Key Skills: • Understand and use mutually exclusive and independent events when calculating probabilities • Link to discrete and continuous distributions	
Links to prior knowledge/learning: GCSE Probability- frequency trees, tree diagrams, venn diagrams, sample space, exhaustive probability	
Cross Curricular link/ World Issues Probability has many real life applications such as the lottery, weather forecast, elections, card games etc.	

Knowledge Organiser A Level Mathematics

Unit: Variable acceleration **Year:** 12

Purpose of Unit:

- To learn how to solve problems with variable acceleration

Key Learning/Knowledge:	**Key Vocabulary and meanings:**
- To be able to use calculus (differentiation) in kinematics to model motion in a straight line for a particle moving with variable acceleration - To understand that gradients of the relevant graphs link to rates of change - To know how to find maximum and minimum velocities by considering zero gradients and understand how this links with the actual motion (i.e. acceleration = 0). - To be able to use calculus (integration) in kinematics to model motion in a straight line for a particle moving under the action of a variable force - To understand that the area under a graph is the integral, which leads to a physical quantity - To know how to use initial conditions to calculate the constant of integration and refer back to the problem.	Displacement- how far from the starting point in a straight line. Usually measured in m. Velocity- speed with direction. This can be obtained by differentiating the displacement or integrating the acceleration. Usually measured in m/s. Acceleration- a measure of how fast the velocity changes. Usually measured in m/s².
Key Skills: - Differentiation - Integration - Displacement - Velocity - Acceleration	

Links to prior knowledge/learning:

- Pure Maths Calculus
- Quadratic graphs
- Gradients

Cross Curricular link/ World Issues
- A Level Physics

Knowledge Organiser A Level Mathematics

Unit:	Algebra and Functions
Year:	12

Purpose of Unit:
- To answer questions involving algebra and functions

Key Learning/Knowledge:
- Algebraic Expressions
- Quadratics
- Equations and Inequalities
- Graphs and Transformations

Key Skills:
- Laws of indices
- Manipulating surds
- Quadratic graphs
- Finding and using the discriminant
- Completing the square
- Solving quadratics
- Set notation
- Solving linear and quadratic inequalities
- Solving simultaneous equations algebraically and graphically
- Transformations of graphs

Key Vocabulary and meanings:

Integer- a whole number
Product- the answer when two or more values are multiplied together
Surd- a number that can't be simplified to remove a square root
Irrational- a real number that can NOT be made by dividing two integers e.g. π
Rational- a number that can be made by dividing two integers
Base- the number that gets multiplied when using an exponent
Quadratic- a function where the highest power is 2
Function- a special relationship where each input has a single output. Often written f(x)
Domain- the inputs of a function
Range- the outputs of a function
Discriminant- $b^2 - 4ac$ is used to determine how many real roots a function has
Equation- a mathematical statement with an equals sign
Inequality- a mathematical statement comparing two values
Cubic- a function where the highest power is 3
Quartic- a function where the highest power is 4
Reciprocal function- a function where the highest power is negative
Asymptote- a line that a curve approaches as it heads to infinity or minus infinity

Links to prior knowledge/learning:
The majority of this unit has been covered at higher GCSE.

Cross Curricular link/ World Issues

- Using quadratics in modelling e.g. bridges
- Simultaneous equations in context
- Link to linear programming for optimisation problems

Knowledge Organiser A Level Mathematics

Unit: **Further Algebra**	
Year: 13	

Purpose of Unit:

- To cover the Further Algebra unit of the Maths A level

Key Learning/Knowledge:	**Key Vocabulary and meanings:**
- Factor theorem - Algebraic division - The Binomial expansion - Algebraic proof	**Binomial-** an algebraic expression of the sum or difference of two terms
Key Skills:	**Coefficient-** a number or symbol in front of a variable that represents a constant
- Manipulate polynomials algebraically, including expanding brackets and collecting like terms, factorisation and simple algebraic division; use of the factor theorem - Understand and use the structure of mathematical proof, proceeding from given assumptions through a series of logical steps to a conclusion; use methods of proof, including: proof by deduction, proof by exhaustion, disproof by counter-example - Understand and use the binomial expansion in the form $(a + bx)^n$	**Counter- example-** an example that satisfies the statements conditions but does not support the statements conclusion **Conjecture-** a mathematical statement that has not yet been rigorously proved. **Factor theorem-** if f(a)=0, then (x-a) is a factor.

Links to prior knowledge/learning:
GCSE knowledge- expanding and factorising brackets, substitution, proof

Cross Curricular link/ World Issues
Probability

Knowledge Organiser A Level Mathematics

Unit: Coordinate Geometry
Year: 12

Purpose of Unit:

- To cover A level content of coordinate geometry and prepare for future topics that will need this knowledge

Key Learning/Knowledge:

- Equation of a straight line
- Parallel and perpendicular lines
- Equation of a circle
- Multi- step problems
- Modelling

Key Skills:

- Understand and use proportional relationships and their graphs
- Understand and use the equation of a straight line
- Gradient conditions for two straight lines to be parallel or perpendicular
- To be able to find lengths and areas using equations of straight lines
- Be able to use straight line models in a variety of contexts
- Understand and use the coordinate geometry of a circle
- Complete the square to find the centre and radius of a circle
- Use circle theorems to solve more complex problems

Key Vocabulary and meanings:

Bisect- cut exactly in half

Parallel- parallel lines have the same gradient

Perpendicular- perpendicular lines meet at a right angle

Straight line equations-
Y=mx+c
ax+by+c=0
y-y1=m(x-x1)

Circle equation-
$$(x - a)^2 + (y - b)^2 = r^2$$

Where (a,b) is the centre and r is the radius.

Links to prior knowledge/learning:
GCSE skills- simultaneous equations, completing the square, equation of a line, parallel and perpendicular lines, trigonometry, Pythagoras' theorem, circle theorems

Cross Curricular link/ World Issues

Knowledge Organiser A Level Mathematics

Unit: Differentiation
Year: 12

Purpose of Unit:

- To be able to find and use the derivative of a function

Key Learning/Knowledge:

- Find the derivative, $f'(x)$ or $\frac{dy}{dx}$, of a function, including from first principles
- Use the derivative to solve problems involving gradient, tangents and normal
- Identify turning points and their nature
- Model real life situations with differentiation

Key Skills:

- To be able to find the derivative of a function from first principles
- To be able to differentiate x^n, quadratics and functions with 2 or more terms
- To be able to use the derivative to identify the gradient at a given point and the gradients of a tangent and normal
- To be able to identify whether a function is increasing or decreasing and to identify and interpret stationary points

Key Vocabulary and meanings:

Gradient – how steep a line is, or the rate of change of one variable with respect to another

Tangent - a straight line that touches a curve at a single point and therefore has the same gradient as the curve at that point

Normal – a straight line perpendicular to another line at a given point

Derivative – the rate at which an output changes with respect to an input

Differentiation – process used to find the derivative of a function

Links to prior knowledge/learning:
- GCSE Finding the gradient of a straight line
- GCSE Finding the gradient of a curve
- GCSE Sketching quadratics and other curved graphs
- GCSE Plotting and interpreting real-life graphs

Cross Curricular link/ World Issues

- A-Level physics
- Design Technology
- Engineering

Knowledge Organiser A Level Mathematics

Unit: Integration
Year: 12

Purpose of Unit:
- To be able to integrate a function

Key Learning/Knowledge:

- Find y, given $\frac{dy}{dx}$ for x^n
- Integrate polynomials
- Find $f(x)$, given $f'(x)$ and a point
- Evaluate definite integrals
- Find the area bounded by a curve and straight line

Key Skills:

- To be able to integrate x^n
- To be able to find indefinite integrals
- To be able to find a function given its derivative
- To be able to find the area under a curve

Key Vocabulary and meanings:

Integration – reverse process of differentiation, used to add slices to find a whole, e.g. to find the total area under a curve

Integral – the result of an integration.

Polynomial – expression made up of a combination of variables, constants and exponents

Derivative – the rate at which an output changes with respect to an input

Differentiation – process used to find the derivative of a function

Links to prior knowledge/learning:
- GCSE Finding the area of shapes formed by straight line on an axis
- GCSE Finding the area under a curve
- GCSE Sketching quadratics and other curved graphs
- GCSE Plotting and interpreting real-life graphs

Cross Curricular link/ World Issues

- A-Level physics
- Design Technology
- Engineering

Knowledge Organiser A Level Mathematics

Unit: **Vectors**
Year: 12

Purpose of Unit:

- To learn Year 12 vectors content and solve problems involving this

Key Learning/Knowledge:	Key Vocabulary and meanings:
- Use vectors in two dimensions - Calculate the magnitude and direction of a vector and convert between component form and magnitude/direction form - Add vectors diagrammatically and perform the algebraic operations of vector addition and multiplication by scalars, and understand their geometrical interpretations - Understand and use position vectors; calculate the distance between two points represented by position vectors - Use vectors to solve problems in pure mathematics and in context, (including forces)	**Vector-** A vector has direction and magnitude **Scalar-** A number on its own, used when dealing with vectors or matrices **Magnitude-** The size of a vector **Direction-** where a vector is pointing or heading **Position vector-** a vector from a given point. At A level, this is usually the origin.
Key Skills: - Pythagoras' theorem - Coordinate geometry - Non right-angled trigonometry	

Links to prior knowledge/learning:
GCSE vectors, surds, trigonometry

Cross Curricular link/ World Issues
A level Physics
A level Maths Mechanics
Engineering
There are many real-life applications, including any situation that involves force of velocity.

Knowledge Organiser A Level Mathematics

Unit:	Exponentials and Logarithms
Year:	12

Purpose of Unit:

- To learn exponentials and logarithms content for year 1 of the course

Key Learning/Knowledge:

- To know what is meant by an exponential function
- To sketch graphs of exponential and logarithmic functions
- To solve problems with exponential modelling
- To know what is meant by a logarithm
- To simplify expressions using laws of logarithms
- To solve equations using logarithms
- To work with natural logarithms
- To use logarithms to estimate the values of constants in non-linear models

Key Skills:

- Laws of indices
- Substitution
- Plotting graphs
- Lines of best fit

Key Vocabulary and meanings:

Exponential-where a value increases or decreases in proportion to its current value

Logarithm- A logarithm answers the question "How many of this number do we multiply to get that number?"

Initial value- the starting value in context of the problem

Rate of change- the amount that the initial value is increasing or decreasing over time

Links to prior knowledge/learning:
Unit 1 Algebra and Functions
GCSE Algebra and Statistics

Cross Curricular link/ World Issues
A level Biology
Statistics part of the A level Maths course