Year 13 Spring 2

**Unit Overview: Binomial Expansion 2, Radians, Trigonometric Functions, Moments, Application of forces 1, Normal distribution 2**

| **Half- Term:** | AUT 1 | AUT 2 | SPR 1 | SPR 2 | SUM 1 | SUM 2 | **No of Lessons:** | **30** |
|---|---|---|---|---|---|---|---|---|

**Key Focus for Unit:**

*What is the key knowledge being delivered?*
*What is the intent of this unit?*

Pure

**Differentiation**

- Differentiate simple trigonometric functions
- Differentiate simple logarithmic and exponential functions (including a^x)
- Extend differentiation from first principles rigorously to find the derivative of sinx or cosx
- Differentiate sums and differences of functions involving trigonometric, logarithmic and exponential functions
- Differentiate using the chain rule
- Differentiate using partial fractions
- Differentiate using the product rule
- Differentiate using the quotient rule
- Differentiate reciprocal and inverse trigonometric functions
- Differentiate simple functions defined parametrically including application to tangents and normals
- Understand and use the rule for differentiating general inverse functions
- Differentiate simple functions defined implicitly
- Use second derivatives to solve problems of concavity, convexity and points of inflection
- Solve problems involving connected rates of change
- Construct simple differential equations
- Solve problems involving the differentiation of a wide range of functions
- Construct differential equations in a range of contexts

**Integration**

- Integrate a range of standard functions including trigonometric and exponential functions
- Integrate 1/x
- Integrate functions of the form f(ax + b)
- Integrate functions using trigonometric identities
- Integrate functions of the form f'(x)/f(x) by recognition
- Integrate functions using the reverse chain rule
- Integrate functions using a given substitution and understand the connection with the chain rule
- Integrate functions by parts (single application) and understand the connection with the product rule
- Integrate functions using partial fractions
- Use definite integration to find areas between curves (or a curve and a line)
- Solve differential equations using standard methods
- Understand the role of constants of integration and particular integrals in the solutions of differential equations
- Understand how to sketch a family of solution curves of differential equations
- Integrate functions using a substitution which is not given
- Integrate functions by parts (repeated application)
- Integrate functions using a range of methods in familiar contexts
- Use definite integration to find areas between curves (or a curve and a line) in context
- Solve differential equations using separation of variables
- Integrate functions using a range of methods in unfamiliar contexts
- Understand and use integration as the limit of a sum
- Solve differential equations in a range of contexts
- Interpret solutions to differential equations in a range of contexts and identify limitations, including consideration of validity for large values

Applied (Mechanics)

**Variable Acceleration**

- Understand general kinematics problems with vectors
- Solve general kinematics problems using more complex functions of time
- Solve general kinematics problems using calculus of vectors
- Solve general kinematics problems in a range of contexts using vectors

Applied (Statistics)

**Conditional Probability 2 and Regression 1**

- Understand and calculate conditional probabilities in the context of tree diagrams
- Understand independence and its associated rules in the context of conditional probability
- Use a linear change of variable with bivariate data
- Calculate the PPMC as a measure of correlation
- Interpret the PPMC as a measure of correlation
- Understand exponential models in bivariate data
- Understand the effect of a change of variable on the PPMC
- Use a change of variable to estimate coefficients for an exponential model

Year 13 Spring 2

**Key Knowledge and Big Ideas:**

*What **Powerful Knowledge** and **Big Ideas** are explored in this Unit?*

*How have these progressed from previous learning? What **gaps in knowledge** have you identified from **baselining** and how are these being closed?*

**BIG IDEAS:**

Differentiation, Integration, Variable Acceleration, Conditional Probability and Correlation and Regression

**Powerful Knowledge:**

- Extend differentiation from first principles rigorously to find the derivative of sinx or cosx
- Differentiate sums and differences of functions involving trigonometric, logarithmic and exponential functions
- Differentiate using the chain rule
- Differentiate using partial fractions
- Differentiate using the product rule
- Differentiate using the quotient rule
- Differentiate simple functions defined parametrically including application to tangents and normals
- Understand and use the rule for differentiating general inverse functions
- Differentiate simple functions defined implicitly
- Use second derivatives to solve problems of concavity, convexity and points of inflection
- Solve problems involving connected rates of change
- Use definite integration to find areas between curves (or a curve and a line) in context
- Solve differential equations using separation of variables
- Integrate functions using a range of methods in unfamiliar contexts
- Understand and use integration as the limit of a sum
- Solve differential equations in a range of contexts
- Solve general kinematics problems using more complex functions of time
- Solve general kinematics problems using calculus of vectors
- Use a linear change of variable with bivariate data
- Calculate the PPMC as a measure of correlation
- Interpret the PPMC as a measure of correlation
- Understand exponential models in bivariate data
- Understand the effect of a change of variable on the PPMC

**Previous Learning:**

- Trigonometry and modelling
- Parametric Equation
- Application of forces 1
- Projectiles 1
- Conditional probability 1

**Gaps in Knowledge and Misconceptions:**

Resolving forces

- Some students may still be confused choosing between sin 0 and FcosΘ when resolving forces. Stress the word adjacent used in the definition of cosΘ

Friction

- The concepts relating to friction may create uncertainty. Discuss these points.
- F= P for as long as the object is in equilibrium.
- F reaches Fmax (called limiting friction) when the object is on the point of moving, a position called limiting equilibrium.
- When P increases beyond this limit, P> F max and the object is no longer in equilibrium; it is accelerating.
- Fmax depends on the coefficient of friction, U, between the object and the surface.
- Fmax = UR and the rougher the surface, the greater the value of u

Equilibrium

- When an object is in equilibrium, students may be unsure whether to write an equation with a zero resultant force or an equation showing balanced forces. Both are valid and the students can choose whichever they prefer.
- For example, the diagram shows an object held in equilibrium on a rough slope by a horizontal force P
- Resolving along the slope gives:
- either
- Pcos Θ- F- Wsin Θ = 0 (resultant force is zero) or
- Pcos Θ = F+ Wsin Θ (forces balance in equilibrium)

Year 13 Spring 2

**Projectiles**

The positive direction

When a projectile is fired at an upward angle, upwards is usually taken as positive, but discuss the idea that, when projecting downwards, taking downwards as positive may be better.

The use of symmetry

When a projectile is fired on a horizontal plane, students may not realise that

- The time to reach the maximum height is half the total time of flight
- The horizontal distance covered to reach the maximum height is half the range.

.

The use of time

- The kinematic equation s= ut+ - 1/2at can be used horizontally and vertically to find the horizontal and vertical distances, x and y, covered in a given time, t. In many questions, time t is the link between x and y. Students may need frequent reminders about this.

Vector notation

When working simultaneously with vertical and horizontal motion, a vector equation can be used.

**Variable Acceleration**

Some misconceptions will have been met before and students should be more aware of them by now. Other difficulties arise as problems become more complex.

Use of diagrams

Many problems are text-rich and diagram-poor. Students will find it useful to take the data given in the text and convert it into a diagram. It helps to visualise the problem more easily and avoids having to keep referring to the text.

Multi-stage problems

These problems occur when a journey is undertaken in two or more stages. Students may need plenty of practice to get an overall strategy linking the various stages. For example, some students may be slow to realise that the final velocity, v, of one stage is the initial velocity, u, of the following stage.

Limitations in the model

Remind students that modelling has limitations which are likely to affect a realistic answer. For example, instantaneous changes in a variable are unlikely to occur in real-life situations.

**Unit Assessment:**

*How will this unit be assessed?*

*What is the frequency of assessments – baselines etc?*

How we will assess

- Students will be assessed at the end of each chapter using past exam questions. These assessments will be cumulative so the chapter 5 assessment will test content from Chapter 1, 2, 3 and 4.

**Key Retrieval Topics (Interleaving):**

- Revise differentiation of simple functions
- Revise basic logarithmic and exponential functions
- Revise the concept of differentiation from first principles
- Revise differentiation of basic trigonometric, logarithmic and exponential functions
- Revise integrating simple functions
- Revise using trigonometric identities
- Revise the chain rule for differentiation
- Revise the chain rule for differentiation
- Revise simple integration techniques
- Revise the concept of a vector
- Revise using calculus techniques with complex mathematical functions
- Revise the principles of coding in data analysis
- Revise calculating summary statistics

Year 13 Spring 2

| **Key Skills Explored** | **Vocabulary Selected for DVI** | **Links to Previous Unit** |
|---|---|---|
| Pure Maths<br>• Differentiation<br>• Integration<br><br>Applied (Mechanics)<br>• Projectiles 2<br>• Variable acceleration<br><br>Applied (Statistics)<br>• Conditional probability 2<br>• Regression 1 | • Chain Rule<br>• Parametric Differentiation and Integration<br>• Implicit Differentiation<br>• Limits<br>• PMCC<br>• Bivariate<br>• Variable Acceleration | • The units covered in Spring 2 builds on the work students covered in Autumn 1and 2 and Spring 1. |
| **Links to Careers/Employability** | **How does this unit prepare students for the next unit?** | |
| • Teaching<br>• Engineering<br>• Accounting<br>• Banking<br>• Architecture | **Pure Maths**<br>• Numerical methods<br>• Vectors 3D<br>**Applied (Mechanics)**<br>• Further kinematics<br>**Applied (Statistics)**<br>• Regression 2 | |