Y12 Lesson 1

Overview:
The aim of this lesson is to describe to students how the mathematics they will learn over the following week will be applied in order to build their knowledge of climate science and weather forecasting. The key themes covered in this lesson are:

- Kinematics,
- Calculus of polynomial functions,
- Vectors,
- Parametric equations

Introduction (10 – 15 minutes presentation):
= Only if Year 12 students will be involved in collecting/submitting observations

Introduce the project – students will learn about then role of mathematics in forecasting the weather.

#Set a homework task for students to find and print a published five day weather forecast for the school's location for Monday – Friday, to bring to Lesson 3:

- This must include the predicted weather conditions, temperature, wind speed and direction at 13:00 on each day.
- Suggested sources are Met Office, BBC Weather, other websites, newspapers and radio/television forecasts.

#Describe how students will collect weather observations using the *Instruction Guide*, available at ### distribute copies of this/make copies available for students:

- On each day observations will be required at approximately midday, however it is recommended that they are taken during the student's lunch break to avoid lesson disruption.
- Observations required will be**: cloud cover, wind direction, wind speed, current weather conditions** and **air temperature**.
- Volunteer Year 12 students will act as supervisors for the Year 9 students, will teach skills of team working and management.

#Describe how students will submit the weather observations using the online system:

- Homework/Lesson time/Lunchtime activity for students is to input this data into the website, this is required to be accurate and completed each day.
- Explain to students how this data will be used at the end of the week in conjunction with their collected published forecasts for various activities.

Lesson Plan:
* = activity on individual whiteboards/verbal activity
**=more advanced activities for higher sets

1. **Kinematics in 1-D:** Introduce how we can think of speed as the rate of change of distance and acceleration as the rate of change of speed w.r.t. time.
   1.1. *Demonstrate how we can use **differentiation** to find the speed and acceleration given the distance as a function of time, ie: $x(t) = 2t^3 + 7t^2 + 4t$
   1.2. Ask students to suggest how given acceleration as a function of time we could find speed and distance as a function of time (**integration**), ensure students remember to add a constant of integration.

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1.3. Ask students to work through section 1 on the activity sheet – this re-enforces the concepts to integration and differentiation and introduces the idea of boundary conditions.

2. Describe to students how modelling motion is one of the foundations for producing weather forecasts.
   2.1. Ask students to suggest different aspects of the weather that involve motion and produce a mind map on the whiteboard with these suggestions, ie:
      2.1.1. Clouds in the sky, weather fronts, jet streams, raindrops falling, etc.
   2.2. Explain to students how the other main basis of weather forecasting is modelling energy changes, this will be studied more in the next lesson.

3. **Kinematics in 2-D:** Introduce/Recover the idea of how we can define a point in 2-D space using the Cartesian co-ordinate system with the orthogonal unit vectors **i** and **j** parallel to the x and y axes respectively.
   3.1. Describe how we can think of the motion of a particle acting independently in both of these axes, for instance x(t) representing displacement in the x-axis and y(t) representing displacement in the y-axis.
   3.2. Hence any particle at the point **r** in 2-D space at time t could be represented by the equation **r**(t) **=** x(t)**i** + y(t)**j**
   3.3. **Worksheet:** Instruct students how we can apply the same techniques from kinematics in 1-D to problems in 2-D, using a *vector constant of integration*, ask students to work through section 2 on the activity sheet

4. Discuss with students how we are not limited only to motion in 2 dimensions.
   4.1. The atmosphere physically exists in 3-D but also changes with time, hence we could model the dynamics in 4-D
   4.2. **Cartesian co-ordinates are also not the only system which can be used, could introduce spherical polar co-ordinates.
   4.3. ****Extension Activity:** section 3 on the activity sheet has examples of kinematics of a particle 3-D

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