 Applications of calculus

Applications of calculus to the physical world

Scope and sequence note: Applications of Calculus to the Physical World relies on all the differentiation and integration in the HSC course this topic will need to be completed towards the end of the HSC year.

Teaching strategies and activities

Directly from the syllabus

“In doing questions on rates of change students should be encouraged to draw sketches of Q and  as functions of t whenever this is possible. In particular the relationship between an integral and the area under a curve is relevant here.

Examples should be kept as mathematically simple as possible, with the emphasis on understanding the behaviour of the system. 2 Unit students will not be expected to derive an equation from given information; in all examples, an equation will be given.”

Page 70, Mathematics 2/3 Unit Syllabus – Years 11 – 12, Board of Studies NSW 1982. 14.1 Applications of Calculus to the Physical World.

Content note: Rates of change problems.

These questions can involve differentiation or integration of any function encountered in the course and use any of the methods such as function of a function rule, product rule, quotient rule area under a curve, volumes of solids of revolution.

There are a number of ‘experiments’ that can show student the effects of exponential growth and decay.

Some of these are:

* “M&M Decay”
  + Each student group gets a large number of M&Ms + a cup + butcher paper.
  + Count the population.
  + Put M&Ms in cup, shake, and toss onto paper.
  + All the M&Ms with the “M” visible are considered “dead” and removed.
  + Count the population and record
  + Repeat until no M&Ms left.
* “Heads and Tails” game with a dice. This will show the concept of the decay of radioactive isotopes

Content note: Exponential growth and decay 

Resources

[AMSI website](http://www.amsi.org.au/ESA_Senior_Years/SeniorTopic3/3_md/SeniorTopic3e.html) – Supporting Australian Mathematics Project (A guide for teachers of year 11 and 12) has a good comprehensive overview of Exponential Growth and Decay

[Teachers resource](http://splash.abc.net.au/res/teacher_res/14-exponential-growth.html) – includes videos and spreadsheets (compound interest, bacterial growth)

Students should use graphing software to explore the change in the graph  for different values of A and k.

Situations such as radioactive decay, inflation and population growth should be explored. Notation such as , , , ,  should be used.

Vocabulary such as “at rest”, initially, displacement, velocity, acceleration should be defined for the use in this topic. The significance of negative displacements, velocities and accelerations should be clearly understood.

In past years, HSC questions have also included interpretation questions, where a student is asked to describe the velocities, displacements and accelerations.

Content note: Velocity and acceleration in terms of time – differentiation with respect to time. Distance given, velocity given– integration with respect to time.

Resources

[AMSI website](http://www.amsi.org.au/ESA_Senior_Years/SeniorTopic3/3_md/SeniorTopic3i.html.) – Supporting Australian Mathematics Project (A guide for teachers of year 11 and 12) has a good comprehensive overview of Motion with respect to time.

See HSC Question 2013 Q10.