VCE Mathematical Methods Unit 2

Unit 2 Area of Study 3: Calculus

Example of learning activity: Simulating rectilinear motion

Introduction

Straight line motion occurs in many contexts.

This learning activity looks at two approaches to representing rectilinear motion graphically, for a given position-time function, where the points of the graph represent the particle. The first approach is to construct a static time series plot of as set of points $(t, x\left(t\right))$ for integer values of *t* from 0 to some specified value, where *t* is in seconds and $x(t)$ is in metres. The second approach is to construct a dynamic simulation (or animation) plot as a set of points $(0, x\left(t\right))$ for integer values of *t* from 0 to some specified value, where *t* is in seconds and $x(t)$ is in metres per second. This will show the particle moving along the line $x=0$: that is, along a vertical axis. These graphs can be used to describe the motion qualitatively. As the points are ‘one second apart’ the *difference* between consecutive positions gives the velocity of the particle in metres per second.

Task

For each of the following position-time functions:

1. Plot the set of points $(t, x\left(t\right))$ over the specified domain.
2. Plot the set of points $(0, x\left(t\right))$ over the specified domain and run the simulation.
3. Give a qualitative description of the motion of the particle

Position-time functions:

1. $x\left(t\right)=1.5t, 0 \leq t \leq 10$
2. $x\left(t\right)=20-2t, 0 \leq t \leq 10$
3. $x\left(t\right)=\frac{20}{t+1}, 0 \leq t \leq 20$
4. $x\left(t\right)=200-4t^{2}, 0 \leq t \leq 7$
5. $x\left(t\right)=2t for 0 \leq t \leq 10 and 20-1.5t for 10 \leq t \leq 20$
6. $x\left(t\right)=25+6\cos(\left(t\right)), 0 \leq t \leq 12 $
7. $x\left(t\right)= 2(t-1)(t-9), 0 \leq t \leq 10 $
8. $x\left(t\right)=40-2^{\left(5-t\right)}, 0 \leq t \leq 10 $

Part 2

1. Devise several simulations and show them to another student. Have the student devise a qualitative description of the motion and conjecture a possible position-time function as a model for the motion.
2. Identify a range of contexts that may be modelled by rectilinear motion over a given domain.

Areas of study

The following content from the areas of study is addressed through this task.

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| **Unit 2** |
| **Area of study** | **Content dot point** |
| Functions, relations and graphs | – |
| Algebra, number and structure | – |
| Calculus | 5 |
| Data analysis, probability and statistics  | – |

Outcomes

The following outcomes, key knowledge and key skills are addressed through this task.

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| **Unit 2** |
| **Outcome** | **Key knowledge dot points** | **Key skills dot points** |
| 1 | 5, 8 | 6, 8 |
| 2 | 1, 2, 5 | 1, 3 |
| 3 |  3, 5, 6 |  3, 4, 6, 8, 12 |