VCE Mathematical Methods Unit 3

Sample application task: Drug concentrations

Introduction

A context such as the following can be used to investigate drug absorption, using a product function model involving circular functions and exponential functions.

For each of the following functions the behaviour and variety of shapes of their graphs is to be investigated. The modelling domain and corresponding range should be identified, as well as key features such as axis intercepts, stationary points and points of inflection, symmetry, asymptotes, and the shape of the graph over its natural domain, using the derivative function for analysis as applicable.

The task will begin with an investigation of a graph that might model the concentration of a certain drug in a patient’s system over time. The use of parameters in the family of the function gives students the opportunity to explore the effect the size of parameters has on the graph and hence on the magnitude of the drug in a patient’s system over time. Students then explore a similar function that may model the situation more closely.

Component 1

Consider the function with rule.

a. Graph the function identifying its key features and explain how the shape of its graph can be deduced from its component functions.

The graph of , where *A* and *k* are positive real constants, can be used to describe drug absorption in a patient’s bloodstream, using units mg/litre per unit of time in minutes.

b. Consider the special case where and , and discuss this with respect to a dose of a drug taken at .

c. Select several pairs of values of *A* and *k* where  and $0.1\leq A\leq 1$, and explore and interpret features of the graph of .

d. Discuss the role of the sine function, the exponential function, and constants *A* and *k* in determining the shape of the graph of .

Component 2

Consider the function , where measures units mg/l per unit of time in minutes.

a. Let  and . Graph this function, identifying its key features, and construct a corresponding table of values.

b. Identify and interpret the maximum rates of increase and decrease, and when the concentration is half of its maximum value.

c. Investigate what happens to the graph when *A* and *k* are systematically varied, and discuss any patterns.

Jordan is in hospital and needs a particular drug to manage pain.

d. Let where the particular drug in Jordan’s bloodstream is measured in mg/l and time is measured in minutes. Draw the corresponding graph and compare this with the investigations above.

Component 3

Investigate any points of intersection between graphs of

 and 

Discuss where these points of intersection exist in relation to the stationary point(s) of the graph of .

Areas of study

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

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| --- | --- |
| **Area of study** | **Content dot points** |
| Functions, relations and graphs | 2, 3, 4, 5, 6 |
| Algebra, number and structure | 4, 5, 6 |
| Calculus | 3, 4, 5 |
| Data analysis, probability and statistics | – |

Outcomes

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

|  |  |  |
| --- | --- | --- |
| **Outcome** | **Key knowledge dot points** | **Key skill dot points** |
| 1 | 1, 2, 4, 6, 7, 8, 9, 10, 12 | 1, 2, 8, 9, 10, 11, 12 |
| 2 | 1, 2, 3, 5 | 1, 2, 3, 4, 5, 6, 7 |
| 3 | 1, 2, 3, 4, 5, 8 | 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12 |