**Stage 2 Mathematical Methods**

**Differential Calculus Test**

**Topic 1: Subtopics 1.1, 1.2, 1.5**

**Total Marks – 60**

**This Skills and Applications Task is to be completed without a calculator or notes.**

1. (12 marks)

Differentiate the following. There is no need to simplify your answers.

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1. (4 marks)

Find, from first principles, if

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(4 marks)

1. (4 marks)

Find the equation, in the form , of the **NORMAL** to at the point .

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(4 marks)

1. (13 marks)

Consider the graph of the function .

1. Find the axis intercepts of the graph.

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(2 marks)

1. Clearly show that

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(3 marks)

1. Algebraically find the *coordinates* and the *nature* of the stationary point(s) of the graph of .

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(6 marks)

1. Sketch the graph of for showing the features found in parts (a) and (c) above.

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(2 marks)

1. (19 marks)

A model train travels along a straight tack with position (in metres relative to a signal tower) given by for where is the time in minutes.

1. Determine the train’s initial position.

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(1 mark)

1. Write down expressions for the train’s velocity and acceleration.

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(2 marks)

1. Algebraically find the train’s positions when it stops and changes direction.

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(4 marks)

1. Does the train return to its original position? Give a reason for your answer.

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(2 marks)

1. Find when the acceleration is zero and then draw sign diagrams for both the velocity and the acceleration of the train.

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(3 marks)

1. When is the train speeding up?

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(2 marks)

1. What is the minimum velocity of the train?

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(1 mark)

1. Determine how far the train travels in the first 3 minutes.

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(4 marks)

1. (8 marks)

The population of rabbits in a national park in the period following the release of a rabbit virus can be modelled by for , where is the time in weeks since the virus’ release and is the population of rabbits in thousands.

1. Write down an expression for .

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(2 marks)

1. What is the meaning of in the context of the situation?

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(1 mark)

1. Solve for .

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(2 marks)

1. Draw a sign diagram of and then use it to describe what is happening to the rabbit population for .

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(2 marks)

1. When is the rabbit population decreasing at its fastest rate?

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(1 mark)