**Stage 2 Mathematical Methods**

**Differential Calculus Test**

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

**Total Marks – 59**

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

1. (10 marks)

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

1. $y=2x^{2}-6\sqrt{x}$

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(2 marks)

1. $y=\frac{x^{2}-4x+5}{x^{2}}$

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(2 marks)

1. $y=\left(3x-2x^{4}\right)^{5}$

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(2 marks)

1. $f\left(x\right)=3x^{2}\left(5-2x\right)^{3}$

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(2 marks)

1. $y=\frac{4\sqrt{x}}{\left(6+2x\right)^{2}}$

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(2 marks)

1. (5 marks)

Find, from first principles, $f^{'}\left(6\right)$ if $f\left(x\right)=\frac{x}{x-4}$

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(5 marks)

1. (4 marks)

Find the equation, in the form $y=mx+c$, of the **TANGENT** to $y=8\sqrt{x}-\frac{1}{x^{2}}$ at the point where $x=1$.

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(4 marks)

1. (14 marks)

The function $f(x)=-3x^{4}+2ax^{3}-24x^{2}+6$ has a stationary point at $x=2$.

1. Explain why $f^{'}\left(2\right)=0$.

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(1 mark)

1. Hence show that $a=8$.

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(2 marks)

1. Find and classify the stationary points of $f\left(x\right)$. (Make sure you include a sign diagram.)

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(4 marks)

1. Find the x-coordinates of the points of inflection of $f\left(x\right)$ and use a sign diagram to determine what shape change is occurring at these points.

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(3 marks)

1. Classify the points you found in part (d) as horizontal or non-horizontal inflection points.

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(2 marks)

1. Sketch the graph of $y=f\left(x\right)$ labelling all the information from parts (c), (d) and (e).

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(2 marks)

1. (17 marks)

A particle moves in a straight line such that its position $t$ seconds after it has passed through the origin, $O$, is given by $s(t)=2t^{3}-9t^{2}+12t-5$ metres,$ t\geq 0$.

1. Find expressions for the velocity and acceleration of the particle after $t$ seconds.

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(2 marks)

1. Find when the particle is at rest and its position at these times.

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(4 marks)

1. Hence or otherwise, determine the time when the particle **PASSES THROUGH** the origin.

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(1 mark)

1. Draw sign diagrams for $v\left(t\right)$ and $a\left(t\right)$ and determine the time(s) when the particle’s speed is **INCREASING**.

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(4 marks)

1. Draw a diagram to illustrate the motion of the particle.

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(2 marks)

1. Calculate the total distance travelled by the particle in the first 3 seconds of its motion.

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(4 marks)

1. (9 marks)

Consider the function $h\left(t\right)=3\left(2-\frac{8}{t+6}\right)$ where $h(t)$ is the height of a tree $t$ years after it was planted.

1. Find the height of the tree at the time that it was planted.

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(1 mark)

1. Determine how much the tree had grown in the first 3 years of its life.

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(2 marks)

1. Find the rate at which the tree is growing after 5 years.

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(2 marks)

1. Is $h^{'}\left(t\right)>0$ for all values of $t$? What is the significance of this result?

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(2 marks)

1. Is $h^{''}\left(t\right)>0$ for all values of $t$? What is the significance of this result?

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(2 marks)