

# Differentiation

## Question Paper

Course	Edexcel IGCSE Maths
Section	3. Sequences, Functions & Graphs
Topic	Differentiation
Difficulty	Hard

**Time allowed:** 90  
**Score:** /72  
**Percentage:** /100

**Question 1a**

A curve has equation  $y = 2x^2 + x - 3$ . Find:  
the coordinates where the curve crosses the  $x$ -axis,

[2 marks]

**Question 1b**

the coordinates where the curve crosses the  $y$ -axis,

[1 mark]

**Question 1c**

the coordinates of the turning point on the curve,

[3 marks]

**Question 1d**

Sketch the curve showing the points you have found.

[2 marks]

### Question 2a

A particle is moving along a straight line.

The fixed point  $O$  lies on this line.

The displacement of the particle from  $O$  at time  $t$  seconds is  $s$  metres where

$$s = 2t^3 - 9t^2 - 60t$$

Find an expression for the velocity,  $v$   $m/s$  of the particle at time  $t$  seconds.

[2 marks]

### Question 2b

Find the time at which the velocity is instantaneously zero.

[2 marks]

### Question 3a

For the curve with equation  $y = x^3 - 7x^2 - 5x$ :

find  $\frac{dy}{dx}$

[2 marks]

### Question 3b

find the  $x$ -coordinates of the two turning points on the curve.

[2 marks]

### Question 3c

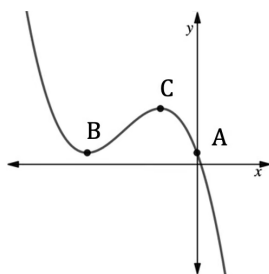
By considering the shape of the curve determine which of your answers to (b) is the  $x$ -coordinate of a maximum point.

[1 mark]

### Question 4a

The curve  $G$  has equation  $y = 1 - x^3 - 6x^2 - 9x$ .

Part of the graph of  $G$  is shown below.



Write the coordinates of A.

[1 mark]

### Question 4b

Points B and C are stationary points on  $G$ .

Find the coordinates of points B and C, stating the nature of the stationary point in each case.

[5 marks]

**Question 4c**

For which values of  $x$  is the gradient of the curve  $G$  negative?

[2 marks]

**Question 5a**

For the curve with equation  $y = 4x + \frac{64}{x} + 7$

find  $\frac{dy}{dx}$

[2 marks]

**Question 5b**

find the coordinates of the stationary points on the curve.

[3 marks]

**Question 5c**

find the exact distance between the two stationary points.

[2 marks]

**Question 6a**

A particle is moving along a straight line and passes a fixed point  $O$ .

The displacement of the particle, from point  $O$ , at time  $t$  seconds is

$$s = \frac{1}{3}t^3 - \frac{5}{2}t^2 + 20t - 15$$

where  $s$  is measured in metres.

Initially how far is the particle from  $O$ ?

[1 mark]

**Question 6b**

Find, in terms of  $t$ , the velocity of the particle.

[2 marks]

**Question 6c**

Find the time at which the particle's velocity is at its minimum.

[2 marks]

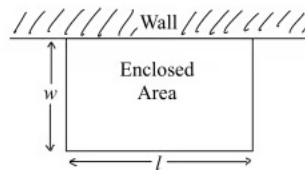
**Question 6d**

For how long is the particle decelerating?

[2 marks]

**Question 7a**

A homeowner wishes to enclose a rectangular part of their garden by building a fence, using an existing wall as one side of the rectangle as shown in the diagram below.



The width of the enclosed rectangle is  $w$  metres and its length  $l$  metres.

The homeowner has 40 metres of fence to use and would like to use it all in order to maximise the area of the garden to be enclosed.

Show that  $l = 40 - 2w$

[1 mark]

**Question 7b**

Show that the area of the garden to be enclosed,  $A$ , is given by  $A = 40w - 2w^2$

[2 marks]

**Question 7c**

Find  $\frac{dA}{dW}$

[2 marks]

**Question 7d**

Find the value of  $w$  that maximises  $A$

[2 marks]

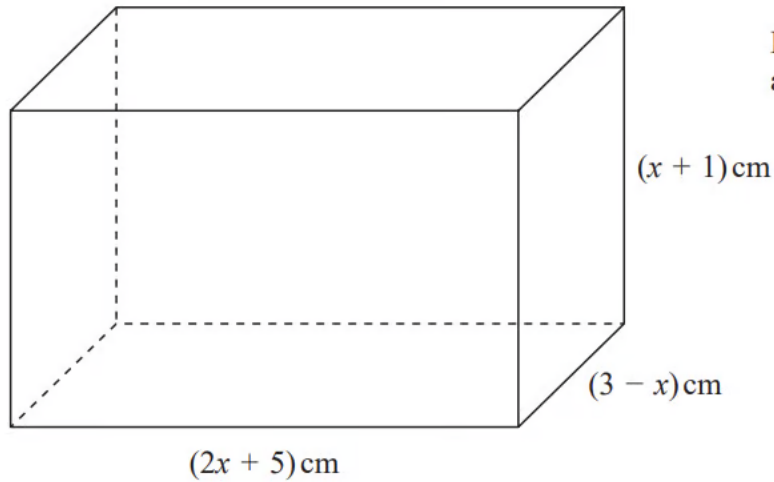
**Question 7e**

Find the dimensions of the rectangle that produce the maximum area that can be enclosed using all of the fence. Also find the maximum area.

[2 marks]



**Question 8a**



The diagram shows a cuboid of volume  $V\text{cm}^3$

Show that  $V = 15 + 16x - x^2 - 2x^3$

[3 marks]

**Question 8b**

There is a value of  $x$  for which the volume of the cuboid is a maximum.

Find this value of  $x$ .

Show your working clearly.

Give your answer correct to 3 significant figures.

[5 marks]

**Question 9**

A particle  $P$  is moving along a straight line.

The fixed point  $O$  lies on this line.

At time  $t$  seconds where  $t \geq 0$ , the displacement,  $s$  metres, of  $P$  from  $O$  is given by

$$s = t^3 + 5t^2 - 8t + 10$$

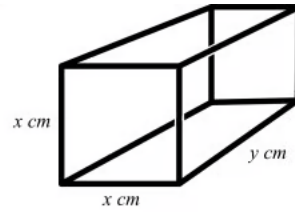
Find the displacement of  $P$  from  $O$  when  $P$  is instantaneously at rest.

Give your answer in the form  $\frac{a}{b}$  where  $a$  and  $b$  are integers.

**[5 marks]**

### Question 10a

A cuboid with a square cross section is to be made from rods as shown in the diagram. The shorter rods making the square are of length  $x$  cm and the longer rods



are of length  $y$  cm.

Explain why 12 rods in total will be needed to make the cuboid, and state how many of each length will be required.

The total length of the rods is to be fixed at 36 cm.

[2 marks]

### Question 10b

The total length of the rods is to be fixed at 36 cm.

Find  $y$  in terms of  $x$

[2 marks]

### Question 10c

Show that the volume of the cuboid,  $V$  cm<sup>3</sup> is  $V = 9x^2 - 2x^3$ .

[2 marks]

**Question 10d**

Find the value of  $x$  that maximises the volume.

**[3 marks]**

**Question 10e**

Find the maximum volume.

**[2 marks]**