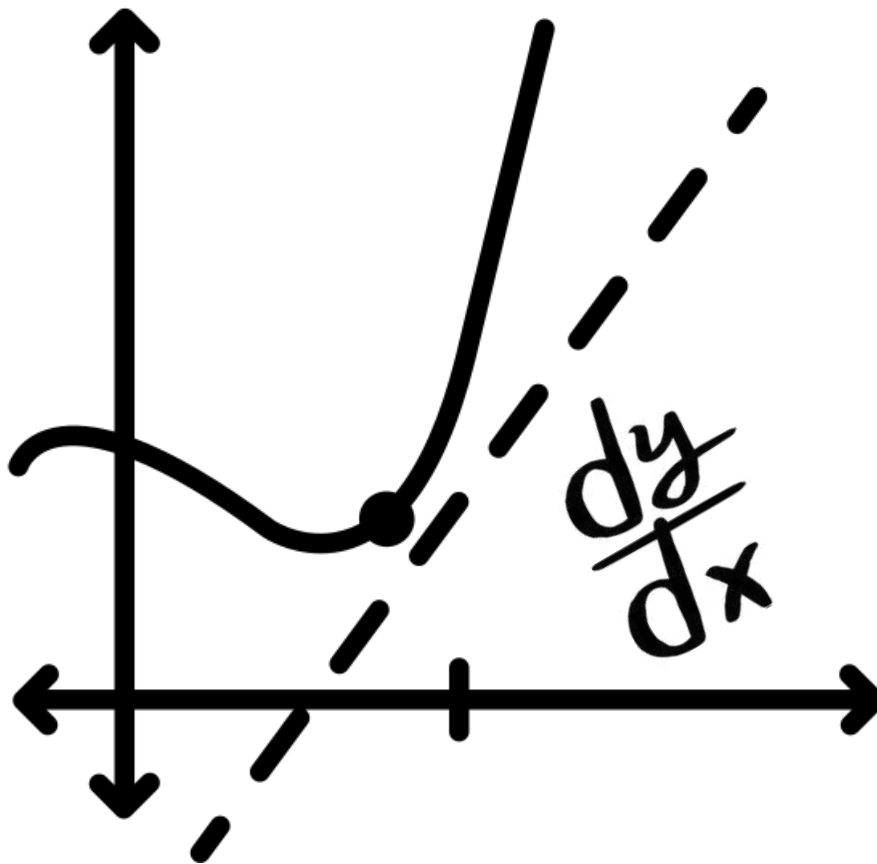

EDEXCEL IGCSE MATHEMATICS

UNIT 2 (MODULAR) DIFFERENTIATION

QP & MS (2018 - 2025)



COMPILED BY:
SIR MUHAMMAD ABDULLAH SHAH



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1. Nov 2024 1H/Q20

The curve with equation $y = 2x^4 - 64x$ has a minimum point.

Find an equation of the tangent to the curve at the minimum point.
Show clear algebraic working.



(Total for Question 20 is 4 marks)



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2. June 2024 1H/Q18

A curve C has equation $y = x^3 - 40x + 1$

Find the coordinates of both the points on C at which the gradient is 8



(.....,.....)

(.....,.....)

(Total for Question 18 is 5 marks)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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3. June 2024 1HR/Q19

A curve C has equation $y = x^3 - 8x^2 - 12x + 5$

Curve C has exactly two stationary points, one at point A and one at point B such that

x coordinate of point $A > x$ coordinate of point B

Find the coordinates of point A

Show clear algebraic working.



(.....,))

(Total for Question 19 is 5 marks)



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4. Nov 2023 1H/Q16

A curve has equation $y = 4x^3 - 8x + 5$

Find the x coordinates of the two points on the curve where the gradient is $\frac{1}{3}$



(Total for Question 16 is 4 marks)



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5. June 2023 1H/Q11

The curve C has equation $y = 4x^3 + x^2 - 20x$

(a) Find $\frac{dy}{dx}$

$$\frac{dy}{dx} = \dots\dots\dots$$

(2)

(b) Find the x coordinates of the points on C where the gradient is 4
Show clear algebraic working.



.....

(4)

(Total for Question 11 is 6 marks)



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6. June 2023 1HR/Q21

The curve **T** has equation $y = x^3 - 2x^2 - 9x + 15$

(a) Find $\frac{dy}{dx}$

$$\frac{dy}{dx} = \dots\dots\dots$$

(2)

(b) Find the range of values of x for which **T** has a positive gradient.
Give your values correct to 3 significant figures.
Show your working clearly.



.....

(4)

(Total for Question 21 is 6 marks)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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7. Jan 2023 1H/Q20

The radius of a right circular cylinder is x cm.

The height of the cylinder is $\left(\frac{800}{\pi x} - x\right)$ cm.

The volume of the cylinder is V cm³

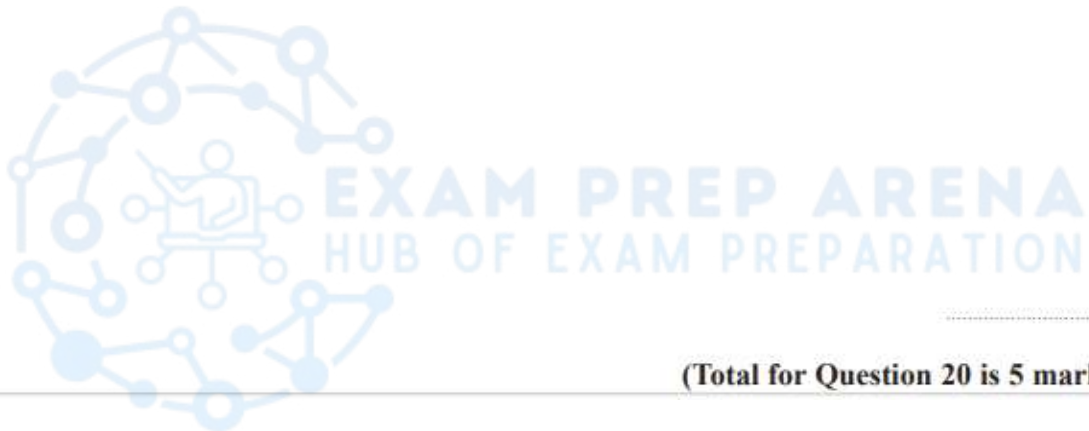
Find the maximum value of V

Give your answer correct to the nearest whole number.



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8. Jan 2023 1HR/Q23

G is the point on the curve with equation $y = 8x^2 - 14x - 6$ where the gradient is 10

The straight line Q passes through the point G and is perpendicular to the tangent at G

Find an equation for Q

Give your answer in the form $ax + by + c = 0$ where a , b and c are integers.



(Total for Question 23 is 5 marks)



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9. June 2022 1H/Q17

A particle P moves along a straight line.
The fixed point O lies on this line.

The displacement of P from O at time t seconds, $t \geq 1$, is s metres where

$$s = 4t^2 + \frac{125}{t}$$

The velocity of P at time t seconds, $t \geq 1$, is v m/s

Work out the distance of P from O at the instant when $v = 0$



..... m

(Total for Question 17 is 5 marks)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 - DIFFERENTIATION

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10. June 2022 1HR/Q22

The diagram shows a sketch of part of the curve with equation $y = x^2 - \frac{p}{x}$ where p is a positive constant.

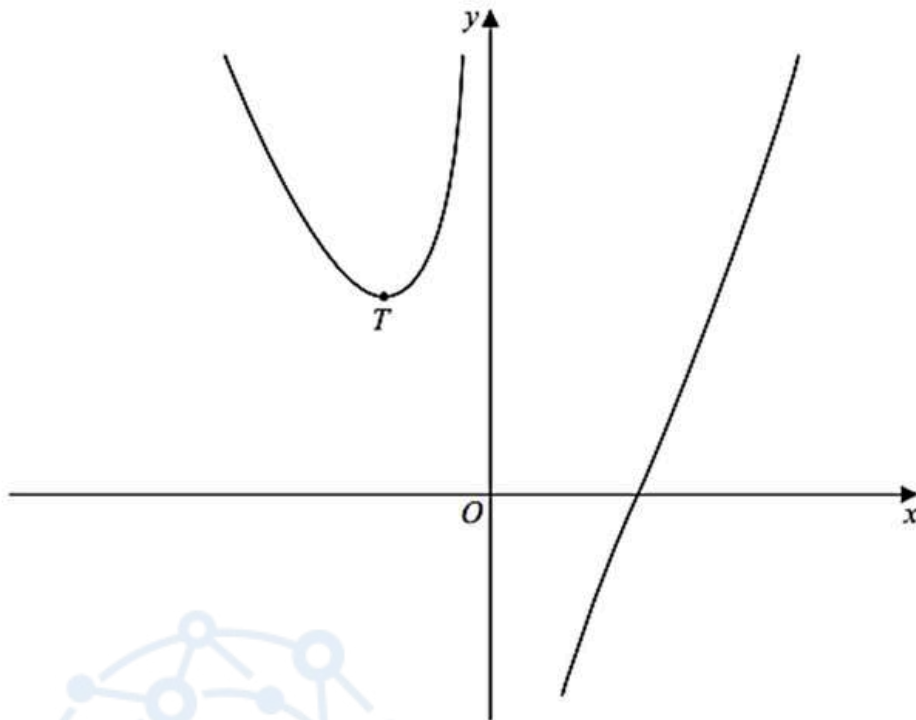


Diagram NOT accurately drawn

For all values of p , the curve has exactly one turning point and this turning point is a minimum shown as the point T in the sketch.

For the curve where the x coordinate of T is -3

(a) find the value of p

$p = \dots\dots\dots$
(4)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 - DIFFERENTIATION

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The line with equation $y = k$ is a tangent to the curve with equation $y = x^2 - \frac{16}{x}$

(b) Find the value of k



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$k = \dots\dots\dots$
(3)

(Total for Question 22 is 7 marks)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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11. Jan 2022 1H/Q24

The curve **C** has equation $y = ax^3 + bx^2 - 12x + 6$ where a and b are constants.

The point A with coordinates $(2, -6)$ lies on **C**

The gradient of the curve at A is 16

Find the y coordinate of the point on the curve whose x coordinate is 3

Show clear algebraic working.



$y = \dots\dots\dots$

(Total for Question 24 is 6 marks)



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12. Jan 2022 1HR/Q23

Two particles, P and Q , move along a straight line.

The fixed point O lies on this line.

The displacement of P from O at time t seconds is s metres, where

$$s = t^3 - 4t^2 + 5t \quad \text{for } t > 1$$

The displacement of Q from O at time t seconds is x metres, where

$$x = t^2 - 4t + 4 \quad \text{for } t > 1$$

Find the range of values of t where $t > 1$ for which both particles are moving in the same direction along the straight line.



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(Total for Question 23 is 6 marks)

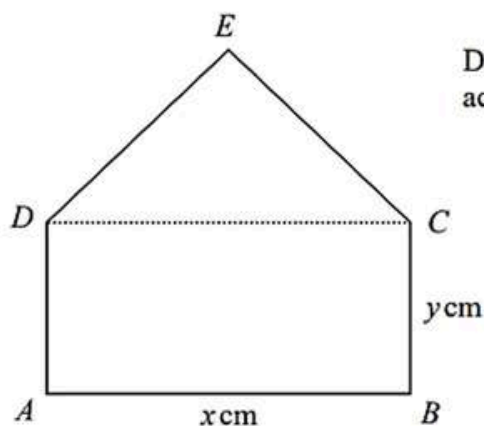


EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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13. Nov 2021 1H/Q19

$ABCED$ is a five-sided shape.



$ABCD$ is a rectangle.

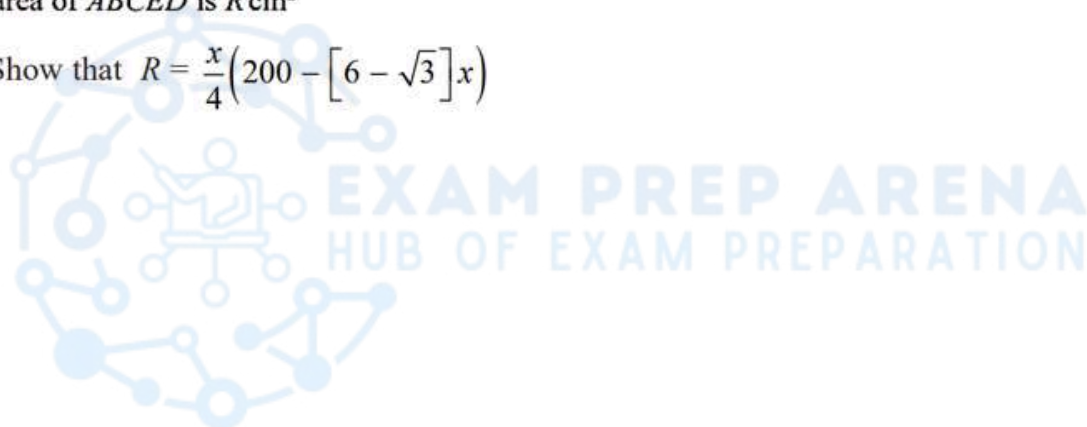
CED is an equilateral triangle.

$AB = x$ cm $BC = y$ cm

The perimeter of $ABCED$ is 100 cm.

The area of $ABCED$ is R cm²

(a) Show that $R = \frac{x}{4}(200 - [6 - \sqrt{3}]x)$



(3)



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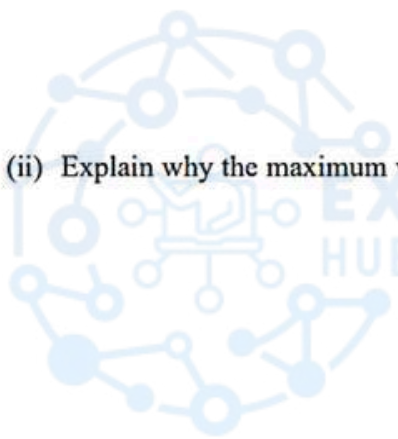
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(b) (i) Find the value of x for which R has its maximum value.

Give your answer in the form $\frac{p}{q - \sqrt{3}}$ where p and q are integers.

$x =$
(2)

(ii) Explain why the maximum value of R is given by this value of x .



EXAM PREP ARENA
HUB OF EXAM PREPARATION

.....
.....
.....

(1)

(Total for Question 19 is 6 marks)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 - DIFFERENTIATION

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14. Jan 2021 1H/Q21

A curve has equation $y = f(x)$

The coordinates of the minimum point on this curve are $(-9, 15)$

(a) Write down the coordinates of the minimum point on the curve with equation

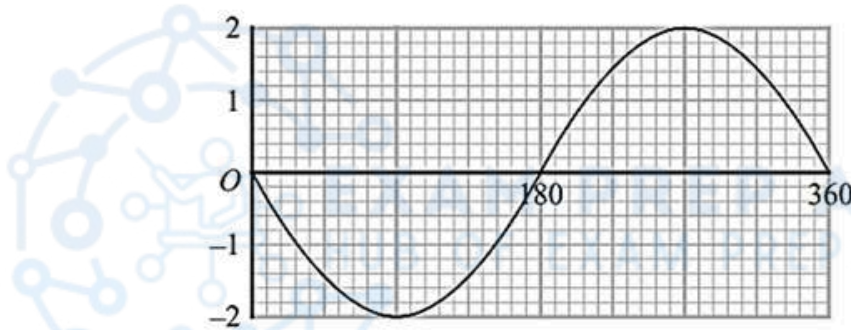
(i) $y = f(x + 3)$

(.....,))

(ii) $y = \frac{1}{3} f(x)$

(.....,))
(2)

The graph of $y = a \cos(x + b)^\circ$ for $0 \leq x \leq 360$ is drawn on the grid below.



Given that $a > 0$ and that $0 < b < 360$

(b) find the value of a and the value of b .

$a =$

$b =$

(2)

(Total for Question 21 is 4 marks)



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15. Jan 2021 1HR/Q20

A particle P is moving along a straight line.
The fixed point O lies on the line.

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

$$s = t^3 - 9t^2 + 33t - 6$$

Find the minimum speed of P .



..... m/s

(Total for Question 20 is 5 marks)



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16. Nov 2020 1H/Q23

Curve C has equation $y = px^3 - mx$ where p and m are positive integers.

Find the range of values of x , in terms of p and m , for which the gradient of C is negative.



.....
(Total for Question 23 is 4 marks)



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17. Nov 2020 1HR/Q13

The curve C has equation $y = 5x^3 - x^2 - 6x + 4$

(a) Find $\frac{dy}{dx}$

$$\frac{dy}{dx} = \dots\dots\dots (2)$$

There are two points on the curve C at which the gradient of the curve is 2

(b) Find the x coordinate of each of these two points.
Show clear algebraic working.



.....
(4)

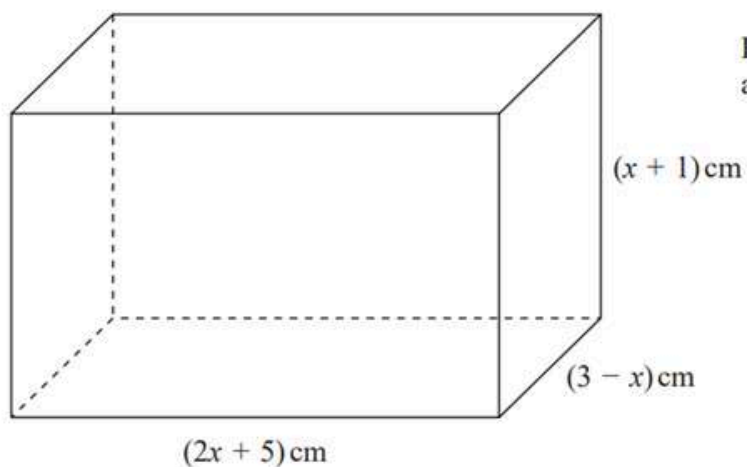
(Total for Question 13 is 6 marks)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 - DIFFERENTIATION

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18. Jan 2020 1H/Q15



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

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



(3)



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

- (b) Find this value of x .
Show your working clearly.
Give your answer correct to 3 significant figures.



$x =$
(5)

(Total for Question 15 is 8 marks)



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19. Jan 2020 1HR/Q23

A particle moves along a straight line.

The fixed point O lies on this line.

The displacement of the particle from O at time t seconds, $t \geq 0$, is s metres where

$$s = t^3 + 4t^2 - 5t + 7$$

At time T seconds the velocity of P is V m/s where $V \geq -5$

Find an expression for T in terms of V .

Give your expression in the form $\frac{-4 + \sqrt{k + mV}}{3}$ where k and m are integers to be found.



$T =$

(Total for Question 23 is 6 marks)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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20. June 2019 1H/Q24

A particle P is moving along a straight line that passes through the fixed point O .
The displacement, s metres, of P from O at time t seconds is given by

$$s = t^3 - 6t^2 + 5t - 4$$

Find the value of t for which the acceleration of P is 3 m/s^2



$t = \dots\dots\dots$

(Total for Question 24 is 4 marks)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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21. June 2019 1HR/Q16

A particle P is moving along a straight line.
The fixed point O lies on this line.

At time t seconds, the displacement, s metres, of P from O is given by

$$s = 4t^3 - 6t^2 + 5t$$

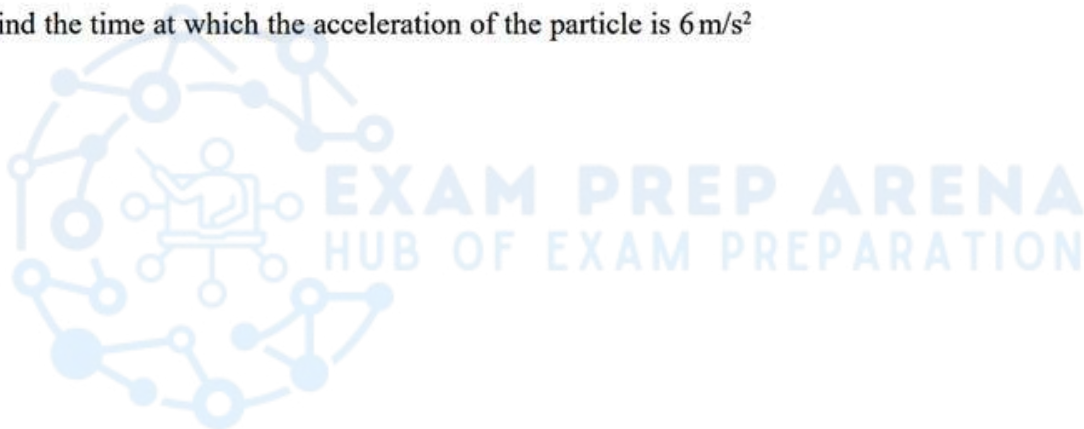
At time t seconds, the velocity of P is v m/s.

(a) Find an expression for v in terms of t .

$$v = \dots\dots\dots$$

(2)

(b) Find the time at which the acceleration of the particle is 6 m/s^2



$$\dots\dots\dots \text{ seconds}$$

(3)

(Total for Question 16 is 5 marks)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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22. Jan 2019 1H/Q12

The curve C has equation $y = \frac{1}{3}x^3 - 9x + 1$

(a) Find $\frac{dy}{dx}$

$$\frac{dy}{dx} = \quad (2)$$

(b) Find the range of values of x for which C has a negative gradient.



(3)

(Total for Question 12 is 5 marks)



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23. Jan 2019 1HR/Q13

A curve C has equation $y = x^3 - x^2 - 8x + 12$

(a) Find $\frac{dy}{dx}$

$$\frac{dy}{dx} = \dots\dots\dots (2)$$

The curve C has two turning points.

(b) Work out the x coordinates of the two turning points.
Show your working clearly.



(c) Show that the x -axis is a tangent to the curve C.

(2)

(Total for Question 13 is 7 marks)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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24. June 2018 1HR/Q19

The curve shown in the diagram has equation

$$y = x^3 - 27x + k \text{ where } k \text{ is a positive constant with } k < 54$$

The curve has a maximum point at $A(a, b)$

The curve has a minimum point at $B(c, d)$

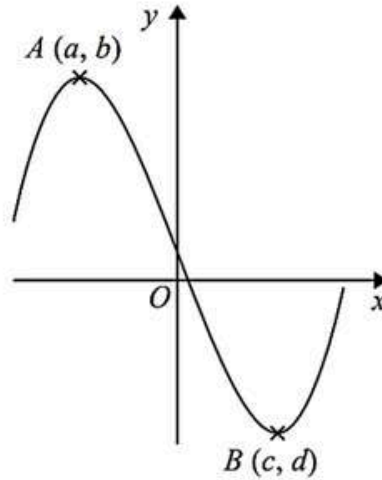
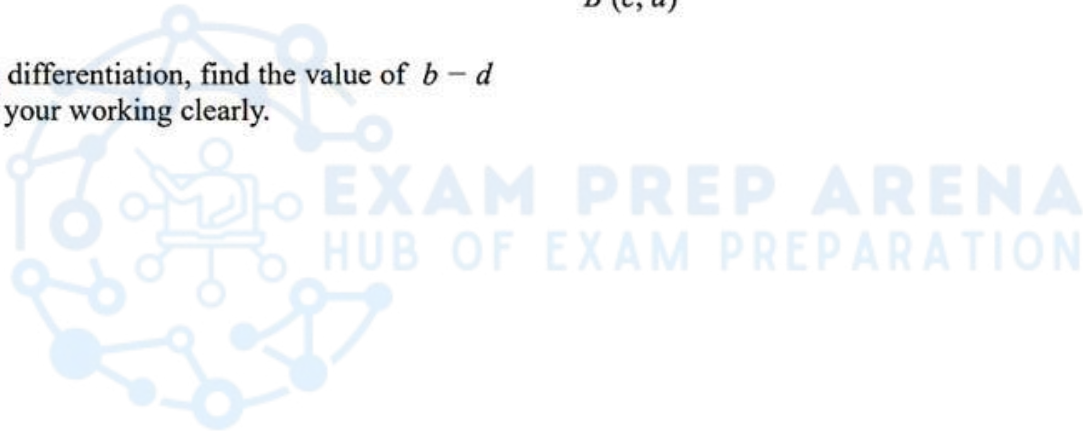


Diagram NOT
accurately drawn

Using differentiation, find the value of $b - d$
Show your working clearly.



(Total for Question 19 is 6 marks)



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 - DIFFERENTIATION

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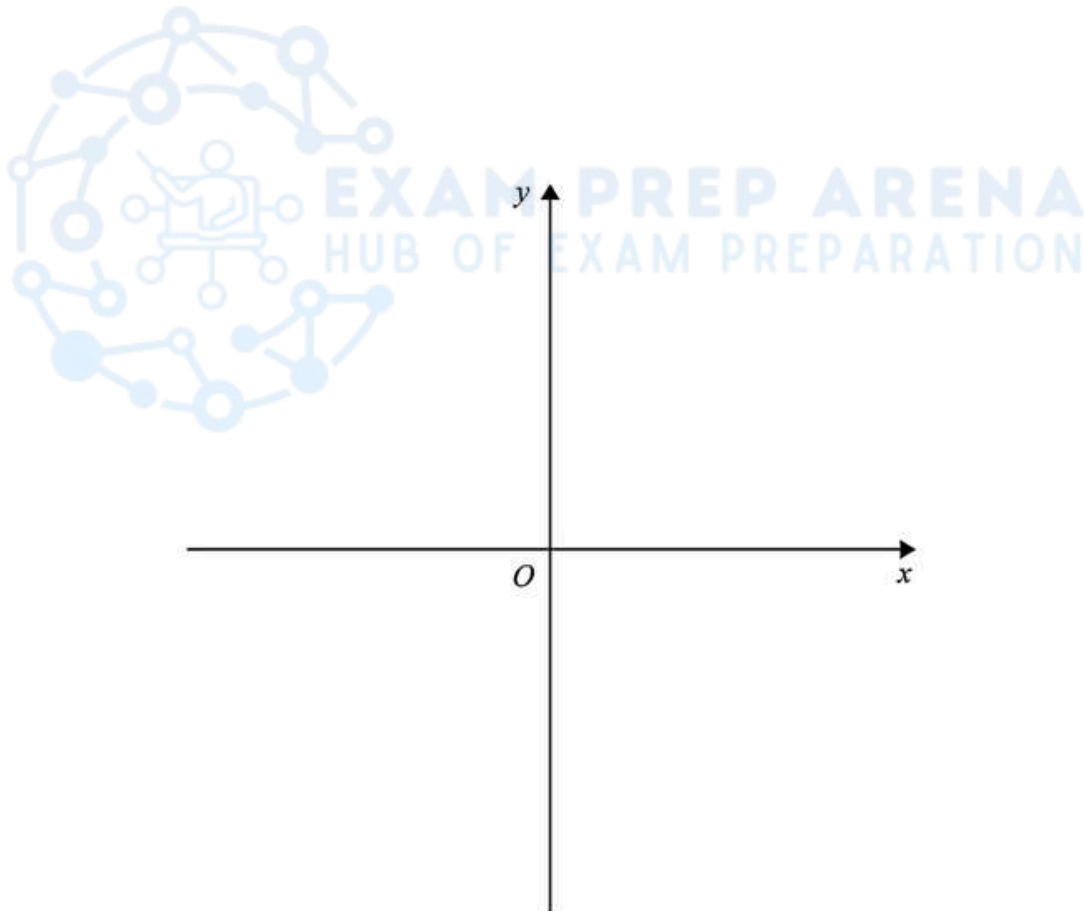
25. Sample 2018 1H/Q21

The curve C has equation $y = x^2 - 6x + 4$

Using the axes below, sketch the curve C .

On your sketch show clearly

- (i) the exact coordinates of any points of intersection of C with the coordinate axes,
- (ii) the coordinates of the turning point.



(Total for Question 21 is 6 marks)



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MARKING SCHEME

1. Nov 2024 1H/Q20

20	$4 \times 2x^3$ or $8x^3$ or ± 64		4	M1 for differentiating one term correctly
	$8x^3 - 64 = 0$ oe			M1 dep on M1 The equation must be in the form $ax^3 - 64 = 0$ oe where $a \neq 0$ or $8x^3 + b = 0$ oe where $b \neq 0$ where a and b are constants
	$x = \sqrt[3]{\frac{64}{8}} (= 2)$			M1 dep on previous M1 for solving for x . The equation must be in the form $ax^3 - 64 = 0$ oe where $a \neq 0$ or $8x^3 + b = 0$ oe where $b \neq 0$ where a and b are constants
	<i>Working required</i>	$y = -96$		A1 oe eg $y + 96 = 0$ or $y = 0x - 96$ or $-y = 96$ dep on M3 must be an equation in terms of y Do not accept -96 or $(2, -96)$
				Total 4 marks

2. June 2024 1H/Q18

18	$3x^2$ or -40		5	M1 for differentiating one of the first two terms correctly
	$3x^2 - 40$			A1 for both terms correct and no additions
	" $3x^2 - 40$ " = 8			M1 ft dep on M1 for equating their quadratic derivative with 8 (Derivative must be in the form $ax^2 - 40$ or $3x^2 - b$ where $a \neq 0$ and $b \neq 0$)
	$(y = "4" - 40 \times "4" + 1 (= -95)$ or $y = ("4")^3 - 40 \times "4" + 1 (= 97)$			M1 ft dep on previous M1 for substituting at least one x value into y NB Following through from $ax^2 - 40 = 8$ or $3x^2 - b = 8$, their x values must be correct
	<i>Working not required, so correct answer scores full marks (unless from obvious incorrect working)</i>	$(4, -95), (-4, 97)$		A1 both coordinates must be paired correctly
				Total 5 marks

3. June 2024 1HR/Q19

18	$3x^2$ or -40		5	M1 for differentiating one of the first two terms correctly
	$3x^2 - 40$			A1 for both terms correct and no additions
	" $3x^2 - 40$ " = 8			M1 ft dep on M1 for equating their quadratic derivative with 8 (Derivative must be in the form $ax^2 - 40$ or $3x^2 - b$ where $a \neq 0$ and $b \neq 0$)
	$(y = "4" - 40 \times "4" + 1 (= -95)$ or $y = ("4")^3 - 40 \times "4" + 1 (= 97)$			M1 ft dep on previous M1 for substituting at least one x value into y NB Following through from $ax^2 - 40 = 8$ or $3x^2 - b = 8$, their x values must be correct
	<i>Working not required, so correct answer scores full marks (unless from obvious incorrect working)</i>	$(4, -95), (-4, 97)$		A1 both coordinates must be paired correctly
				Total 5 marks



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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4. Nov 2023 1H/Q16

16	$\left(\frac{dy}{dx} = \right) 3 \times 4x^2 - 8 (= 12x^2 - 8)$		4	B2 for $3 \times 4x^2 - 8$ or $12x^2 - 8$ (with no other terms) (B1 for one term, ie $3 \times 4x^2$ or $12x^2$ or -8)
	" $12x^2 - 8 = \frac{1}{3}$ "			M1 for equating their initial derivative with the given gradient. Derivative must be a quadratic (dep on B1)
	<i>Working not required, so correct answer scores full marks (unless from obvious incorrect working)</i>	$\pm \frac{5}{6}$		A1 oe Ignore y values Allow $\pm 0.83(333\dots)$ or $\pm \sqrt{\frac{25}{36}}$ oe
				Total 4 marks

5. June 2023 1H/Q11

11 (a)		$12x^2 + 2x - 20$	2	M1 for at least 2 of $12x^2$, $2x$, -20 A1
(b)	$12x^2 + 2x - 20 = 4$ oe		4	M1 ft, for equating their dy/dx to 4
	$12x^2 + 2x - 24 (= 0)$ or $6x^2 + x - 12 (= 0)$			M1 (dep on M1) ft their dy/dx in the form $ax^2 + bx + c$
	eg $(6x - 8)(2x + 3) (= 0)$ or $(3x - 4)(2x + 3) (= 0)$ or $x = \frac{-2 \pm \sqrt{(2)^2 - (4 \times 12 \times -24)}}{2 \times 12}$			M1 for solving their three-term quadratic equation using any correct method - if factorising, allow brackets which expanded give 2 out of 3 terms correct (if using formula or completing the square allow one sign error and some simplification – allow as far as eg $\frac{-2 \pm \sqrt{4 + 1152}}{24}$ oe)
	<i>Working required</i>	$\frac{4}{3}, -\frac{3}{2}$		A1 (dep on M2) oe, allow 1.33(3...) for $\frac{4}{3}$, both values – isw any attempt to find y coordinates
				Total 6 marks

6. June 2023 1HR/Q21

21 (a)	$3x^2$ or $-2 \times 2x$ or $-4x$ or -9 oe		2	M1 for differentiating one term correctly A1 for a correct expression Allow $3x^2 - 2 \times 2x - 9$
		$3x^2 - 4x - 9$		
(b)	$(x =) \frac{4 \pm \sqrt{(-4)^2 - (4 \times 3 \times -9)}}{2 \times 3}$ or $3 \left[\left(x - \frac{2}{3}\right)^2 - \left(\frac{2}{3}\right)^2 \right] - 9 (= 0)$		4	M1 for finding the critical values for a 3-term quadratic using any correct method - if using formula or completing the square allow one sign error and some simplification – allow as far as eg $\frac{4 \pm \sqrt{16 + 108}}{6}$ oe or eg $3 \left(x - \frac{2}{3}\right)^2 - 10\frac{1}{3}$ oe
		-1.19 and 2.52		A1 for critical values of -1.19 and 2.52 or better (for this A1 mark allow -1.2 or -1.18 and 2.5 or $\frac{2 \pm \sqrt{31}}{3}$ oe)
		$x < -1.19$		A1 awrt -1.19
		$x > 2.52$		A1 awrt 2.52
				Total 6 marks



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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7. Jan 2023 1H/Q20

20	$(V =) \pi x^2 \left(\frac{800}{\pi x} - x \right)$ or $800x - \pi x^3$ oe		5	M1 for volume of cylinder (in terms of one variable, e.g. x or r)
	$\left(\frac{dV}{dx} = \right) 800 - 3\pi x^2$			M1ft for differentiating an expression in one variable to find 800 or $\pm 3\pi x^2$ (must come from a cubic in the form $800x \pm \pi x^3$ or $800x \pm ax^3$ or $bx \pm \pi x^3$ where $a \neq 0$ and $b \neq 0$)
	" $800 - 3\pi x^2 = 0$ "			M1ft dep on previous M1 for equating their $\frac{dV}{dx}$ to zero (must be a quadratic in the form $800 \pm ax^2$ or $b \pm 3\pi x^2$ where $a \neq 0$ and $b \neq 0$)
	$(x =) \sqrt{\frac{800}{3\pi}}$ ($= \sqrt{84.8(8263\dots)}$) or $\frac{\sqrt{9600\pi}}{6\pi}$ or $9.2(13177\dots)$			A1 for a correct value of x Allow use of quadratic formula
	Award marks within the range from correct working	4914		A1 accept 4910 – 4914
				Total 5 marks

8. Jan 2023 1HR/Q23

23	$\left(\frac{dy}{dx} = \right) 16x - 14$		5	M1 Differentiation to obtain 2 terms with at least 1 correct
	$16x - 14 = 10$			M1 their $dy/dx = 10$ dep on M1
	$(1.5, -9)$ or $x = 1.5, y = -9$			A1 coordinates of point on curve at which gradient is 10 – allow given as coordinates or as x worked out and y worked out if meaning is clear
	eg $y - -9 = -\frac{1}{10}(x - \frac{3}{2})$ oe or eg $-9 = -\frac{1}{10} \times 1.5 + c$ oe			M1 A correct method to find the equation for line Q using $(1.5, -9)$
	Correct answer scores full marks (unless from obvious incorrect working)	$2x + 20y + 177 = 0$		A1 oe where a, b, c are integers eg $10x + 100y + 885 = 0$
				Total 5 marks

9. June 2022 1H/Q17

17	$8t$ or $\pm 125t^{-2}$ oe		5	M1 for differentiating one term correctly
	$8t - 125t^{-2}$ oe or $8t - \frac{125}{t^2}$ oe			A1 for both terms correct
	$8t - 125t^{-2} = 0$ and $(t =) \sqrt[3]{\frac{125}{8}}$ ($= 2.5$)			M1 for equating their $8t \pm at^{-2}$ oe or $bt \pm 125t^{-2}$ oe to zero and solving for t ie must have correct powers of t and at least one correct coefficient and correct isolation of t
	$4("2.5")^2 + \frac{125}{"2.5"}$			M1 dep on previous M mark for substituting into s
		75		A1
				Total 5 marks

10. June 2022 1HR/Q22

22	(a)	$\left(\frac{dy}{dx} = \right) 2x + px^{-2}$ oe		4	M2 Both terms correct (M1 for one term correct)
		$2(-3) + p(-3)^{-2} (= 0)$			M1 (dep on M1) substitute -3 into a derivative of the form $ax + bx^{-2}$
			54		A1
	(b)	$\left(\frac{dy}{dx} = \right) 2x + 16x^{-2} = 0$		3	M1 set $\frac{dy}{dx} = 0$, at least one term correct
		eg $2x^3 + 16 = 0$ or $2x^3 = -16$ or $x^3 = -8$ or $x = \sqrt[3]{-8}$ or $x = -2$			M1 rearrangement of the correct equation to remove the negative power of x
			12		A1
				Total 7 marks	



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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11. Jan 2022 1H/Q24

24	eg $-6 = 8a + 4b - 24 + 6$ or $8a + 4b = 12$ oe		6	M1 for substituting $x = 2$ and $y = -6$ into the equation for C
	$\left(\frac{dy}{dx}\right) = 3ax^2 + 2bx - 12$ oe			M1 at least 2 terms correct
	eg $16 = 12a + 4b - 12$ or $12a + 4b = 28$ oe			M1ft (dep on previous M1) follow through their $\frac{dy}{dx}$
	$a = 4$ and $b = -5$			M1 for $a = 4$ and $b = -5$
	eg $"4" \times 3^3 + "-5" \times 3^2 - 12 \times 3 + 6$			M1ft correctly substituting their a , their b and $x = 3$ into the equation for C
		33		A1 (dep on M3) allow (3, 33)
				Total 6 marks

12. Jan 2022 1HR/Q23

23	$3t^2 - 2 \times 4t + 5$ or $3t^2 - 8t + 5$		6	M1 for differentiation of s with 2 out of 3 terms correct (can be implied by subsequent working)
	$3t^2 - 2 \times 4t + 5 = 0$ or $3t^2 - 8t + 5 = 0$			M1 (dep on previous M1) for equating at least a 2TQ to zero (allow inequality signs), E.g. $3t^2 - 8t = 0$ or $3t^2 + 5 = 0$ (can be implied by subsequent working)
	$(t = \frac{5}{3})$ oe (and $t = 1$)			A1 for $\frac{5}{3}$ (and $t = 1$ may be crossed out or absent) (allow $\frac{5}{3} = 1.6(66666)$ to 2 sf truncated or rounded)
	$2t - 4 = 0$			M1 for differentiation of x to find $at + b = 0$ (allow inequality signs) where $a = 2$ and $b = -4$
	$(t = 2)$			A1 for a correct value of t
		$(1 <) t < \frac{5}{3}$ and $t > 2$		A1 oe ($t > 1$) $t < \frac{5}{3}$ and $t > 2$
				Total 6 marks

13. Nov 2021 1H/Q19

19 (a)	E.g. $x + y + x + y + x = 100$ oe or $3x + 2y = 100$ oe $\left(y = \frac{100 - 3x}{2}\right)$		3	M1 for a correct equation for the perimeter of the shape or for a correct expression for the area of triangle CED
	E.g. $\frac{1}{2} \times x \times x \times \sin 60$ $\left(= \frac{1}{2} \times x \times x \times \frac{\sqrt{3}}{2}\right)$ $\left(= \frac{x^2 \sqrt{3}}{4}\right)$	E.g. $x^2 = \left(\frac{x}{2}\right)^2 + h^2$ and $= \frac{1}{2} \times x \times \frac{x\sqrt{3}}{2} \left(= \frac{x^2 \sqrt{3}}{4}\right)$		
	$x \left(\frac{100 - 3x}{2}\right) + \frac{x^2 \sqrt{3}}{4}$ oe			M1 for the area of the shape in terms of x only
	E.g. $x \left(\frac{200 - 6x}{4}\right) + \frac{x^2 \sqrt{3}}{4}$ or $\frac{x}{4}(200 - 6x + x\sqrt{3})$ or $\frac{200x - 6x^2}{4} + \frac{x^2 \sqrt{3}}{4}$ or $\frac{x}{4}(200x - 6x^2 + x^2 \sqrt{3})$	Shown		A1 for the area given in correct form with full working shown (at least one intermediate step before the answer)



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(b) (i)	$\left(\frac{dR}{dx}\right) = 50 - \frac{3}{2} \times 2 \times x + 2 \times \frac{x\sqrt{3}}{4} = 0$ oe		2	M1 for differentiation of correct expression with 2 out of 3 terms correct and equated to 0 (can be implied by subsequent working)
	<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	$\frac{100}{6-\sqrt{3}}$		A1 for a correct expression
(ii)		Correct reason	1	B1 for correct reason R is a quadratic with negative coefficient of x^2 E.g. the graph of R is \cap shaped or (allow $\frac{d^2R}{dx^2} < 0$ oe)
				Total 6 marks

14. Jan 2021 1H/Q21

21	(a)(i)		(-12, 15)	1	B1
	(ii)		(-9, 5)	1	B1
	(b)		$a = 2$ and $b = 90$	2	B2 for both values correct (B1 for $a = 2$ or $b = 90$ or $a = -2$ and $b = -90$)
				Total 4 marks	

15. Jan 2021 1HR/Q20

20	$(v =) 3t^2 - 9 \times 2t + 33$			5	M1 for differentiating at least 2 terms correctly
	$(a =) 3 \times 2t - '18'$ or $(t =) -\frac{-18}{2 \times 3} (= \frac{18}{6})$	$(v =) 3[(t-3)^2 - (3)^2] (+33)$ or $(v =) 3[(t-3)^2 - (3)^2] (+11)$			M1 dep ft must be a two term linear equation or for the use of $(t =) -\frac{b}{2a}$ or for a correct first step for completing the square on at least a two term quadratic
	$6t - 18 = 0$ or $t = 3$	$(v =) 3[(t-3)^2 - (3)^2] + 33$ or $(v =) 3[(t-3)^2 - (3)^2] + 11$			M1 dep on at least M2 for equating their acceleration to 0 or for a correct method for completing the square on at least a two term quadratic
	$3 \times '3'^2 - 18 \times '3' + 33$	$(v =) 3(t-3)^2 + 6$ or $(v =) 3[(t-3)^2 + 2]$			M1 dep on at least M2 for substituting their t into v or for a seeing a correct simplified expression after completing the square
				6	A1
				Total 5 marks	

16. Nov 2020 1H/Q23

23	$\left(\frac{dy}{dx}\right) = 3px^2 - m$		4	M1 for $3px^2$ or $-m$
	$3px^2 - m < 0$ oe			M1 ft dep on M1 for setting up an inequality with their ' $3px^2 - m$ ' must be a two-term expression in the form $apx^2 \pm m$
	$\pm \sqrt{\frac{m}{3p}}$			B1 for both critical values
		$-\sqrt{\frac{m}{3p}} < x < \sqrt{\frac{m}{3p}}$		A1 may be seen as two separate inequalities
				Total 4 marks



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17. Nov 2020 1HR/Q13

13	(a)		$15x^2 - 2x - 6$	2	B2 for correct differentiation (B1 for 2 of $15x^2$, $-2x$, -6 correct)
	(b)	e.g. " $15x^2 - 2x - 6$ " = 2 oe		4	M1 ft, for equating their dy/dx to 2
		$15x^2 - 2x - 8 (= 0)$			M1 (dep on M1) ft their three-term quadratic
		e.g. $(3x + 2)(5x - 4) (= 0)$ $x = \frac{2 \pm \sqrt{(-2)^2 - (4 \times 15 \times -8)}}{2 \times 15}$			M1 for solving their quadratic equation using any correct method - if factorising, allow brackets which expanded give 2 out of 3 terms correct (if using formula or completing the square allow one sign error and some simplification - allow as far as e.g. $\frac{2 \pm \sqrt{4 + 480}}{30}$ oe)
			$-\frac{2}{3}, \frac{4}{5}$		A1 oe, dep on M2 (allow -0.66 or better), Both values - isw any attempt to find y coordinates
Total 6 marks					

18. Jan 2020 1H/Q15

15	(a)	$(2x + 5)(x + 1) = 2x^2 + 2x + 5x + 5$ $(= 2x^2 + 7x + 5)$ or $(x + 1)(3 - x) = -x^2 + 3x - x + 3$ $(= -x^2 + 2x + 3)$ or $(3 - x)(2x + 5) = -2x^2 + 6x - 5x + 15$ $(= -2x^2 + x + 15)$		3	M1 for multiplying out two brackets correctly at least 3 terms correct	M2 for at least 4 terms correct out of a maximum of 8 terms $6x^2 - 2x^3 + 6x - 2x^2 + 15x - 5x^2 + 15 - 5x$
		E.g. [[$(2x^2 + 7x + 5)(3 - x) =$] $-2x^3 - 7x^2 - 5x + 6x^2 + 21x + 15$ or [[$(-x^2 + 2x + 3)(2x + 5) =$] $-2x^3 - 5x^2 + 10x + 4x^2 + 6x + 15$ or [[$(-2x^2 + x + 15)(x + 1) =$] $-2x^3 - 2x^2 + 15x + x^2 + x + 15$			M1 for at least 3 terms correct out of a maximum of 6 terms or for at least 4 terms correct out of a maximum of 8 terms	
			Shown		A1	

15	(b)	$\left(\frac{dV}{dx} = \right) 16 - 2x + (3 \times -2x^2)$ oe		5	M1 for the correct differentiation of at least 2 correct terms from 16 or $-2x$ or $(3 \times -2x^2)$
		$\left(\frac{dV}{dx} = \right) 16 - 2x - 6x^2$ oe			A1 for a correct differentiated expression
		$'16 - 2x - 6x^2 = 0$ oe			M1 (dep on M1) for equating their differentiated expression to zero
		E.g. $(x =) \frac{-2 \pm \sqrt{2^2 - 4 \times 6 \times -16}}{2 \times 6}$ oe (accept + in place of \pm) or E.g. $6 \left(\left(x + \frac{1}{6} \right)^2 - \left(\frac{1}{6} \right)^2 \right) - 16 (= 0)$ oe			M1 (dep on M1) for a complete method to solve their 3-term quadratic equation (allow one sign error and some simplification - allow as far as $\frac{-2 \pm \sqrt{4 + 384}}{12}$)
			1.47		A1 dep on M1 for answer in range 1.47 - 1.5 from correct working (Must reject -1.80 to -1.81 if calculated)
Total 8 marks					



EDEXCEL IGCSE MATHEMATICS MODULAR UNIT 2 – DIFFERENTIATION

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19. Jan 2020 1HR/Q23

18	ai				B1	tangent drawn at $P(x=2)$
					M1	(dep on B1) for a method to find gradient e.g. $\frac{\text{difference in } y\text{-values}}{\text{difference in } x\text{-values}}$
			-0.6	3	A1	(dep on B1) accept answers in range -0.4 to -0.7 and from correct figures for their line
	aii	e.g. $y = -0.6x + c$ or $y = mx + 3.6$ or $2.4 = -0.6 \times 2 + c$			M1	for start of method to find the tangent equation e.g. $y = mx + c$ where m is their gradient or $y = mx + c$ where c is the y -intercept for their tangent or for substituting a point from the curve e.g. (2, 2.4) into $y = mx + c$ where m is their gradient
			$y = -0.6x + 3.6$	2	A1	fit their gradient from (i) and intercept of their tangent, so long as intercept / value of c is > 3
	b		3		B1	
			-1	2	B1	
Total 7 marks						

20. June 2019 1H/Q24

24		$(v=) 3t^2 - 6 \times 2t + 5 (+0)$		4	M1	for differentiating at least 2 terms correctly
		$(a=) 3 \times 2t - 12$			M1	dep ft
		$6t - 12 = 3$			M1	dep on at least M1 for equating their acceleration in terms of t to 3
			2.5 oe		A1	
Total 4 marks						

21. June 2019 1HR/Q16

16	(a)	$3 \times 4t^2 - 2 \times 6t + 5$		2	M1	For 2 terms correct
			$12t^2 - 12t + 5$		A1	Fully correct
	(b)	$24t - 12$		3	M1	Method to differentiate their v , ft a 3 term quadratic expression from (a)
		$"24t - 12" = 6$			M1	ft if previous M1 awarded
			0.75		A1	oe
Total 5 marks						

22. Jan 2019 1H/Q12

Question	Working	Answer	Mark	Notes
12 (a)	$3 \times \frac{1}{3}x^2 - 9$			M1 for $3 \times \frac{1}{3}x^2$ oe or -9 oe
		$x^2 - 9$ oe	2	A1 or for $1x^2 - 9$ oe
(b)		$-3 < x < 3$ oe	3	B3 may be seen as two separate inequalities if not B3 then award B2 for $x < 3$ or $x > -3$ or $-3 \leq x \leq 3$ if not B2 then award B1 for $x^2 - 9 < 0$ or $x^2 < 9$ oe or for $(x-3)(x+3)$ or for $(x \pm) \pm 3$ (values maybe seen in incorrect inequalities)
SC: If no marks awarded and M1 awarded in (a) then award B1 for "quadratic" < 0				



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23. Jan 2019 1HR/Q13

Question	Working	Answer	Mark	Notes
13 (a)		$3x^2 - 2x - 8$	2	B2 (B1 for at least 1 correct non zero term)
(b)	$“3x^2 - 2x - 8” = 0$ $(3x + 4)(x - 2) (=0)$ or $x = \frac{2 \pm \sqrt{100}}{2 \times 3}$ or $x = \frac{2 \pm \sqrt{(-2)^2 - 4 \times 3 \times (-8)}}{2 \times 3}$	$-\frac{4}{3}, 2$	3	M1 Dep on at least B1, ft on M marks only dep on $\frac{dy}{dx}$ being a 3 term quadratic M1
(c)	At $x = 2, y = 2^3 - 2^2 - 8 \times 2 + 12 (=0)$ or at $x = -\frac{4}{3}$, $y = \left(-\frac{4}{3}\right)^3 - \left(-\frac{4}{3}\right)^2 - 8 \times \left(-\frac{4}{3}\right) + 12$ $\left(= \frac{500}{27}\right)$	Shown	2	A1 (dep 2nd M1) M1 Substitutes at least one of $-\frac{4}{3}$ or 2 or their answer from (b) into $(y =)x^3 - x^2 - 8x + 12$ A1 must show that (2,0) is a turning point on the curve and give concluding statement

24. June 2018 1HR/Q19

19	$\frac{dy}{dx} = 3x^2 - 27$	108	M1 for at least one of $3x^2$ or 27
	$3x^2 - 27 = 0$		M1 (dep) for a 2 or 3 term quadratic =0
	$x = \pm 3$		A1
	When $x = -3, b = (-3)^3 - 27(-3) + k (= 54 + k)$ When $x = 3, d = 3^3 - 27(3) + k (= -54 + k)$		M1 for either substituting $x = 3$ or $x = -3$ into the y expression. Only award this mark if k or a number representing k is in the expression for b or d
	$b - d = 54 + k - (-54 + k)$		M1 dep on all previous M marks Expressions for b and d must have k or the same number representing k
			A1
Total 6 marks			

25. Sample 2018 1H/Q21

21	e.g. $\frac{dy}{dx} = 2x - 6$ or $(x - 3)^2 - 3^2 + 4$ or $\frac{‘3 + \sqrt{5}’ + ‘3 - \sqrt{5}’}{2}$		M1
	$(x - 3)^2 - 5$ or $x = 3$		A1 (ft providing previous M1 scored) for (3, -5)
	eg. $x = \frac{- -6 \pm \sqrt{(-6)^2 - 4 \times 1 \times 4}}{2 \times 1}$ or $x = 3 \pm \sqrt{3^2 - 4}$ or $(x - 3)^2 = 5$		M1 for correct method to find roots
	$x = 3 \pm \sqrt{5}$		A1 or exact equivalents
		Correct graph	6
			B2 for fully correct labelled graph (see end of mark scheme) (B1 for parabola intercepting y -axis at (0, 4))
Total 6 marks			

