1.7 Pure: Differentiation: 30-minute Pack

EDEXCEL 9MA0 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The curve C has equation $y = (3x^2 - 4x + 1)^5$.

(a) Using the chain rule, find dy/dx. **(3)**

(b) Find the exact value of the gradient of C at the point where x = 2. **(2)**

(c) Find the equation of the tangent to C at the point where x = 2, giving your answer in the form y = mx + c. **(3)**

(Total for Question 1 is 8 marks)

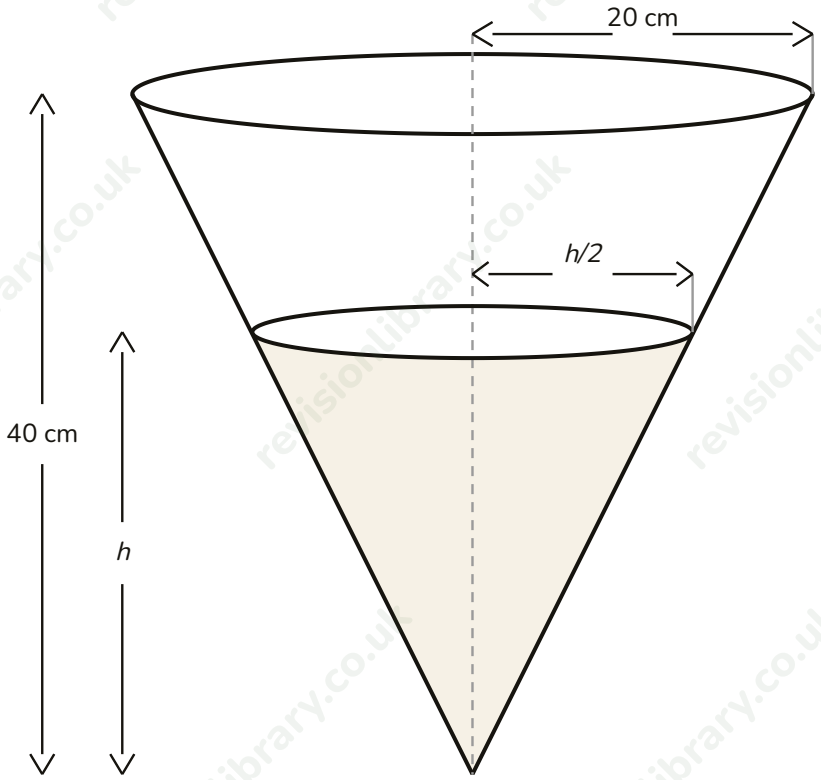
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2 Differentiate $y = 7x^3 - 2x$ with respect to x.

(Total for Question 2 is 1 mark)

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3 Water is poured into an inverted conical container at a constant rate of 30 cm^3/s. The container has height 40 cm and radius 20 cm at the top. By similar triangles, when the depth of water is h cm the radius of the water surface is h/2 cm, so the volume of water is $V = (\pi h^3)/12\ cm^3$.



(a) Show that $dV/dh = (\pi h^2)/4$. **(2)**

(b) Given that $dV/dt = 30$, find an expression for dh/dt in terms of h. **(3)**

(c) Find the rate at which the depth of the water is increasing at the instant when h = 10 cm, giving your answer to 3 significant figures. **(2)**

(d) State one assumption made in modelling this situation that could affect the accuracy of your answer to part (c). **(1)**

(Total for Question 3 is 8 marks)

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4 $f(x) = x^2 - 2x$.

(a) Use differentiation from first principles to show that $f'(x) = 2x - 2$. **(4)**

(b) Hence find the gradient of the curve $y = f(x)$ at the point where $x = 2$. **(2)**

(Total for Question 4 is 6 marks)

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5 The curve C has equation $y = x^3 - 3x^2 - 9x + 4$. Find the x-coordinates of the stationary points of C, and use the second derivative to determine the nature of each.

(Total for Question 5 is 3 marks)

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Mark scheme · 1.7 Pure: Differentiation: 30-minute Pack

Question 1

(a) attempts chain rule of the form $n(3x^2 - 4x + 1)^{n-1}$ x (derivative of bracket)	**M1**
(a) $5(3x^2 - 4x + 1)^4$ correct outer part	**A1**
(a) (6x - 4) correct derivative of the bracket, combined cao	**A1**
(a) Answer: $dy/dx = 5(3x^2 - 4x + 1)^4 (6x - 4)$	
(b) substitutes x = 2 into their dy/dx: $5(5)^4(8)$	**M1**
(b) cao: gradient = 25000	**A1**
(b) Answer: 25000	
(c) finds y-coordinate at x = 2: $y = 5^5 = 3125$	**M1**
(c) uses y - 3125 = 25000(x - 2) (ft their gradient)	**M1**
(c) cao: y = 25000x - 46875	**A1**
(c) Answer: y = 25000x - 46875	

Question 2

$21x^2$ - 2 cao	**B1**
Answer: $dy/dx = 21x^2 - 2$	

Question 3

(a) differentiates $V = (\pi h^3)/12$ to get $(\pi/12)(3h^2)$	**M1**
(a) cso: $dV/dh = (\pi h^2)/4$	**A1**
(a) Answer: $dV/dh = (\pi h^2)/4$ (shown)	
(b) states the chain rule dh/dt = (dV/dt) / (dV/dh)	**M1**
(b) substitutes to get $dh/dt = 30 / ((\pi h^2)/4)$	**M1**
(b) cao: $dh/dt = 120/(\pi h^2)$	**A1**
(b) Answer: $dh/dt = 120/(\pi h^2)$	
(c) substitutes h = 10 into their dh/dt	**M1**
(c) awrt 0.382 cm/s	**A1**
(c) Answer: 0.382 cm/s (awrt)	
(d) valid modelling assumption, e.g. the container is a perfect cone with no leaks/deformation, or water is poured in at a genuinely constant rate, or no water is lost to splashing/evaporation	**B1**
(d) Answer: e.g. the cone is assumed to be a perfect rigid cone with no leaks and the inflow rate is exactly constant	

Question 4

(a) forms [f(x + h) - f(x)]/h	**M1**
(a) expands $f(x + h) = 1(x^2 + 2xh + h^2) - 2(x + h)$	**M1**
(a) simplifies the quotient to 2x + h - 2	**dM1**
(a) lets h tend to 0: f'(x) = 2x - 2 (cso)	**A1**
(a) Answer: f'(x) = 2x - 2	
(b) substitutes x = 2 into f'(x)	**M1**
(b) 2	**A1**
(b) Answer: 2	

Question 5

sets $dy/dx = 3x^2 - 6x - 9 = 0$ and factorises to 3(x-3)(x+1) = 0	**M1**
x = 3 and x = -1 cao	**A1**
$d^2y/dx^2 = 6x-6$ gives minimum at x=3 (d2y/dx2=12>0) and maximum at x=-1 (d2y/dx2=-12<0)	**A1**
Answer: Minimum at x = 3, maximum at x = -1	

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