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0606/21

May/June 2018

2 hours

Additional Materials: Electronic calculator

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

You are reminded of the need for clear presentation in your answers.

The total number of marks for this paper is 80.

This document consists of **15** printed pages and **1** blank page.

Mathematical Formulae**1. ALGEBRA***Quadratic Equation*

For the equation $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Binomial Theorem

$$(a + b)^n = a^n + \binom{n}{1} a^{n-1} b + \binom{n}{2} a^{n-2} b^2 + \dots + \binom{n}{r} a^{n-r} b^r + \dots + b^n,$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

2. TRIGONOMETRY*Identities*

$$\sin^2 A + \cos^2 A = 1$$

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

Formulae for $\triangle ABC$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$\Delta = \frac{1}{2} bc \sin A$$

1 A , B and C are subsets of the same universal set.

(i) Write each of the following statements in words.

(a) $A \not\subset B$ [1]

(b) $A \cap C = \emptyset$ [1]

(ii) Write each of the following statements in set notation.

(a) There are 3 elements in set A or B or both. [1]

(b) x is an element of A but it is not an element of C . [1]

2 The variables x and y are such that $y = \ln(3x - 1)$ for $x > \frac{1}{3}$.

(i) Find $\frac{dy}{dx}$. [2]

(ii) Hence find the approximate change in x when y increases from $\ln(1.2)$ to $\ln(1.2) + 0.125$. [3]

- 3 A 7-character password is to be selected from the 12 characters shown in the table. Each character may be used only once.

	Characters			
Upper-case letters	A	B	C	D
Lower-case letters	e	f	g	h
Digits	1	2	3	4

Find the number of different passwords

- (i) if there are no restrictions, [1]

- (ii) that start with a digit, [1]

- (iii) that contain 4 upper-case letters and 3 lower-case letters such that all the upper-case letters are together and all the lower-case letters are together. [3]

4 Do not use a calculator in this question.

It is given that $x + 4$ is a factor of $p(x) = 2x^3 + 3x^2 + ax - 12$. When $p(x)$ is divided by $x - 1$ the remainder is b .

(i) Show that $a = -23$ and find the value of the constant b . [2]

(ii) Factorise $p(x)$ completely and hence state all the solutions of $p(x) = 0$. [4]

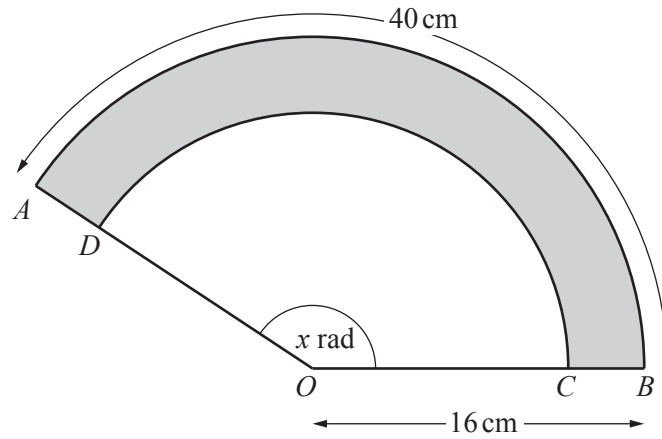
5 The function f is defined by $f(x) = \frac{1}{2x-5}$ for $x > 2.5$.

(i) Find an expression for $f^{-1}(x)$. [2]

(ii) State the domain of $f^{-1}(x)$. [1]

(iii) Find an expression for $f^2(x)$, giving your answer in the form $\frac{ax+b}{cx+d}$, where a , b , c and d are integers to be found. [3]

6



In the diagram AOB and DOC are sectors of a circle centre O . The angle AOB is x radians. The length of the arc AB is 40 cm and the radius OB is 16 cm.

(i) Find the value of x . [2]

(ii) Find the area of sector AOB . [2]

(iii) Given that the area of the shaded region $ABCD$ is 140 cm², find the length of OC . [3]

7 Differentiate with respect to x

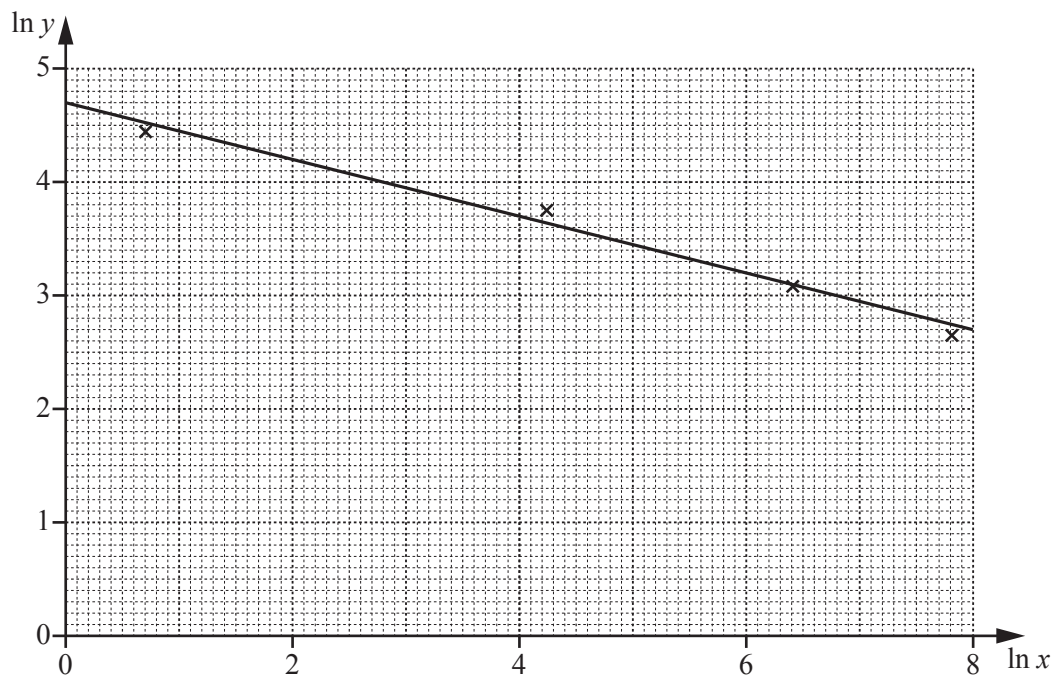
(i) $4x \tan x$, [2]

(ii) $\frac{e^{3x+1}}{x^2-1}$. [3]

- 8 An experiment was carried out recording values of y for certain values of x . The variables x and y are thought to be connected by the relationship $y = ax^n$, where a and n are constants.

(i) Transform the relationship $y = ax^n$ into straight line form. [2]

The values of $\ln y$ and $\ln x$ were plotted and a line of best fit drawn. This is shown in the diagram below.

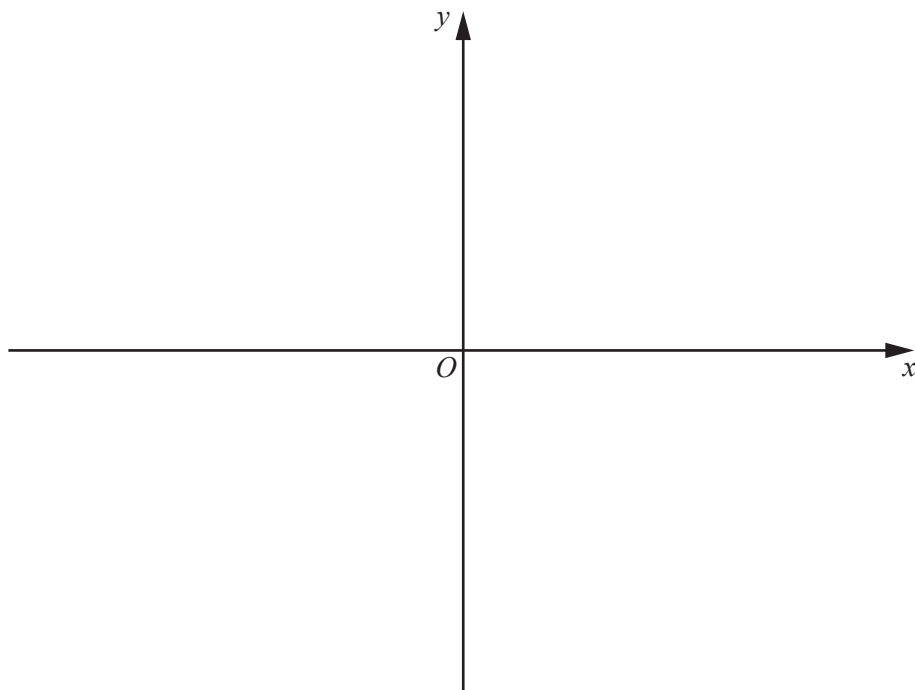


(ii) Use the graph to find the value of a and of n , stating the coordinates of the points that you use. [3]

(iii) Find the value of x when $y = 50$. [2]

- 9 (i) Express $5x^2 - 14x - 3$ in the form $p(x + q)^2 + r$, where p , q and r are constants. [3]

- (ii) Sketch the graph of $y = |5x^2 - 14x - 3|$ on the axes below. Show clearly any points where your graph meets the coordinate axes. [4]



- (iii) State the set of values of k for which $|5x^2 - 14x - 3| = k$ has exactly four solutions. [2]

- 10** A particle moves in a straight line such that its displacement, s metres, from a fixed point O at time t seconds, is given by $s = 4 + \cos 3t$, where $t \geq 0$. The particle is initially at rest.

(i) Find the exact value of t when the particle is next at rest. [2]

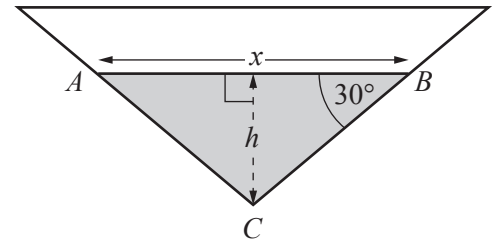
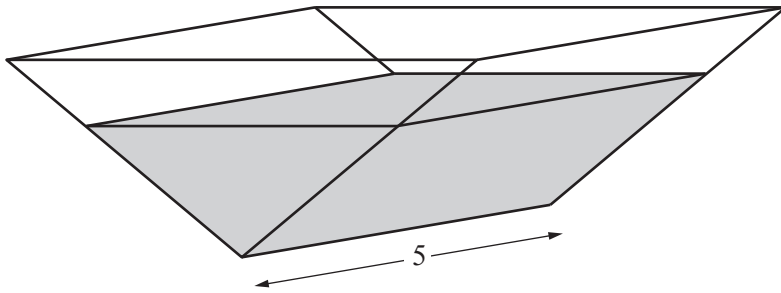
(ii) Find the distance travelled by the particle between $t = \frac{\pi}{4}$ and $t = \frac{\pi}{2}$ seconds. [3]

(iii) Find the greatest acceleration of the particle. [2]

11 (a) Solve $10 \cos^2 x + 3 \sin x = 9$ for $0^\circ < x < 360^\circ$. [5]

(b) Solve $3 \tan 2y = 4 \sin 2y$ for $0 < y < \pi$ radians. [5]

12 In this question all lengths are in metres.



A water container is in the shape of a triangular prism. The diagrams show the container and its cross-section. The cross-section of the water in the container is an isosceles triangle ABC , with angle $ABC = \text{angle } BAC = 30^\circ$. The length of AB is x and the depth of water is h . The length of the container is 5.

- (i) Show that $x = 2\sqrt{3}h$ and hence find the volume of water in the container in terms of h . [3]

(ii) The container is filled at a rate of 0.5 m^3 per minute. At the instant when h is 0.25 m , find

(a) the rate at which h is increasing,

[4]

(b) the rate at which x is increasing.

[2]

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