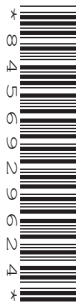




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0606/21

May/June 2015

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 $\triangle ABC$

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

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

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

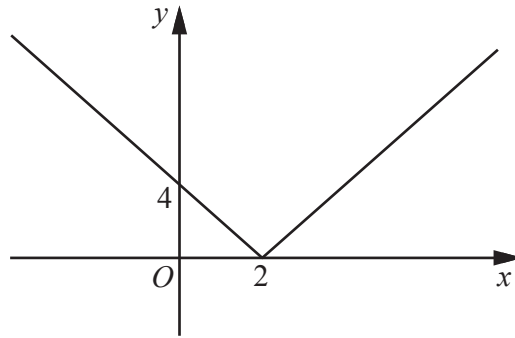
- 1 (a) Write $\log_{27}x$ as a logarithm to base 3.

[2]

- (b) Given that $\log_a y = 3(\log_a 15 - \log_a 3) + 1$, express y in terms of a .

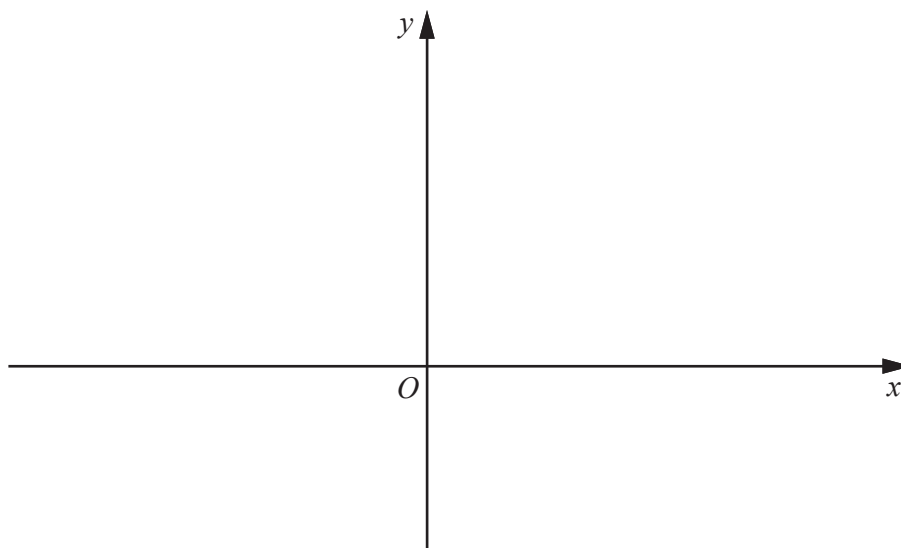
[3]

2 (a)



The diagram shows the graph of $y = |f(x)|$ passing through $(0, 4)$ and touching the x -axis at $(2, 0)$. Given that the graph of $y = f(x)$ is a straight line, write down the two possible expressions for $f(x)$. [2]

- (b) On the axes below, sketch the graph of $y = e^{-x} + 3$, stating the coordinates of any point of intersection with the coordinate axes. [3]



3 (a) Find the matrix **A** if $4\mathbf{A} + 5\begin{pmatrix} 4 & 0 & -1 \\ 3 & -2 & 5 \end{pmatrix} = \begin{pmatrix} 52 & -8 & 19 \\ 31 & 2 & 65 \end{pmatrix}$. [2]

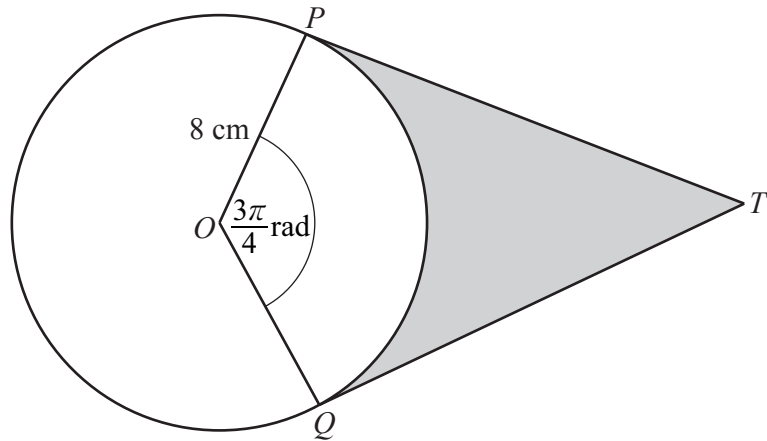
(b) $\mathbf{P} = \begin{pmatrix} 30 & 25 & 65 \\ 70 & 15 & 80 \\ 50 & 40 & 30 \\ 40 & 20 & 75 \end{pmatrix} \quad \mathbf{Q} = \begin{pmatrix} 650 & 500 & 450 & 225 \end{pmatrix}$

The matrix **P** represents the number of 4 different televisions that are on sale in each of 3 shops.
The matrix **Q** represents the value of each television in dollars.

(i) State, without evaluation, what is represented by the matrix **QP**. [1]

(ii) Given that the matrix $\mathbf{R} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$, state, without evaluation, what is represented by the matrix **QPR**. [1]

4



The diagram shows a circle, centre O , radius 8 cm. The points P and Q lie on the circle. The lines PT and QT are tangents to the circle and angle $POQ = \frac{3\pi}{4}$ radians.

(i) Find the length of PT . [2]

(ii) Find the area of the shaded region. [3]

(iii) Find the perimeter of the shaded region. [2]

- 5 (a) A lock can be opened using only the number 4351. State whether this is a permutation or a combination of digits, giving a reason for your answer. [1]

- (b) There are twenty numbered balls in a bag. Two of the balls are numbered 0, six are numbered 1, five are numbered 2 and seven are numbered 3, as shown in the table below.

Number on ball	0	1	2	3
Frequency	2	6	5	7

Four of these balls are chosen at random, without replacement. Calculate the number of ways this can be done so that

- (i) the four balls all have the same number, [2]

- (ii) the four balls all have different numbers, [2]

- (iii) the four balls have numbers that total 3. [3]

- 6 A particle P is projected from the origin O so that it moves in a straight line. At time t seconds after projection, the velocity of the particle, $v \text{ ms}^{-1}$, is given by $v = 2t^2 - 14t + 12$.

(i) Find the time at which P first comes to instantaneous rest. [2]

(ii) Find an expression for the displacement of P from O at time t seconds. [3]

(iii) Find the acceleration of P when $t = 3$. [2]

- 7 (a) The four points O, A, B and C are such that

$$\overrightarrow{OA} = 5\mathbf{a}, \quad \overrightarrow{OB} = 15\mathbf{b}, \quad \overrightarrow{OC} = 24\mathbf{b} - 3\mathbf{a}.$$

Show that B lies on the line AC .

[3]

- (b) Relative to an origin O , the position vector of the point P is $\mathbf{i} - 4\mathbf{j}$ and the position vector of the point Q is $3\mathbf{i} + 7\mathbf{j}$. Find

(i) $|\overrightarrow{PQ}|$, [2]

(ii) the unit vector in the direction \overrightarrow{PQ} , [1]

(iii) the position vector of M , the mid-point of PQ . [2]

8 (a) (i) Find $\int e^{4x+3} dx$. [2]

(ii) Hence evaluate $\int_{2.5}^3 e^{4x+3} dx$. [2]

(b) (i) Find $\int \cos\left(\frac{x}{3}\right) dx$. [2]

(ii) Hence evaluate $\int_0^{\frac{\pi}{6}} \cos\left(\frac{x}{3}\right) dx$. [2]

(c) Find $\int (x^{-1} + x)^2 dx$.

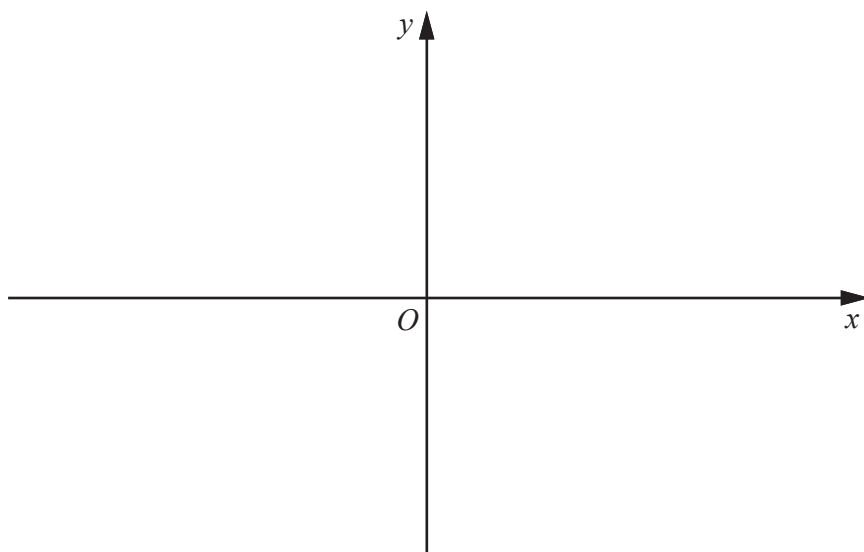
[4]

- 9 (a) Find the set of values of x for which $4x^2 + 19x - 5 \leq 0$. [3]

- (b) (i) Express $x^2 + 8x - 9$ in the form $(x + a)^2 + b$, where a and b are integers. [2]

- (ii) Use your answer to part (i) to find the greatest value of $9 - 8x - x^2$ and the value of x at which this occurs. [2]

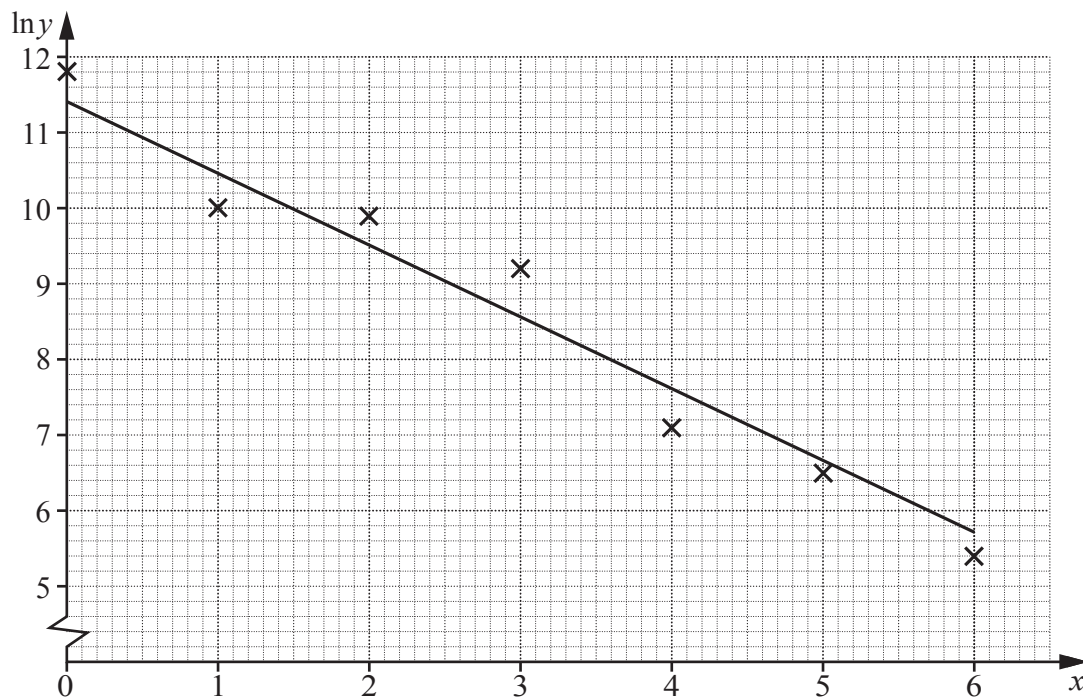
- (iii) Sketch the graph of $y = 9 - 8x - x^2$, indicating the coordinates of any points of intersection with the coordinate axes. [2]



10 The relationship between experimental values of two variables, x and y , is given by $y = Ab^x$, where A and b are constants.

(i) By transforming the relationship $y = Ab^x$, show that plotting $\ln y$ against x should produce a straight line graph. [2]

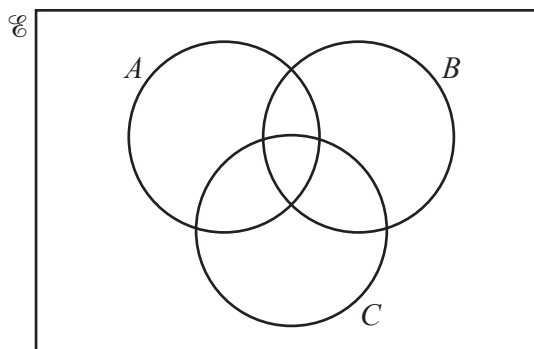
(ii) The diagram below shows the results of plotting $\ln y$ against x for 7 different pairs of values of variables, x and y . A line of best fit has been drawn.



By taking readings from the diagram, find the value of A and of b , giving each value correct to 1 significant figure. [4]

(iii) Estimate the value of y when $x = 2.5$. [2]

11



The Venn diagram above shows the sets A , B and C . It is given that

$$n(A \cup B \cup C) = 48,$$

$$n(A) = 30, \quad n(B) = 25, \quad n(C) = 15,$$

$$n(A \cap B) = 7, \quad n(B \cap C) = 6, \quad n(A' \cap B \cap C') = 16.$$

(i) Find the value of x , where $x = n(A \cap B \cap C)$. [3]

(ii) Find the value of y , where $y = n(A \cap B' \cap C)$. [3]

(iii) Hence show that $A' \cap B' \cap C = \emptyset$. [1]

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