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0606/22

February/March 2019

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 **14** printed pages and **2** blank pages.

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 ΔABC

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

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

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

- 1 A band can play 25 different pieces of music. From these pieces of music, 8 are to be selected for a concert.

(i) Find the number of different ways this can be done. [1]

The 8 pieces of music are then arranged in order.

(ii) Find the number of different arrangements possible. [1]

The band has 15 members. Three members are chosen at random to be the treasurer, secretary and agent.

(iii) Find the number of ways in which this can be done. [1]

- 2 Variables x and y are related by the equation $y = \frac{\ln x}{e^x}$.

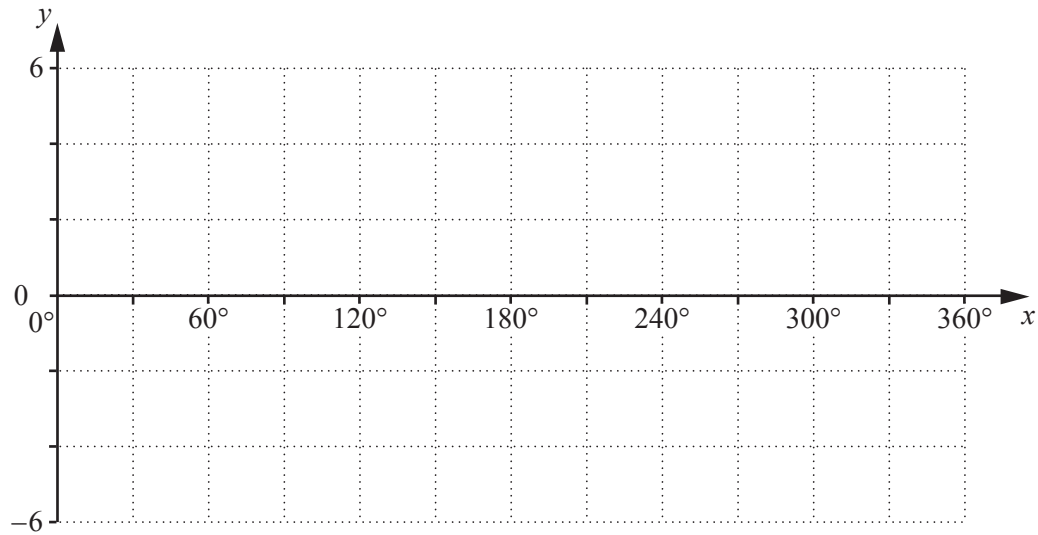
(i) Show that $\frac{dy}{dx} = \frac{1 - x \ln x}{xe^x}$. [4]

(ii) Hence find the approximate change in y as x increases from 2 to $2 + h$, where h is small. [2]

- 3 The function f is defined, for $0^\circ \leq x \leq 360^\circ$, by $f(x) = a + b \sin cx$, where a , b and c are constants with $b > 0$ and $c > 0$. The graph of $y = f(x)$ meets the y -axis at the point $(0, -1)$, has a period of 120° and an amplitude of 5.

(i) Sketch the graph of $y = f(x)$ on the axes below.

[3]



(ii) Write down the value of each of the constants a , b and c .

[2]

$a = \dots\dots\dots$ $b = \dots\dots\dots$ $c = \dots\dots\dots$

- 4 (a) Find the values of x for which $(2x+1)^2 \leq 3x+4$. [3]

- (b) Show that, whatever the value of k , the equation $\frac{x^2}{4} + kx + k^2 + 1 = 0$ has no real roots. [3]

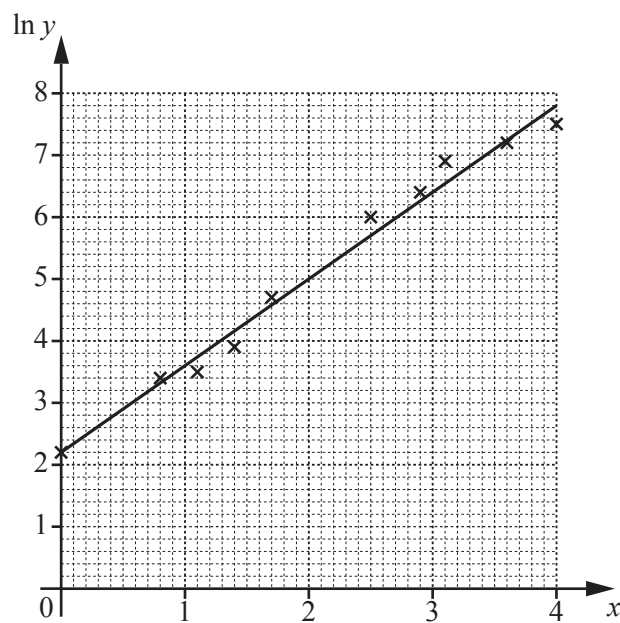
5 Solutions to this question by accurate drawing will not be accepted.

The points $A(3, 2)$, $B(7, -4)$, $C(2, -3)$ and $D(k, 3)$ are such that CD is perpendicular to AB . Find the equation of the perpendicular bisector of CD . [6]

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

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

The diagram shows $\ln y$ plotted against x for ten different pairs of values of x and y . The line of best fit has been drawn.



(ii) Find the equation of the line of best fit and the value, correct to 1 significant figure, of A and of b . [4]

(iii) Find the value, correct to 1 significant figure, of y when $x = 2.7$. [2]

7 (i) Given that $y = x\sqrt{x^2 + 1}$, show that $\frac{dy}{dx} = \frac{ax^2 + b}{(x^2 + 1)^p}$, where a , b and p are positive constants. [4]

(ii) Explain why the graph of $y = x\sqrt{x^2 + 1}$ has no stationary points. [2]

8 Relative to an origin O , the position vectors of the points A and B are $2\mathbf{i} + 12\mathbf{j}$ and $6\mathbf{i} - 4\mathbf{j}$ respectively.

- (i) Write down and simplify an expression for $\overrightarrow{AB}$. [2]

The point C lies on $\overrightarrow{AB}$ such that $AC : CB$ is $1 : 3$.

- (ii) Find the unit vector in the direction of $\overrightarrow{OC}$. [4]

The point D lies on $\overrightarrow{OA}$ such that $OD : DA$ is $1 : \lambda$.

- (iii) Find an expression for $\overrightarrow{AD}$ in terms of λ , $\mathbf{i}$ and $\mathbf{j}$. [2]

9 (a) It is given that $g(x) = 6x^4 + 5$ for all real x .

(i) Explain why g is a function but does not have an inverse. [2]

(ii) Find $g^2(x)$ and state its domain. [2]

It is given that $h(x) = 6x^4 + 5$ for $x \leq k$.

(iii) State the greatest value of k such that h^{-1} exists. [1]

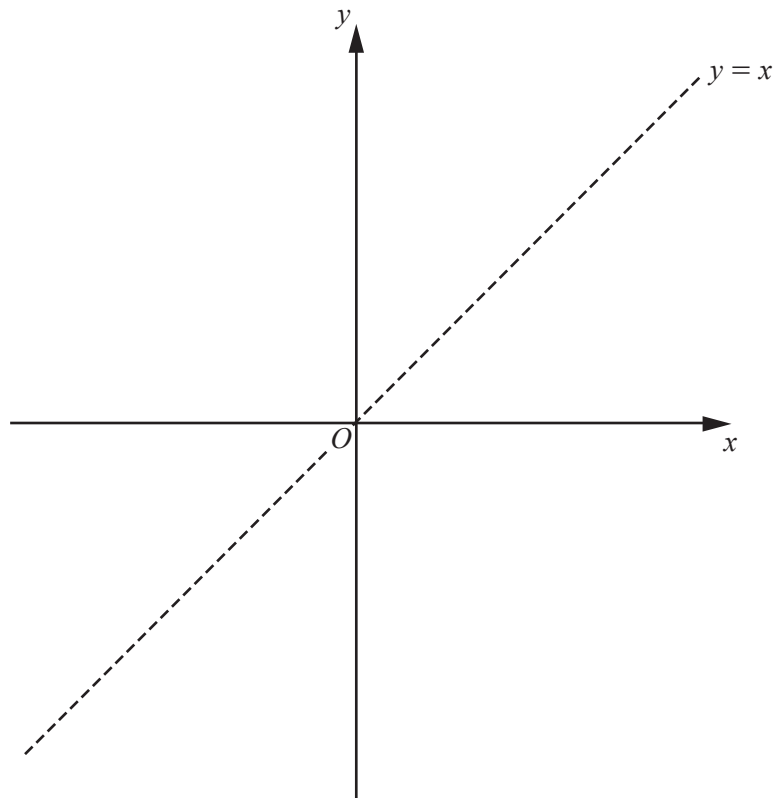
(iv) For this value of k , find $h^{-1}(x)$. [3]

(b) The function p is defined by $p(x) = 3e^x + 2$ for all real x .

(i) State the range of p .

[1]

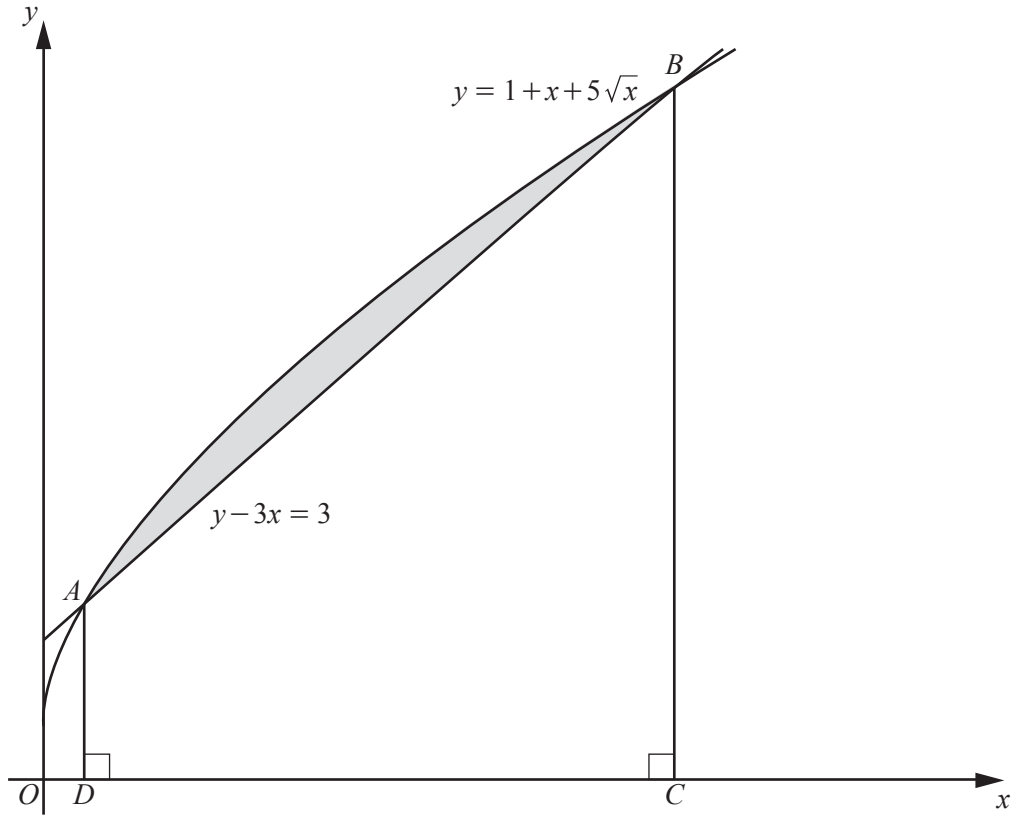
(ii) On the axes below, sketch and label the graphs of $y = p(x)$ and $y = p^{-1}(x)$. State the coordinates of any points of intersection with the coordinate axes. [3]



(iii) Hence explain why the equation $p(x) = p^{-1}(x)$ has no solutions.

[1]

10



The diagram shows the curve $y = 1 + x + 5\sqrt{x}$ and the straight line $y - 3x = 3$. The curve and line intersect at the points A and B . The lines BC and AD are perpendicular to the x -axis.

- (i) Using the substitution $u^2 = x$, or otherwise, find the coordinates of A and of B . You must show all your working. [6]

- (ii) Find the area of the shaded region, showing all your working.

[6]

11 (a) Find $\int \frac{x^2(x^6+1)}{x^6} dx$. [3]

(b) (i) Find $\int \cos(4\theta-5) d\theta$. [2]

(ii) Hence evaluate $\int_{1.25}^2 \cos(4\theta-5) d\theta$. [2]

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