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0606/22

May/June 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 **16** printed 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 $\triangle ABC$

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

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

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

- 1 Given that $y = \frac{\sin x}{\ln x^2}$, find an expression for $\frac{dy}{dx}$. [4]

- 2 Find the values of k for which the equation $(k-1)x^2 + kx - k = 0$ has real and distinct roots. [4]

3 (i) Given that $x-2$ is a factor of $ax^3 - 12x^2 + 5x + 6$, use the factor theorem to show that $a = 4$. [2]

(ii) Showing all your working, factorise $4x^3 - 12x^2 + 5x + 6$ and hence solve $4x^3 - 12x^2 + 5x + 6 = 0$. [4]

- 4 A circle has diameter x which is increasing at a constant rate of 0.01 cm s^{-1} . Find the exact rate of change of the area of the circle when $x = 6 \text{ cm}$. [5]

5 (i) Express $5x^2 - 15x + 1$ in the form $p(x+q)^2 + r$, where p , q and r are constants. [3]

(ii) Hence state the least value of $x^2 - 3x + 0.2$ and the value of x at which this occurs. [2]

- 6 (a) State the order of the matrix $\begin{pmatrix} 0 & 1 & 4 & 8 \\ 5 & 8 & 1 & 6 \end{pmatrix}$. [1]

(b) $\mathbf{A} = \begin{pmatrix} 2 & -4 \\ -1 & 3 \end{pmatrix}$

- (i) Find \mathbf{A}^{-1} . [2]

- (ii) Hence, given that $\mathbf{ABA} = \mathbf{I}$, find the matrix \mathbf{B} . [3]

7 (a) Solve $\lg(x^2 - 3) = 0$.

[2]

(b) (i) Show that, for $a > 0$, $\frac{\ln a^{\sin(2x+5)} + \ln\left(\frac{1}{a}\right)}{\ln a}$ may be written as $\sin(2x+5) + k$, where k is an integer. [3]

(ii) Hence find $\int \frac{\ln a^{\sin(2x+5)} + \ln\left(\frac{1}{a}\right)}{\ln a} dx$. [3]

- 8 (a) In the binomial expansion of $\left(a - \frac{x}{2}\right)^6$, the coefficient of x^3 is 120 times the coefficient of x^5 . Find the possible values of the constant a . [4]

- (b) (i) Expand $(1 + 2x)^{20}$ in ascending powers of x , as far as the term in x^3 . Simplify each term. [2]

- (ii) Use your expansion to show that the value of 0.98^{20} is 0.67 to 2 decimal places. [2]

9 (a) Solve $6\sin^2x - 13\cos x = 1$ for $0^\circ \leq x \leq 360^\circ$.

[4]

- (b) (i) Show that, for $-\frac{\pi}{2} < y < \frac{\pi}{2}$, $\frac{4 \tan y}{\sqrt{1 + \tan^2 y}}$ can be written in the form $a \sin y$, where a is an integer. [3]

- (ii) Hence solve $\frac{4 \tan y}{\sqrt{1 + \tan^2 y}} + 3 = 0$ for $-\frac{\pi}{2} < y < \frac{\pi}{2}$ radians. [1]

- 10 (a) Find the unit vector in the direction of $5\mathbf{i} - 15\mathbf{j}$. [2]

- (b) The position vectors of points A and B relative to an origin O are $\begin{pmatrix} 3 \\ -5 \end{pmatrix}$ and $\begin{pmatrix} 12 \\ 7 \end{pmatrix}$ respectively. The point C lies on AB such that $AC : CB$ is $2 : 1$.

- (i) Find the position vector of C relative to O . [3]

The point D lies on OB such that $OD : OB$ is $1 : \lambda$ and $\overrightarrow{DC} = \begin{pmatrix} 6 \\ 1.25 \end{pmatrix}$.

(ii) Find the value of λ .

[3]

- 11** The velocity, $v \text{ m s}^{-1}$, of a particle travelling in a straight line, t seconds after passing through a fixed point O , is given by $v = \frac{4}{(t+1)^3}$.

(i) Explain why the direction of motion of the particle never changes. [1]

(ii) Showing all your working, find the acceleration of the particle when $t = 5$. [3]

(iii) Find an expression for the displacement of the particle from O after t seconds. [3]

(iv) Find the distance travelled by the particle in the fourth second. [2]

12 (a) The functions f and g are defined by

$$\begin{aligned} f(x) &= 5x - 2 \quad \text{for } x > 1, \\ g(x) &= 4x^2 - 9 \quad \text{for } x > 0. \end{aligned}$$

(i) State the range of g . [1]

(ii) Find the domain of gf . [1]

(iii) Showing all your working, find the exact solutions of $gf(x) = 4$. [3]

Question 12(b) is printed on the next page.

(b) The function h is defined by $h(x) = \sqrt{x^2 - 1}$ for $x \leq -1$.

(i) State the geometrical relationship between the graphs of $y = h(x)$ and $y = h^{-1}(x)$. [1]

(ii) Find an expression for $h^{-1}(x)$. [3]

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