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4037/13

October/November 2019

2 hours

No Additional Materials are required.

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*

$$\begin{aligned}\sin^2 A + \cos^2 A &= 1 \\ \sec^2 A &= 1 + \tan^2 A \\ \operatorname{cosec}^2 A &= 1 + \cot^2 A\end{aligned}$$

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 In a group of 145 students, the numbers studying mathematics, physics and chemistry are given below. All students study at least one of the three subjects.

x students study all 3 subjects

24 students study both mathematics and chemistry

23 students study both physics and chemistry

28 students study both mathematics and physics

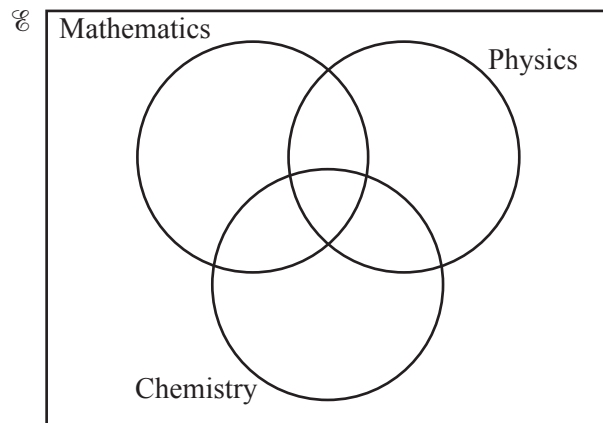
50 students study chemistry

75 students study physics

80 students study mathematics

- (i) Using the Venn diagram, find the value of x .

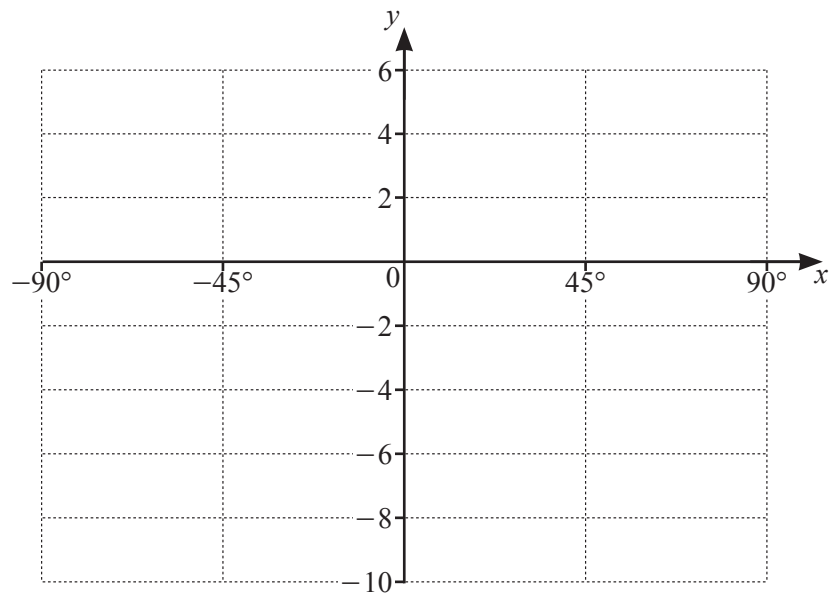
[4]



- (ii) Find the number of students who study mathematics only.

[1]

- 2 (i) On the axes below, sketch the graph of $y = 5 \cos 4x - 3$ for $-90^\circ \leq x \leq 90^\circ$.



[4]

- (ii) Write down the amplitude of y .

[1]

- (iii) Write down the period of y .

[1]

3 (i) Differentiate $y = (3x^2 - 1)^{-\frac{1}{3}}$ with respect to x . [2]

(ii) Find the approximate change in y as x increases from $\sqrt{3}$ to $\sqrt{3} + p$, where p is small. [1]

(iii) Find the equation of the normal to the curve $y = (3x^2 - 1)^{-\frac{1}{3}}$ at the point where $x = \sqrt{3}$. [3]

4 It is given that $\mathbf{A} = \begin{pmatrix} 5 & 2 \\ 4 & -1 \end{pmatrix}$.

(i) Find $\mathbf{A}^{-1}$.

[2]

(ii) Hence find, in radians, the acute angles x and y such that

$$5 \tan x + 2 \tan y = 12,$$

$$4 \tan x - \tan y = 7.$$

[5]

5 (i) Differentiate $(x^2 + 3)\ln(x^2 + 3)$ with respect to x . [3]

(ii) Hence find $\int x \ln(x^2 + 3) dx$. [2]

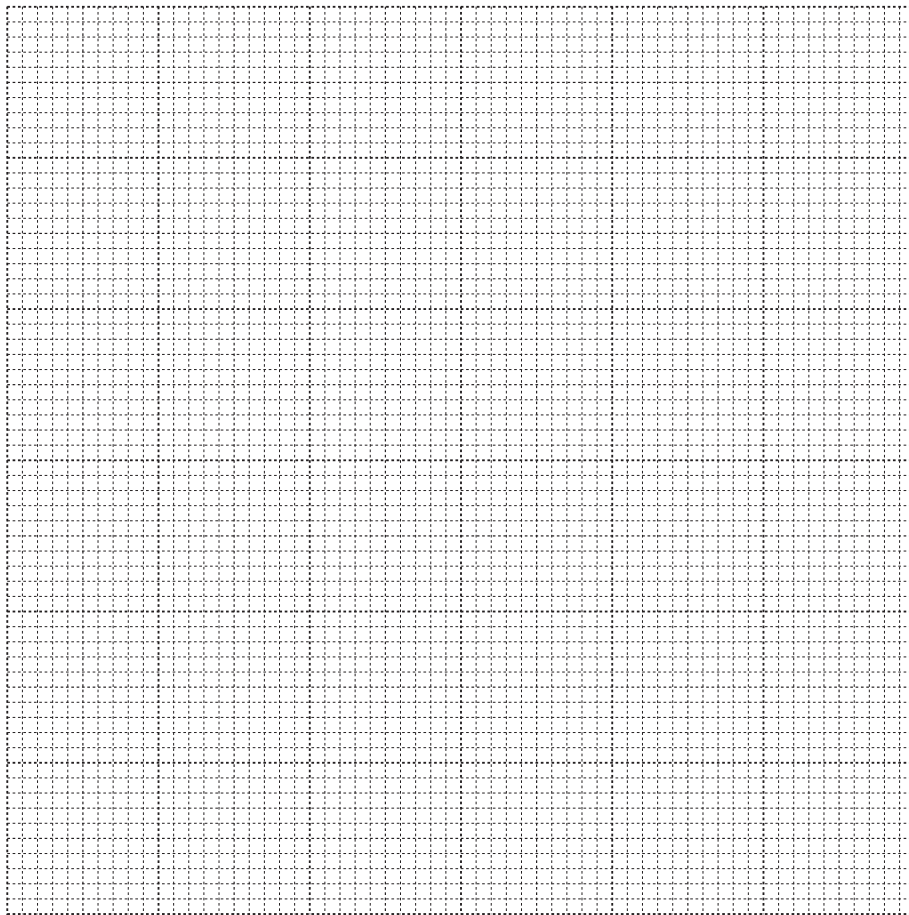
6

x	1	1.5	2	2.5	3
y	6	14.3	48	228	1536

The table shows values of the variables x and y such that $y = Ab^{x^2}$, where A and b are constants.

(i) Draw a straight line graph to show that $y = Ab^{x^2}$.

[4]



(ii) Use your graph to find the value of A and of b .

[4]

(iii) Estimate the value of x when $y = 100$.

[2]

- 7 (a) A 5-digit code is to be chosen from the digits 1, 2, 3, 4, 5, 6, 7, 8 and 9. Each digit may be used once only in any 5-digit code. Find the number of different 5-digit codes that may be chosen if
- (i) there are no restrictions, [1]
 - (ii) the code is divisible by 5, [1]
 - (iii) the code is even and greater than 70 000. [3]
- (b) A team of 6 people is to be chosen from 8 men and 6 women. Find the number of different teams that may be chosen if
- (i) there are no restrictions, [1]
 - (ii) there are no women in the team, [1]
 - (iii) there are a husband and wife who must not be separated. [3]

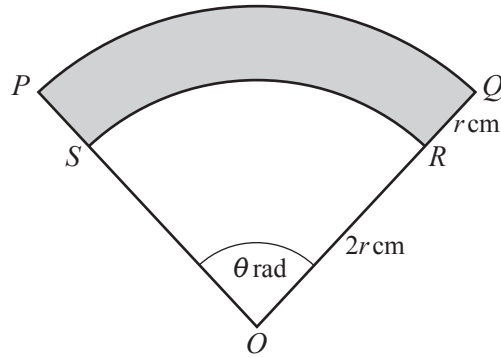
8 (a) Given that $\log_a x = p$ and $\log_a y = q$, find, in terms of p and q ,

(i) $\log_a axy^2$, [2]

(ii) $\log_a \left(\frac{x^3}{ay} \right)$, [2]

(iii) $\log_x a + \log_y a$. [1]

(b) Using the substitution $m = 3^x$, or otherwise, solve $3^x - 3^{1+2x} + 4 = 0$. [3]



The diagram shows a sector OPQ of the circle centre O , radius $3r$ cm. The points S and R lie on OP and OQ respectively such that ORS is a sector of the circle centre O , radius $2r$ cm. The angle $POQ = \theta$ radians. The perimeter of the shaded region $PQRS$ is 100 cm.

- (i) Find θ in terms of r . [2]

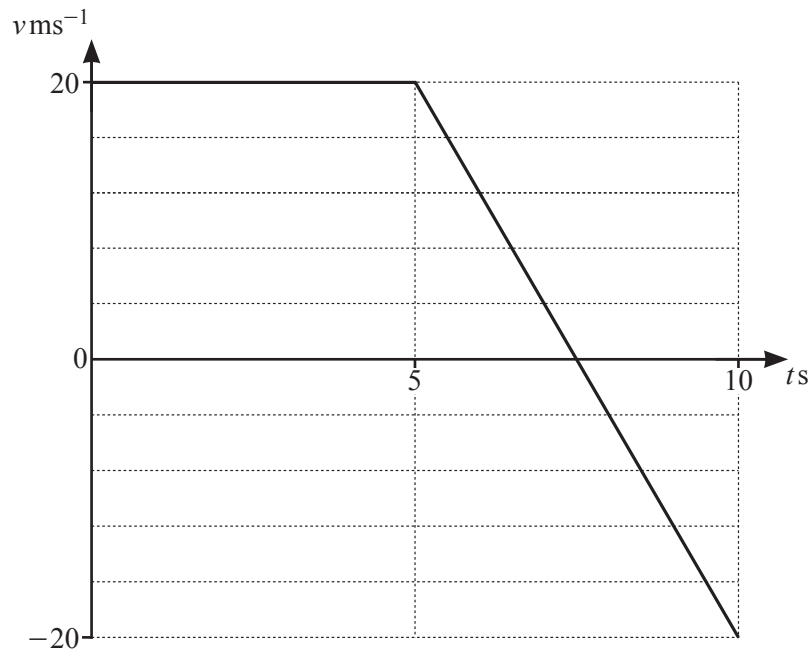
- (ii) Hence show that the area, A cm², of the shaded region $PQRS$ is given by $A = 50r - r^2$. [2]

(iii) Given that r can vary and that A has a maximum value, find this value of A . [2]

(iv) Given that A is increasing at the rate of $3 \text{ cm}^2 \text{ s}^{-1}$ when $r = 10$, find the corresponding rate of change of r . [3]

(v) Find the corresponding rate of change of θ when $r = 10$. [3]

10 (a)



The velocity-time graph for a particle P is shown by the two straight lines in the diagram.

(i) Find the deceleration of P for $5 \leq t \leq 10$. [2]

(ii) Write down the value of t when the speed of P is zero. [1]

(iii) Find the distance P has travelled for $0 \leq t \leq 10$. [2]

(b) A particle Q has a displacement of x m from a fixed point O , t s after leaving O . The velocity, $v \text{ ms}^{-1}$, of Q at time t s is given by $v = 6e^{2t} + 1$.

(i) Find an expression for x in terms of t . [3]

(ii) Find the value of t when the acceleration of Q is 24 ms^{-2} . [3]

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