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ADDITIONAL MATHEMATICS (US)

0459/01

Paper 1

For examination from 2020

SPECIMEN PAPER

2 hours

You must answer on the question paper.

You will need: List of formulae (MF25)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, center number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in parentheses [].

This document has **16** pages. Blank pages are indicated.

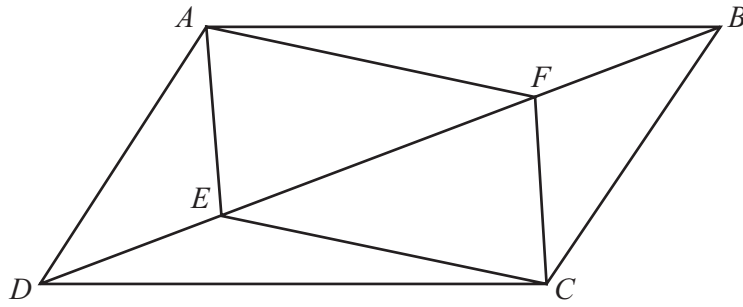
- 1 Find the equation of the circle with center $(-2, 8)$ and radius 7 units. [2]
- 2 (a) State briefly two possible reasons for gathering statistical information by taking a sample from a population. [2]
- (b) Explain why choosing every tenth item from a list does not produce a random sample. [2]

- 3 Find z_1 such that $z_1 = \frac{a + i\sqrt{b}}{c}$ is a root of the equation $z^2 - 3z + 4 = 0$, where a , b , and c are constants to be determined. State also z_2 , the other root of this equation. [3]

- 4 P is the point (x, y) and S is the point $(6, 1)$. The point P moves in such a way that its distance from S is equal to its distance from the line $x = -1$. Show that the equation of the parabola traced out by the point P is $y(y - 2) = 14x + k$, where k , is a constant to be found. [4]

- 5 Without using a calculator, express $\frac{(5 + 2\sqrt{3})^2}{2 + \sqrt{3}}$ in the form $p + q\sqrt{3}$, where p and q are integers. [4]

6 $ABCD$ is a parallelogram.



The points E and F lie on the diagonal DB such that $DE:EF:FB$ is $1:2:1$.
Prove that the quadrilateral $AFCE$ is a parallelogram.

[5]

- 7 Given that the matrix $\mathbf{A} = \begin{pmatrix} 2 & -3 \\ 1 & 1 \end{pmatrix}$, find the matrix \mathbf{B} , such that $10\mathbf{A}^{-1} - \mathbf{B} = \mathbf{A}^2$. [6]

8 A hospital uses a test to determine whether incoming patients have a particular disease. It is found that:

- 97% of patients with the disease are declared positive
- 5% of patients without the disease are declared positive.

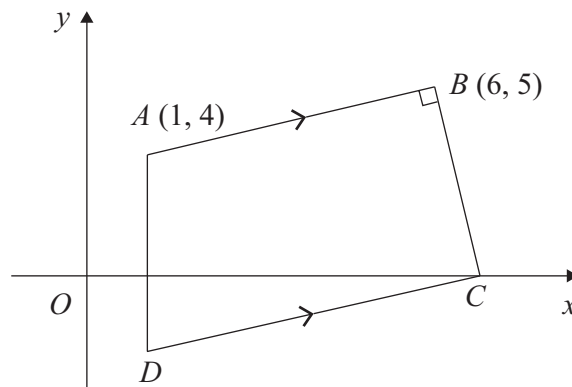
Over time the hospital has found that 4% of incoming patients have the disease.

(a) Calculate the probability that an incoming patient is declared positive. [4]

(b) Given that an incoming patient is declared positive, show that the probability the incoming patient is actually suffering from the disease is approximately 0.447. [2]

- 9 The line $y = x + 4$ intersects the curve $2x^2 + 3xy - y^2 + 1 = 0$ at the points A and B . Find the length of the line AB . [7]

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



The diagram shows a quadrilateral $ABCD$ in which A is the point $(1, 4)$ and B is the point $(6, 5)$. Angle ABC is a right angle and the point C lies on the x -axis. The line AD is parallel to the y -axis and the line CD is parallel to BA .

(a) Find the equation of the line CD .

[5]

(b) State the coordinates of D .

[1]

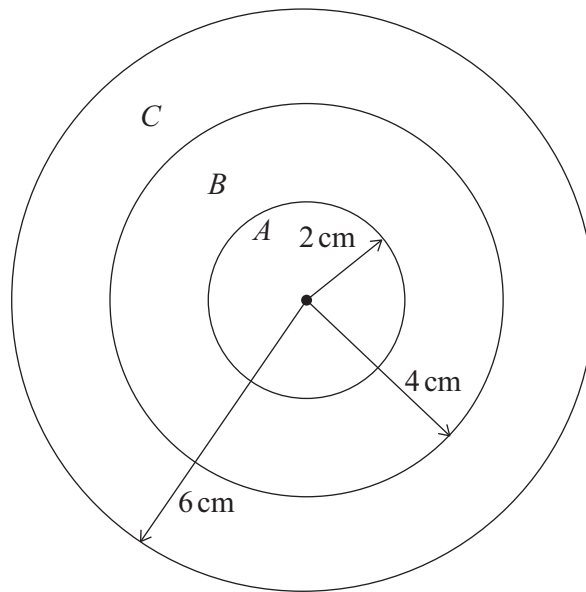
11 Solve these equations for angles between 0° and 360° .

(a) $5(\sin x - \cos x) = 4 \sin x - 3 \cos x$ [4]

(b) $2 \sin^2 y + 3 \cos y = 0$ [4]

- 12 A plane flies from A to B . The position vector of B relative to A is $(1200\mathbf{i} + 240\mathbf{j})$ km, where \mathbf{i} and \mathbf{j} are unit vectors due East and North. The flight takes 4 hours because of a constant wind. Given that the velocity in still air of the plane is $(260\mathbf{i} + 156\mathbf{j})$ km h⁻¹, calculate the speed and direction of the wind. [7]

- 13 The figure shows a circular target, radius 6 cm, divided into three regions, A , B , and C , by two concentric circles of radii 2 cm and 4 cm.



- (a) Show that the areas of A , B and C are in the ratio 1 : 3 : 5. [2]

A man shoots an arrow at the target. The probability that he hits the target with any single shot is $\frac{3}{4}$ and he is just as likely to hit one point of the target as any other. The man scores 12, 6, or 3 points if he hits A , B , or C respectively. The number of points he scores with one shot is denoted by S .

- (b) Find $P(S = 12)$. [2]

(c) Determine the probability distribution of S , displaying this information in a table. [2]

(d) By first finding $E(S)$, deduce the expected number of points the man would score with 20 shots. [3]

14 (a) Functions f and g are defined, for $x \in \mathbb{R}$, by:

$$f(x) = 3 - x$$
$$g(x) = \frac{x}{x+2}, \text{ where } x \neq -2.$$

(i) Find $f(g(x))$. [1]

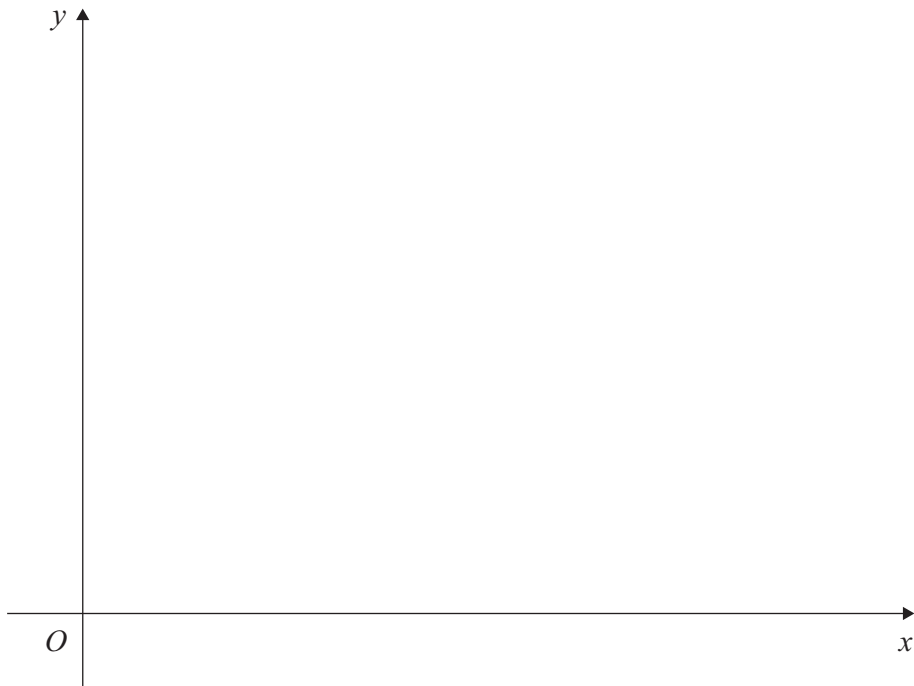
(ii) Hence find the value of x for which $f(g(x)) = 10$. [2]

(b) A function h is defined for $x \in \mathbb{R}$, by $h(x) = 4 + \ln x$, where $x > 1$.

(i) Find the range of h . [1]

(ii) Find the value of $h^{-1}(9)$. [2]

(iii) On the same axes, sketch the graphs of $y = h(x)$ and $y = h^{-1}(x)$. [3]



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