

**FREE-STANDING MATHEMATICS QUALIFICATION
ADVANCED LEVEL**

ADDITIONAL MATHEMATICS

6993

Candidates answer on the Answer Booklet

OCR Supplied Materials:

- 16 page Answer Booklet
- Graph paper

Other Materials Required:

None

**Friday 5 June 2009
Afternoon**

Duration: 2 hours



INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the spaces provided on the Answer Booklet.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given correct to three significant figures where appropriate.

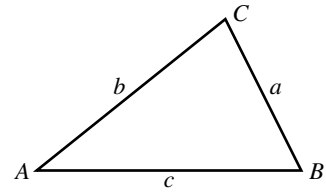
INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **100**.
- This document consists of **8** pages. Any blank pages are indicated.

Formulae Sheet: 6993 Additional Mathematics

In any triangle ABC

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



Binomial expansion

When n is a positive integer

$$(a + b)^n = a^n + \binom{n}{1} a^{n-1} b + \binom{n}{2} a^{n-2} b^2 + \dots + \binom{n}{r} a^{n-r} b^r + \dots + b^n$$

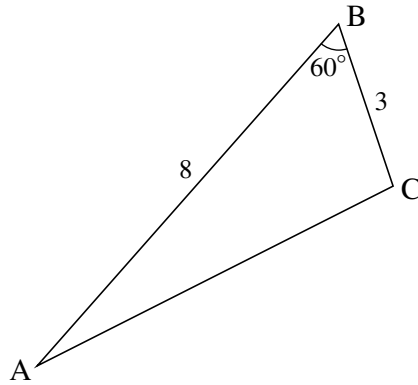
where

$$\binom{n}{r} = {}^n C_r = \frac{n!}{r!(n-r)!}$$

Section A

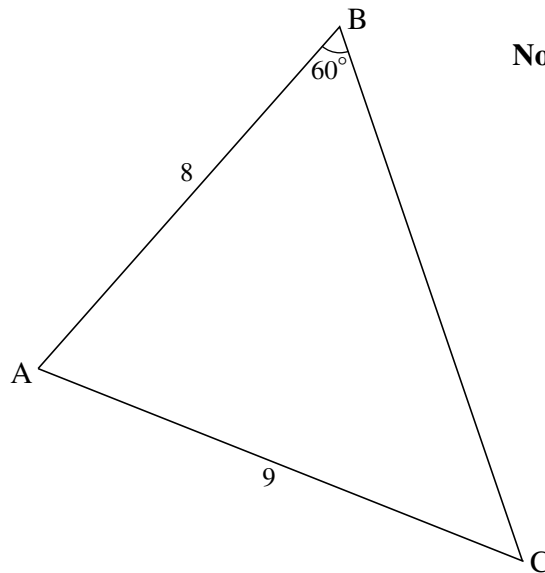
- 1 The angle θ is greater than 90° and less than 360° and $\cos \theta = \frac{2}{3}$. Find the exact value of $\tan \theta$. [3]
- 2 Find the equation of the normal to the curve $y = x^3 + 5x - 7$ at the point $(1, -1)$. [5]
- 3 A is the point $(1, 5)$ and C is the point $(3, p)$.
- (i) Find the equation of the line through A which is parallel to the line $2x + 5y = 7$. [2]
- (ii) This line also passes through the point C. Find the value of p . [2]
- 4 AB is a diameter of a circle, where A is $(1, 1)$ and B is $(5, 3)$.
- Find
- (i) the exact length of AB, [2]
- (ii) the coordinates of the midpoint of AB, [1]
- (iii) the equation of the circle. [3]
- 5 Parcels slide down a ramp. Due to resistance the deceleration is 0.25 m s^{-2} .
- (i) One parcel is given an initial velocity of 2 m s^{-1} . Find the distance travelled before the parcel comes to rest. [3]
- (ii) A second parcel is given an initial velocity of 3 m s^{-1} and takes 4 seconds to reach the bottom of the ramp. Find the length of the ramp. [3]
- 6 The gradient function of a curve is given by $\frac{dy}{dx} = 1 - 4x + 3x^2$.
- Find the equation of the curve given that it passes through the point $(2, 6)$. [4]

- 7 The course of a cross-country race is in the shape of a triangle ABC.
 $AB = 8$ km, $BC = 3$ km and angle $ABC = 60^\circ$.



Not to scale

- (i) Calculate the distance AC and hence the total length of the course. [4]
 (ii) The organisers extend the course so that $AC = 9$ km.



Not to scale

Calculate the angle BCA. [3]

- 8 Calculate the x -coordinates of the points of intersection of the line $y = 2x + 11$ and the curve $y = x^2 - x + 5$. Give your answers correct to 2 decimal places. [5]

9 A car accelerates from rest. At time t seconds, its acceleration is given by $a = 4 - 0.2t \text{ m s}^{-2}$ until $t = 20$.

(i) Find the velocity after 5 seconds. [3]

(ii) What is happening to the velocity at $t = 20$? [1]

(iii) Find the distance travelled in the first 20 seconds. [3]

10 (i) Illustrate on one graph the following three inequalities.

$$y \geq x - 1$$

$$x \geq 2$$

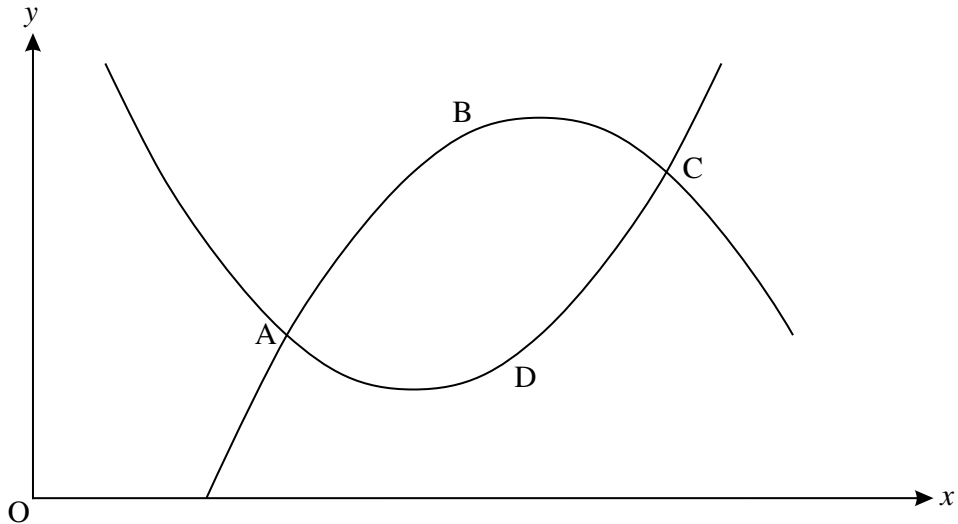
$$2x + y \geq 8$$

Draw suitable boundaries and shade areas that are **excluded**. [4]

(ii) Write down the minimum value of y in this region. [1]

Section B

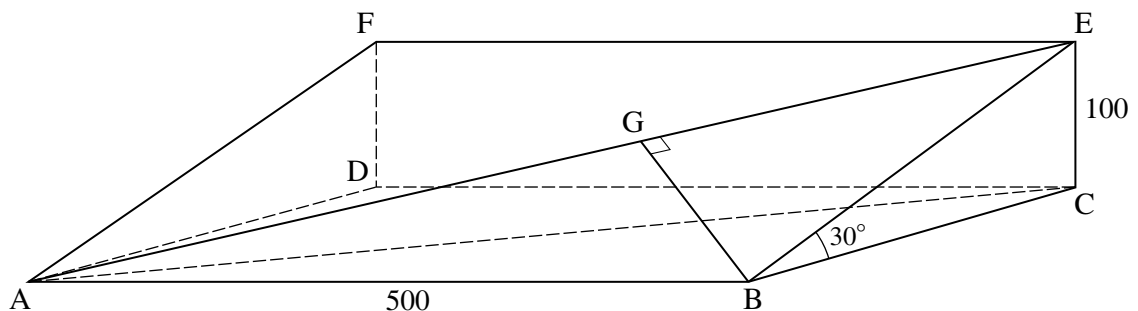
- 11 The shape ABCD below represents a leaf.
 The curve ABC has equation $y = -x^2 + 8x - 9$.
 The curve ADC has equation $y = x^2 - 6x + 11$.



- (i) Find algebraically the coordinates of A and C, the points where the curves intersect. [5]
- (ii) Find the area of the leaf. [7]
- 12 The diagram shows a rectangle ABEF on a plane hillside which slopes at an angle of 30° to the horizontal. ABCD is a horizontal rectangle. E and F are 100 m vertically above C and D respectively. $AB = DC = FE = 500$ m.

AE is a straight path.

From B there is a straight path which runs at right angles to AE, meeting it at G.



- (i) Find the distance BE. [3]
- (ii) Find the angle that the path AE makes with the horizontal. [4]
- (iii) Find the area of the triangle ABE.

Hence find the length BG. [5]

- 13** In a supermarket chain there are a large number of employees, of whom 40% are male.
- (a) One employee is chosen to undergo training.
What assumption is made if 0.4 is taken to be the probability that this employee is male? [1]
- (b) 6 employees are chosen at random to undergo training.
- (i) Show that $P(\text{all 6 chosen are female}) = 0.0467$, correct to 4 decimal places. [2]
- Find the probability that
- (ii) 3 are male and 3 are female, [4]
- (iii) there are more females than males chosen. [5]
- 14** (a) (i) On the same graph, draw sketches of the curve $y = x^3$ and the line $y = 3 - 2x$. [2]
- (ii) Use your sketch to explain why the equation $x^3 + 2x - 3 = 0$ has only one root. [1]
- (b) (i) Show by differentiation that there are no stationary points on the curve $y = x^3 + 3x - 4$. [3]
- (ii) Hence explain why the equation $x^3 + 3x - 4 = 0$ has only one root. [1]
- (c) (i) Use the factor theorem to find an integer root of the equation $x^3 + x - 10 = 0$. [1]
- (ii) Write the equation $x^3 + x - 10 = 0$ in the form $(x - a)(x^2 + px + q) = 0$ where a , p and q are values to be determined. [2]
- (iii) By considering the quadratic equation $x^2 + px + q = 0$ found in part (ii), show that the cubic equation $x^3 + x - 10 = 0$ has only one root. [1]
- (d) You are given that r and s are positive numbers. What do the results in parts (a), (b) and (c) suggest about the equation $x^3 + rx - s = 0$? [1]

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