

**FREE-STANDING MATHEMATICS QUALIFICATION  
ADVANCED LEVEL**

**Additional Mathematics**

**6993**

**QUESTION PAPER**

Candidates answer on the printed answer book.

**OCR supplied materials:**

- Printed answer book 6993

**Other materials required:**

- Scientific or graphical calculator

**Monday 13 June 2011  
Morning**

**Duration: 2 hours**

**INSTRUCTIONS TO CANDIDATES**

These instructions are the same on the printed answer book and the question paper.

- The question paper will be found in the centre of the printed answer book.
- Write your name, centre number and candidate number in the spaces provided on the printed answer book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the printed answer book.** Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure 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**

This information is the same on the printed answer book and the question paper.

- The number of marks is given in brackets [ ] at the end of each question or part question on the question paper.
- 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**.
- The printed answer book consists of **20** pages. The question paper consists of **8** pages. Any blank pages are indicated.

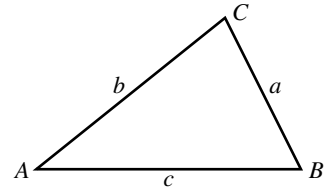
**INSTRUCTION TO EXAMS OFFICER / INVIGILATOR**

- Do not send this question paper for marking; it should be retained in the centre or destroyed.

## 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

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

Answer all questions on the Printed Answer Book provided.

Section A

- 1 Determine whether the point (5, 2) lies inside or outside the circle whose equation is  $x^2 + y^2 = 30$ . You must show your working. [3]
- 2 The equation of a curve is  $y = x^3 - x^2 - 2x - 3$ .  
Find the equation of the tangent to this curve at the point (3, 9). [5]
- 3 In the triangle PQR, PQ = 8 cm, RQ = 9 cm and RP = 7 cm.  
(i) Find the size of the largest angle. [4]  
(ii) Calculate the area of the triangle. [3]
- 4 Solve the equation  $5 \sin 2x = 2 \cos 2x$  in the interval  $0^\circ \leq x \leq 360^\circ$ .  
Give your answers correct to 1 decimal place. [5]
- 5 The coordinates of the points A, B and C are (-2, 1), (5, 2) and (4, 9) respectively.  
(a) Find the coordinates of the midpoint, M, of the line AC. [1]  
(b) Show that BM is perpendicular to AC. [3]  
(c) (i) Use the result of part (b) to state the mathematical name of the triangle ABC. [1]  
(ii) Prove this by another method. [2]
- 6 Solve the inequality  $x^2 - 12x + 35 \leq 0$ . [4]
- 7 (a) Determine whether or not each of the following is a factor of the expression  $x^3 - 7x + 6$ .  
You must show your working.  
(i)  $(x - 2)$  [2]  
(ii)  $(x + 1)$  [1]  
(b) (i) Factorise the function  $f(x) = x^3 - 7x + 6$ . [3]  
(ii) Solve the equation  $f(x) = 0$ . [1]

- 8 (i) On the axes given, indicate the region for which the following inequalities hold. You should shade the region which is **not** required.

$$5x + 3y \geq 30$$

$$3x + y \geq 12$$

$$y \geq 0$$

$$x \geq 0$$

[5]

- (ii) Find the minimum value of  $6x + y$  subject to these conditions.

[2]

- 9 The gradient function of a curve is given by  $\frac{dy}{dx} = 3x^2 - 2x + 4$ .

Find the equation of the curve, given that it passes through the point (2, 2).

[4]

- 10 You are given that  $\sin \theta = \frac{2}{5}$  with  $0^\circ \leq \theta \leq 90^\circ$ .

Using the identity  $\sin^2 \theta + \cos^2 \theta = 1$ , find an exact value for  $\cos \theta$ .

[3]

## Section B

- 11** Eggs are delivered to a supermarket in boxes of 6.  
For each egg, the probability that it is cracked is 0.05 independently of other eggs.

Find the probability that

- (i) in one box there are no cracked eggs, [2]  
(ii) in one box there is exactly 1 cracked egg. [4]

The manager checks the eggs as follows.

- He takes a box at random from the delivery.
- He accepts the whole delivery if this box contains no cracked eggs.
- He rejects the whole delivery if the box contains 2 or more cracked eggs.
- If the box contains 1 cracked egg then he chooses another box at random.
- He accepts the delivery only if this second box contains no cracked eggs.

- (iii) Find the probability that the delivery is rejected. [6]

- 12** Two cars, A and B, move from rest away from a point O on a straight road starting at the same time.

- (a) Car A moves with constant acceleration of  $2 \text{ m s}^{-2}$ .

Express the displacement of car A after time  $t$  seconds as a function of  $t$ . [2]

- (b) Car B moves with acceleration given by  $a = \frac{1}{2}t + 1$ .

Express the displacement of car B after time  $t$  seconds as a function of  $t$ . [4]

- (c) (i) Find the time at which the cars are the same distance from O. [2]

(ii) Find the distance they have travelled at that time. [2]

- (d) Draw a sketch graph of the velocity of each car on the axes given. [2]

- 13 A pyramid has a square base, ABCD, with vertex E. E is directly above the centre of the base, O, as shown in Fig. 13.

The lengths of the sides of the base are each  $2x$  metres and the height is  $h$  metres.

The lengths of the sloping edges, AE, BE, CE and DE, are each 5 metres.

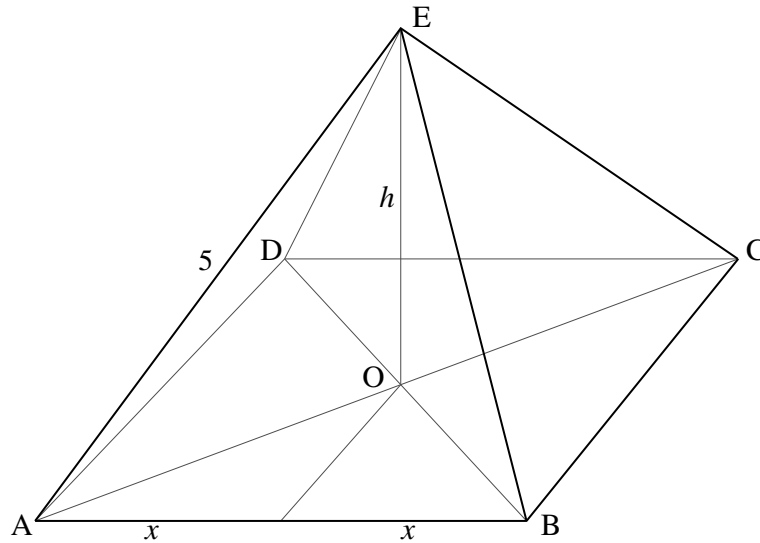


Fig. 13

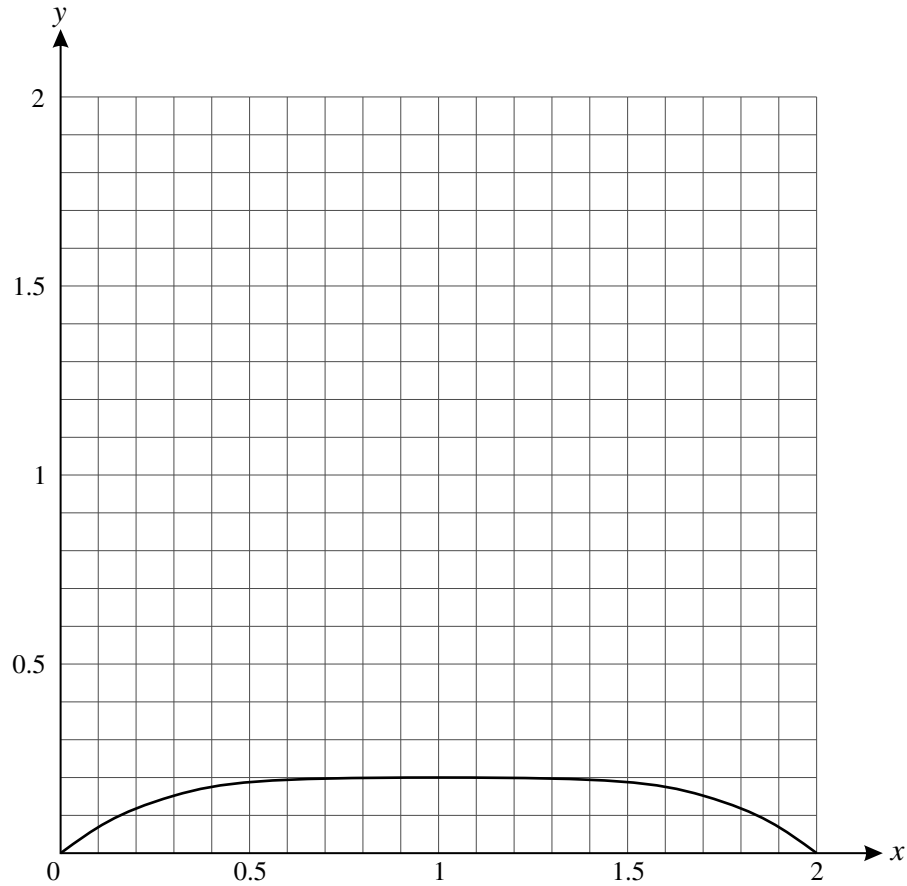
- (i) Show that  $2x^2 = 25 - h^2$ . [2]
- (ii) Show that the volume of the pyramid,  $V \text{ m}^3$ , is given by  $V = \frac{50h - 2h^3}{3}$ . [2]
- (iii) As  $h$  varies, find the value of  $h$  for which  $V$  has a stationary value. [4]
- (iv) Prove that this stationary value is a maximum. [2]
- (v) Calculate the angle between the edge AE and the base when  $h$  takes this value. [2]

[Volume of a pyramid =  $\frac{1}{3} \times$  base area  $\times$  height.]

- 14 The cross-section of a speed hump is modelled by the region enclosed by the  $x$ -axis and the curve

$$y = \frac{1 - (x - 1)^4}{5}.$$

The graph is shown in Fig. 14.  
Units are metres.



**Fig. 14**

- (a) (i) Write down the maximum value of  $1 - (x - 1)^4$ . [1]  
(ii) Hence write down the maximum height of the speed hump. [1]
- (b) Show that  $y = \frac{1}{5}(4x - 6x^2 + 4x^3 - x^4)$ . [3]
- (c) Find the area of the cross-section of the speed hump. [7]

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