

Wednesday 5 June 2013 – Afternoon

FSMQ ADVANCED LEVEL

6993/01 Additional Mathematics

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:

- Printed Answer Book 6993

Other materials required:

- Scientific or graphical calculator

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. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- 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.

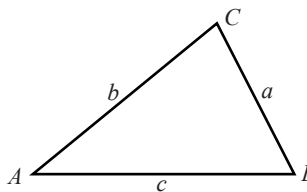
INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

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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

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

Section A

- 1 (i) Find the gradient of the line, L, whose equation is $3x + 2y = 7$. [2]
(ii) Find the equation of the line which is perpendicular to L and which passes through the point (3, 1). [3]
- 2 Find the integers that satisfy the inequality $-7 < 3x + 1 < 12$. [4]
- 3 This year John is 4 times as old as his son Paul. In 5 years' time John will be only 3 times as old as Paul.
Let the age of Paul now be x years.
By forming an equation in x and solving it, find Paul's age now. [4]
- 4 You are given that θ is an acute angle and $\sin \theta = \frac{\sqrt{5}}{3}$.
Find the **exact** value of $\tan \theta$. [3]
- 5 (i) Use calculus to find the stationary points on the curve $y = x^3 - \frac{3}{2}x^2 - 6x + 3$. [5]
(ii) Sketch the curve on the axes provided showing the stationary points and the point where it cuts the y -axis. [2]
- 6 Amanda throws 3 fair dice. What is the probability that
(i) exactly 2 sixes are thrown, [3]
(ii) at least 1 six is thrown? [3]

- 7 John and Jennie are asked to draw a triangle ABC with the following properties:

$$AC = 6 \text{ cm}, CB = 4 \text{ cm and the angle } A = 40^\circ.$$

John draws the triangle as shown in Fig. 7.1 and Jennie draws the triangle as shown in Fig. 7.2.

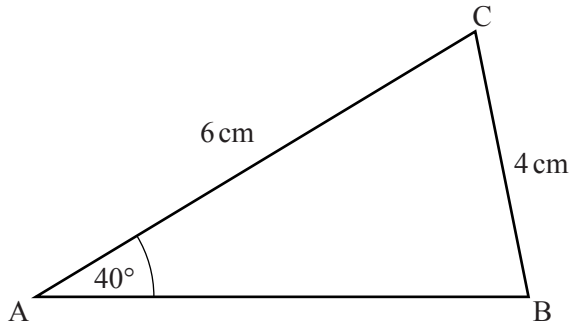


Fig. 7.1

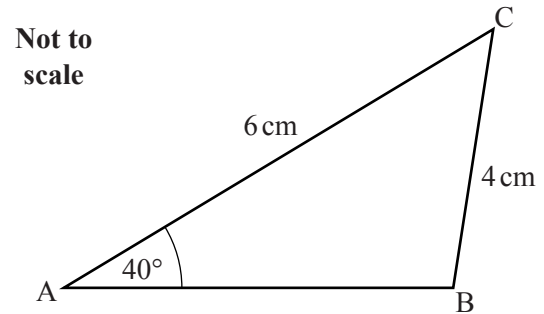


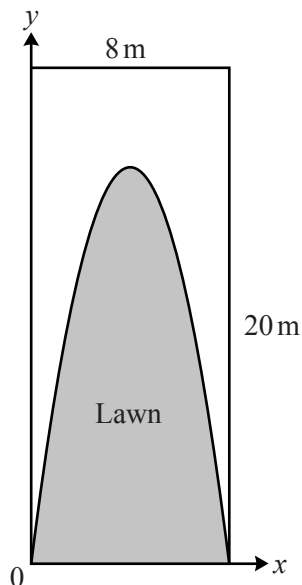
Fig. 7.2

Calculate the angle B in each case.

[4]

- 8 A mathematical gardener has a garden which is rectangular in shape measuring 20 metres by 8 metres. He wishes to arrange the garden so that approximately half of it is lawn and the rest flower bed.

He sets up a coordinate system as shown in the diagram below and maps out the graph of the curve $y = 8x - x^2$.



Show that the area of the lawn is approximately 53% of the total area.

[6]

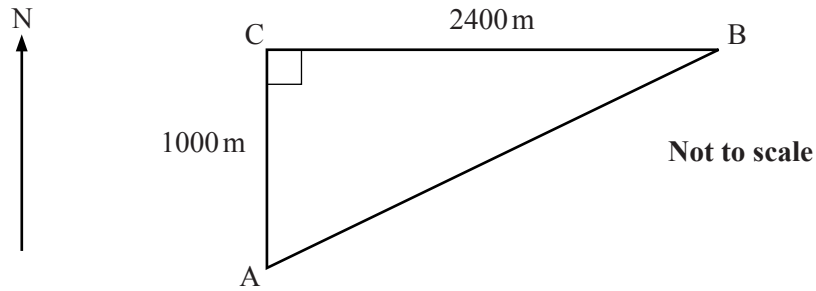
- 9 (i) Find the values of the constants a and b such that, for all values of x

$$x^2 + 8x + 19 = (x + a)^2 + b. \quad [3]$$

- (ii) Hence state the least value of $x^2 + 8x + 19$ and the value of x at which this occurs. [2]

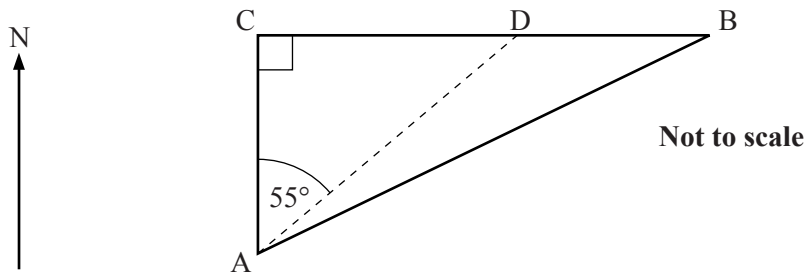
- (iii) Write down the greatest value of $\frac{1}{x^2 + 8x + 19}$. [1]

- 10 One leg of a cross-country race is from A to B. The checkpoint B is at the end of a wall that runs due east-west, as shown in the diagram. A is a point 1000 m due south of a point C on the wall. $BC = 2400$ m.



- (i) What bearing should a runner take to travel from A to B and what is the distance AB? [4]

John sets off from A unable to see the checkpoint, B. He heads out on a bearing of 055° and when he reaches the wall at point D he knows he has to go east along the wall to reach the point B, as shown in the diagram.



- (ii) How much further than the distance AB does John run? [3]

Section B

- 11 A circle has equation $(x - 2)^2 + y^2 = 100$.
- (a) Write down the radius and the coordinates of the centre, C, of this circle. [2]
- The line $y = 2x + 6$ cuts the circle at two points, A and B.
- (b) Find
- (i) the coordinates of A and B, [5]
- (ii) the midpoint, M, of AB, [1]
- (iii) the length AB. [2]
- (c) Hence find the distance of the centre of the circle from the line AB. [2]
- 12 An object sinks through a thick liquid such that at time t seconds after being released on the surface the depth, s metres, is given by
- $$s = 4t^2 - \frac{2t^3}{3} \quad \text{for } 0 \leq t \leq 4.$$
- (a) Find the formula for the velocity, v metres per second, t seconds after being released. Hence show that the object stops sinking when $t = 4$. [4]
- (b) Find
- (i) the acceleration of the object when it is released on the surface of the liquid, [4]
- (ii) the greatest depth of the object. [2]
- (c) On the grids provided sketch the velocity-time and acceleration-time graphs. [2]
- 13 A number of students from a group of 20 boys and 30 girls are to be selected to attend a one-day conference. The number of girls attending must be at least the same as the number of boys but no more than twice the number of boys.
- (i) Let there be x boys and y girls selected. Given that $x > 0$ and $y > 0$, write down four more inequalities to represent the information. [3]
- (ii) Plot these inequalities on the grid provided. Indicate the region for which the inequalities hold. Shade the area that is **not** required. [5]
- (iii) In order to attend the conference the students need to be given a special uniform. The uniform for the boys costs £40 and the uniform for the girls cost £50. The school has £2000 to spend on the uniforms.
- By plotting the appropriate line on your graph, find the maximum number of students that could go to the conference. [4]

14 A curve has equation $y = 4x^3 - 5x^2 + 1$ and passes through the point A(1, 0).

(i) Find the equation of the normal to the curve at A. [5]

(ii) This normal also cuts the curve in two other points, B and C. Show that the x -coordinates of the three points where the normal cuts the curve are given by the equation $8x^3 - 10x^2 + x + 1 = 0$. [2]

(iii) Show that the point B $\left(\frac{1}{2}, \frac{1}{4}\right)$ satisfies the normal and the curve. [2]

(iv) Find the coordinates of C. [3]

THERE ARE NO QUESTIONS WRITTEN ON THIS PAGE.



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