OCR
Oxford Cambridge and RSA

Wednesday 3 June 2015 – Morning

FSMQ ADVANCED LEVEL

6993/01 Additional Mathematics

QUESTION PAPER

4396281055

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 6993/01

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 inside 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

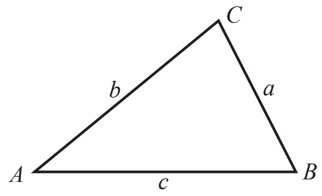
This information is the same on the Printed Answer Book and the Question Paper.

- 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

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

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

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

where

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

Section A

1 Find the equation of the line which is perpendicular to the line $2x+3y=5$ and which passes through the point (3, 4). **[3]**

2 **(i)** Find α in the range $0° \leqslant \alpha \leqslant 180°$ such that $\tan\alpha = -1.5$. **[2]**

(ii) Find β in the range $0° \leqslant \beta \leqslant 180°$ such that $\sin\beta = 0.2$. **[2]**

3 Find the equation of the tangent to the curve $y = x^3 + 3x - 5$ at the point (2, 9). **[5]**

4 **(i)** Find $\int_1^2 (x^2 + 2x + 3)\,\mathrm{d}x$. **[4]**

(ii) Interpret your answer geometrically. **[1]**

5 A train accelerates from rest from a point O such that at t seconds the displacement, s metres from O, is given by the formula $s = \frac{3}{2}t^2 - 2t + 3$.

(i) Show by calculus that the acceleration is constant. **[3]**

(ii) Find the velocity after 5 seconds. **[2]**

6 You are given that n is a positive integer and $(n-1)$, n, $(n+1)$ are three consecutive integers.

In each of the following cases form an equation in n and solve it.

(i) The three integers add up to 99. **[2]**

(ii) When the product of the first integer and third integer is added to 5 times the second integer the sum is 203. **[4]**

7 **(i)** Solve algebraically the simultaneous equations $y = 3 + 5x - x^2$ and $y = x + 7$. **[4]**

(ii) Interpret your answer geometrically. **[1]**

8 The cubic polynomial $f(x) = x^3 + ax + 6$, where a is a constant, has a factor of $(x + 3)$.

(i) Find the value of a. **[2]**

(ii) Hence or otherwise, solve the equation $f(x) = 0$ for this value of a. **[4]**

9 The equation of the circle C is $x^2 + y^2 - 8x + 2y - 19 = 0$.

(i) Express the equation of C in the form $(x-a)^2 + (y-b)^2 = r^2$. **[4]**

(ii) Hence or otherwise, use an algebraic method to decide whether the point $(8, 3)$ lies inside, outside or on the circumference of the circle.
Show all your working. **[2]**

10 Fig. 10 shows a partly open window OA, viewed from above. The window is hinged at O. When the window is closed, the end A is at point B. The window is kept open by a rod CD, where C is a fixed point on the line OB.
The point D slides along a fixed bar EF. When the window is closed, D is at F. When the window is fully open, D is at E.

OA = OB = 20 cm, OC = 8 cm, CD = 7 cm, EF = 5 cm, OE = 10 cm

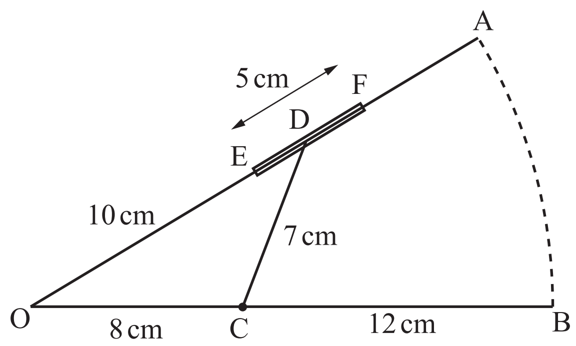


Fig. 10

Find

(i) angle EOC when the window is fully open, **[3]**

(ii) the distance OD when angle EOC is 30°. **[4]**

Section B

11 Two curves, S_1 and S_2 have equations $y = x^2 - 4x + 7$ and $y = 6x - x^2 - 1$ respectively. The curves meet at A and at B.

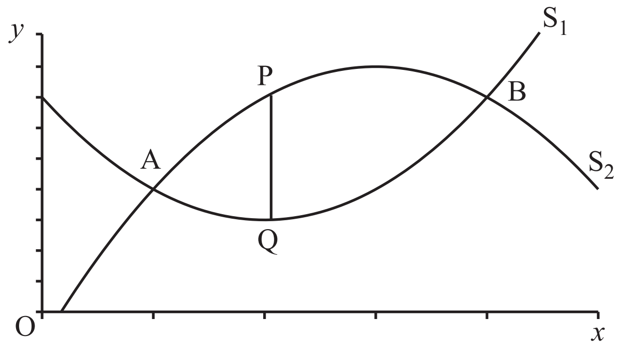


Fig. 11

(i) Show that the coordinates of A and B are (1, 4) and (4, 7) respectively. **[2]**

Points P and Q lie on S_2 and S_1 between A and B. P and Q have the same x coordinate so that PQ is parallel to the y-axis, as shown in Fig. 11.

(ii) Find an expression, in its simplest form, for the length PQ as a function of x. **[2]**

(iii) Use calculus to find the greatest length of PQ. **[4]**

(iv) Find the area between the two curves. **[4]**

12 A distributor of flower bulbs has a large number of tulip bulbs and daffodil bulbs, mixed in the ratio 1 : 3 respectively. He packs the bulbs in boxes. He puts 10 bulbs, chosen at random, into each box.

(a) Find the probability that a box, chosen at random, contains

(i) exactly 4 daffodil bulbs, **[4]**

(ii) at least 1 tulip bulb. **[3]**

(b) Two boxes of bulbs are chosen at random.

Find the probability that there is a total of 3 tulip bulbs in the two boxes. **[5]**

13 A gardener marks out a regular hexagon ABCDEF on his horizontal garden.
Each side of the hexagon is 0.5 m. The gardener sticks a cane in the ground at each point of the hexagon. He joins the six canes at V where V is vertically above the centre, O, of the hexagon, as shown in Fig. 13. Each cane has a length of 2.4 m from the ground to V.

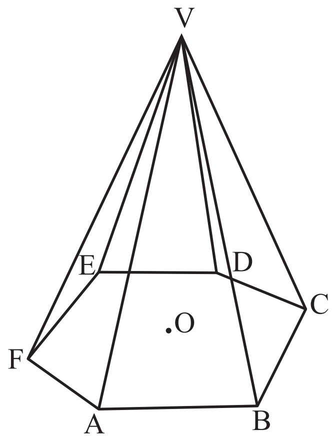


Fig. 13

Calculate, giving your answers to 3 significant figures,

(i) the vertical height of V above the ground, **[3]**

(ii) the angle between each cane and the ground, **[2]**

(iii) the angle between the plane VAB and the ground. **[4]**

The gardener stretches a horizontal wire around the structure to strengthen it. He fixes the wire to each cane at a point 1 m vertically above the ground.

(iv) Find the length of the wire. **[3]**

14 A company produces bottles of two liquids, X and Y. There are two ingredients, A and B, in each liquid.

The table shows the quantities, in centilitres (cl), of A and B needed for each bottle of liquid.

	A	B
X	4	2
Y	3	5

Each day the company can use 84 cl of A and 90 cl of B.

From this information an analyst writes down the inequality $4x + 3y \leqslant 84$.

(i) Explain what x and y stand for in this inequality and explain what the inequality models. **[2]**

(ii) Use the information given to write down another inequality, other than $x \geqslant 0$ and $y \geqslant 0$. **[1]**

(iii) On the grid given in the answer booklet, illustrate your two inequalities. Shade the region that is not required. **[3]**

(iv) The company needs to produce the same number of bottles of X and of Y each day.

Find the maximum number of bottles of X and of Y that the company can produce. **[2]**

(v) On one day the company does not have to produce the same numbers of bottles of X and of Y.

Write down the maximum number of bottles that can be produced and all the combinations that will give this maximum. **[4]**

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