OCR
Oxford Cambridge and RSA

Tuesday 19 June 2018 – Afternoon

FSMQ ADVANCED LEVEL

6993/01 Additional Mathematics

QUESTION PAPER

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 barcodes.
- 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.

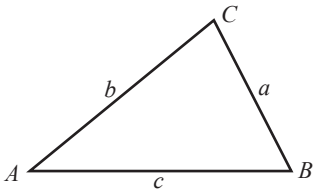
INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

- 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

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

Answer **all** the questions.

Section A

1 Solve the inequality $2-x < 1+3(x-2)$. **[3]**

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

Find the equation of the curve given that it passes through the point (2, 3). **[4]**

3 The graph of $y = x^2+2x-3$ is given on the grid in the Printed Answer Book.

(i) Write down the solution to the equation $x^2+2x-3 = 0$. **[1]**

(ii) By plotting the appropriate straight line on the grid, find the solution to the equation $x^2-x-6 = 0$. **[3]**

4 You are given that the acute angle θ is such that $\sin\theta = \frac{1}{5}$.

Find the **exact** value of each of the following.

- $\cos\theta$
- $\tan\theta$

[4]

5 Fig. 5 shows part of the graph of the curve with equation $y = 6x^2 - 2x^3$.

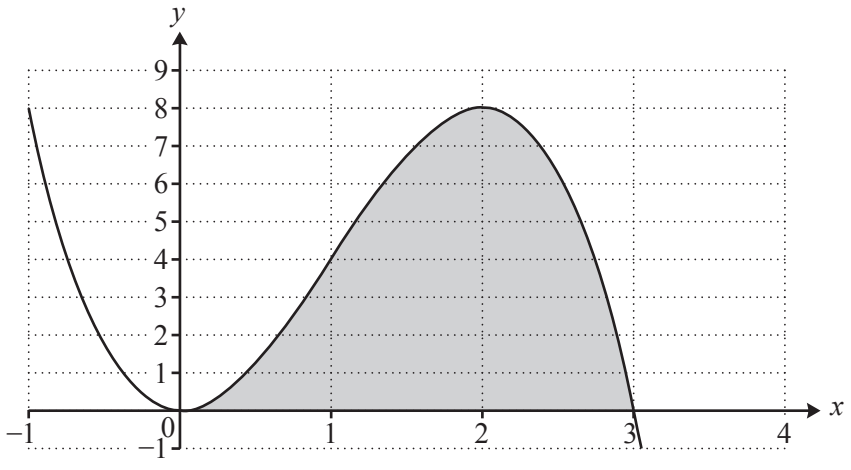


Fig. 5

Find the area of the shaded region enclosed by the curve and the x-axis. **[4]**

6 **(i)** Solve these simultaneous equations.

$$3x + 4y = 18$$
$$7x - 3y = 5$$

[4]

(ii) Draw a rough sketch of the lines to demonstrate graphically the solution to part **(i)**. **[2]**

7 **(i)** Find the coordinates of the points where the line $y = 7x - 9$ cuts the curve $y = x^2 + 2x - 5$. **[4]**

(ii) Determine whether the line is a normal to the curve at either of the points of intersection. **[3]**

8 **(i)** Simplify the equation $\frac{x+a}{x} + \frac{x-2}{4} = 0$, leaving your answer in the form $(x+p)^2 = q$

where p is an integer and q is given in terms of the constant a. **[3]**

(ii) Hence write down the range of values of a for which the equation has real roots. **[2]**

(iii) Using your answer to part **(i)**, solve the equation when $a = -1$, giving your answers **exactly**. **[2]**

9 The proportion of people who are left-handed is 20%.

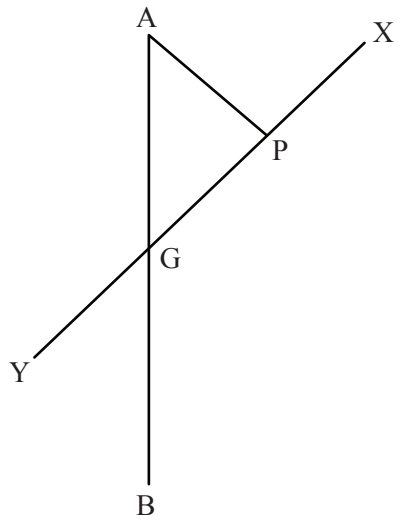
(a) For a group of 10 students chosen at random, use the binomial distribution to find the probability that

(i) no student is left-handed, **[2]**

(ii) exactly 4 students are left-handed. **[3]**

(b) State the conditions necessary for the binomial distribution to be valid. **[2]**

10 Fig. 10 shows an "up and over" garage door, XY, that is 200 cm long. There is a small wheel at the point G on the door. The wheel runs freely up a groove in a fixed vertical door frame, AB. A metal rod AP is fixed to the top of the door frame, A, and is also fixed to the point P on the door. The rod is hinged at both ends.
GP = PX = AP = 60 cm and YG = 80 cm.
When the door is closed, Y is at B and X is at A. When the door is fully open, G is at A and the door is horizontal, 200 cm above the horizontal ground.



Not to scale

Fig. 10

(i) Explain why P is the centre of the circle through A, G and X. **[1]**

(ii) Hence show that AX is horizontal whatever the position of the garage door. **[1]**

(iii) Find the height of Y above the ground when angle AGP = 40°. **[4]**

Section B

11 A circle has centre (0, 3) and radius 3.

(i) Show that the equation of the circle is $x^2 + y^2 - ky = 0$ where k is to be determined. **[2]**

The line $y = mx - 2$ passes through the point P (0, –2) and is a tangent to the circle.

(ii) Find the two possible values of m. **[6]**

The two tangents from P meet the circle at the points A and B respectively.

(iii) Find the lengths PA and PB. **[4]**

12 The shape shown in Fig. 12 is made of metal rods. ABCD is a rectangle.
AB = CD = y cm and BC = DA = $6x$ cm.
AED is an isosceles triangle with height $4x$ cm and AE = ED.

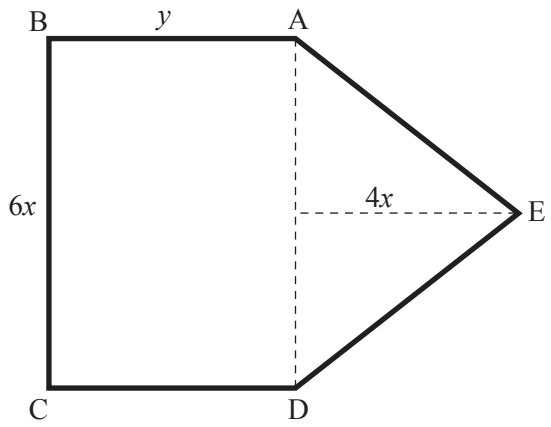


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Fig 12

(i) Show that the perimeter, p cm, can be written as $p = 16x + 2y$. **[3]**

You are given that $p = 96$.

(ii) Show that the area of the shape, A cm^2, can be written as $A = 288x - 36x^2$. **[3]**

(iii) Find the maximum area of the shape as x and y vary and find the values of x and y for this area. **[6]**

13 Jessie walks at 3 km per hour in a straight line from a point B to a point C, a distance of 5 km. C is on a bearing 050° from B, as shown in Fig 13.1.
Brandon sets out at the same time as Jessie. He starts from a point A which is 2 km due East of B. He walks at 2 km per hour directly to C.

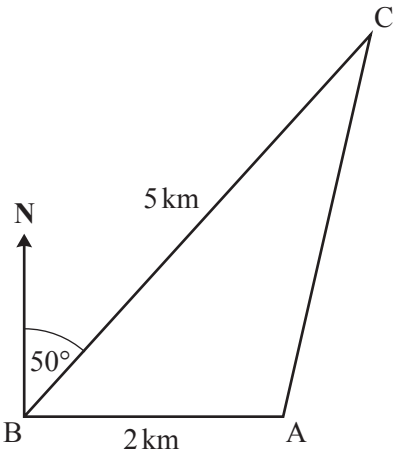

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Fig. 13.1

(i) Calculate the distance AC, correct to 3 significant figures. **[4]**

(ii) Show that Brandon arrives at C approximately 11 minutes after Jessie arrives. **[3]**

Charlie also sets out at the same time as Jessie. He walks in a straight line from A at 2 km per hour to meet Jessie at a point X on BC, as shown in Fig. 13.2. He arrives at the point X at the same time as Jessie.

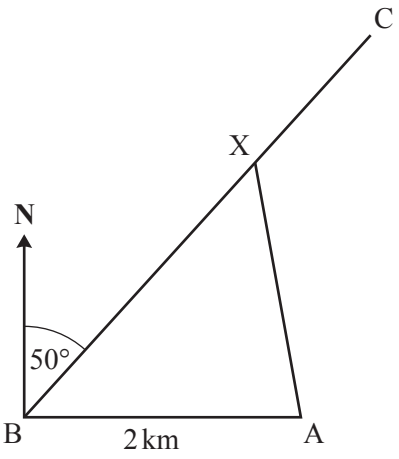

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Fig. 13.2

(iii) Show that there are two possible positions for X and find the bearing on which Charlie must walk in each case. **[5]**

14 Two cars, P and Q, accelerate from rest from a point O at the same time.

(a) P accelerates uniformly at $2\,\text{m}\,\text{s}^{-2}$.

(i) Write down the formula for the displacement, s metres, of P at time t seconds after leaving O. **[1]**

(ii) Using appropriate units, find the time taken for P to reach a speed of $90\,\text{km}\,\text{h}^{-1}$. **[3]**

(b) Q accelerates from rest with **variable** acceleration $a\,\text{m}\,\text{s}^{-2}$ where, at time t seconds, $a = 1 + kt$, where k is a positive constant. Q passes P when $t = 10$.

(i) Find the value of k. **[5]**

(ii) Show that at the time when P reaches $90\,\text{km}\,\text{h}^{-1}$, Q is travelling at a speed just less than $130\,\text{km}\,\text{h}^{-1}$. **[3]**

END OF QUESTION PAPER