

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS  
FSMQ**

**6993/01**

**ADVANCED LEVEL  
Additional Mathematics  
QUESTION PAPER**

**MONDAY 6 JUNE 2016: Afternoon  
DURATION: 2 hours  
plus your additional time allowance**

**MODIFIED ENLARGED**

**Candidates answer on the Printed Answer Book or any suitable paper provided by the centre. The Printed Answer Book may be enlarged by the centre.**

**OCR SUPPLIED MATERIALS:**

**Insert for Question 10(i)**

**OTHER MATERIALS REQUIRED:**

**Scientific or graphical calculator**

**READ INSTRUCTIONS OVERLEAF**



## **INSTRUCTIONS TO CANDIDATES**

**Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book or on the paper provided by the centre. Please write clearly and in capital letters.**

**IF YOU USE THE PRINTED ANSWER BOOK WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.**

**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.**

**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 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.**

**Any blank pages are indicated.**

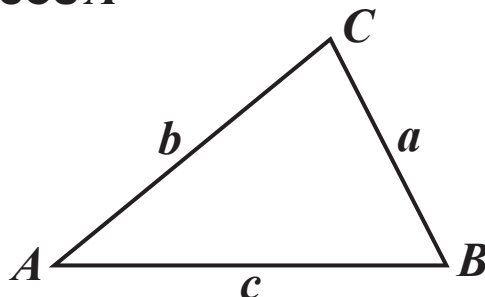
## **INSTRUCTION TO EXAMS OFFICER/INVIGILATOR**

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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

Answer ALL the questions.

1 Solve the inequality  $1 - 2(x - 3) > 4x$ . [3]

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

Find the equation of the curve, given that it passes through the point (1, 3). [4]

3 Find all the values of  $x$  in the range  $0^\circ < x < 360^\circ$  that satisfy  $3\sin x = 4\cos x$ . [4]

4 You are given that  $f(x) = x^3 - x^2 + x - 6$ .

Show that

(i)  $(x - 2)$  is a factor of  $f(x)$ , [1]

(ii) the equation  $f(x) = 0$  has only one real root. [4]

5 John draws a triangle ABC with sides  $AB = 12$  cm,  $BC = 16$  cm and  $AC = 20$  cm. However, he can only measure the sides to the nearest centimetre.

(i) State the smallest possible length of AB in John's drawing. [1]

(ii) Hence calculate the largest possible value of the angle B in John's drawing. [3]

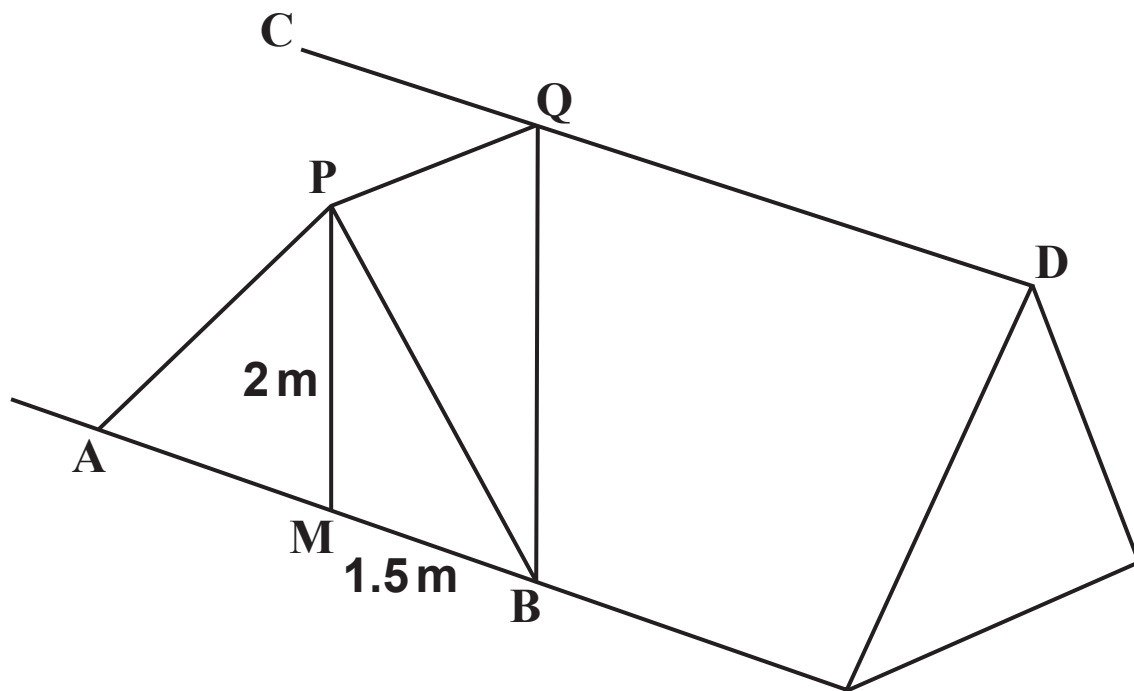
- 6 Two cars are initially at rest facing in the same direction on a straight road. Car A is 100m ahead of car B. The two cars start from rest at the same moment.**

**Car A moves with constant acceleration of  $1.5 \text{ m s}^{-2}$  and car B moves with constant acceleration of  $2 \text{ m s}^{-2}$ .**

**Find**

- (i) the distance that car B travels before it overtakes car A, [4]**
- (ii) the speed of car B at the moment when it overtakes car A. [2]**

- 7 An extension to the roof of a house is shown in the diagram below.



The ridge,  $CD$ , and the lines  $AB$  and  $PQ$  are horizontal.  
 $PQ$  is perpendicular to  $CD$ .

$M$  is the midpoint of  $AB$ . The line  $PM$  is vertical.

$APB$  is an isosceles triangle with height 2 metres and base length 3 metres.

Angle  $PQM$  is  $45^\circ$ .

Find

- (i) the length of  $PQ$ , [1]
- (ii) the angle  $PBQ$ . [4]

**8 (i) Write down the binomial expansion of  $(1 + \delta)^3$ . [2]**

**(ii) Hence explain why, if  $\delta$  is small,  $(1 + \delta)^3 \approx 1 + 3\delta$ .  
[ $\approx$  means ‘is approximately equal to’] [1]**

**You are given that the equation  $x^3 - 0.9x - 0.206 = 0$   
has a root very close to  $x = 1$ .**

**(iii) Substitute  $x = 1 + \delta$  into the equation and use the  
approximation in part (ii) to find an estimate of this  
root, correct to 3 significant figures. Show all your  
working. [4]**

**9 A curve has equation  $y = x^3 - 3x^2 - 3x + 4$ .  
Points P and Q lie on the curve. The coordinates of P  
are  $(3, -5)$ .**

**(i) Find the equation of the tangent to the curve  
at P. [4]**

**The tangent to the curve at Q is parallel to the tangent  
to the curve at P.**

**(ii) Find the coordinates of Q. [3]**



- 10 (i) On the axes given in the insert, indicate the region for which the following inequalities hold. You should shade the region that is NOT satisfied by the inequalities.

$$4x + 3y \leq 30$$

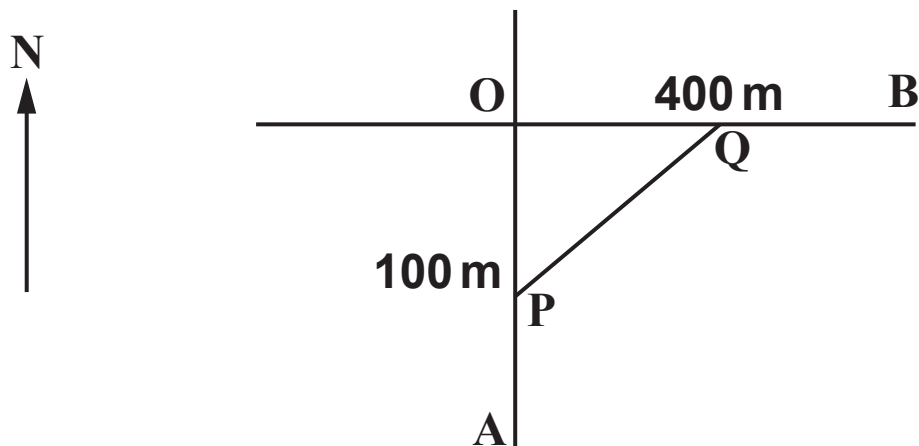
$$y \geq 2x$$

$$x \geq 1 \quad [5]$$

- (ii) Find the maximum value of  $7x + 4y$  subject to these conditions. [2]

## SECTION B

- 11 A railway track runs due east-west and is crossed at O by a road running due south-north, as shown below. The crossing has no barriers.



Initially a train is at point B, 400 m from O, and a car is at point A, 100 m from O. The train is travelling at a constant speed of  $25 \text{ m s}^{-1}$  towards O and the car is travelling at a constant speed of  $20 \text{ m s}^{-1}$  towards O.

At time  $t$  seconds the train is at point Q and the car is at point P.

- (i) Find expressions for the distances OP and OQ as functions of  $t$ . [2]
- (ii) The distance between the car and the train at time  $t$  s is  $x$  m. Find a formula for  $x^2$  in terms of  $t$ . Give your formula in the form  $x^2 = a + bt + ct^2$  where  $a$ ,  $b$  and  $c$  are to be determined. [3]
- (iii) Differentiate this formula with respect to  $t$  and find the time at which  $x^2$  is a minimum. Hence find the shortest distance between the car and the train. [6]
- (iv) Show that the car passes point O before the train. [1]

**12 The line  $L_1$  has equation  $3x - y = 1$  and the point P has coordinates (8, 3).**

- (i) Find the equation of the line  $L_2$  which passes through P and is perpendicular to line  $L_1$ . [3]**
- (ii) Find the coordinates of the point Q where  $L_1$  and  $L_2$  intersect. [3]**
- (iii) Find the length PQ. [2]**
- (iv) Write down the equation of the circle that has centre P and line  $L_1$  as a tangent. [1]**
- (v) Find the equation of the other line that is a tangent to the circle and is parallel to line  $L_1$ . [3]**

**13 The cost of a packet of buns in a local supermarket is  $x$  pence and the cost of a loaf of bread is  $x + 75$  pence.**

- (i) Write an expression for the number of packets of buns that can be bought for £5.40 and an expression for the number of loaves that can be bought for £5.40. [2]**

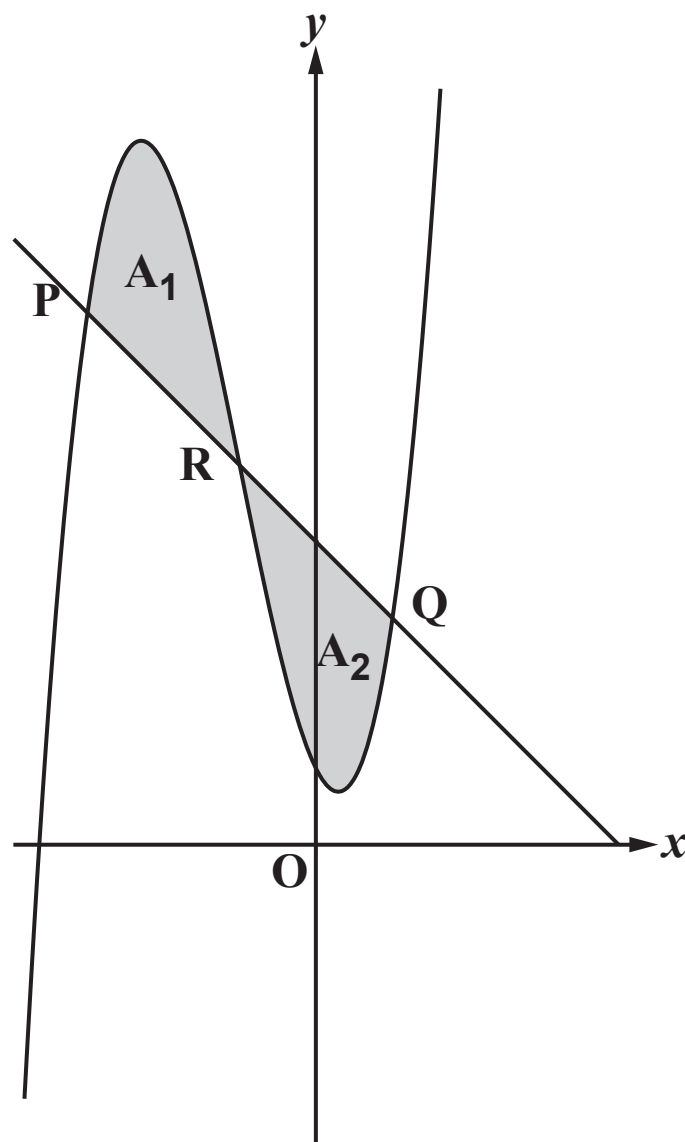
**The number of packets of buns that can be bought for £5.40 is 5 more than the number of loaves that can be bought for £5.40.**

- (ii) Using this information and your answer to part (i), derive an equation in  $x$  and show that it simplifies to  $x^2 + 75x - 8100 = 0$ . [5]**
- (iii) Solve this equation to find the cost of a packet of buns and the cost of a loaf of bread. [5]**

**14** The equation of a curve is given by  $y = x^3 + ax^2 + bx + 1$ . The points P (−3, 7) and Q (1, 3) lie on the curve.

- (i) Form two equations in  $a$  and  $b$ . Solve these equations to show that  $a = 3$  and  $b = -2$ . [4]
- (ii) Find the midpoint, R, of the line PQ and show that R lies on the curve. [2]

The diagram below shows the curve and the line PRQ.



The area between the curve and the line segment PR is  $A_1$  and the area between the curve and the line segment RQ is  $A_2$ .

(iii) Show that  $A_1 = A_2$ . [6]

**END OF QUESTION PAPER**

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