OCR
Oxford Cambridge and RSA

Monday 6 June 2016 – 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**. 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.
- 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.

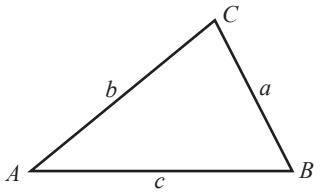
INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

- 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

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 $0° < x < 360°$ 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]**

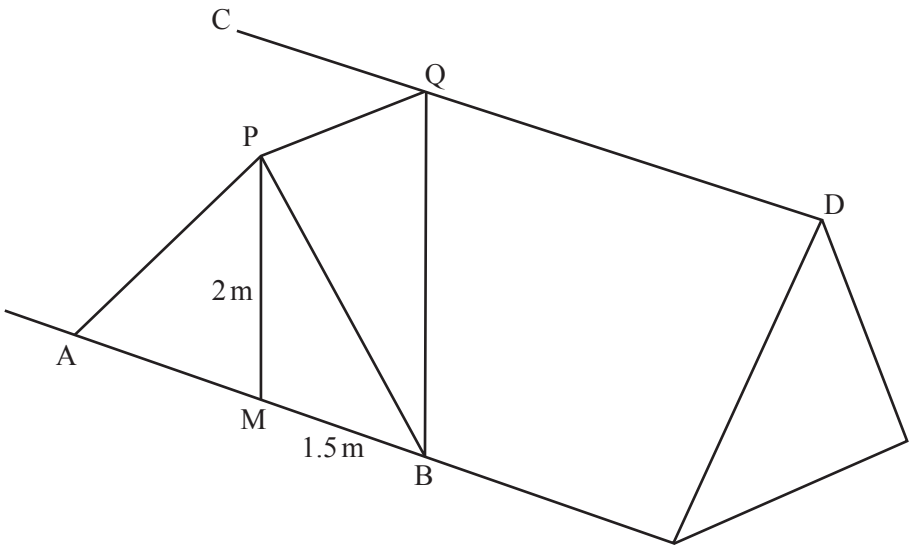
6 Two cars are initially at rest facing in the same direction on a straight road. Car A is 100 m ahead of car B. The two cars start from rest at the same moment.
Car A moves with constant acceleration of $1.5\,m\,s^{-2}$ and car B moves with constant acceleration of $2\,m\,s^{-2}$.

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°.

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 δ 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 Printed Answer Book, indicate the region for which the following inequalities hold. You should shade the region that is **not** satisfied by the inequalities.

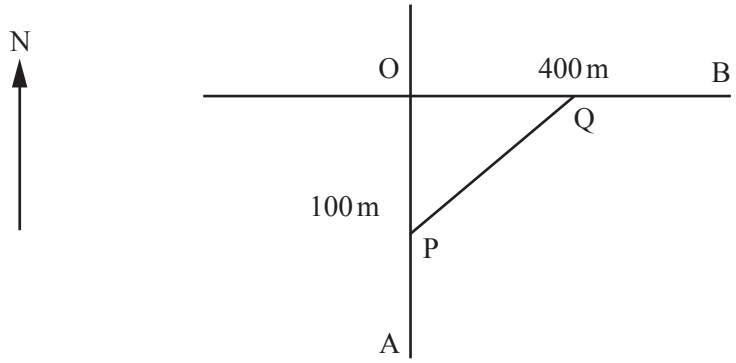
$$4x + 3y \leqslant 30$$
$$y \geqslant 2x$$
$$x \geqslant 1$$

[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 $25\,\text{m}\,\text{s}^{-1}$ towards O and the car is travelling at a constant speed of $20\,\text{m}\,\text{s}^{-1}$ 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]**

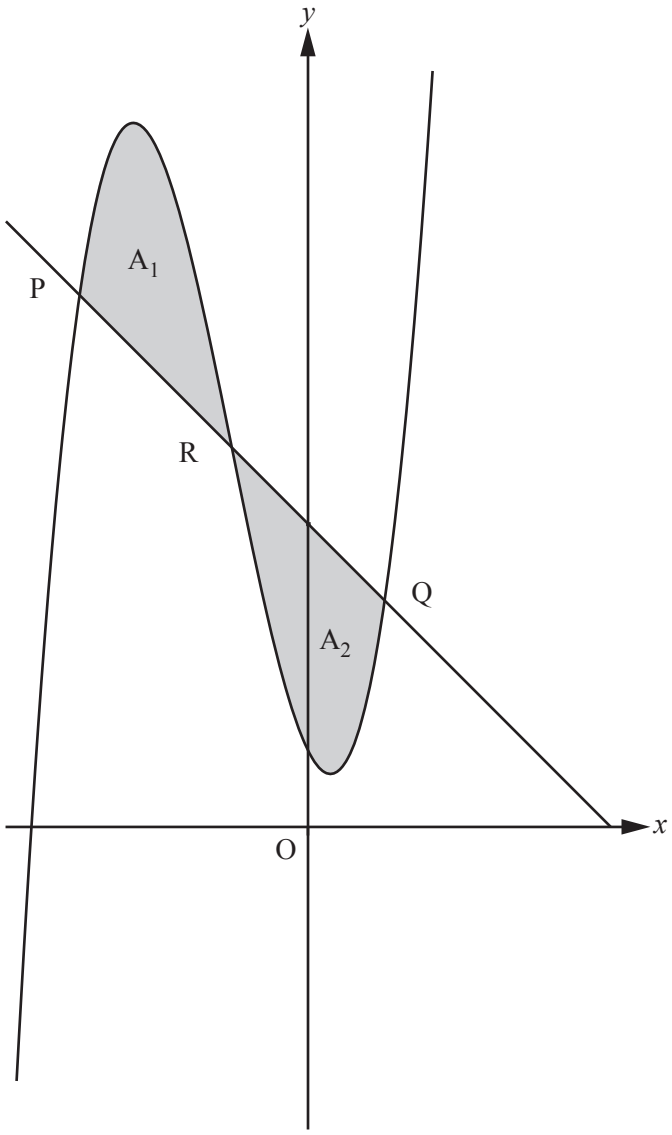
Question 14 is printed overleaf

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