Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Award

Centre Number | | | | | |

Candidate Number | | | | |

Sample Assessment Material for first teaching September 2017

Time: **3 hours** | Paper Reference **9811/11**

Advanced Extension Award Mathematics

You must have:
Mathematical Formulae and Statistical Tables
An insert for Question 6 and 7

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need*.
- **Calculators may not be used**.
- You must **show all your working**.
- Answers should be given in as simple a form as possible. e.g. $\frac{2\pi}{3}$, $\sqrt{2}$, $3\sqrt{2}$.

Information

- The total mark for this paper is 100 of which **7** marks are for style and clarity of presentation.
- The style and clarity of presentation marks will be indicated as **(+S1) or (+S2)**.
- There are 7 questions in this question paper.
- The marks for each question are shown in brackets.
- The total mark for each question is shown at the end of the question.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

S63221A

©2019 Pearson Education Ltd.

1/1/

S 6 3 2 2 1 A 0 1 3 2

Pearson

Answer ALL questions. Write your answers in the spaces provided.

1. (a) For $|y| < 1$, write down the binomial series expansion of $(1 - y)^{-2}$ in ascending powers of y up to and including the term in y^3

(1)

(b) Show that when it is convergent, the series

$$1 + \frac{2x}{x+3} + \frac{3x^2}{(x+3)^2} + \ldots + \frac{rx^{r-1}}{(x+3)^{r-1}} + \ldots$$

can be written in the form $(1 + ax)^n$, where a and n are constants to be found.

(4)

(c) Find the set of values of x for which the series in part (b) is convergent.

(3)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 1 continued

(Total for Question 1 is 8 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

2. (a) On separate diagrams, sketch the curves with the following equations. On each sketch you should label the exact coordinates of the points where the curve meets the coordinate axes.

(i) $y = 8 + 2x - x^2$

(ii) $y = 8 + 2|x| - x^2$

(iii) $y = 8 + x + |x| - x^2$

(7)

(b) Find the values of x for which

$$\left|8 + x + |x| - x^2\right| = 8 + 2|x| - x^2$$

(4)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 2 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 2 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 2 continued

(Total for Question 2 is 11 marks)

3.

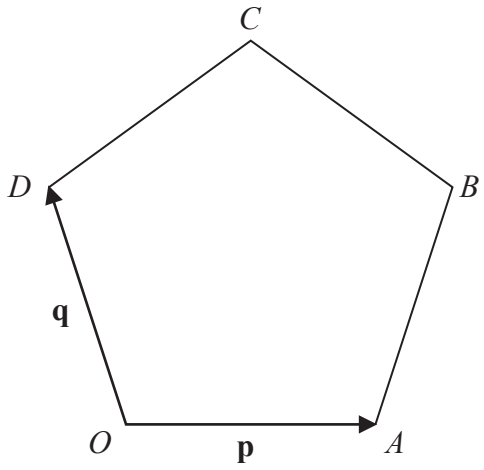

Figure 1

Figure 1 shows a regular pentagon $OABCD$. The vectors $\mathbf{p}$ and $\mathbf{q}$ are defined by $\mathbf{p} = \overrightarrow{OA}$ and $\mathbf{q} = \overrightarrow{OD}$ respectively.

Let k be the number such that $\overrightarrow{DB} = k\overrightarrow{OA}$.

(a) Write down $\overrightarrow{AC}$ in terms of $\mathbf{p}$, $\mathbf{q}$ and k as appropriate.

(1)

(b) Show that $\overrightarrow{CD} = -\mathbf{p} - \frac{1}{k}\mathbf{q}$

(3)

(c) Hence find the value of k

(4)

(+S1)

By considering triangle DBC, or otherwise,

(d) find the exact value of $\sin 54°$

(3)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 3 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 3 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 3 continued

(Total for Question 3 is 12 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

4.

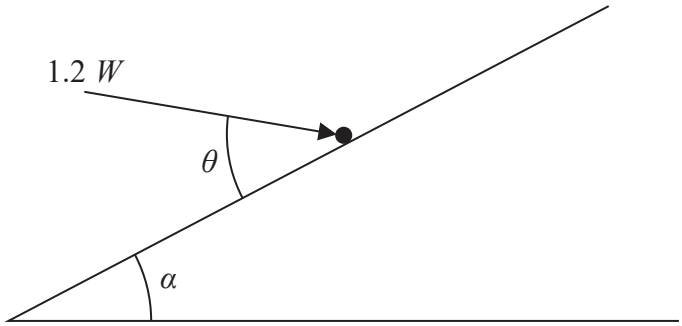

Figure 2

A particle of weight W lies on a rough plane. The plane is inclined to the horizontal at an angle α where $\tan\alpha = \frac{3}{4}$. The coefficient of friction between the particle and the plane is $\frac{1}{2}$

The particle is held in equilibrium by a force of magnitude $1.2W$. The force makes an angle θ with the plane, where $0 < \theta < \pi$, and acts in a vertical plane containing a line of greatest slope of the plane, as shown in Figure 2.

(a) Find the value of θ for which there is no frictional force acting on the particle.

(2)

The minimum value of θ for the particle to remain in equilibrium is β

(b) Show that

$$\beta = \arccos\left(\frac{\sqrt{5}}{3}\right) - \arctan\left(\frac{1}{2}\right)$$

(5)

(c) Find the range of values of θ for which the particle remains in equilibrium with the frictional force acting up the plane.

(5)

(+S1)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 4 continued

Question 4 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 4 continued

(Total for Question 4 is 13 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

5.

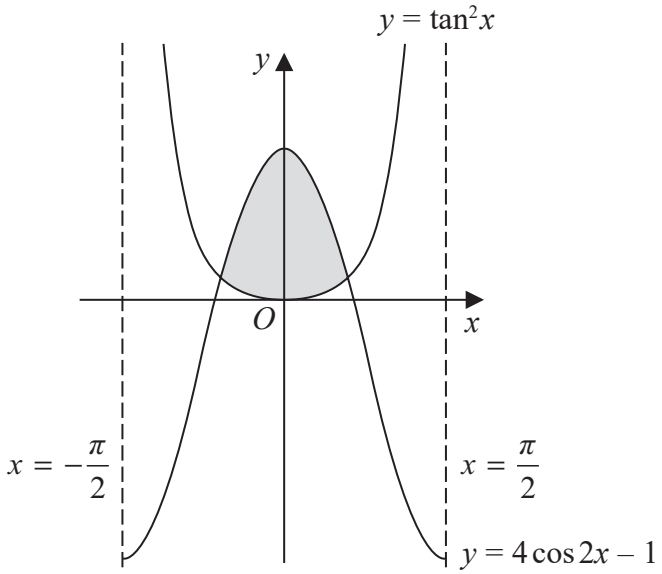

Figure 3

Show that the area of the finite region between the curves $y = \tan^2 x$ and $y = 4\cos 2x - 1$ in the interval $-\frac{\pi}{2} < x < \frac{\pi}{2}$, shown shaded in Figure 3, is given by

$$2\sqrt{2\sqrt{3}} - 2\sqrt{2\sqrt{3} - 3}$$

(12)

(+S1)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 5 continued

Question 5 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 5 continued

(Total for Question 5 is 13 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

6. (i) Eden, who is confused about the laws of logarithms, states that

$$(\log_5 p)^2 = \log_5(p^2)$$

and $\log_5 (q - p) = \log_5 q - \log_5 p$

However, there is a value of p and a value of q for which both statements are correct.

Determine these values.

(7)

(ii) (a) Let $r \in \mathbb{R}^+$, $r \neq 1$. Prove that

$$\log_r A = \log_{r^2} B \Rightarrow A^2 = B$$

(2)

(b) Solve

$$\log_4 (3x^3 + 26x^2 + 40x) = 2 + \log_2(x + 2)$$

(7)

(+S2)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 6 continued

Question 6 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 6 continued

Question 6 continued

(Total for Question 6 is 18 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

7.

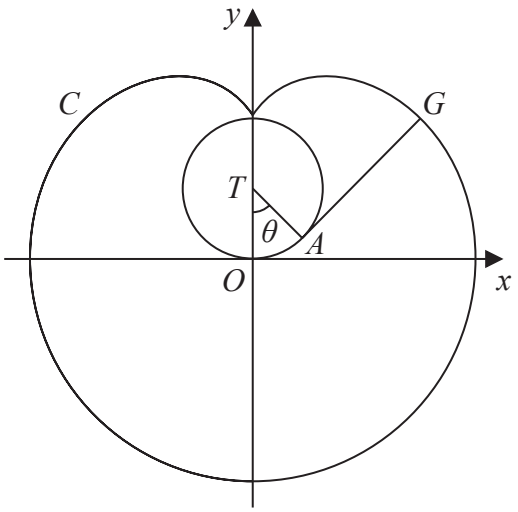

Figure 4

A circular tower of radius 1 metre stands in a large horizontal field of grass. A goat is attached to one end of a rope and the other end of the rope is attached to a fixed point O at the base of the tower. The goat cannot enter the tower.

Taking the point O as the origin (0, 0), the centre of the base of the tower is at the point $T(0, 1)$, where the unit of length is the metre.

The rope has length π metres and you may ignore the size of the goat.

The curve C shown in Figure 4 represents the edge of the region that the goat can reach.

(a) Write down the equation of C for $y < 0$

(1)

When the goat is at the point $G(x, y)$, with $x > 0$ and $y > 0$, as shown in Figure 4, the rope lies along OAG where OA is an arc of the circle with angle $OTA = \theta$ radians and AG is a tangent to the circle at A.

(b) With the aid of a suitable diagram show that

$$x = \sin\theta + (\pi - \theta)\cos\theta$$
$$y = 1 - \cos\theta + (\pi - \theta)\sin\theta$$

(5)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 7 continued

(c) By considering $\int y \frac{\mathrm{d}x}{\mathrm{d}\theta} \mathrm{d}\theta$, show that the area, in the first quadrant, between C, the positive x-axis and the positive y-axis can be expressed in the form

$$\int_0^{\pi} u \sin u \mathrm{d}u + \int_0^{\pi} u^2 \sin^2 u \mathrm{d}u + \int_0^{\pi} u \sin u \cos u \mathrm{d}u$$

(5)

(d) Show that $\int_0^{\pi} u^2 \sin^2 u \mathrm{d}u = \frac{\pi^3}{6} + \int_0^{\pi} u \sin u \cos u \mathrm{d}u$

(4)

(e) Hence find the area of grass that can be reached by the goat.

(8)

(+S2)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 7 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 7 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 7 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 7 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 7 continued

(Total for Question 7 is 25 marks)

FOR STYLE AND CLARITY OF PRESENTATION: 7 MARKS
TOTAL FOR PAPER IS 100 MARKS

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

BLANK PAGE

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA