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**Mathematics**  
**Standard level**  
**Paper 2**

Tuesday 14 May 2019 (morning)

Candidate session number

1 hour 30 minutes

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**Instructions to candidates**

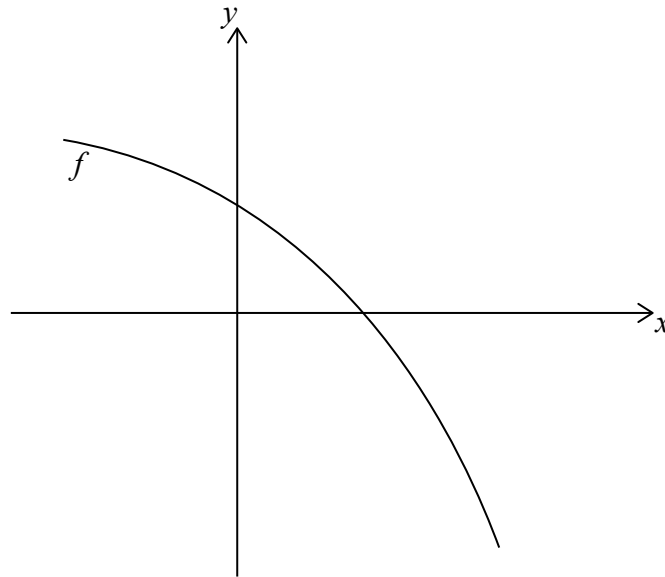
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- A graphic display calculator is required for this paper.
- Section A: answer all questions. Answers must be written within the answer boxes provided.
- Section B: answer all questions in the answer booklet provided. Fill in your session number on the front of the answer booklet, and attach it to this examination paper and your cover sheet using the tag provided.
- Unless otherwise stated in the question, all numerical answers should be given exactly or correct to three significant figures.
- A clean copy of the **mathematics SL formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[90 marks]**.





2. [Maximum mark: 5]

Let  $f(x) = 4 - 2e^x$ . The following diagram shows part of the graph of  $f$ .



- (a) Find the  $x$ -intercept of the graph of  $f$ . [2]
- (b) The region enclosed by the graph of  $f$ , the  $x$ -axis and the  $y$ -axis is rotated  $360^\circ$  about the  $x$ -axis. Find the volume of the solid formed. [3]

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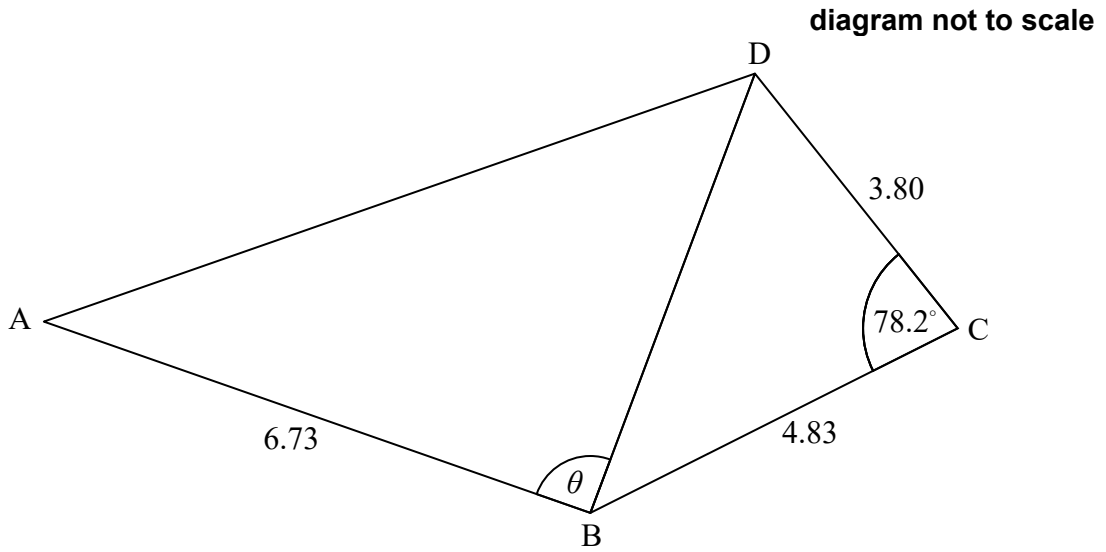
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3. [Maximum mark: 7]

The following diagram shows the quadrilateral ABCD.



$AB = 6.73 \text{ cm}$ ,  $BC = 4.83 \text{ cm}$ ,  $\widehat{BCD} = 78.2^\circ$  and  $CD = 3.80 \text{ cm}$ .

(a) Find  $BD$ . [3]

(b) The area of triangle  $ABD$  is  $18.5 \text{ cm}^2$ . Find the possible values of  $\theta$ . [4]

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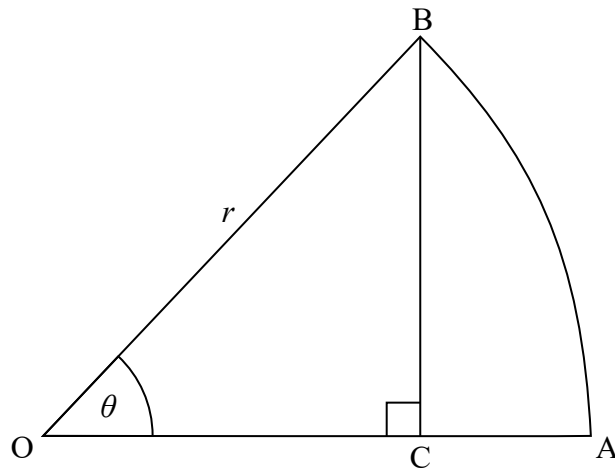
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4. [Maximum mark: 7]

OAB is a sector of the circle with centre O and radius  $r$ , as shown in the following diagram.

diagram not to scale



The angle AOB is  $\theta$  radians, where  $0 < \theta < \frac{\pi}{2}$ .

The point C lies on OA and OA is perpendicular to BC.

- (a) Show that  $OC = r \cos \theta$ . [1]
- (b) Find the area of triangle OBC in terms of  $r$  and  $\theta$ . [2]
- (c) Given that the area of triangle OBC is  $\frac{3}{5}$  of the area of sector OAB, find  $\theta$ . [4]

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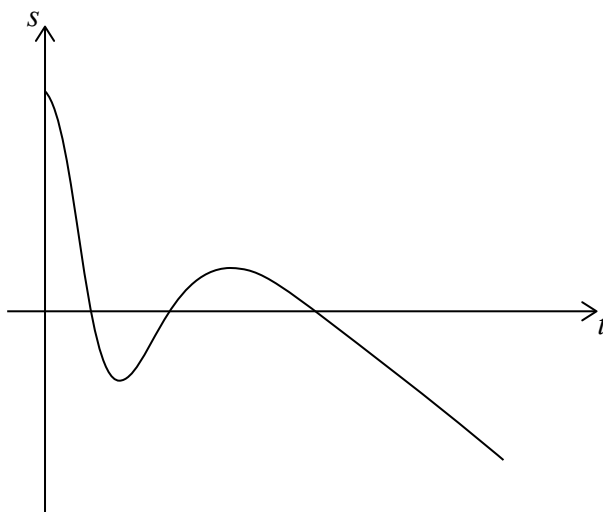
**Section B**

Answer **all** questions in the answer booklet provided. Please start each question on a new page.

8. [Maximum mark: 16]

**In this question distance is in centimetres and time is in seconds.**

Particle A is moving along a straight line such that its displacement from a point P, after  $t$  seconds, is given by  $s_A = 15 - t - 6t^3 e^{-0.8t}$ ,  $0 \leq t \leq 25$ . This is shown in the following diagram.



- (a) Find the initial displacement of particle A from point P. [2]
- (b) Find the value of  $t$  when particle A first reaches point P. [2]
- (c) Find the value of  $t$  when particle A first changes direction. [2]
- (d) Find the total distance travelled by particle A in the first 3 seconds. [3]

Another particle, B, moves along the same line, starting at the same time as particle A. The velocity of particle B is given by  $v_B = 8 - 2t$ ,  $0 \leq t \leq 25$ .

- (e) (i) Given that particles A and B start at the same point, find the displacement function  $s_B$  for particle B.
- (ii) Find the other value of  $t$  when particles A and B meet. [7]



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9. [Maximum mark: 14]

At Penna Airport the probability,  $P(A)$ , that all passengers arrive on time for a flight is 0.70. The probability,  $P(D)$ , that a flight departs on time is 0.85. The probability that all passengers arrive on time for a flight and it departs on time is 0.65.

(a) Show that event  $A$  and event  $D$  are **not** independent. [2]

(b) (i) Find  $P(A \cap D')$ .

(ii) Given that all passengers for a flight arrive on time, find the probability that the flight does **not** depart on time. [5]

The number of hours that pilots fly per week is normally distributed with a mean of 25 hours and a standard deviation  $\sigma$ . 90% of pilots fly less than 28 hours in a week.

(c) Find the value of  $\sigma$ . [3]

(d) All flights have two pilots. Find the percentage of flights where **both** pilots flew more than 30 hours last week. [4]



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10. [Maximum mark: 16]

In an arithmetic sequence,  $u_1 = 1.3$ ,  $u_2 = 1.4$  and  $u_k = 31.2$ .

(a) Find the value of  $k$ . [4]

(b) Find the exact value of  $S_k$ . [2]

Consider the terms,  $u_n$ , of this sequence such that  $n \leq k$ .

Let  $F$  be the sum of the terms for which  $n$  is not a multiple of 3.

(c) Show that  $F = 3240$ . [5]

An infinite geometric series is given as  $S_\infty = a + \frac{a}{\sqrt{2}} + \frac{a}{2} + \dots$ ,  $a \in \mathbb{Z}^+$ .

(d) Find the largest value of  $a$  such that  $S_\infty < F$ . [5]



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Answers written on this page  
will not be marked.



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