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Diploma Programme
Programme du diplôme
Programa del Diploma

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Diploma Programme
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Mathematics
Standard level
Paper 2

Tuesday 14 May 2019 (morning)

1 hour 30 minutes

Candidate session number

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]**.

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Full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations. In particular, solutions found from a graphic display calculator should be supported by suitable working, for example if graphs are used to find a solution, you should sketch these as part of your answer. Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. You are therefore advised to show all working.

Section A

Answer **all** questions. Answers must be written within the answer boxes provided. Working may be continued below the lines if necessary.

1. [Maximum mark: 6]

A group of 7 adult men wanted to see if there was a relationship between their Body Mass Index (BMI) and their waist size. Their waist sizes, in centimetres, were recorded and their BMI calculated. The following table shows the results.

Waist (x cm)	58	63	75	82	93	98	105
BMI (y)	19	20	22	23	25	24	26

The relationship between x and y can be modelled by the regression equation $y = ax + b$.

(a) (i) Write down the value of a and of b.

(ii) Find the correlation coefficient. [4]

(b) Use the regression equation to estimate the BMI of an adult man whose waist size is 95 cm. [2]

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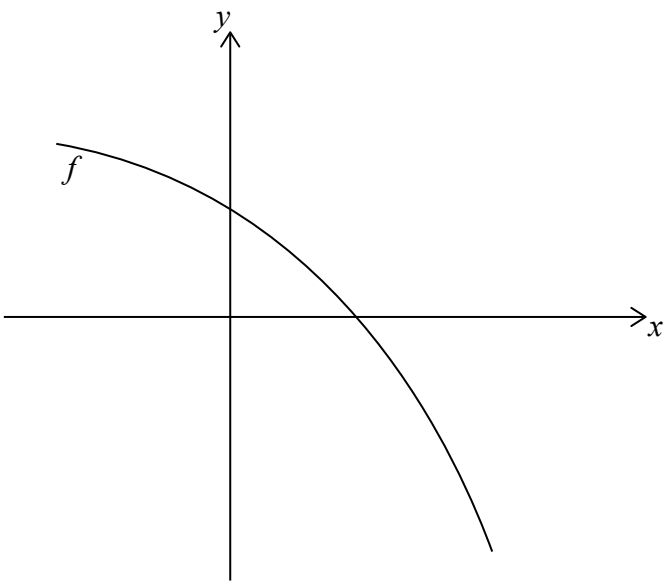
2. [Maximum mark: 5]

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° about the x-axis. Find the volume of the solid formed. [3]

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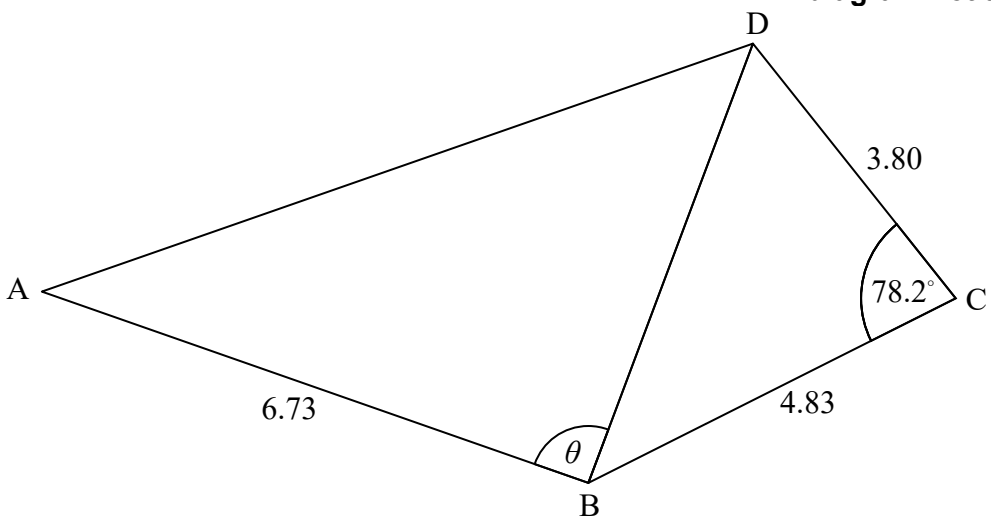
3. [Maximum mark: 7]

The following diagram shows the quadrilateral ABCD.

diagram not to scale



$AB = 6.73\,\text{cm}$, $BC = 4.83\,\text{cm}$, $B\hat{C}D = 78.2^\circ$ 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 θ. [4]

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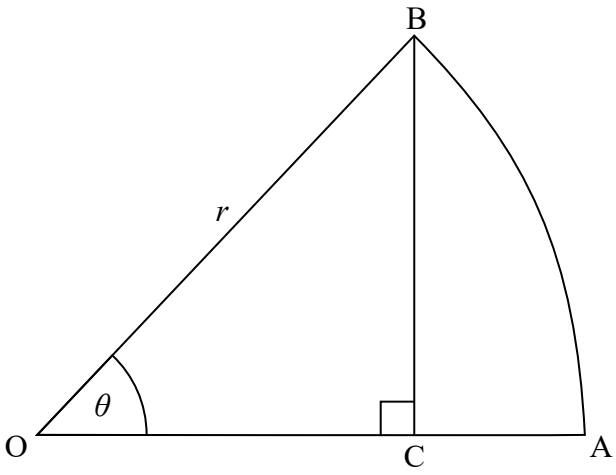
4. [Maximum mark: 7]

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 θ radians, where $0 < \theta < \frac{\pi}{2}$.

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

(a) Show that $\mathrm{OC} = r\cos\theta$. [1]

(b) Find the area of triangle OBC in terms of r and θ. [2]

(c) Given that the area of triangle OBC is $\frac{3}{5}$ of the area of sector OAB, find θ. [4]

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5. [Maximum mark: 6]

The population of fish in a lake is modelled by the function

$$f(t) = \frac{1000}{1 + 24e^{-0.2t}}, 0 \le t \le 30$$, where t is measured in months.

(a) Find the population of fish at $t = 10$. [2]

(b) Find the rate at which the population of fish is increasing at $t = 10$. [2]

(c) Find the value of t for which the population of fish is increasing most rapidly. [2]

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6. [Maximum mark: 7]

In the expansion of the following expression, find the exact value of the constant term.

$$x^3\left(\frac{1}{2x}+x^2\right)^{15}$$

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7. [Maximum mark: 6]

The vector equation of line L is given by $\boldsymbol{r} = \begin{pmatrix} -1 \\ 3 \\ 8 \end{pmatrix} + t \begin{pmatrix} 4 \\ 5 \\ -1 \end{pmatrix}$.

Point P is the point on L that is closest to the origin. Find the coordinates of P.

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Do **not** write solutions on this page.

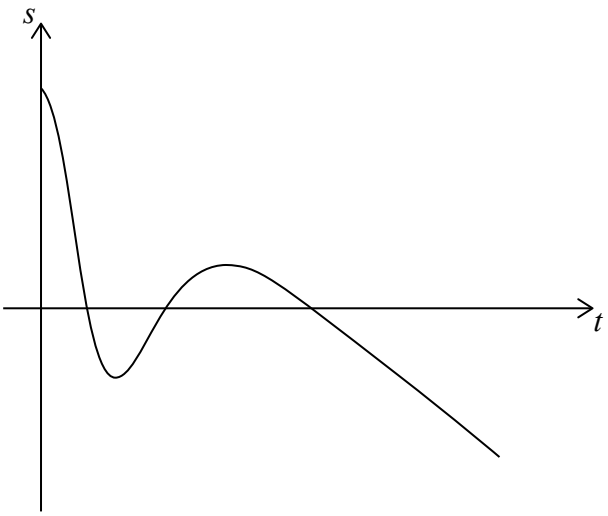
Section B

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 $s_A = 15 - t - 6t^3 e^{-0.8t}$, $0 \le t \le 25$. 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 $v_B = 8 - 2t$, $0 \le t \le 25$.

(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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Do **not** write solutions on this page.

9. [Maximum mark: 14]

At Penna Airport the probability, $\mathrm{P}(A)$, that all passengers arrive on time for a flight is 0.70. The probability, $\mathrm{P}(D)$, 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 $\mathrm{P}(A \cap D')$.

(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 σ. $90\,\%$ of pilots fly less than 28 hours in a week.

(c) Find the value of σ. [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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Do **not** write solutions on this page.

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 $S_\infty = a + \frac{a}{\sqrt{2}} + \frac{a}{2} + \ldots,\ a \in \mathbb{Z}^+$.

(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.