UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

MATHEMATICS (SYLLABUS D) **4024/02**

Paper 2 **May/June 2009**

2 hours 30 minutes

Additional Materials: Answer Booklet/Paper
Electronic calculator
Geometrical instruments
Graph paper (2 sheets)
Mathematical tables (optional)

READ THESE INSTRUCTIONS FIRST

If you have been given an Answer Booklet, follow the instructions on the front cover of the Booklet.
Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **four** questions.

Show all your working on the same page as the rest of the answer.
Omission of essential working will result in loss of marks.
You are expected to use an electronic calculator to evaluate explicit numerical expressions. You may use mathematical tables as well if necessary.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 100.

This document consists of **11** printed pages and **1** blank page.

Section A [52 marks]

Answer **all** questions in this section.

1 **(a)** Express as a single fraction in its simplest form $\frac{2a}{3} + \frac{3}{2a}$. [1]

(b) Factorise completely $5b^2 - 10b$. [1]

(c) The points P and Q are (4, 7) and (8, −3) respectively.

Find

(i) the midpoint of PQ, [1]

(ii) the length of PQ. [2]

(d) Solve the equation $3x^2 + 11x - 7 = 0$, giving each answer correct to 2 decimal places. [4]

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2 **(a)** During a 20 week period in 2007, a bank made a profit of \$378 million.

(i) Calculate the average profit it made each second. [2]

(ii) During the same 20 week period in 2008, the profit was \$945 million.

For this 20 week period, calculate the percentage increase in the profit from 2007 to 2008. [2]

(iii) Find the ratio of \$378 million to \$945 million.
Give your answer in the form $m : n$, where m and n are the smallest possible integers. [2]

(b) Mary changed 480 euros into dollars.
The exchange rate was \$1 = 0.6 euros.
The bank took, as commission, 2% of the amount that had been changed.

Calculate the number of **dollars** the bank took as commission. [2]

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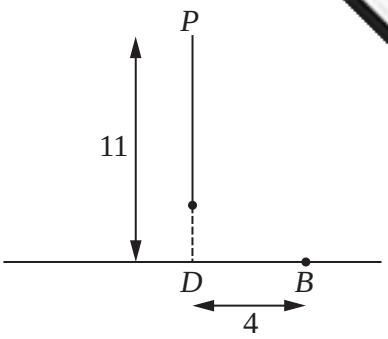
3 **(a)** A heavy ball hangs from a point P, 11 m above horizontal ground, by means of a thin wire.

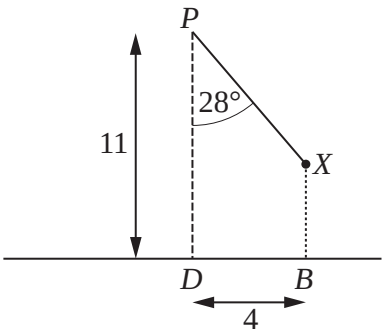
The point D is on the ground vertically below P. The point B is on the ground 4 m from D.



(i) Calculate the angle of elevation of P from B. [2]

(ii) The ball swings, with the wire straight, in the vertical plane PDB.

When the ball is at X, directly above B, $D\hat{P}X = 28°$.



Calculate

(a) PX, [2]

(b) XB. [3]

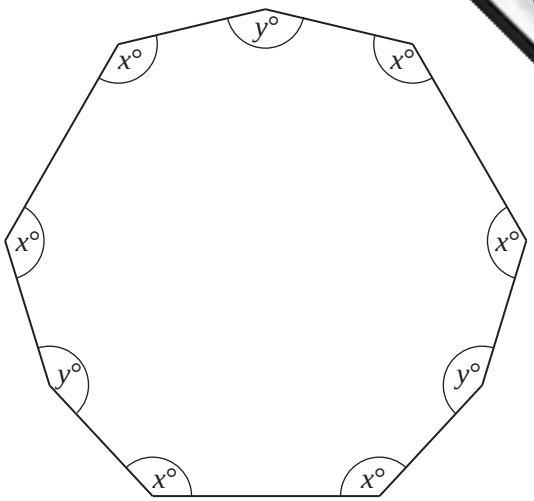
(b) **[The volume of a sphere is $\frac{4}{3}\pi r^3$.]**

The ball is a sphere of volume 96 cm^3.

Calculate its radius. [2]

4 **(a)**

In the diagram, the 9-sided polygon has 6 angles of $x°$ and 3 angles of $y°$.



(i) For this polygon, state

(a) the number of lines of symmetry, [1]

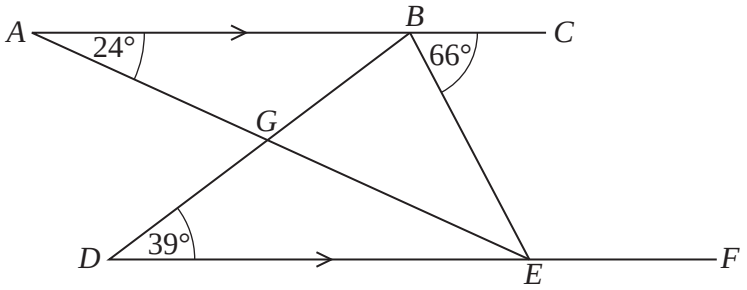
(b) the order of rotational symmetry. [1]

(ii) **(a)** Show that the sum of the interior angles of a 9-sided polygon is 1260°. [1]

(b) Find an expression for y in terms of x. [2]

(c) Given also that $y = 12 + x$, find x. [2]

(b)



In the diagram, the lines ABC and DEF are parallel.
AE meets DB at G.
$B\hat{A}E = 24°$, $C\hat{B}E = 66°$ and $B\hat{D}E = 39°$.

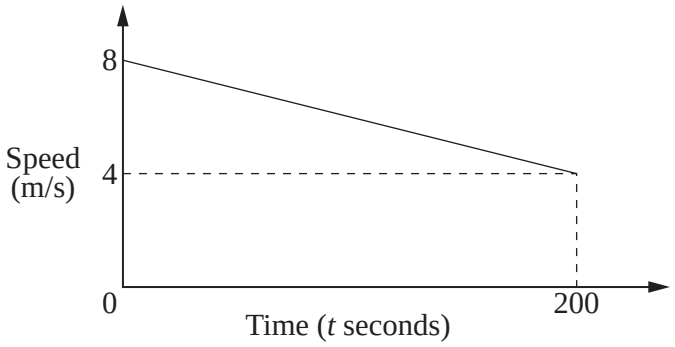
Calculate

(i) $F\hat{E}B$, [1]

(ii) $B\hat{E}A$, [1]

(iii) $A\hat{G}D$. [1]

5 **(a)**



Ali was on a training run.
The diagram is the speed-time graph of part of his run.
At $t = 0$, his speed was 8 m/s.
His speed decreased at a constant rate until it was 4 m/s at $t = 200$.

(i) Calculate

(a) his retardation during the 200 s, [1]

(b) the distance he ran during the 200 s, [2]

(c) his speed at $t = 150$. [1]

(ii) Ben ran at a constant speed in the same direction as Ali.
At $t = 0$, Ali and Ben were level.
They ran the same distance in the next 150 seconds.

Calculate Ben's speed. [2]

(b) Chris ran 200 m, correct to the nearest 10 metres.
He took 25 s, correct to the nearest second.

Find lower bounds for

(i) the distance run, [1]

(ii) his average speed. [3]

6 The diagram shows the first four rows of a pattern of numbers.

Row 1 1 2 1

Row 2 2 3 2 3 2

Row 3 3 4 3 4 3 4 3

Row 4 4 5 4 5 4 5 4 5 4

The table shows some results obtained from this pattern.

Row number	1	2	3	4	5		*n*
Number of numbers in the row	3	5	7	9	*p*		*x*
Product of the first two numbers in the row	2	6	12	20	*q*		*y*
Sum of all the numbers in the row	4	12	24	40	*r*		*z*
Middle number in the row	2	2	4	4	*s*		

(a) Find the values of *p*, *q*, *r* and *s*. [2]

(b) Find expressions, in terms of *n*, for *x*, *y* and *z*. [3]

(c) Write down the middle number in Row 101. [1]

Section B [48 marks]

Answer **four** questions in this section.

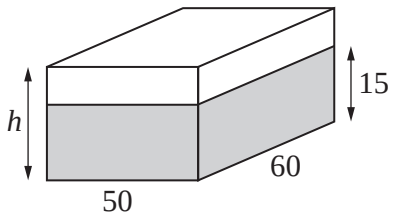
Each question in this section carries 12 marks.

7 **(a)** When a solid rectangular wooden block of oak floats, 60% of its height is under water.

(i) What fraction of its height is **above** water? [1]

(ii) A block of oak has length 60 cm, breadth 50 cm and height h centimetres.

It floats with 15 cm of its height under water.

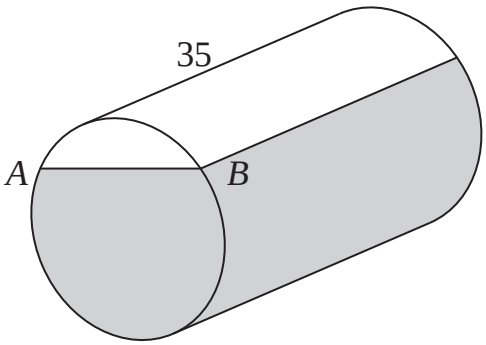


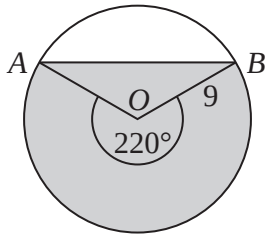
(a) Find the value of h. [1]

(b) In the diagram, the shaded region represents part of the surface area of the block that is in contact with the water.

Calculate the **total** surface area of the block that is in contact with the water. [2]

(b)





A solid cylinder, made from a different type of wood, floats in water.
The shaded region represents part of the surface of the cylinder that is in contact with the water.
The right hand diagram shows the circular cross-section of one end.
The centre of the circle is O and the water level reaches the points A and B on the circumference.
Reflex angle $AOB = 220°$.
The cylinder has radius 9 cm and length 35 cm.

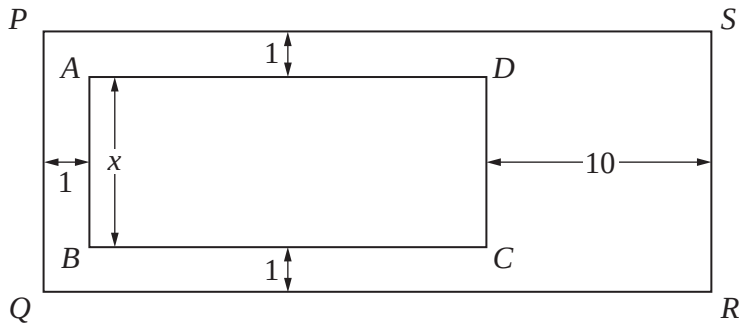
Calculate

(i) the area of the **curved surface** of the cylinder that is in contact with the water, [2]

(ii) the surface area of **one end** of the cylinder that is in contact with the water, [4]

(iii) the distance between the water level AB and the top of the cylinder. [2]

8 **Answer THE WHOLE of this question on a sheet of graph paper.**



The diagram represents a rectangular pond, *ABCD*, surrounded by a paved region.
The paved region has widths 1 m and 10 m as shown.
The pond and paved region form a rectangle *PQRS*.
The area of the pond is 168 m^2.

(a) Taking the length of *AB* to be *x* metres, write down expressions, in terms of *x*, for

(i) *PQ*,

(ii) *BC*,

(iii) *QR*. [2]

(b) Hence show that the area, *y* square metres, of the paved region, is given by

$$y = 22 + 11x + \frac{336}{x}.$$ [2]

(c) The table below shows some values of *x* and the corresponding values of *y*.

x	3	3.5	4	5	6	7	8	9
y	167	156.5	150	144.2	144	147	152	*p*

Calculate *p*. [1]

(d) Using a scale of 2 cm to represent 1 metre, draw a horizontal *x*-axis for $3 \leqslant x \leqslant 9$.

Using a scale of 2 cm to represent 5 square metres, draw a vertical *y*-axis for $140 \leqslant y \leqslant 170$.

On your axes, plot the points given in the table and join them with a smooth curve. [3]

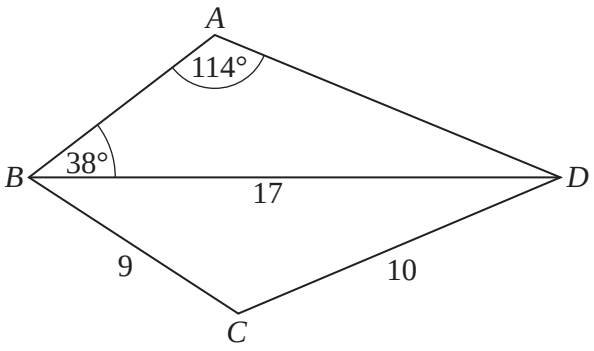
(e) By drawing a tangent, find the gradient of the curve at (4, 150). [2]

(f) Use your graph to find

(i) the smallest area of the paved region, [1]

(ii) the length of *PQ* when the area of the paved region is smallest. [1]

9 **(a)**



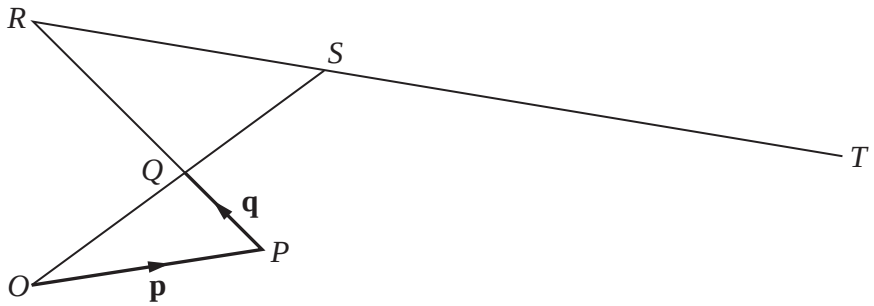
In the diagram, $BD = 17\,\text{cm}$, $CD = 10\,\text{cm}$, $BC = 9\,\text{cm}$, $B\hat{A}D = 114°$ and $A\hat{B}D = 38°$.

Calculate

(i) AD, [3]

(ii) $B\hat{C}D$. [3]

(b)



In the diagram, $\overrightarrow{OQ} = \overrightarrow{QS}$, $\overrightarrow{QR} = 2\overrightarrow{PQ}$ and $\overrightarrow{ST} = 2\overrightarrow{RS}$.

$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{PQ} = \mathbf{q}$.

(i) Express, as simply as possible, in terms of **p** and/or **q**,

(a) $\overrightarrow{OQ}$, [1]

(b) $\overrightarrow{RS}$, [1]

(c) $\overrightarrow{OS}$, [1]

(d) $\overrightarrow{OT}$. [1]

(ii) Hence write down two facts about O, P and T. [2]

10 Answer THE WHOLE of this question on a sheet of graph paper.

The waiting times of 50 people at a supermarket checkout were recorded.
The results are summarised in the table below.

Time (t minutes)	$1 < t \leqslant 3$	$3 < t \leqslant 4$	$4 < t \leqslant 5$	$5 < t \leqslant 7$	$7 < t \leqslant 9$	$9 < t \leqslant 12$
Number of people	4	10	8	14	8	6

(a) Using a scale of 1 cm to represent 1 minute, draw a horizontal axis for waiting times between 0 and 12 minutes.
Using a scale of 1 cm to represent 1 unit, draw a vertical axis for frequency densities from 0 to 10 units.
On your axes, draw a histogram to illustrate the distribution of waiting times. [3]

(b) In which class does the upper quartile lie? [1]

(c) Calculate an estimate of the mean waiting time. [3]

(d) One person is chosen, at random, from the 50 people.

Write down the probability that this person waited

(i) less than 1 minute, [1]

(ii) more than 5 minutes. [1]

(e) A second person is now chosen, at random, from the remaining 49 people.

Expressing each answer as a fraction in its lowest terms, calculate the probability that

(i) both people waited more than 5 minutes, [1]

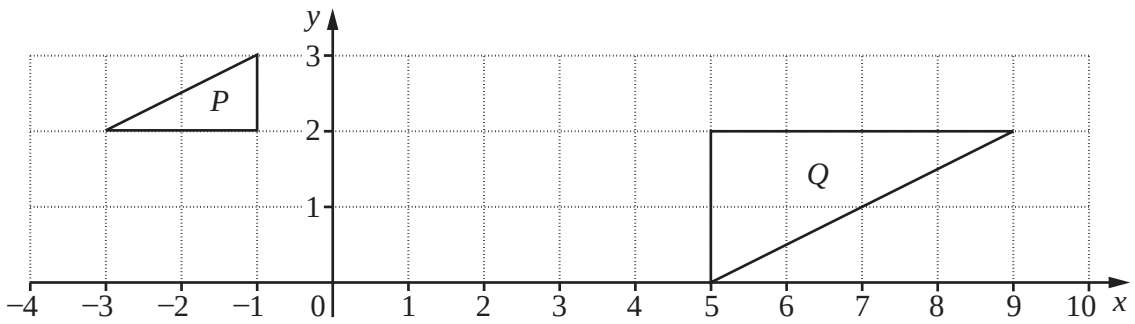
(ii) one person waited more than 5 minutes and the other waited 5 minutes or less. [2]

11 **(a)** $\mathbf{A} = \begin{pmatrix} 0 & 3 \\ -1 & x \end{pmatrix}$ $\mathbf{B} = \begin{pmatrix} 1 & -1 \\ \frac{1}{3} & 0 \end{pmatrix}$

(i) Express $2\mathbf{A} - 3\mathbf{B}$ in terms of x. [2]

(ii) Given that $\mathbf{A} = \mathbf{B}^{-1}$, find the value of x. [2]

(b)



The diagram shows the triangles P and Q.

(i) The enlargement E maps triangle P onto triangle Q.

For this enlargement,

(a) write down the scale factor, [1]

(b) find the coordinates of the centre of enlargement. [2]

(ii) The **single** transformation T is represented by the matrix $\begin{pmatrix} 1 & 2 \\ 0 & 1 \end{pmatrix}$.

Describe T completely. [2]

(iii) L is the point $(k, 2)$.
T maps L onto $(8, 2)$.

(a) Find the value of k. [1]

(b) Find the coordinates of ET(L). [2]

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