UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

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

Paper 2 **May/June 2008**

2 hours 30 minutes

Additional Materials:	Answer Booklet/Paper Electronic calculator Geometrical instruments	Graph paper (1 sheet) 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.

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International Examinations

[Turn over

Section A [52 marks]

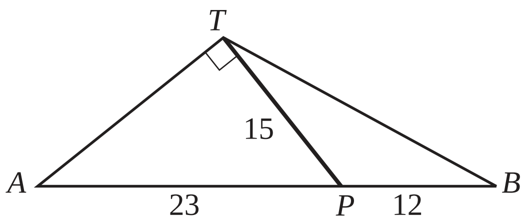
Answer **all** questions in this section.

1 **(a)** A flagpole is a cylinder of length 15 m and diameter 14 cm.

Calculate the volume of the flagpole.
Give your answer in **cubic metres**. [3]

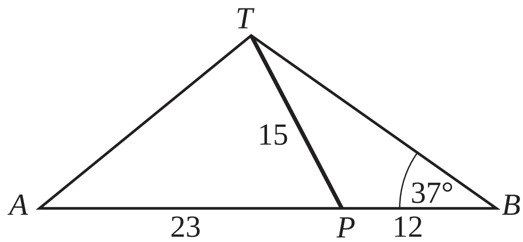
(b) The flagpole, represented by TP in the diagrams below, is hinged at the point P.
It is raised by using two ropes.
Each rope is fastened to the top of the flagpole and the ropes are held at A and B.
The points A, P, B and T are in a vertical plane with A, P and B on horizontal ground.
$TP = 15$ m, $AP = 23$ m and $BP = 12$ m.

(i) When $A\hat{T}P = 90°$, calculate $T\hat{P}A$.



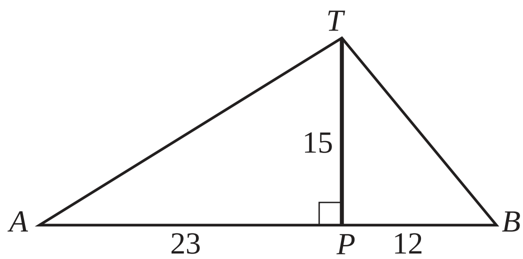
[2]

(ii) When $T\hat{B}P = 37°$, calculate $B\hat{P}T$.



[3]

(iii) When the flagpole is vertical, calculate the angle of elevation of the top of the flagpole from A.



[2]

2 **(a)** Anne's digital camera stores its images on a memory card.
The memory card has 128 units of storage space.
When 50 images were stored, there were 40 units of **unused** storage space on the memory card.

(i) Calculate the percentage of **unused** storage space on the memory card. [1]

(ii) Calculate the average amount of storage space used by each image. [2]

(b) Shop A charged 60 cents for each photograph.
Shop B charged 63 cents for each photograph and gave a discount of $1 on all purchases more than $10.

(i) Anne bought 24 photographs from Shop A and paid with a $20 note.

Calculate the change she received. [1]

(ii) Find how much cheaper it was to buy 24 photographs from Shop B than from Shop A. [2]

(iii) Find the smallest number of photographs for which it was cheaper to use Shop B. [2]

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3 **(a)** On average, Jim's heart beats 75 times per minute.

Calculate the number of times his heart beats during 50 weeks.
Give your answer in standard form. [2]

(b) After an exercise, Ali and Ben measured their heart rates.
The ratio of their heart rates was $15 : 17$.
Ben's heart beat 18 times per minute more than Ali's.

Calculate Ali's heart rate. [2]

(c) The recommended maximum heart rate, H, for a man during exercise, is given by the formula

$$H = \frac{4}{5}(220 - n),$$

where n years is the age of the man.

(i) Calculate H when $n = 25$. [1]

(ii) Calculate n when $H = 144$. [1]

(iii) Make n the subject of this formula. [2]

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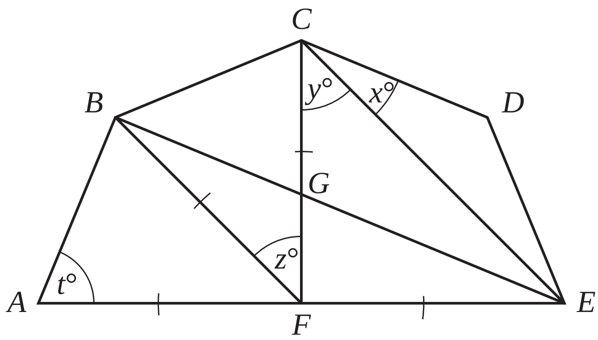
4 **(a)** Show that each interior angle of a regular octagon is 135°. [2]

(b)



In the diagram, *AB*, *BC*, *CD* and *DE* are four adjacent sides of a regular octagon.
FA = *FB* = *FC* = *FE*.
CF meets *BE* at *G*.

(i) Calculate

(a) x, [1]

(b) y, [1]

(c) z, [1]

(d) t. [1]

(ii) Write down the special name given to the quadrilateral *BCEF*. [1]

(iii) Given that $FC = 10$ cm, calculate *CE*. [2]

(iv) **(a)** Show that ΔCGE is similar to ΔFGB. [1]

(b) Find $\dfrac{\text{the area of } \Delta CGE}{\text{the area of } \Delta FGB}$. [1]

5 **(a)** Mary has 50 counters.
Some of the counters are square, the remainder are round.
There are 11 square counters that are green.
There are 15 square counters that are not green.
Of the round counters, the number that are not green is double the number that are green.

By drawing a Venn diagram, or otherwise, find the number of counters that are

(i) round, [1]

(ii) round and green, [1]

(iii) not green. [1]

(b) Tina has two fair, normal 6-sided dice. One is red and the other is blue.
She throws both of them once.
You may find it helpful to draw a possibility diagram to answer the following questions.

Find, as a fraction in its lowest terms, the probability that

(i) the red die shows a 2 and the blue die does **not** show a 2, [1]

(ii) the sum of the two numbers shown is equal to 5, [1]

(iii) one die shows a 3 and the other shows an even number. [2]

(c) Ann went on a car journey that was split into three stages.
Two relevant matrices are shown below.
The first matrix shows the average speed, in kilometres per hour, of the car during each stage.
The second matrix shows the time, in hours, taken for each stage.

$$\begin{array}{cc} & \begin{array}{ccc}\text{First stage} & \text{Second stage} & \text{Third stage}\end{array} \\ \text{Average speed} & \begin{pmatrix} 40 & 30 & 50 \end{pmatrix}\end{array}$$

$$\begin{array}{cc} \text{Time} & \\ \begin{pmatrix} 1\frac{1}{2} \\ 1 \\ 2\frac{1}{2} \end{pmatrix} & \begin{array}{l}\text{First stage} \\ \text{Second stage} \\ \text{Third stage}\end{array}\end{array}$$

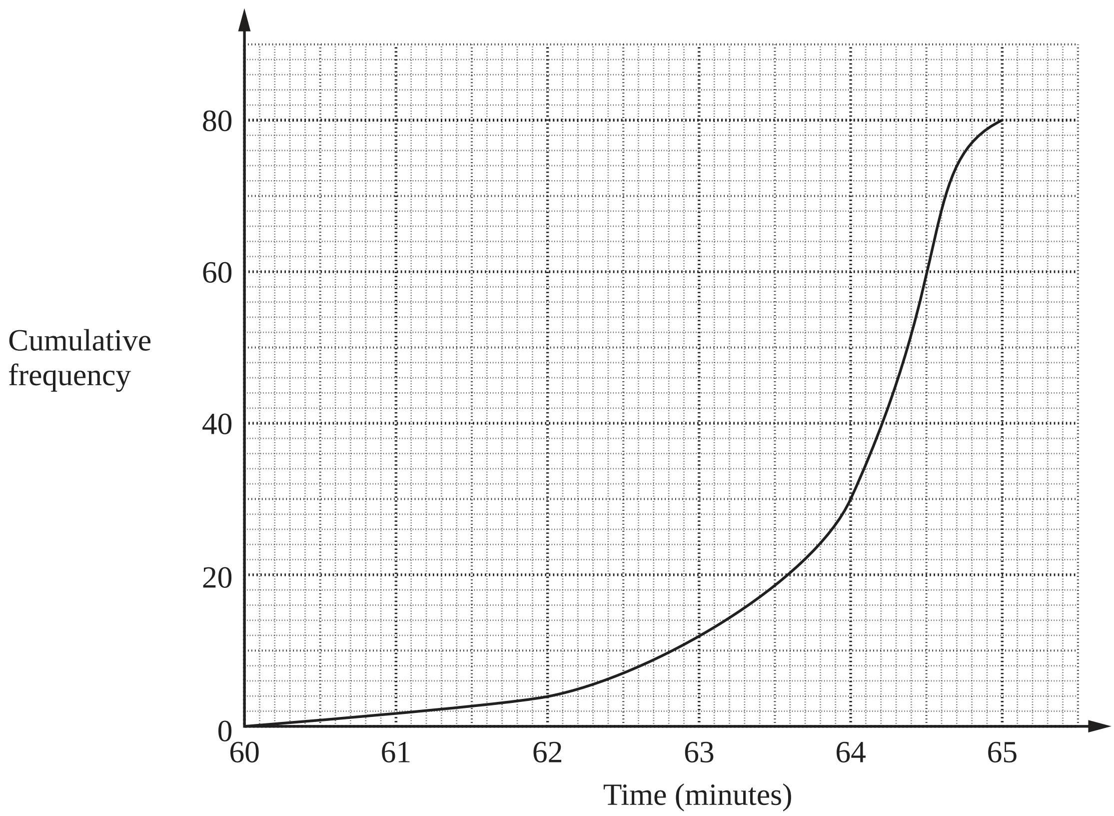
(i) Find $\begin{pmatrix} 40 & 30 & 50 \end{pmatrix} \begin{pmatrix} 1\frac{1}{2} \\ 1 \\ 2\frac{1}{2} \end{pmatrix}$. [1]

(ii) What information is given by the matrix obtained in part **(i)**? [1]

(iii) Calculate the average speed for the whole journey. [1]

6 Paul and Sam are two athletes who have training sessions together.
On 80 sessions during 2007 they ran the same route, and their times were recorded.

(a) The cumulative frequency curve shows the distribution of Paul's times.



Use the curve to estimate

(i) the median, [1]

(ii) the interquartile range, [2]

(iii) how often Paul took more than 64 minutes. [1]

(b) Sam's times had a lower quartile of 62.5 minutes, a median of 63 minutes and an upper quartile of 64 minutes.

State which athlete was the more consistent runner, giving a reason for your answer. [1]

Section B [48 marks]

Answer **four** questions in this section.

Each question in this section carries 12 marks.

7 A, B, C, D and E are five different shaped blocks of ice stored in a refrigerated room.

(a) At 11 p.m. on Monday the cooling system failed, and the blocks started to melt.
At the end of each 24 hour period, the volume of each block was 12% less than its volume at the start of that period.

(i) Block A had a volume of $7500\,\text{cm}^3$ at 11 p.m. on Monday.

Calculate its volume at 11 p.m. on Wednesday. [2]

(ii) Block B had a volume of $6490\,\text{cm}^3$ at 11 p.m. on Tuesday.

Calculate its volume at 11 p.m. on the previous day. [2]

(iii) **Showing your working clearly**, find on which day the volume of Block C was half its volume at 11 p.m. on Monday. [2]

(b) **[The volume of a sphere is $\frac{4}{3}\pi r^3$.]**
[The surface area of a sphere is $4\pi r^2$.]

At 11 p.m. on Monday Block D was a **hemisphere** with radius 18 cm.

Calculate

(i) its volume, [2]

(ii) its **total** surface area. [2]

(c) As Block E melted, its shape was always **geometrically similar** to its original shape.
It had a volume of $5000\,\text{cm}^3$ when its height was 12 cm.

Calculate its height when its volume was $1080\,\text{cm}^3$. [2]

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

The table below shows some values of x and the corresponding values of y, correct to one decimal place, for

$$y = \frac{4}{5} \times 2^x.$$

x	–2	–1	0	1	2	2.5	3	3.5	4
y	p	0.4	0.8	1.6	3.2	4.5	6.4	9.1	12.8

(a) Calculate p. [1]

(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x-axis for $-2 \leqslant x \leqslant 4$.

Using a scale of 2 cm to represent 2 units, draw a vertical y-axis for $0 \leqslant y \leqslant 14$.

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

(c) As x decreases, what value does y approach? [1]

(d) By drawing a tangent, find the gradient of the curve at the point (3, 6.4). [2]

(e) **(i)** On the axes used in part **(b)**, draw the graph of $y = 8 - 2x$. [2]

(ii) Write down the coordinates of the point where the line intersects the curve. [1]

(iii) The x coordinate of this point of intersection satisfies the equation

$$2^x = Ax + B.$$

Find the value of A and the value of B. [2]

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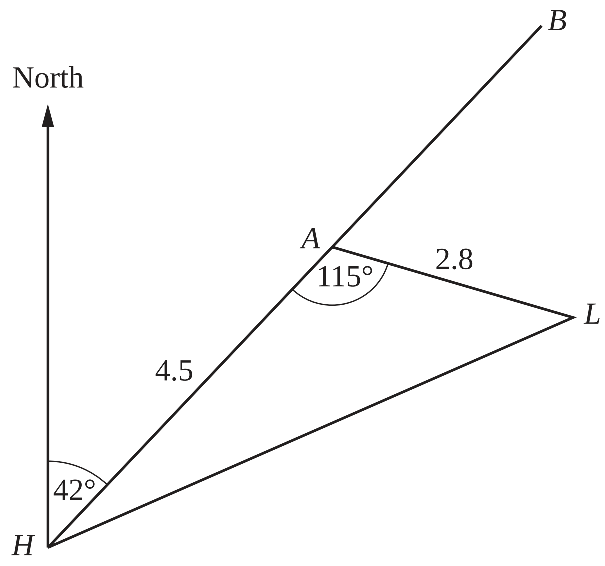

The diagram shows the positions of a harbour, H, a lighthouse, L, and two buoys A and B.
HAB is a straight line.
The bearing of A from H is 042°.
$HA = 4.5$ km, $AL = 2.8$ km and $H\hat{A}L = 115°$.

(a) Find the bearing of

(i) H from A, [1]

(ii) L from A. [1]

(b) Calculate

(i) HL, [4]

(ii) the area of triangle HAL. [2]

(c) A boat sailed from the harbour along the line HAB.

(i) Calculate the shortest distance between the boat and the lighthouse. [2]

(ii) The boat sailed at a constant speed of 3 m/s.

Given that the boat reached A at 07 15, find at what time it left the harbour. [2]

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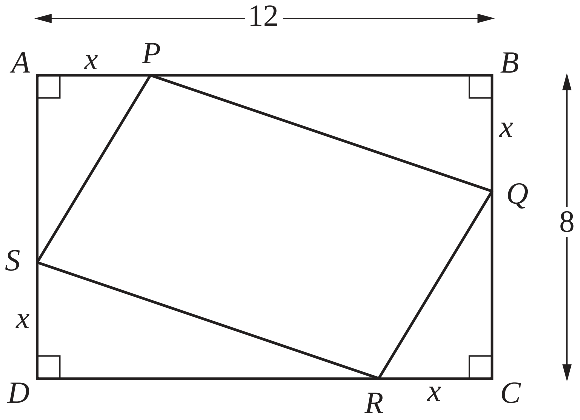


In the diagram, $ABCD$ is a rectangle.
$AB = 12$ cm and $BC = 8$ cm.
$AP = BQ = CR = DS = x$ centimetres.

(a) Find an expression, in terms of x, for

(i) the length of QC, [1]

(ii) the area of triangle CRQ. [1]

(b) Hence show that the area, in square centimetres, of the quadrilateral $PQRS$ is $2x^2 - 20x + 96$. [3]

(c) When the area of quadrilateral $PQRS$ is $60\,\text{cm}^2$, form an equation in x and show that it simplifies to

$$x^2 - 10x + 18 = 0. \quad [1]$$

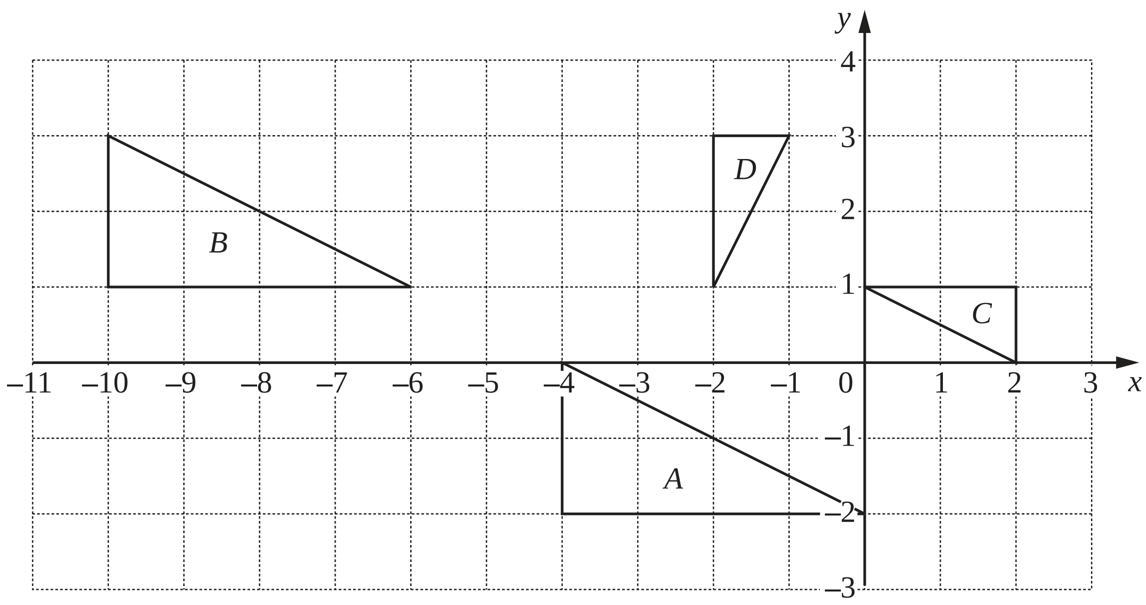
(d) Solve the equation $x^2 - 10x + 18 = 0$, giving each answer correct to 2 decimal places. [3]

(e) It is given that $2x^2 - 20x + 96 = 2(x - 5)^2 + K$.

(i) Find the value of K. [1]

(ii) Hence **write down** the smallest possible area of the quadrilateral $PQRS$ and the value of x at which it occurs. [2]

11 **(a)** The diagram shows triangles A, B, C and D.



(i) Describe fully the **single** transformation that maps ΔA onto ΔB. [2]

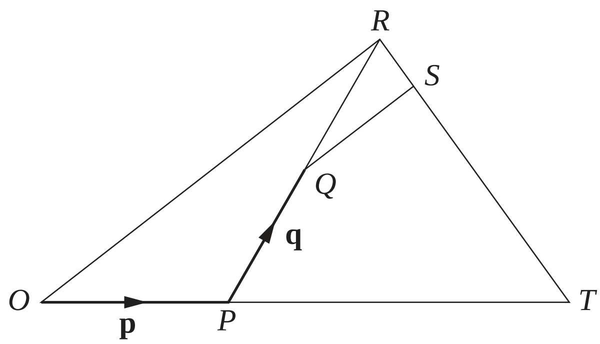
(ii) Describe fully the **single** transformation that maps ΔB onto ΔC. [2]

(iii) Describe fully the **single** transformation that maps ΔC onto ΔD. [2]

(iv) Write down the matrix that represents the transformation which maps ΔC onto ΔA. [1]

(b) In the diagram,

$OT = 3OP$, $RS = \frac{1}{6}RT$ and
Q is the midpoint of PR.
$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{PQ} = \mathbf{q}$.



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

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

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

(c) $\overrightarrow{QS}$. [2]

(ii) Write down the value of $\dfrac{QS}{OR}$. [1]

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