OCR
Oxford Cambridge and RSA

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Thursday 26 May 2016 – Morning

GCSE APPLICATIONS OF MATHEMATICS

A381/02 Applications of Mathematics 1 (Higher Tier)

6355291240

Candidates answer on the Question Paper.

OCR supplied materials:
None

Other materials required:
- Scientific or graphical calculator
- Geometrical instruments
- Tracing paper (optional)

Duration: 1 hour 15 minutes

A381O2

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Your answers should be supported with appropriate working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

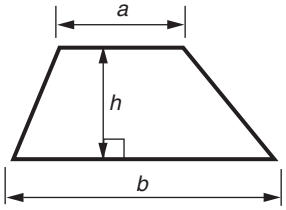
INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Your quality of written communication is assessed in questions marked with an asterisk (*****).
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.

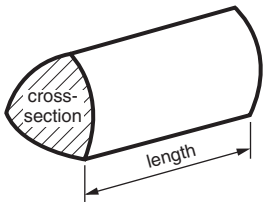
You are permitted to use a calculator for this paper

Formulae Sheet: Higher Tier

Area of trapezium $= \frac{1}{2}(a + b)h$



Volume of prism = (area of cross-section) × length

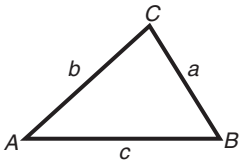


In any triangle *ABC*

Sine rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

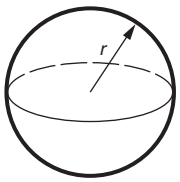
Cosine rule $a^2 = b^2 + c^2 - 2bc\cos A$

Area of triangle $= \frac{1}{2}ab\sin C$



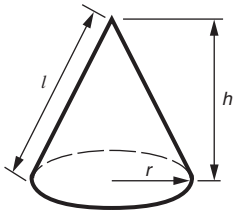
Volume of sphere $= \frac{4}{3}\pi r^3$

Surface area of sphere $= 4\pi r^2$



Volume of cone $= \frac{1}{3}\pi r^2 h$

Curved surface area of cone $= \pi rl$



The Quadratic Equation

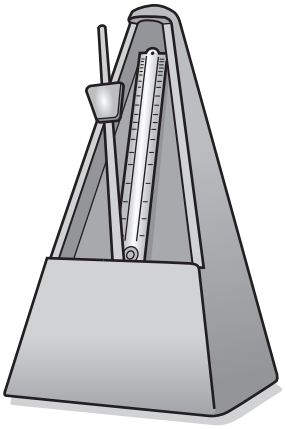
The solutions of $ax^2 + bx + c = 0$,
where $a \neq 0$, are given by

$$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$$

PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

1 A metronome is used by musicians to keep in time.
It ticks regularly at a speed set by the musician.
The frequency of the ticks is counted in beats per minute.



Reuben sets two different metronomes ticking.
He labels the metronomes A and B.

(a) Metronome A ticks at 200 beats per minute.

Show that the time between each beat is 0.3 seconds.

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..... **[1]**

(b)* Metronome B ticks once every 0.8 seconds.

What is the greatest number of times that the two metronomes could tick together at exactly the same time within a period of 1 minute 45 seconds?

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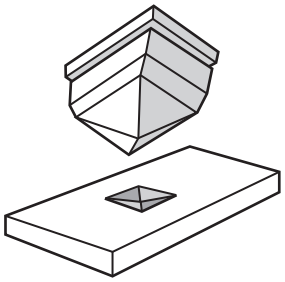
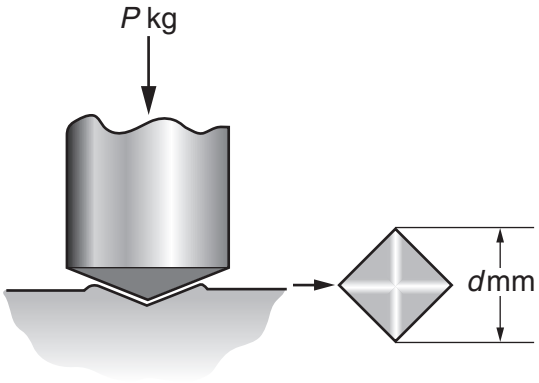
..... **[3]**

2 The hardness of moving parts of machines is important.
If two parts are too hard they will damage each other.



(a) The Vickers test for hardness uses a point in the shape of a square-based pyramid.
The point is made of diamond.
It leaves a square indent.



The Vickers hardness, V, is worked out using $V = \frac{1.85P}{d^2}$

where P kg is the load on the point
and d mm is the length of the diagonal of the square indent.

The greater the value of V, the harder the material.

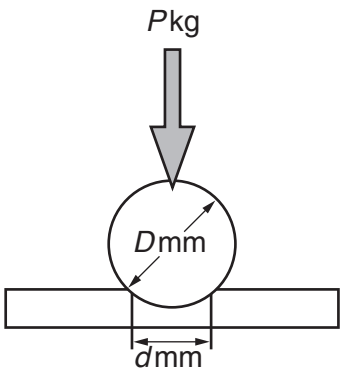
A Vickers hardness test on a sheet of iron and a sheet of zirconium gave these results.

Metal	**Load (kg)**	**Length of diagonal (mm)**
Iron	100	1.73
Zirconium	150	1.84

Use these results to decide which is harder, iron or zirconium.
Show all your calculations clearly.

(a) ..... **[4]**

(b) Another measure of hardness is the Brinell hardness.



A round ball of diameter D mm is loaded with a P kg weight.

This produces an indent of diameter d mm.

The Brinell hardness, B, of the material is found by using these three calculations:

1. $W = D - \sqrt{D^2 - d^2}$

2. $Z = 1.57\,D\,W$

3. $B = \dfrac{P}{Z}$

A ball of diameter 10 mm is loaded with a 500 kg weight.
It makes an indent of diameter 3.54 mm in a sheet of iron.

Calculate the Brinell hardness of this sheet of iron.
Show all the steps in your calculation.

(b) ..... **[4]**

3 Kishan is investigating the correlation between a person's arm length and their leg length. He measures the arm length and the leg length of several people.

(a) Kishan calculates the strength of the correlation using this calculation.

$$\frac{2695.3 - 45.2 \times 55}{\sqrt{(2202.6 - 45.2^2) \times (3306 - 55^2)}}$$

Work out this calculation, giving your answer correct to 6 decimal places.

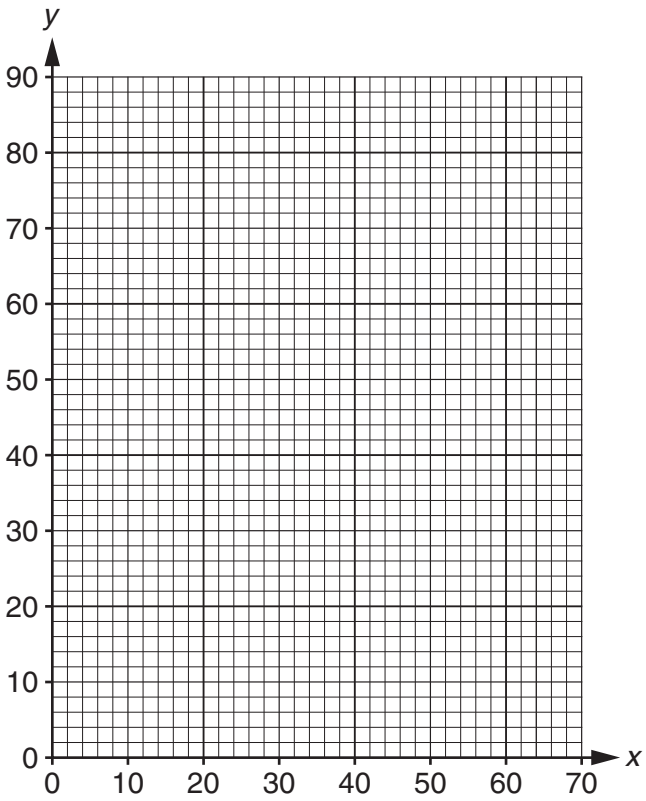
(a) ..... **[2]**

(b) Kishan also uses his data to calculate the equation of a line of best fit connecting arm length (x) with leg length (y).

This is his equation.

$$y = 1.31x - 4.29$$

Draw this line of best fit accurately on the grid on the opposite page.



[2]

4 The National Theatre complex contains three theatres.
These are the Olivier, the Lyttelton and the Dorfman.

(a)* In total, the National Theatre has 2340 seats.
An information leaflet contains the following two facts.

Fact 1:	**Fact 2:**
38% of the National Theatre seats are in the Lyttelton Theatre.	The Lyttelton Theatre seats 890 audience members.

Tom thinks that the facts **cannot** both be correct.

Explain why both facts **could** be considered to be correct.

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..... **[3]**

(b) At one performance in the Olivier Theatre, each member of the audience is classified as a child, an adult or a senior citizen.

- $\frac{2}{5}$ of the audience members are children.
- 468 of the audience members are adults.
- $\frac{1}{6}$ of the audience members are senior citizens.

Calculate the total number of audience members at the performance.

(b) ..... **[4]**

(c) The National Theatre receives income from a variety of sources including ticket sales, fundraising and grants from the Arts Council.

(i) In 2013, the National Theatre received a £17.5 million grant from the Arts Council. This grant was 20% of their total income in 2013.

Calculate the total income for the National Theatre in 2013.

(c)(i) £ ..... million **[2]**

(ii) In 2012, ticket sales income was £38 million.
By 2013, ticket sales income had risen by 35.5%.

Calculate the ticket sales income in 2013.

(ii) £ ..... million **[2]**

(iii) In 2011, the National Theatre's total income was £70.6 million.
In 2014, the total income was £99.9 million.

Calculate the percentage increase in total income between 2011 and 2014.

(iii) ..... % **[2]**

(iv) Between 2012 and 2013, fundraising income rose by 6%.
Between 2013 and 2014, fundraising income fell by 7%.

Calculate the overall percentage change in fundraising income between 2012 and 2014.
Remember to state whether this is an increase or decrease.

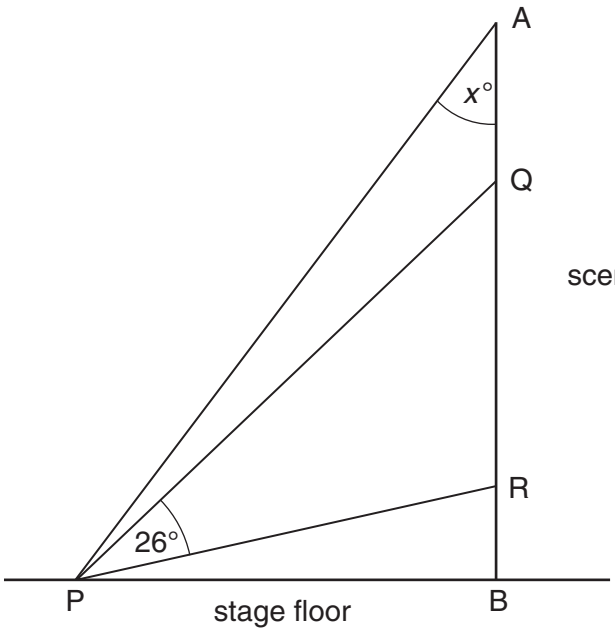
(iv) ..... **[4]**

(d) Adult tickets for a performance cost £t.
Child tickets cost half the adult ticket price.
At one performance, 600 adult tickets and 210 child tickets are sold.
Ticket sales total £33 840.

Form an equation in t. Solve the equation to find the cost of an adult ticket.

(d) £ ..... **[3]**

(e) The diagram below shows a piece of scenery AB standing perpendicular to the horizontal stage floor.
The scenery is held in place by three metal poles PA, PQ and PR with point P fixed on the stage floor.



Not to scale

Angle PAB is $x°$.
Angle PQB is 10° larger than x.
Angle PRB is three times the size of x.
The angle between poles PR and PQ is 26°.

Form an equation in x. Solve the equation to find the value of x.

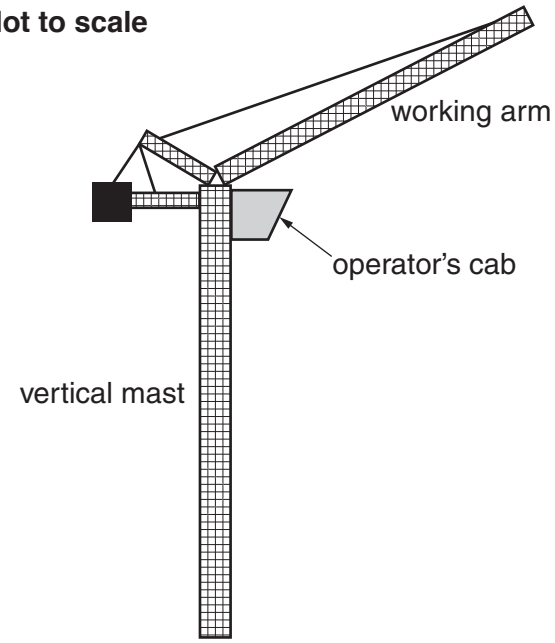
(e) ..... **[4]**

5 Tower cranes come in different sizes.
The photograph shows two tower cranes.

You may assume that the tower cranes in this question are mathematically similar.

Three important features of a tower crane are the vertical mast, the working arm and the operator's cab.

Not to scale



(a) The vertical mast of a tower crane is 46.2 m high, and its working arm is 48 m in length.
A smaller tower crane has a working arm of length 40 m.

Calculate the height of the vertical mast of the smaller tower crane.
Remember that the cranes are mathematically similar.

(a) ..... m **[3]**

(b) A third tower crane has a vertical mast 58 m high and an operator's cab with volume 5 m^3. The volume of the operator's cab on another larger tower crane is 7.5 m^3.

Calculate the height of the vertical mast of the larger tower crane.

(b) ..... m **[4]**

(c) A crane hire company has large and small cranes.

Hiring a large crane costs $\frac{2}{3}$ **more** than hiring a small crane.

Hiring one small crane and two large cranes for a week costs £1950 **more** than hiring two small cranes and one large crane for a week.

Find the cost of hiring a small crane for a week.

(c) £ ..... **[4]**

(d) On a large building site, there are 4 cranes operated by Tobin, Carmella, Jinan and Heather.

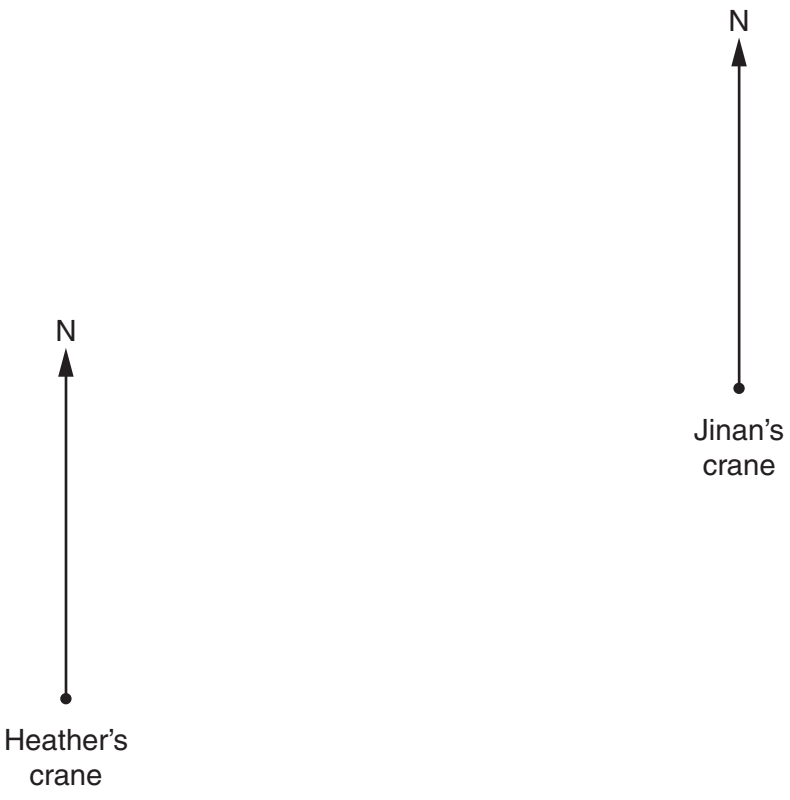
(i) The bearing of Tobin's crane from Jinan's crane is 212°.

Work out the bearing of Jinan's crane from Tobin's crane.

(d)(i) .....° **[2]**

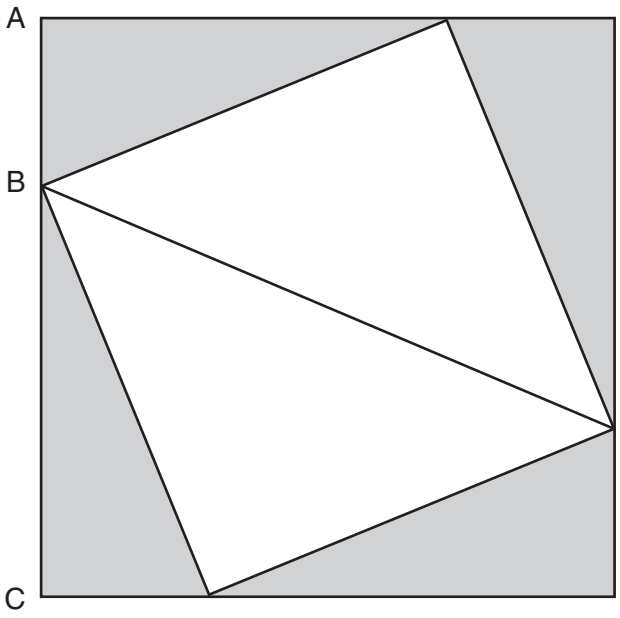
(ii) The map below shows the positions of Jinan's crane and Heather's crane.
The bearing of Carmella's crane from Jinan's crane is 313°.
The bearing of Carmella's crane from Heather's crane is 031°.

Show the position of Carmella's crane on the map.



[3]

6 Josiah is playing with a jigsaw that has triangular pieces.
There are four grey congruent right-angled triangles.
There are two larger white congruent right-angled triangles.
The pieces fit together to form a square as shown.



Not to scale

The length of AB is $\frac{2}{7}$ the length of AC.

Calculate the fraction of the area of the jigsaw occupied by one white triangle.

..... **[4]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin.