OCR
Oxford Cambridge and RSA

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Thursday 26 May 2016 – Morning

GCSE APPLICATIONS OF MATHEMATICS

A381/01 Applications of Mathematics 1 (Foundation Tier)

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

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.

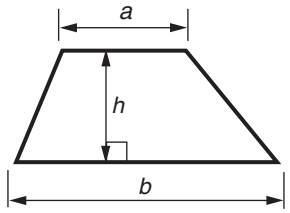
INFORMATION FOR CANDIDATES

- 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 **20** pages. Any blank pages are indicated.

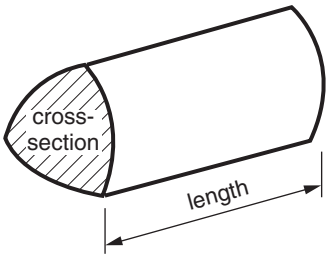
You are permitted to use a calculator for this paper

Formulae Sheet: Foundation Tier

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



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



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Answer **all** the questions.

1 The number of public libraries in England is reducing.

(a) (i) In 2000 there were 4620 public libraries.

$\frac{1}{10}$ of these libraries had closed by 2012.

How many libraries had closed?

(a)(i) ..... **[1]**

75% of young children visit a public library at least once a year.

(ii) What fraction of young children visit a public library at least once a year?
Give your answer as a fraction in its simplest terms.

(ii) ..... **[2]**

(iii) What percentage of young children do **not** visit a public library at least once a year?

(iii) ..... % **[1]**

(iv) The busiest public library in England is the Norfolk & Norwich Millennium library.
In 2011 the number of people visiting it was:

one million, four hundred and ninety six thousand, one hundred and eighty six.

Write this number in digits.

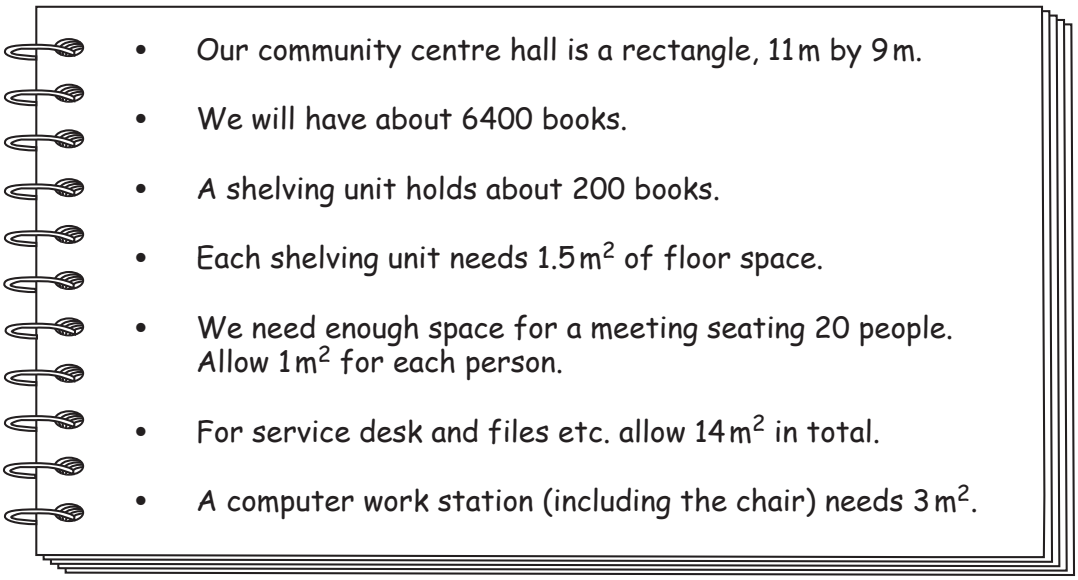
(iv) ..... **[1]**

(v) Write your answer to part **(a)(iv)** correct to the nearest thousand.

(v) ..... **[1]**

(b)* Jan's local library is closing down.
The local community want to run the library from their community centre.
They may get a grant, but only if they have a plan.
They will need space for book shelving, meetings, computer work stations and a service desk.

Jan makes these notes after speaking to a librarian.



Use Jan's figures to show clearly how many computer work stations they could have in the community centre.
Explain whether your answer might be too high or too low and give a reason for this.

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..... **[6]**

(c) There is a grant of £2880 a year to buy new books.
The average price of a new book is £17.92.

Jan does not have a calculator and wants to estimate how many new books the library can buy using only this grant.

Here are four methods she could use.

3000 ÷ 10	2900 ÷ 18	3000 ÷ 20	2800 ÷ 17
A	B	C	D

Choose the **best** method. Give a reason for your choice.

..... because .....

..... **[2]**

(d) The British Library is one of the largest libraries in the world.
It has 14 000 000 books on its shelves, which have a total length of 50 kilometres!

It was suggested that the content of all the books could be stored on HD DVDs.

- A typical book takes up 2 megabytes of memory.
- A single HD DVD has 30 000 megabytes of memory.
- An HD DVD case is 14 mm thick.

What length of shelving would be needed for the HD DVDs storing the content of all 14 000 000 books?
Give your answer in metres and show all your calculations.

(d) ..... metres **[4]**

2 Before radio, messages used to be sent using semaphore.
Symbols making messages were displayed on top of semaphore towers.
Messages were copied down and displayed for the next semaphore tower to see.
The people in this tower copied them down, displaying it for the next tower and so on.

Telescopes made it possible to read these from a long way away.

(a) A telescope has magnifying power *M*.
A symbol of height *h* metres can just be seen from a distance of *d* kilometres using this telescope.
This number machine shows how to work out the distance.

(i) From what distance, using a telescope of magnifying power 10, can a symbol of height 0.5 metres just be seen?

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

(ii) Write down the **formula** giving *d* in terms of *M* and *h*.

(ii) ..... **[1]**

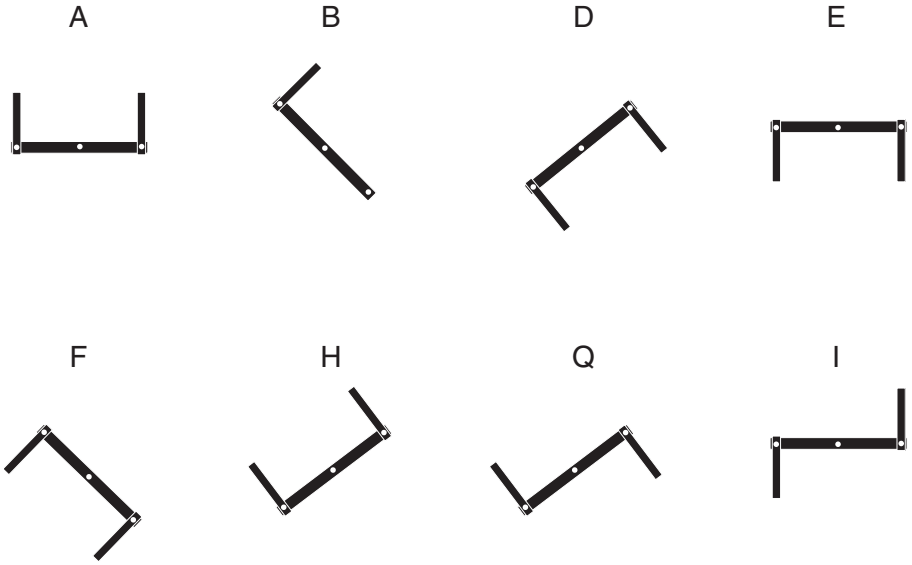
(b) In 18th century France, three arms in different positions were used to send messages. Here are three examples:

(i) Using this system, 2×7^2 different symbols are possible.

Give 2×7^2 as an ordinary number.

(b)(i) ..... **[2]**

Here are some more symbols and the letters they represent.



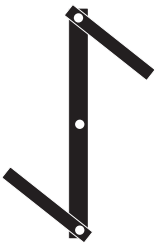
(ii) Write down the letters for any **symbols** that have reflection symmetry.

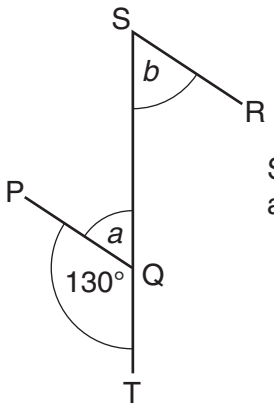
(ii) ..... **[2]**

(iii) Write down the letters for any **symbols** that have rotation symmetry.

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

(c) The diagram below is based on these three semaphore arms.





SR and PQ are equal in length and parallel to each other.

Not to scale

(i) Find the value of *a*.

(c)(i) .....° **[1]**

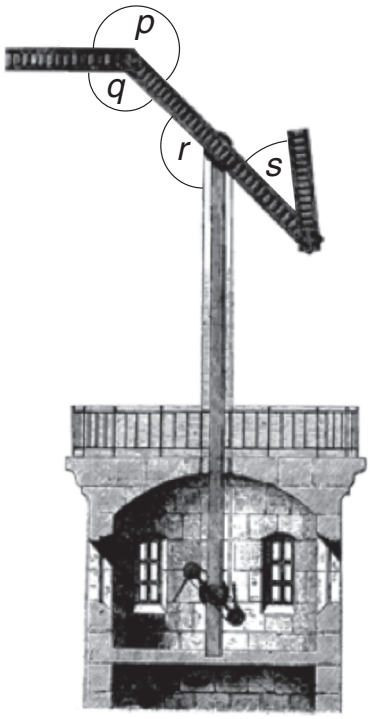
(ii) Find the value of *b*.

(ii) .....° **[1]**

(iii) What is the mathematical name for the quadrilateral PQRS made by joining the points P, Q, R and S in this order with straight lines?

(iii) ..... **[1]**

(iv) This picture shows a semaphore tower in use.



Circle the letter(s) which show an acute angle.

p *q* *r* *s*

Circle the letter(s) which show an obtuse angle.

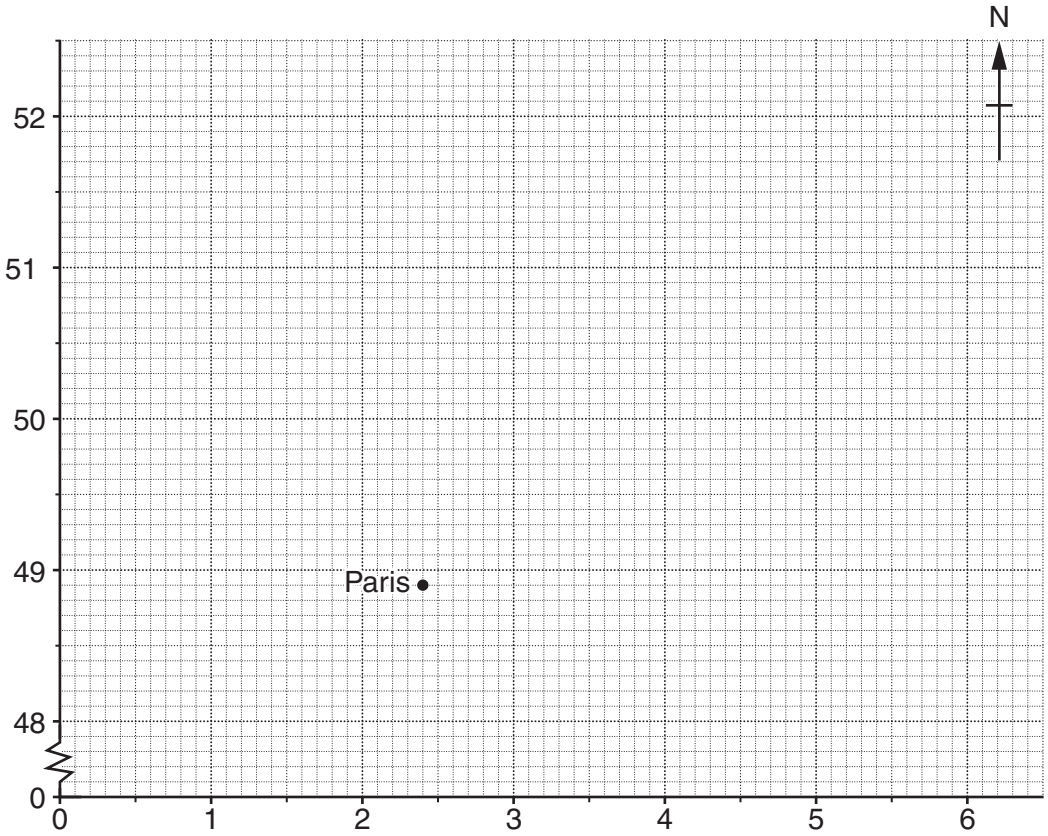
p *q* *r* *s*

Circle the letter(s) which show a reflex angle.

p *q* *r* *s*

[2]

(d) The first line of semaphore towers was built in 1794 and connected Paris to Lille.
This GPS coordinate grid shows the position of Paris.



(i) What are the coordinates of Paris?

(d)(i) (..... , ...) **[1]**

(ii) Clearly mark the position of Lille which is at (3.1, 50.6). **[1]**

(iii) What is the bearing of Lille from Paris?
Leave in any line(s) you draw.

(iii) .....° **[2]**

(e) A semaphore message took 5 minutes to get from Paris to Lille.
This is a distance of 200 kilometres.

(i) How fast was this in kilometres per minute?

(e)(i) ..... kilometres per minute **[1]**

(ii) Convert your answer to part **(e)(i)** into a speed of kilometres per hour.

(ii) ..... kilometres per hour **[1]**

(iii) A fast horse could travel at about 20 kilometres per hour.

How many **times** faster is your answer to part **(e)(ii)** than the speed of a message carried by a fast horse?

(iii) ..... times faster **[1]**

(f) Each semaphore tower had two operators.
During the summer they had to be on duty from 3:30 am till 8:30 pm.
Each operator was paid 25 sous a day.
Each operator was fined 5 sous for each minute's delay in sending on a signal.

(i) How many hours a day did each operator have to be on duty in the summer?

(f)(i) ..... hours **[1]**

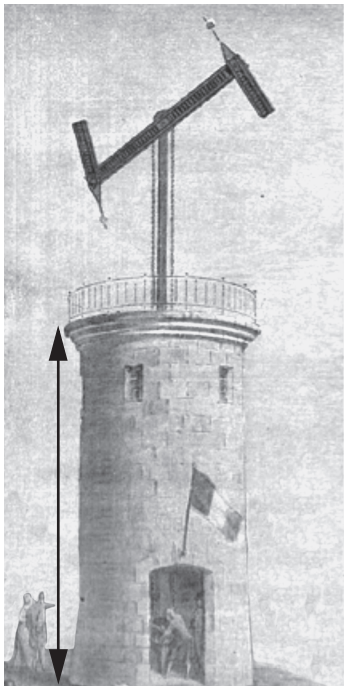
(ii) One day an operator worked out his pay for that day to be

$$25 - 15 = 10 \text{ sous}.$$

What was the total delay in sending signals on that day?

(ii) ..... minutes **[1]**

(g)



(i) Estimate the height of the real semaphore tower shown by the arrow.
Give your answer in metres.

(g)(i) ..... metres **[1]**

(ii) Estimate the diameter of the real tower.

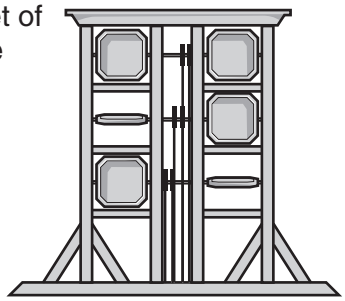
(ii) ..... metres **[1]**

(iii) The tower was built in 1792.
This was 52 years before the first telegraph message was sent.

In what year was the first telegraph message sent?

(iii) ..... **[1]**

(h) The UK had a semaphore system from 1796. It used a set of rectangular frames containing six shutters which could be open or closed to send messages.



(i) With this frame, 2^6 different symbols were possible.

Write this number as an ordinary number.

(h)(i) ..... **[1]**

One of the first semaphore lines went from The Admiralty in London to Portsmouth Dockyard. It had 15 semaphore stations.

Semaphore station		**Semaphore station**	**Distance (km)**
The Admiralty	to	Chelsea	2.8
Chelsea	to	Putney Heath	6.6
Putney Heath	to	Coombe Warren	4.2
Coombe Warren	to	Telegraph Hill	7.5
Telegraph Hill	to	Chatley Heath	9.2
Chatley Heath	to	Pewley Hill	12.8
Pewley Hill	to	Bannicle Hill	12.6
Bannicle Hill	to	Haste Hill	7.0
Haste Hill	to	Older Hill	6.7
Older Hill	to	Beacon Hill	10.9
Beacon Hill	to	Compton Down	3.7
Compton Down	to	Camp Down	12.9
Camp Down	to	Lumps Fort	8.6
Lumps Fort	to	Portsmouth Dockyard	3.5

(ii) What was the greatest distance between one semaphore station and the next?

(ii) ..... kilometres **[1]**

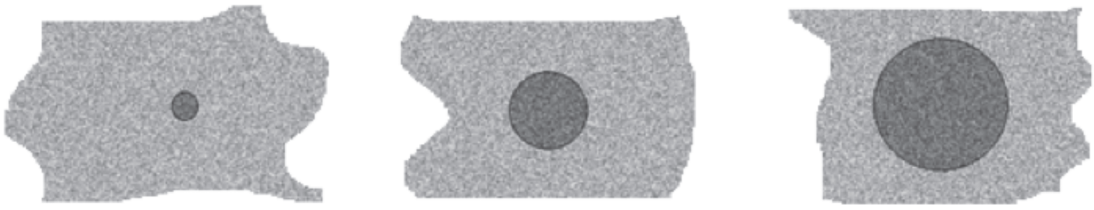
(iii) How far was it from The Admiralty to Portsmouth Dockyard following the line of semaphore stations?

(iii) ..... kilometres **[1]**

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

The hardness of a material is measured by pressing a point into it which makes an indent. The smaller the indent, the harder the material.

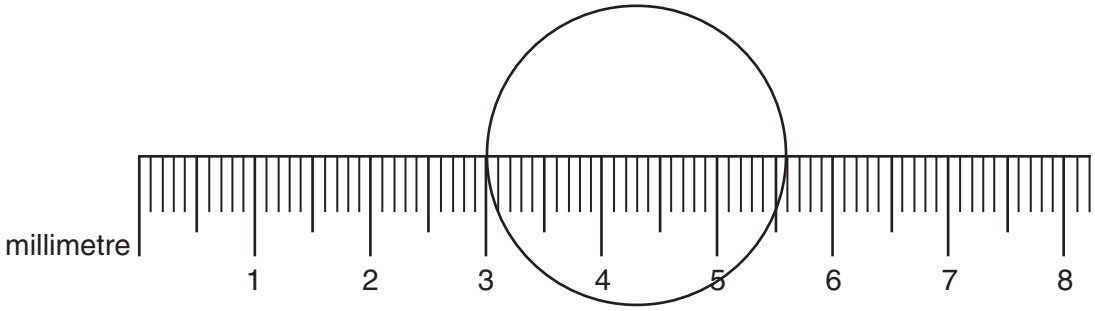
These indents were made by the same point pressed with the same load.



Steel A Steel B Steel C

Steel A is harder than Steel B.
Steel B is harder than Steel C.

(a) (i) Use the magnified millimetre scale to find the diameter of the indent below.



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

(ii) What is the radius of this indent?

(ii) ..... millimetres **[1]**

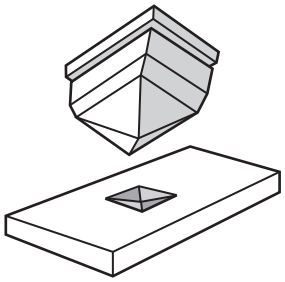
(b) The same point is pushed into some different bronze pieces using the same force. This table shows the diameter of the circular indents made.

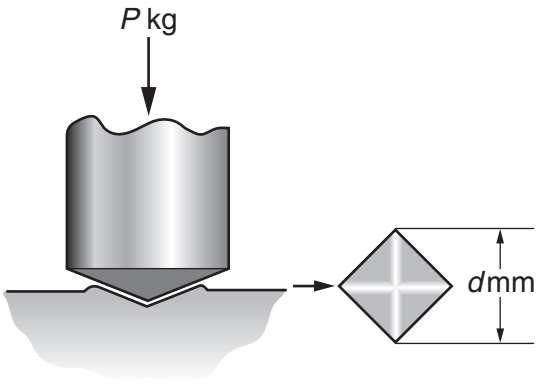
Bronze piece	A	B	C	D	E
Indent diameter	3.1 millimetres	6.1 millimetres	0.9 **centimetres**	1.4 millimetres	1.7 millimetres

List the bronze pieces in order of their hardness, hardest first.

(b) .... **[2]**
hardest

(c) 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.

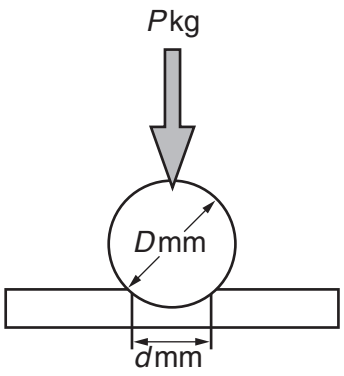
A Vickers hardness test on a sheet of iron and a sheet of zirconium gave these results.

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.

(c) ..... **[4]**

(d) 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.

(d) ..... **[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.