

**Thursday 25 May 2017 – Morning**

**GCSE APPLICATIONS OF MATHEMATICS**

**A381/02 Applications of Mathematics 1 (Higher 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 15 minutes



Candidate forename		Candidate surname	
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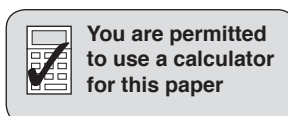
Centre number						Candidate number				
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### INSTRUCTIONS TO CANDIDATES

- 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 barcodes.

### INFORMATION FOR CANDIDATES

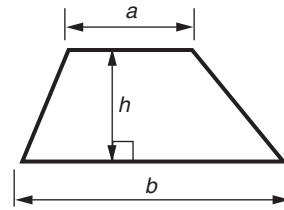
- The number of marks is given in brackets [ ] at the end of each question or part question.
- Your quality of written communication is assessed in questions marked with an asterisk (\*).
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are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



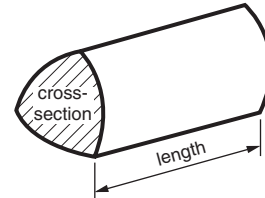
You are permitted to use a calculator for this paper

## Formulae Sheet: Higher Tier

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



**Volume of prism** = (area of cross-section)  $\times$  length

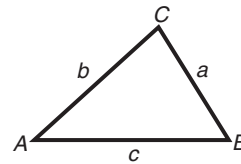


**In any triangle ABC**

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

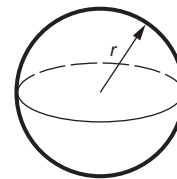
**Cosine rule**  $a^2 = b^2 + c^2 - 2bc \cos A$

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



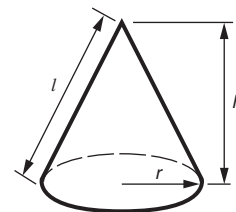
**Volume of sphere** =  $\frac{4}{3}\pi r^3$

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



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

**Curved surface area of cone** =  $\pi r l$



**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 The speed of sound in air depends on the air temperature.  
At an air temperature of  $T^{\circ}\text{C}$  the speed of sound,  $S$  kilometres per hour, is given by:

$$S = 72.2\sqrt{T + 273}.$$

- (i) What is the speed of sound when the air temperature is  $20^{\circ}\text{C}$ ?  
Give your answer correct to 1 decimal place.

(i) ..... kilometres per hour [3]

- (ii) This formula shows approximately how  $S$  depends on  $T$ .

$$S = 1193 + 2.2T$$

Find the difference in sound speed at  $20^{\circ}\text{C}$  given by this formula and the formula you used in **part (i)**.

(ii) .....kilometres per hour [3]

2 Dog Digest, Canine Communication and Woof Weekly are three pet magazines.

$\frac{13}{24}$  of the pages in Dog Digest contain photographs of dogs.

$\frac{17}{30}$  of the pages in Canine Communication contain photographs of dogs.

$\frac{8}{15}$  of the pages in Woof Weekly contain photographs of dogs.

(a) Put the three fractions in order, smallest first.

..... , ..... , .....  
*smallest*

[2]

(b) Woof Weekly and Dog Digest both have the same number of pages.

Calculate the smallest number of pages that they could have.

(b) ..... [2]

- 3 The size of a population of fish,  $P$ , at time  $t$  years can be modelled using the following formula.

$$P = \frac{600 \times 2.72^{\frac{t}{5}}}{1 + 3 \times 2.72^{\frac{t}{5}}}$$

- (a) The initial population of fish can be calculated by the following.

$$P = \frac{600 \times 2.72^0}{1 + 3 \times 2.72^0}$$

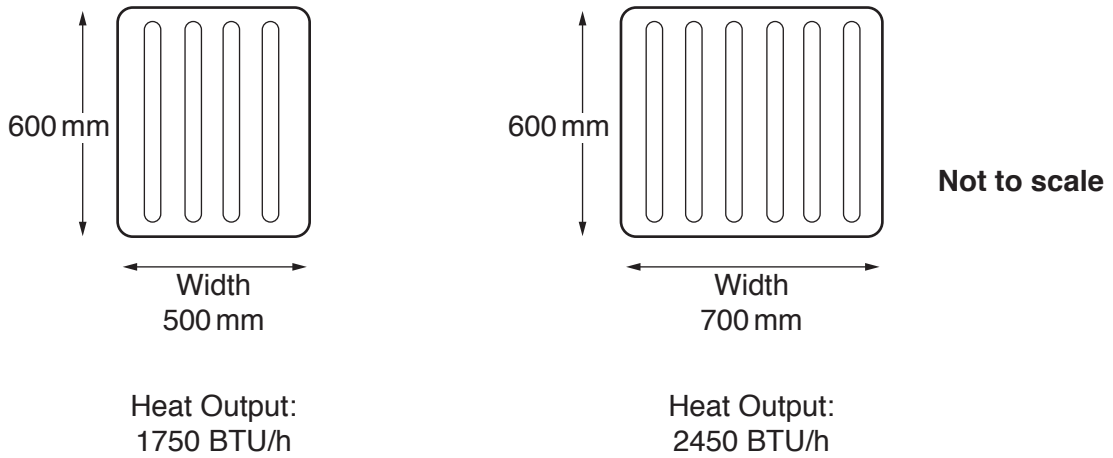
Calculate the initial value of  $P$ .

(a) ..... [1]

- (b) Calculate the population after 6 years.

(b) ..... [2]

- 4 The heat output of a radiator is measured in British Thermal Units per hour (BTU/h). The larger the radiator, the higher the heat output. A standard single-panelled radiator is 600 mm tall. The heat output and dimensions of two standard single-panelled radiators are:



Ethan is a plumber. He claims that the heat output of a standard single-panelled radiator is directly proportional to its width.

- (a)\* Use the information from the two radiators above to show that Ethan is correct.

.....

.....

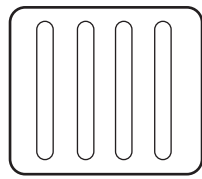
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..... [2]

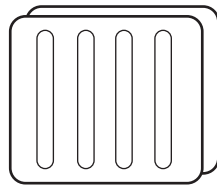
- (b) Calculate the heat output produced by a standard single-panelled radiator of width 1100 mm.

(b) ..... BTU/h [2]

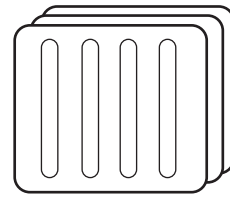
(c)



Single-panelled



Double-panelled



Triple-panelled

Double-panelled radiators and triple-panelled radiators are also available. The heat output of each type of radiator is directly proportional to its width. Double-panelled radiators have a heat output 74% greater than a single-panelled radiator of the same size.

(i) Calculate the heat output of a 600 mm tall and 500 mm wide double-panelled radiator.

(c)(i) ..... BTU/h [2]

(ii) A double-panelled radiator has a heat output of 5481 BTU/h.

Calculate the width of this radiator.

(ii) ..... mm [3]

(iii) Triple-panelled radiators have a heat output 142% higher than a **single**-panelled radiator of the same size.

Triple-panelled radiators have a heat output  $t\%$  higher than a **double**-panelled radiator of the same size.

Find  $t$ .

(iii)  $t =$  ..... [3]

Turn over

- 5 (a)\* Electricity can be generated in different ways.  
The electricity supplied in the UK is generated from:

- fossil fuels (coal, gas, oil, etc.)
- nuclear fuels
- renewables (wind, solar, tidal, etc.)
- other fuel sources or imports.

In 2014,

- 57% was from fossil fuels
- 17% was from nuclear fuels
- 61 terrawatt-hours (TWh) of electricity was supplied from renewables
- $\frac{2}{25}$  was from other fuel sources or imports.

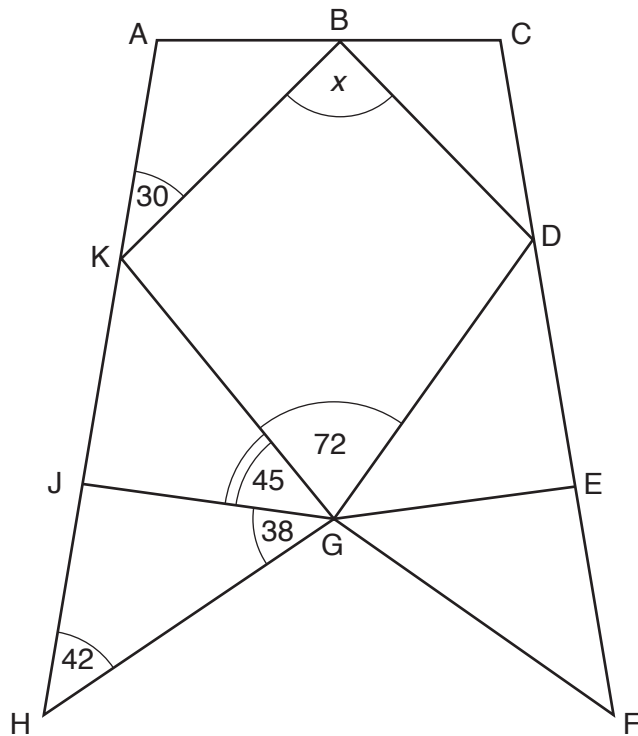
Calculate the total amount of electricity generated in 2014.

(a) ..... TWh [4]



- (b) Electricity pylons are used to transmit electricity from power stations to where it is needed. This symmetrical shape is part of an electricity pylon design.

The angles marked are measured in degrees.



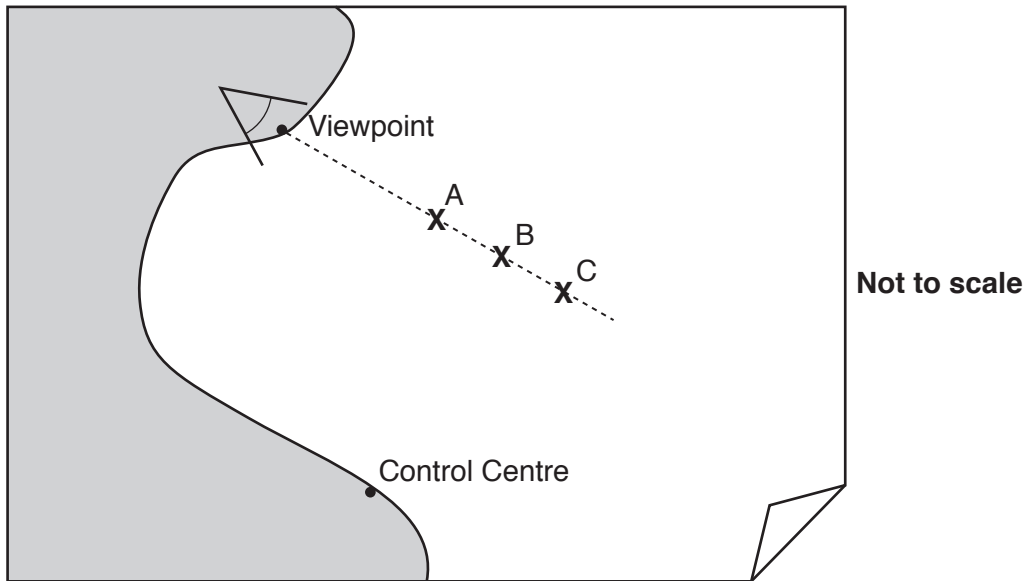
Not to scale

Calculate  $x$ , giving geometrical reasons for each stage of your working.

(b)  $x = \dots\dots\dots^\circ$  [4]

- (c) Three wind turbines A, B and C are positioned in a straight line at sea.  
 B is the midpoint of AC.

The three wind turbines appear to be in line when looked at from a viewpoint on the coast.



The Control Centre is also on the coast.

- (i) A is 11.3 nautical miles from the Control Centre.  
 A boat travelling at an average speed of 25 knots leaves the Control Centre at 15 00.

Calculate the time the boat arrives at A.

1 knot = 1.852 km/h.

1 km = 0.54 nautical miles.

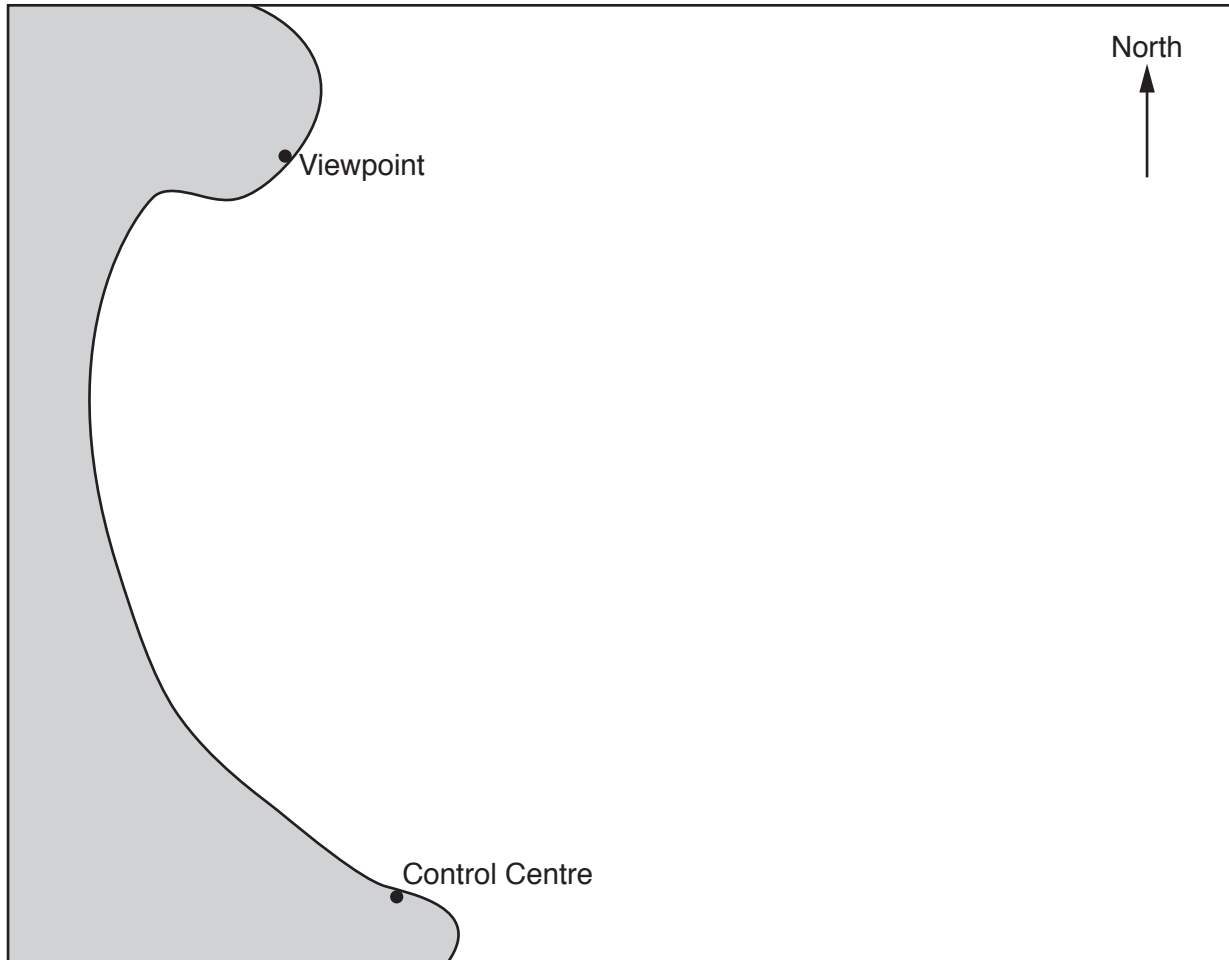
(c)(i) ..... [4]

- (ii) The bearing of the wind turbines from the viewpoint is  $128^\circ$ .

The bearing of turbine A from the Control Centre is  $015^\circ$ .

The bearing of turbine C from the Control Centre is  $032^\circ$ .

Show the positions of all three wind turbines on the map below.



[4]

- (d) Electro Power supply electricity to households.  
 They charge their customers a £4.46 monthly standing charge plus a rate for the amount of electricity used.  
 The rate is  $d$  pence per unit for daytime units and  $n$  pence per unit for nighttime units.

- (i) One month, Karen uses 164 daytime units and 112 nighttime units. She is charged a total of £39.10.

Show that Karen's usage can be expressed by the following simplified equation.

$$41d + 28n = 866$$

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

- (ii) In the same month, Dave uses 230 daytime units and 140 nighttime units and is charged £51.76.

Form a second equation in  $d$  and  $n$ .  
 Solve the two simultaneous equations algebraically to find the costs of each daytime unit and each nighttime unit.

(d)(ii) Cost of a daytime unit = ..... pence  
 Cost of a nighttime unit = ..... pence  
 [4]

6 A sculptor is designing a sculpture.  
He first makes a trial sculpture out of polystyrene. He then makes the actual sculpture out of granite.  
The trial polystyrene sculpture has volume  $2.8\text{m}^3$  and mass  $2940\text{kg}$ .

(a) Show that the density of polystyrene is  $1050\text{kg/m}^3$ .

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

(b) Granite has density  $2800\text{kg/m}^3$ .  
The actual granite sculpture has mass  $220\,000\text{kg}$ .

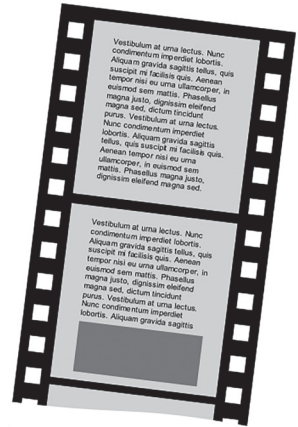
Calculate the volume of the actual granite sculpture.  
Give your answer correct to 3 significant figures.

(b) .....  $\text{m}^3$  [3]

7 Microfilm was used to archive documents before high capacity computer storage was developed.

A reduced photograph of each page of a newspaper, magazine or book is taken on a sheet of film.

The photographs can be read by a machine which magnifies the image and shows it on a screen.



One microfilm process reduces the lengths of the original document by a scale factor of 20.

All lengths on the microfilm are  $\frac{1}{20}$  of the original lengths.

(a) A newspaper headline is 11.8 cm wide on the original newspaper.

How wide is the headline on the microfilm copy?  
Give your answer in mm.

(a) ..... mm [2]

(b) A letter 'T' on a microfilm copy of a book is 0.23 mm tall.

How tall is the letter 'T' in the original book?  
Remember to state the units of your answer.

(b) ..... [2]

(c) A photograph in a magazine has area 260 cm<sup>2</sup>.

(i) Calculate the area of the photograph on the microfilm copy.

(c)(i) ..... cm<sup>2</sup> [2]

- (ii) On a microfilm copy made using a **different** microfilm process, the same photograph has area  $0.416 \text{ cm}^2$ .  
On this microfilm copy a line is  $0.51 \text{ cm}$  long.

Calculate the length of the line in the original magazine.

(ii) ..... cm [3]

**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(s).

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines across the rest of the page, providing space for writing answers.



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