

**Wednesday 2 November 2016 – 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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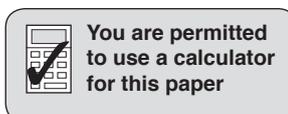
Centre number						Candidate number				
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**INSTRUCTIONS TO CANDIDATES**

- 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. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the barcodes.

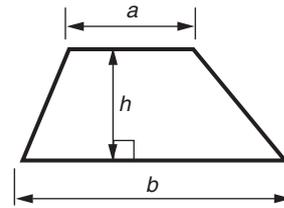
**INFORMATION FOR CANDIDATES**

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

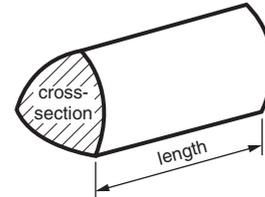


## Formulae Sheet: Higher Tier

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



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

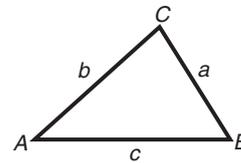


In any triangle *ABC*

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

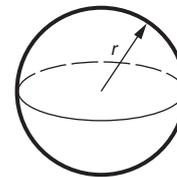
**Cosine rule**  $a^2 = b^2 + c^2 - 2bc \cos A$

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



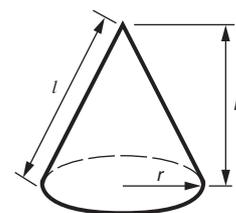
**Volume of sphere** =  $\frac{4}{3}\pi r^3$

**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

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

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Answer **all** the questions.

- 1 Four wind turbines, A, B, C and D, are built in the sea.  
The map shows the positions of two of the turbines.



- (a) Measure the bearing of turbine B from turbine A.

(a) ..... ° [1]

- (b) The bearing of turbine C from turbine A is  $205^\circ$ .  
The bearing of turbine C from turbine B is  $285^\circ$ .

Draw accurately the position of turbine C on the map above. [3]

- (c) Turbine B is on a bearing of  $243^\circ$  from turbine D.

**Calculate** the bearing of turbine D from turbine B.

(c) ..... ° [2]

## 2 Amber has a treadmill.

Amber looks on the internet and finds that safe heartbeat rates depend on age. She finds these two formulas.

Formula A

$$h = 206 - 0.88a$$

Formula B

$$h = 192 - 0.007a^2$$

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$h$  is the maximum safe heartbeat rate in beats per minute (bpm).  
 $a$  is the person's age in years.

(a) Amber is 28 years old.

What does Formula B give as Amber's safe heartbeat rate?  
Give your answer correct to the nearest whole number.

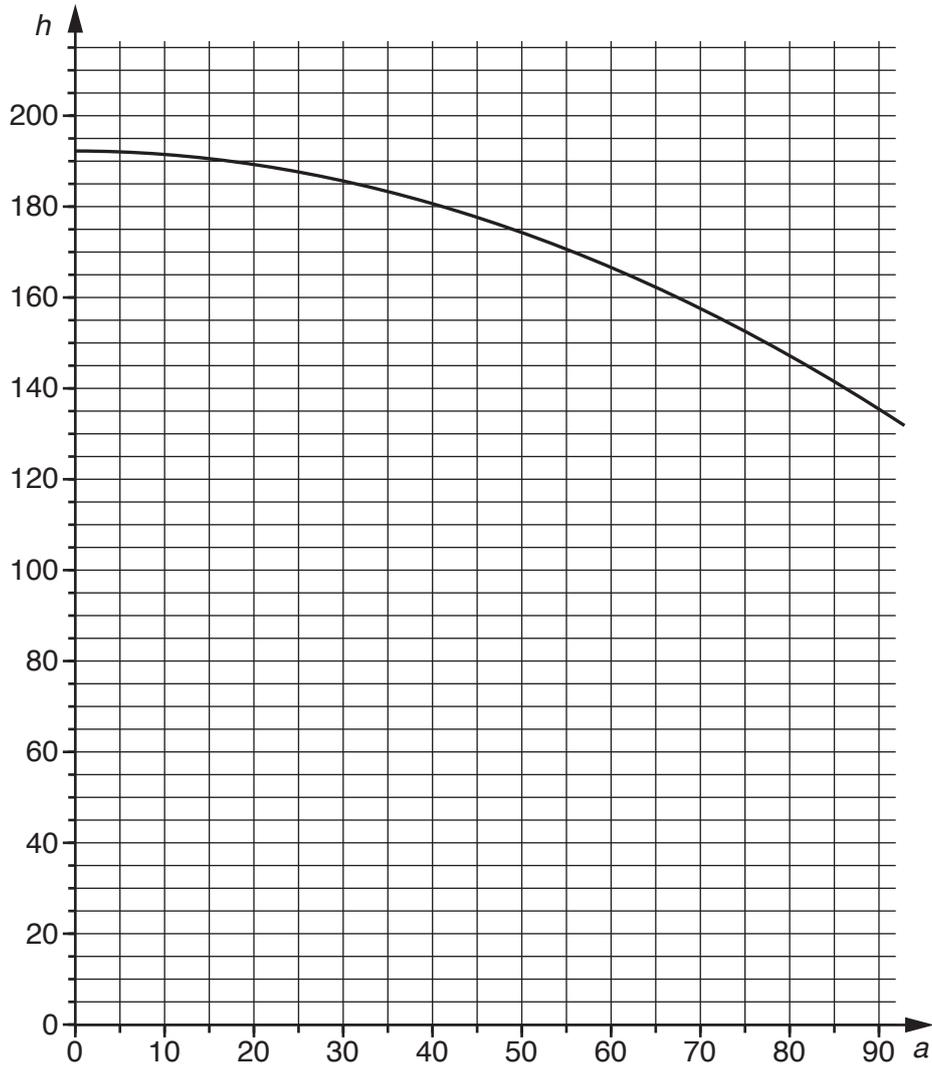
(a) ..... bpm [2]

(b) Amber's friend, Frida, uses Formula A to calculate her safe heartbeat rate. She calculates it as 184, correct to the nearest whole number.

Form an equation in  $a$  and solve it to find Frida's age in years.

(b) ..... years old [3]

- (c) Amber plots a graph to show the connection between age,  $a$ , and safe heartbeat rate,  $h$ , using Formula B.



- (i) Plot the straight line graph representing Formula A for ages 0 to 90 on the axes. [3]

- (ii) Formula A and Formula B give slightly different safe heartbeat rates for most ages.

Use the graph to find an age where the heartbeat rate formulas agree.

- (ii) ..... years old [1]

- (d) Amber wonders how good treadmills are at burning off energy. She runs on a treadmill for  $t$  minutes and burns off  $b$  kcals. This formula is for women:

$$b = (0.1H - 0.006w - 0.02a - 5) \times t$$

$H$  is the average heartbeats rate in bpm whilst using the treadmill,  
 $w$  is the weight of the person in kg,  
 $a$  is their age in years.

Amber's average heartbeats rate on the treadmill is 138 bpm.  
 She is 28 years old and weighs 66 kg.  
 Amber likes ice cream.  
 A serving of ice cream contains 300 kcals.

Will 30 minutes on the treadmill burn this off?  
 You must show working to support your answer.

[4]

- 3 (a) The amount of electricity used is often measured in kilowatt-hours (kWh). Each appliance has a rating, in kilowatts (kW). The amount of electricity used by a television can be calculated by multiplying its rating measured in kW by the time used in hours.

1 kilowatt (kW) = 1000 watts (W).

- (i) A television that is watched for 24 hours uses 0.75 kWh of electricity.

Calculate the rating, in watts, of the television.

(a)(i) ..... watts [3]

- (ii) The television in standby mode only uses 1.5% of the electricity that it would use when being watched.

Calculate the rating, in watts, of the television when it is in standby mode.

(ii) ..... watts [2]

- (b) Kevin earned £16 500 one year and spent a total of £650 on electricity.

- (i) What percentage of his earnings did Kevin spend on electricity?  
Give your answer correct to 2 significant figures.

(b)(i) ..... % [3]

- (ii) Kevin used 3300 kWh of electricity that year.  
Kevin is considering changing energy suppliers and sees this advertisement for Smart Energy.

**Smart Energy saver tariff**

18.9p daily charge

plus

15.1p per kWh of electricity used

Calculate the amount Kevin would have saved that year if he had used Smart Energy for his electricity.

Assume that the year has 365 days.

(ii) £ ..... [3]

4 Teams in English football are given the following points after each match:

- 3 points for winning the match
- 1 point for drawing the match
- 0 points for losing the match.

Kingswood United were given 88 points last season.

(a) (i) What is the least number of matches Kingswood United could have drawn?  
Explain how you know.

..... matches because .....

.....

..... [2]

(ii) Kingswood United's **total points** can be written as an equation.

$$3w + d = 88$$

$w$  is the number of matches won.

$d$  is the number of matches drawn.

In the same season, Kingswood United scored a total of 86 goals during their matches.

- They scored an average of 2.25 goals per match in games they won.
- They scored an average of 2.5 goals per match in games they drew.
- They scored a total of 13 goals in games they lost.

Use the **goals** information to form a second equation and show that it simplifies to the following.

$$9w + 10d = 292 \quad [2]$$

- (iii) Solve the two simultaneous equations in part (ii) algebraically.  
Find the number of matches Kingswood United won and the number of matches drawn in the season.

(iii) Number of matches won .....

Number of matches drawn ..... [3]

- (b)\* Kingswood United's rivals are Queenswood City. They make this claim:

'We score over 30% more goals per match than Kingswood United.'

So far in the current season, Kingswood United have played 13 matches and scored 30 goals.  
Queenswood City have played 11 matches and scored 31 goals.

Is Queenswood City's claim true so far this season? [5]

- (c) Kingswood United's main football pitch is 114 yards long. Their junior team's pitch has one tenth the area of the main pitch. The pitches are mathematically similar.

Calculate the length of their junior team's pitch in metres.  
1 yard = 0.9144 metres.

(c) ..... m [4]

- (d) Kingswood United play a match against Veralium Town. The stadium is filled to 87% of its capacity.

It is recorded that:

- $\frac{1}{4}$  of the crowd are Veralium Town supporters
- $\frac{3}{5}$  of the Veralium Town supporters at the match are male
- there are 7800 **male** Veralium Town supporters at the match.

Calculate the capacity of the stadium correct to the nearest 10 000.

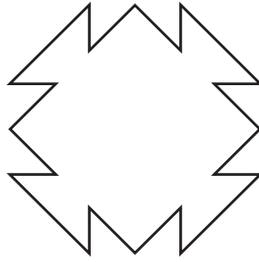
(d) ..... [5]

- (e) A football is dropped from a tall building vertically towards the ground.  
The distance the ball has fallen is directly proportional to the **square** of the time since the ball was released.  
The ball falls 1.2 metres in 0.5 seconds.

How far has the ball fallen 1.5 seconds after being released?

(e) ..... m [4]

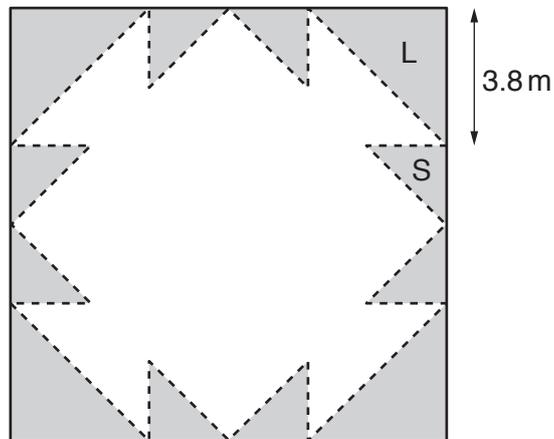
- (f) Kingswood United's badge is based on a symmetrical design.



The badge is cut from a square of metal.

The following shapes are cut from the square:

- Four larger congruent isosceles right-angled triangles, L, one from each corner.
- Eight smaller congruent isosceles right-angled triangles, S, two from each of the four edges.
- L and S are similar and the ratio of corresponding sides is 2 : 1.



There are no gaps between the triangles along an edge.  
A short side of triangle L is 3.8 m as shown.

Calculate the area of the front of the badge.

[5]