H

Wednesday 5 November 2014 – 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	

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. 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 bar codes.

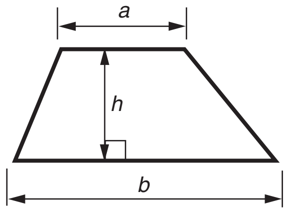
INFORMATION FOR CANDIDATES

- 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.

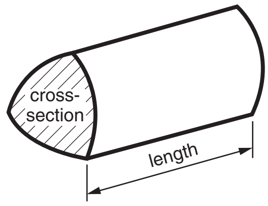
You are permitted to use a calculator for this paper

Formulae Sheet: Higher Tier

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



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

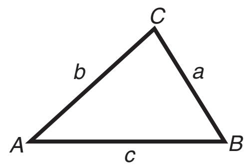


In any triangle *ABC*

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

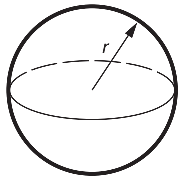
Cosine rule $a^2 = b^2 + c^2 - 2bc \cos A$

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



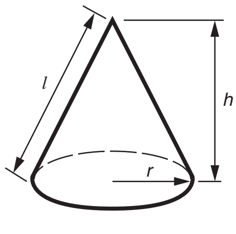
Volume of sphere $= \frac{4}{3}\pi r^3$

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



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

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



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 Kate and her partner Kwami wonder how tall their daughter Evie will be as she gets older.

(a) They find this formula.

$h = 6a + 77$
h is the height of the child, in centimetres
a is the age of the child, in years
The formula should only be used for children aged between 2 and 12 years.

(i) Use the formula to work out how tall Evie should be when she is 10.

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

(ii)* Show that the formula can't possibly work for all adults.

....

....

....

....

.... **[3]**

(b) Kate and Kwami also find this more reliable formula on the internet.

$$A = \frac{m + f - 13}{2}$$

m is the mother's height, in cm.
f is the father's height, in cm.

A is the baby's expected adult height in cm when they grow up.

Kate is 1.62 m tall and Kwami is 1.79 m tall.

What height does the formula predict Evie will be when she grows up?

(b) .... cm **[3]**

(c) Kate finds this table. It shows the expected percentage increase in height from a child's height to their final adult height.

For example, a boy aged 10 years will expect his height to increase by 29% by the time he is an adult.

	Percentage increase in height to adult height	
Child's age (years)	**Boys**	**Girls**
1	146	130
2	106	101
3	86	76
4	73	62
5	62	51
6	54	43
7	47	35
8	40	29
9	35	23
10	29	17

Kate and Kwami have a son, Jack, aged 6 and another daughter, Stephanie, aged 8.

Jack is 110 cm tall. Stephanie is 124 cm tall.

Using the expected percentage increases in the table, work out how much taller Jack will be than Stephanie when they are adults.

Support your answer with calculations.

(c) .... cm **[5]**

2 Solar cells convert light into electricity.
The energy conversion efficiency of a solar cell can be calculated using this formula.

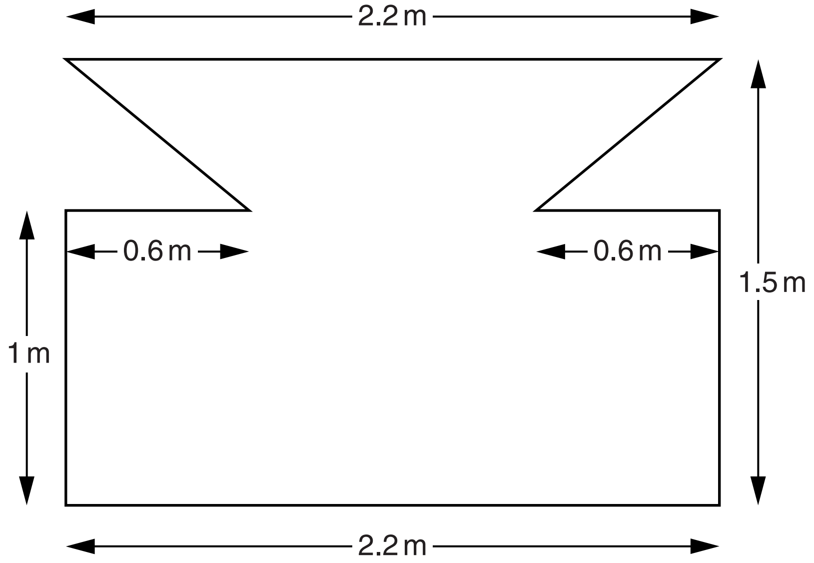
$$M = \frac{P}{E \times A}$$

M is the energy conversion efficiency
P is the maximum power, in watts
E is the amount of input light, in watts/m^2
A is the area of the solar cell, in m^2

(a) Calculate the energy conversion efficiency of a solar cell of area 15 m^2, where the maximum power is 2700 watts and the input light is 3600 watts/m^2.

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

(b) Solar cells are often included in modern building designs.
The symmetrical design for a solar cell is shown below.



Not to scale

When tested, the solar cell is shown to have a maximum power of 860 watts from an input light of 950 watts/m^2.

Show that the area of the solar cell is 3 m^2 and use this to calculate its energy conversion efficiency.

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

3 **(a)** Moore's law is often used to describe the rate at which home computer processing power is increasing.
This is a simple version of Moore's law.

The number of transistors used in the average computer's central processing unit chip **doubles every two years**

The central processing unit (CPU) chip is the part of the computer which processes information.

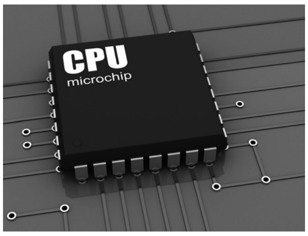
In 2008 a computer magazine contained the following headline.

Launched this year **CPU chip packed with 760 million transistors**

Work out how many transistors will be found on a home computer's CPU chip in 2018.
Assume Moore's law to be true.

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

(b) The picture below shows a CPU chip.



In 1974, one square CPU chip had an **area** of 16 mm^2.
In 2012, the **side** of another square CPU chip was six times longer than the side of the 1974 chip.

Calculate the area of the 2012 chip.

(b) .... mm^2 **[2]**

(c) The memory of a computer is measured in bytes or kilobytes.
1 kilobyte is equivalent to 2^{10} bytes.
The total memory available in a computer is always a power of 2.

One of the world's first laptop computers was the IBM PC Convertible.
It had 256 kilobytes of memory.

(i) Work out 2^{10}.

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

(ii) Write 256 as a power of 2.

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

(iii) Calculate the number of **bytes** of memory in the IBM PC Convertible laptop.
Write your answer as a power of 2.

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

(iv) Modern computers contain much larger memories.
A 64 gigabyte tablet PC contains 2^{26} kilobytes of memory.

How many kilobytes are there in 1 gigabyte?
Give your answer as a power of 2.

(iv) .... **[2]**

(d) The cost of computer memory has fallen over time.
Between 1990 and 2000, the average price fell by 99%.
Between 2000 and 2010, the average price fell by 98%.
In 2010, the average price of computer memory was £12.75 per gigabyte.

(i) Calculate the average price per gigabyte of memory in 1990.

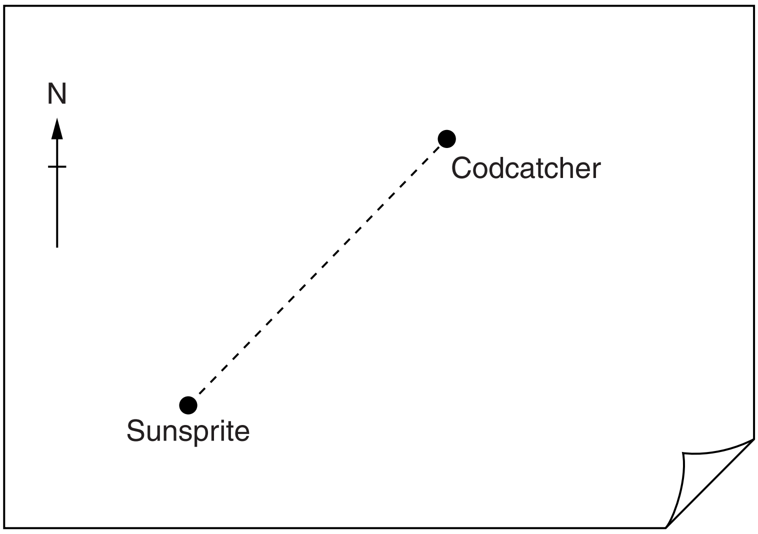
(d)(i) £ .... **[3]**

(ii) The cost of computer memory is predicted to fall by 99% from 2010 to 2020.

Calculate the expected average price per gigabyte of memory in 2020.
Give your answer correct to the nearest penny.

(ii) £ .... **[2]**

4 Two fishing boats, Sunsprite and Codcatcher, are out at sea as shown in the sketch below.



Not to scale

(a) The bearing of Sunsprite from Codcatcher is 213°.

Calculate the bearing of Codcatcher from Sunsprite.

(a) .... ° **[2]**

(b) An hour later a third fishing boat, Hakehunter, is passing through the area.
The new positions of Sunsprite and Codcatcher are shown on the scale diagram below.
Sunsprite measures the bearing of Hakehunter as 063°.
Codcatcher measures the bearing of Hakehunter as 290°.

Indicate clearly the position of Hakehunter on the diagram below.

[3]

(c) The owners of the three fishing boats each claim that theirs is the fastest.

Sunsprite	**Codcatcher**	**Hakehunter**
"At top speed we can travel 220 km in 3½ hours"	"My boat's top speed is 65 km/h"	"It took me from 5.15 am until 7.00 am to travel 100 km at full speed"

List the boats in order of their speed. Start with the slowest.
Show clear calculations to support your answer.

....
slowest

[4]

(d) (i)* Sunsprite caught a variety of fish in one season.

$\frac{1}{7}$ of the fish were cod.

Regulations state that, in a season, a maximum of 15% of a catch may be cod.

Was Sunsprite's catch this season within this limit?

You must show calculations to justify your answer.

....

....

....

.... **[2]**

(ii) Sunsprite has a record of the fish caught in one season.

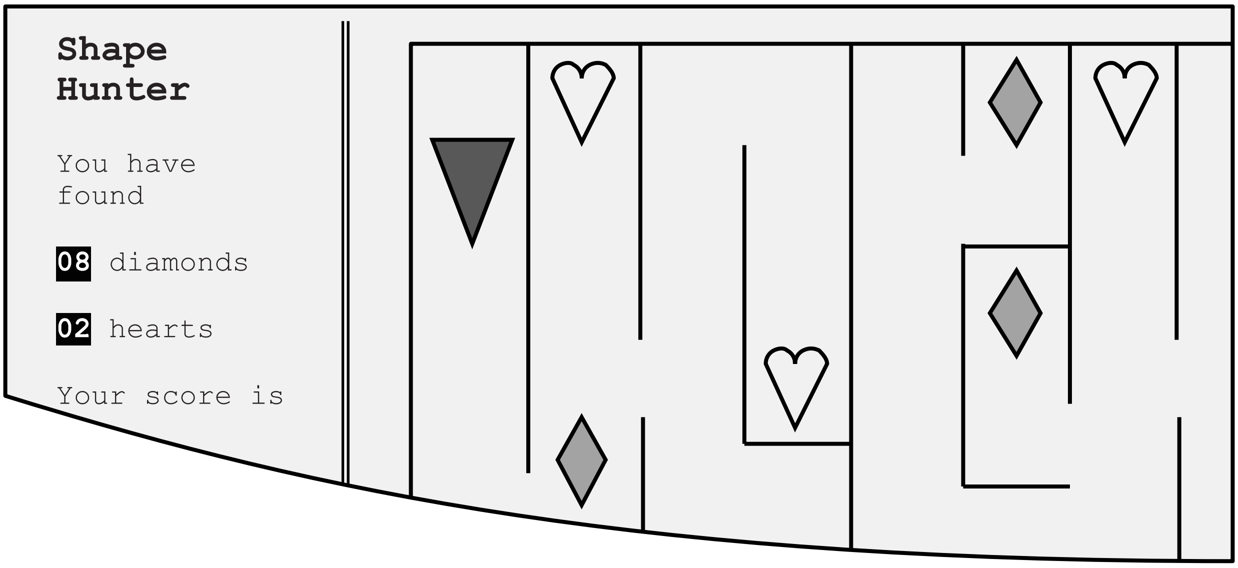
- $\frac{1}{7}$ of the fish were cod
- $\frac{2}{5}$ of the fish were skate
- $\frac{3}{11}$ of the fish were hake

Half of the remaining fish were mackerel and the rest were snappers.

What fraction of the fish were mackerel?

(d)(ii) .... **[3]**

5 In a computer game, points are scored when diamonds or hearts are found in a maze.



Justin and Nazreen both played the game.
Justin found 9 diamonds and 11 hearts and scored 295 points.

Justin's score can be written as an equation.

$$9d + 11h = 295$$

d is the number of points for a diamond, and h is the number of points for a heart.

(a) Nazreen found 14 diamonds and 35 hearts and scored 763 points.

(i) Use Nazreen's score to form another equation and show that it simplifies to

$$2d + 5h = 109$$

....

.... **[1]**

(ii) Solve these two equations using an algebraic method.
Write down the number of points scored for finding each shape.

(a)(ii) A diamond scores .... points

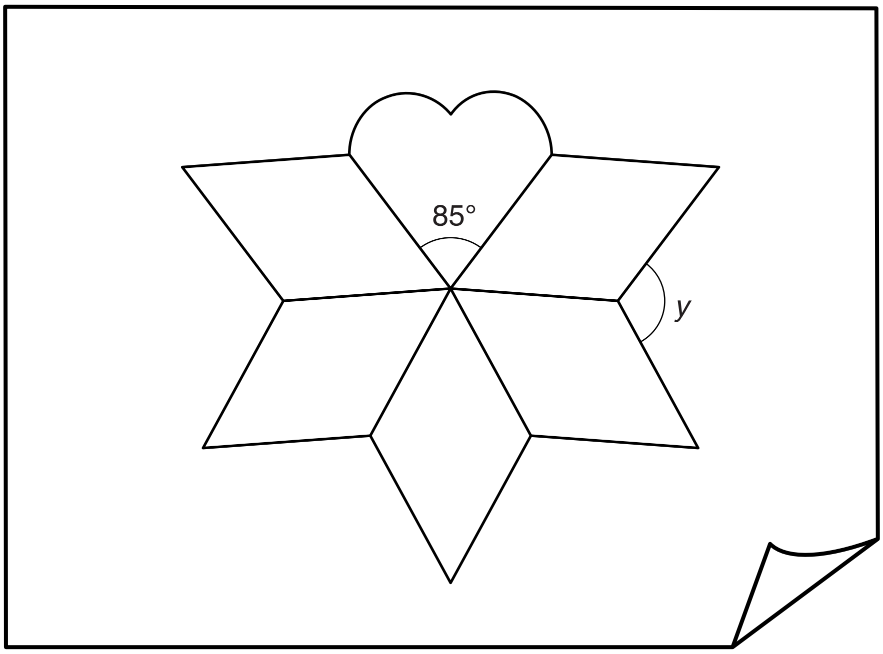
and a heart scores .... points **[4]**

(b) In another level of the game, a bonus score is given for finding a star shape hidden in the maze.
The bonus score is inversely proportional to the **square** of the time taken, in seconds, to find the star.
The bonus score is rounded to the nearest whole number.
When Nazreen played this level she took 12 seconds to find the star in the maze, and scored 35 bonus points.

Justin took 7 seconds to find the star in the maze.
How many bonus points did he score?

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

(c) When the level is completed, five identical diamonds and a heart are shown on the screen as a logo.
Here is a sketch of the logo.



Not to scale

The diamonds have two lines of symmetry.
The heart has one line of symmetry and the interior angle at its base is 85°.

Calculate the angle labelled *y*.

(c) .... ° **[3]**

END OF QUESTION PAPER

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