H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

APPLICATIONS OF MATHEMATICS

A381/02

Paper 1
(Higher Tier)

Candidates answer on the Question Paper

OCR Supplied Materials:
None

Other Materials Required:
- Geometrical instruments
- Tracing paper (optional)
- Scientific or graphical calculator

SPECIMEN

Duration: 1 hour 15 minutes

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that 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.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

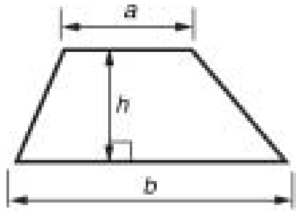
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- Use the π button on your calculator or take π to be 3·142 unless the question says otherwise.
- Your Quality of Written Communication is assessed in questions marked with an asterisk (*).
- This document consists of **16** pages. Any blank pages are indicated.

You are permitted to use a calculator for this paper.

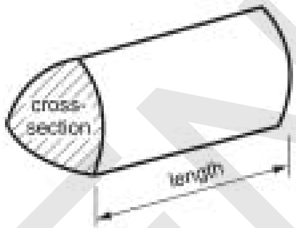
Turn over

Formulae Sheet: Higher Tier

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

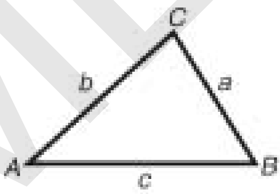


Volume of prism = (area of cross-section)$\times$length



In any triangle *ABC*

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



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

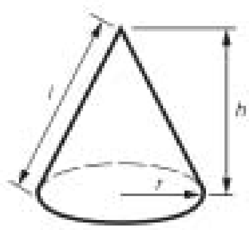
Area of triangle $= \frac{1}{2}ab\sin C$

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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1 A doll is dropped and lands on the ground.
The formula $v = \sqrt{20h}$ gives the speed of the doll when it hits the ground.
h is the distance it has dropped, in metres, and v is its speed in metres per second.

(a) Find the speed when the doll is dropped from a height of 1·5 m.
Give your answer correct to 1 decimal place.

(a) ________________________ m/s **[3]**

(b) The doll is dropped from a window on the upper floor of a two-storey house.

Estimate the speed at which the doll hits the ground.
Show how you reach your decision.

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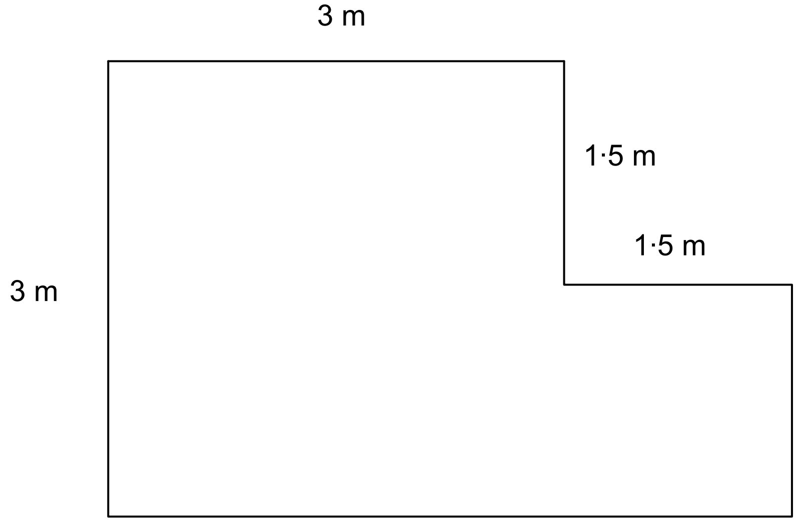
____ **[4]**

2



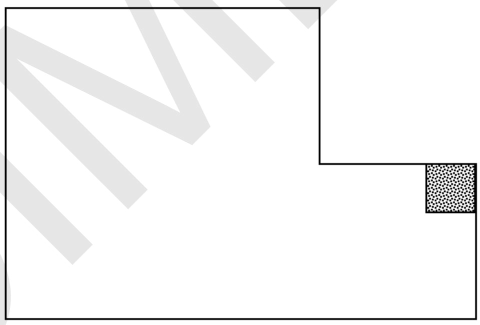
Not to scale

The diagram shows a room. All the corners are right angles. Maria wants to carpet the room using a carpet with no pattern.
There are two possible ways to do this; carpet tiles or carpet from a roll.

Carpet tiles

Each carpet tile measures 0·5 m by 0·5 m.

Each carpet tile costs £6.



(a) How much will it cost to cover the floor with carpet tiles?

(a) £___________________________ **[6]**

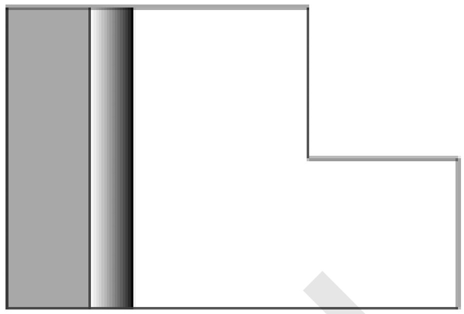
Carpet from a roll

The roll of carpet is 3 m wide.

Only a whole number of metres from the roll can be bought.

It is possible to join pieces together to carpet a room.

The carpet costs £18 per square metre.



(b) (i) How many metres of 'roll carpet' will Maria need to buy for the room?
You must explain how you got your answer.

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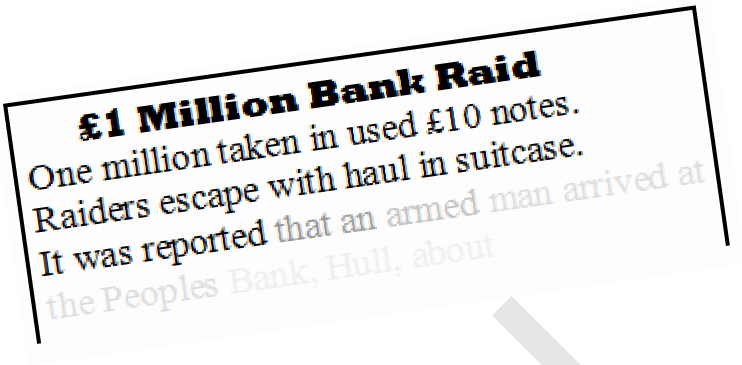
____ **[2]**

(ii) Use your answer to **(b)(i)** to work out how much the 'roll carpet' for the room costs.

(b)(ii) £____________________ **[3]**

3*



£1 Million Bank Raid
One million taken in used £10 notes.
Raiders escape with haul in suitcase.
It was reported that an armed man arrived at
the Peoples Bank, Hull, about

Is it possible to fill an average suitcase with £1 million in £10 notes?

Show all your assumptions, estimates and working clearly.

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____ **[5]**

4 Ryan is going hang-gliding. He finds this information on the internet.

As you climb higher into the sky it gets colder. For each 200 m rise in height the temperature drops by 1°C.

(a) Ryan wants to write a formula giving the temperature, T °C, at a height of h metres up, when the temperature on the ground is G °C.

Write down the formula he should use.

(c) ____ **[2]**

(b) According to the hang-gliding school Ryan's first flight will be to about 600 metres with an instructor.

Assuming the weather will be sunny, will Ryan need any special clothing with him to keep out the cold?

__________ because ____

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____ **[2]**

5 Here is a clip from a financial newspaper.
It gives the price per kilogram of various metals.

Metal	Cost per kilogram (£)
Copper	2.95
Gold	19417.31
Nickel	12.65
Silver	298.03
Tin	284.85
Zinc	1.60

This is taken from The Royal Mint website.

The United Kingdom £1 Coin

Issue Date 21 April 1983

Specifications

Diameter	22.5mm
Weight	9.5 g
Thickness	3.15mm
Composition	Nickel-Brass (70% copper, 5.5% nickel, 24.5% zinc)

How much are the metals in a £1 coin worth?

(a) £__________________ **[4]**

6 There are several rules for working out medicine doses for children.
For a child of age *A* years, their dose *c*, equivalent to an adult's dose *d*, is given by

Young's rule: $c = \frac{A}{A+12}d$ or Cowling's rule: $c = \frac{A+1}{24}d$.

Which rule gives the greater dose for a 7-year old child?

_________________ **[4]**

7 Before the **Global Positioning System (GPS**) sailors used geometry to help them to navigate.

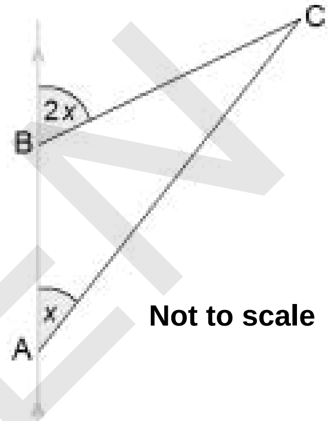
Here are two methods they used.

Explain how or why each one works.

(a) This is called 'doubling the angle at the bow'.
It was used to calculate the distance between a ship and a point on land, for example a tower.

A ship is travelling along the straight line AB.
A tower is at C.
When the ship is at A, the bearing of the tower at C is *x*.
The ship continues to B where the bearing of the tower at C is 2*x*.

Show that the distance BC is equal to the distance that has been travelled by the ship from A to B.



Not to scale

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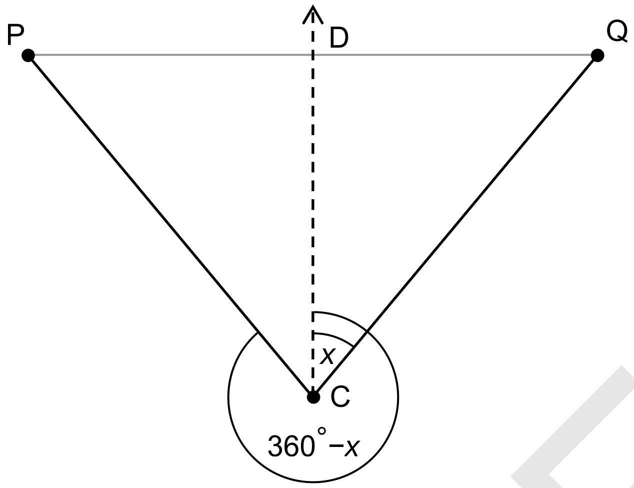
____ **[3]**

(b) To steer a course midway between two rocks, P and Q, the ship needs to ensure that the bearings of the two rocks are x and $(360^\circ - x)$ respectively.



Not to scale

A ship at C is equidistant from P and from Q,

Show that PD = QD.

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____ **[3]**

8 Experiments carried out under zero gravity in space are very useful, but extremely expensive. It is cheaper to use freefall on Earth.

The package containing the experiment falls freely inside a shaft.
During this time this simulates zero gravity inside the package.

The relationship between the freefall distance, *d* metres, and the time there is zero gravity, *t* seconds, is given by

$$d = 5t^2$$

After falling down the shaft the package needs to be brought to rest.

This is done by using a large tank, depth *p* metres, full of polystyrene beads at the bottom of the shaft.

When this happens a force, *G*, acts on the experimental package, where

$$G = \frac{5t^2}{4p},$$

t is the time the package is in freefall.

At the NASA Zero Gravity Centre, the freefall distance is 132 m and the polystyrene tank has a depth of 4.5 m.

(a) For how long does the experimental package fall?

(a) ____________________ seconds **[3]**

(b) Scientists would like to double the period of time the package falls.

What freefall distance would this need?

(b) ____________________ metres **[2]**

(c) The largest force, *G*, some specimens can take is 10.

Would the shaft at the NASA Zero Gravity Centre be suitable to test them?
Show how you arrived at your answer.

[2]

9 Amy is worried about her fuel costs.
She is considering spending money now to reduce her fuel costs in the future.
She realises that an important thing to consider is the 'payback' time.

Payback time is the time taken to recover the cost of an investment, such as loft insulation, from energy savings made.

$$\text{Payback time} = \frac{\text{Initial cost}}{\text{Annual saving}}$$

(a) According to an energy-saving page on the internet it costs just £10 to insulate a hot water tank. This can save £15 a year.

Work out the payback time for insulating a hot water tank.

(a)____________________________ **[1]**

(b) Solar panels cost about £3000 to install and last for about 20 years.
They save £100 a year on energy bills.

(i) Would you advise Amy to invest in solar panels?
Support your answer with working.

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____ **[2]**

(ii) In fact, energy prices, and the savings, are expected to rise by 10% a year – every year.

What advice would you give Amy in this case?
Support your answer with calculations.

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____ **[2]**

10

> "Workrooms should have enough free space to allow people to move about with ease. The volume of the room when empty, divided by the number of people normally working in it, should be at least 11 cubic metres. All or part of a room over 3·0 m high should be counted as 3·0 m high."
>
> Workplace health, safety and welfare: A short guide for managers (HSE)

(a) Use the information in the extract above to work out the maximum number of people who could work in an office 7·5 m wide, 10 m long, and 2·8 m high.

(a) ______________________________ **[4]**

(b) A manager is deciding whether to rent the office in part **(a)**.
He learns that the measurements in part **(a)** are correct to the nearest 10 cm.
He cannot get more accurate measurements quickly.

What is the maximum number of people he could have in the office to be certain that he is not disobeying the guidance on health, safety and welfare?

(b) ______________________________ **[3]**

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OXFORD CAMBRIDGE AND RSA EXAMINATIONS

General Certificate of Secondary Education

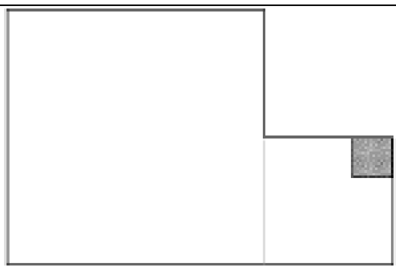
APPLICATIONS OF MATHEMATICS A381/02

Paper 1 (Higher)

Specimen Mark Scheme

The maximum mark for this paper is **60**.

This document consists of **6** printed pages.

1	**(a)**	5·5	**3**	**B2** 5·47… or 5·48 Or **M1** 20 × 1·5 or 30 seen
	(b)	Sensible estimate of height fallen, seen or implied as 3 – 5m Substitution in formula Correct evaluation of their speed Jack's guess is too low, with justification.	**1** **1** **1** **1**	Allow **B1** for 3 – 5 with no units √(20 × **(b)(i)**) seen Or **M1A1** $6^2/20 = 1{\cdot}8$ if done by using speed of 6 m/s.
2	**(a)**	 Large square area is 9 m² 4 tiles for a square metre so 36 tiles for large square Small square needs 3 tiles each way so 9 tiles [or scale drawing] 45 tiles 45 × £6 = £270	**1** **1** **1** **1** **1** **1**	Split into parts (or start scale diagram) Attempt to find area of part or to find how many tiles each way in part Finding number of tiles for part of shape Attempt to deal with other part (could be in a diagram) ft number of tiles
	(b)(i)	4·5 m would be enough but can only buy whole number of metres. She should buy 4 m and use the off-cut to finish the small square.	**2**	**B1** for 4 m without explanation or for 5 m
	(ii)	$4 \times 3 = 12$ m² $12 \times £18 = £216$	**3**	**M1 (b)(i)** × 3 **M1** × 18
3*		A fully explained and 'correct' answer, eg estimates for volume of banknote and suitcase together with calculation of number of banknotes the suitcase will hold and the value of these notes. A 'correct' answer using dimensions outside the range **or** an 'incorrect' answer which uses appropriate estimates for dimensions A clear attempt to calculate the volume of a banknote **and** the volume of the suitcase. No relevant comment or calculation.	**5** **3-4** **1-2** **0**	£10 note: (10–20) cm by (5–10) cm by (0·005–0·05) cm, giving a volume within the range (0·25–10) cm³ Suitcase: (100–150) cm by (50–100) cm by (30–60) cm, giving a volume within the range (150000–900000) cm³ For lower mark – an attempt to calculate the number of banknotes the suitcase will hold based on *their* values for the volume of the suitcase and the volume of a banknote. For lower mark - an attempt, possibly poorly expressed, to calculate the volume of a banknote **or** the volume of the suitcase.

4	(a)	$G - T = \frac{h}{200}$ or equivalent	2	1 for $T = G - \frac{h}{k}$, $T = G - kh$ or $\frac{h}{200}$
	(b)	The temperature will drop by 3°C A sunny day is about (18-25)°C So he'll not need any special clothing	1 1	Need both for 1 mark. Clear conclusion drawn in "good" English dependent on some (not necessarily correct calculation using the rule given). Accept answers involving wind chill if logical and reasonable.
5	(a)	70% of 9·5 g = 6·65 5·5% of 9·5 g = 0·5225 24·5% of 9·5 g = 2·3275 "6·65" × 2·95 ÷ 1000 (=£0·0196 …) "0·5225" × 12·65 ÷ 1000 (=£0·006…) "2·3275" × 1·60 ÷ 1000 (=£0·003 …) Total of "their" above sums ia £0·02995 (≈ 3p)	2 1 1	1 for each correct maximum of 2 marks One of these three in evidence Total of "their" three sums in the correct money units
6		Substitution of A = 7 in at least 1 formula Arriving at $\frac{7}{19}$ and $\frac{8}{24}$ Attempt to work out larger of their two fractions, by equating to decimals or manipulation of fractions, oe Complete correct calculation and conclusion for their two fractions. (Young's rule)	**M1** 1 1 **1ft**	Can include d; $\frac{8}{24}$ may be simplified to $\frac{1}{3}$ Depends on first **M1** May see 0·368 > 0·333 Or 168 > 152, but also need correct formula stated
7	(a)	∠DBC = ∠BCA + ∠BAC or equivalent, so ∠ BCA = x Triangle ABC is isosceles	1 1	Need both to gain credit.

		So BA = BC	1	Other methods may be equally as effective – mark in the spirit of the m/s here.
	(b)	$\angle$PCD = x Δs QDC and PDC are congruent SAS So QD = DP	1 1 1	 Need both to gain credit
8	**(a)**	$t^2 = \dfrac{d}{5}$ seen or implied $\Rightarrow t^2 = \dfrac{132}{5}$ or better $\Rightarrow t = 5{\cdot}1\ (380\ \ldots)$	1 1 1	 Can imply first mark **B3** www
	(b)	$D = 5t^2$ with $t = 2 \times 5{\cdot}1\ (38\ldots)$ or better seen or implied $d = 528$ m	1 1	Allow full follow through from **(a)**
	(c)	$G = \dfrac{d}{4p}$ seen or implied $G = 7{\cdot}(333\ \ldots)$ The package will be safe	1 1	 Can imply the first mark
9	**(a)**	8 months or 0·6 (666 …) years	1	Must have the appropriate unit.
	(b)	**(i)** Payback time is 30 years No because this is more than the lifetime of the equipment or equivalent.	1 1	
		(ii) Possibly not, the amount saved would be greater. At price rise of 10% the saving in the 20th year would be about £670.	1 1	Qualitative Quantitative
10	**(a)**	19	4	**M1A1** $7{\cdot}5 \times 10 \times 2{\cdot}8 = 210$ **M1** 210 / 11 (= 19·09…) Accept trial and improvement.
	(b)	18	3	**B1** 7·45, 9·95 or 2·75 seen **M1** $7{\cdot}45 \times 9{\cdot}95 \times 2{\cdot}75$

Assessment Objectives and Functional Elements Grid

GCSE Application of Mathematics

A381/02 (Higher)

Qn	Topic	AO1	AO2	AO3	Functional
1	Use of formula	3		4	4
2a	Area	2	4		2
2b,c	Area		3	2	2
3	Estimating/volume		3	2	5
4	Const. formulae	3	1		
5	Percetages/ data	4			
6	Subst/fractions	4			
7	Triangles			6	
8	Using formulae	7			
9	Payback time	1	4		5
10a	Volume		4		
10b	Limits of accuracy		3		
	TOTAL	24	22	14	18