OCR
Oxford Cambridge and RSA

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Thursday 8 June 2017 – Morning

GCSE APPLICATIONS OF MATHEMATICS

A382/01 Applications of Mathematics 2 (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 30 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. 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

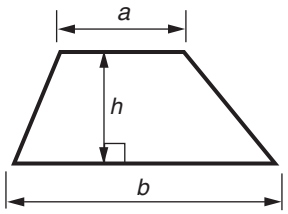
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Your quality of written communication is assessed in questions marked with an asterisk (*****).
- The total number of marks for this paper is **90**.
- This document consists of **28** pages. Any blank pages are indicated.

You are permitted to use a calculator for this paper

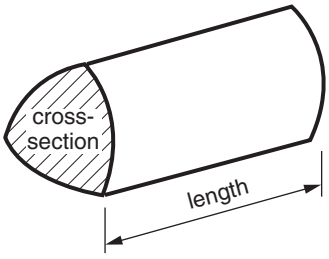
OCR is an exempt Charity

Formulae Sheet: Foundation Tier

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



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

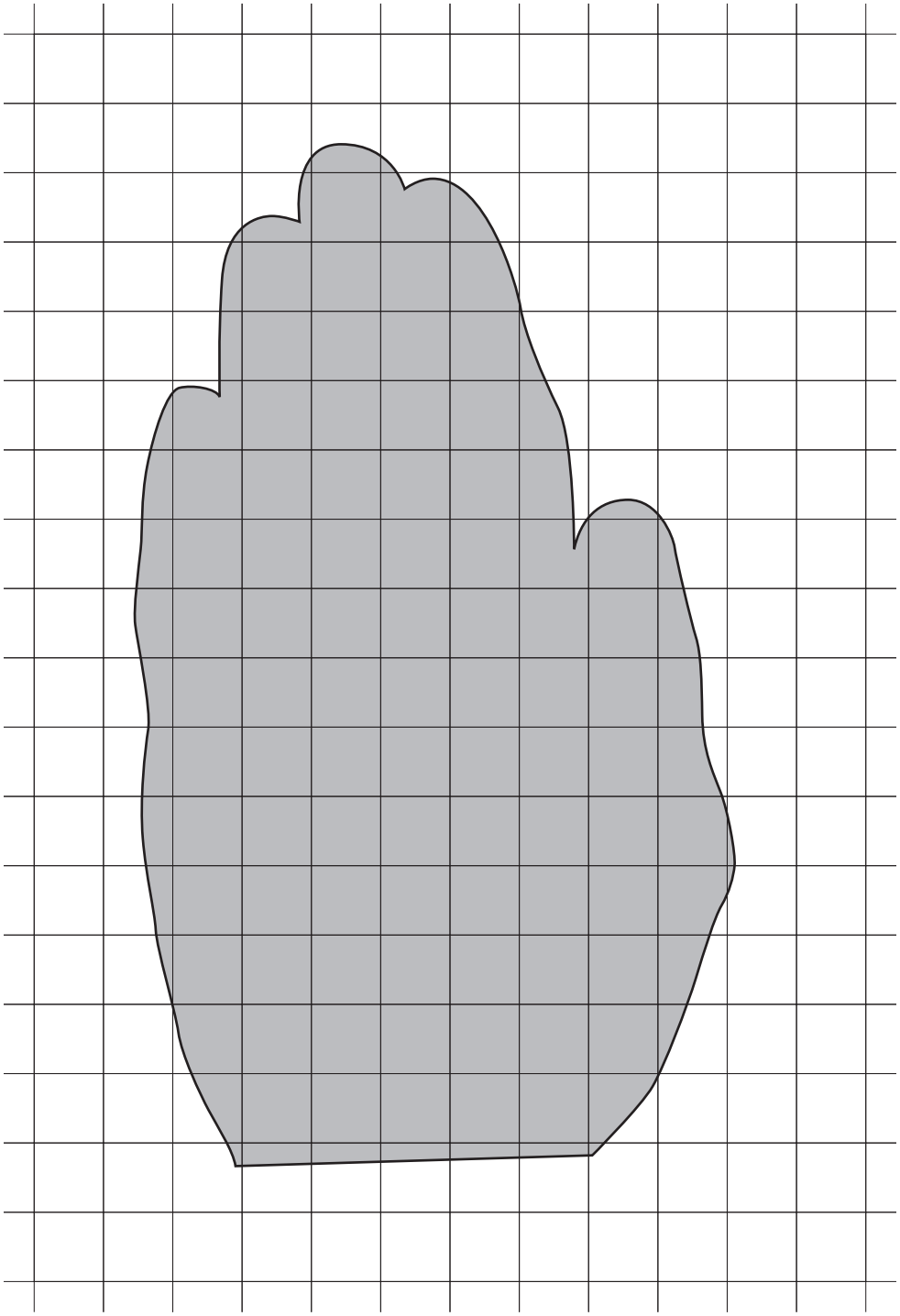


PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

1 The area of a person's hand is used to calculate their approximate total skin area.

(a) Estimate the area of this person's hand (shown in grey).
The grid is a centimetre square grid.



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

(b) The area of a person's hand is 1% of the total surface area of their skin.

What is the total skin area of the person in **part (a)**?

(b) ..... cm^2 **[1]**

(c) This expression gives a person's total skin area in square metres.

$$\frac{\sqrt{(\text{Weight in kilograms}) \times (\text{Height in centimetres})}}{60}$$

Use the expression to find the total skin area of a person who weighs 80 kilograms and whose height is 185 centimetres.

(c) ..... square metres **[2]**

(d) Patients who have suffered burns need fluids.
The amount of fluids depends on the percentage of total skin area affected by the burns.

For a person weighing 100 kg, with b% of their total skin area affected, the amount of fluids needed in 24 hours, F litres, is given by the following formula.

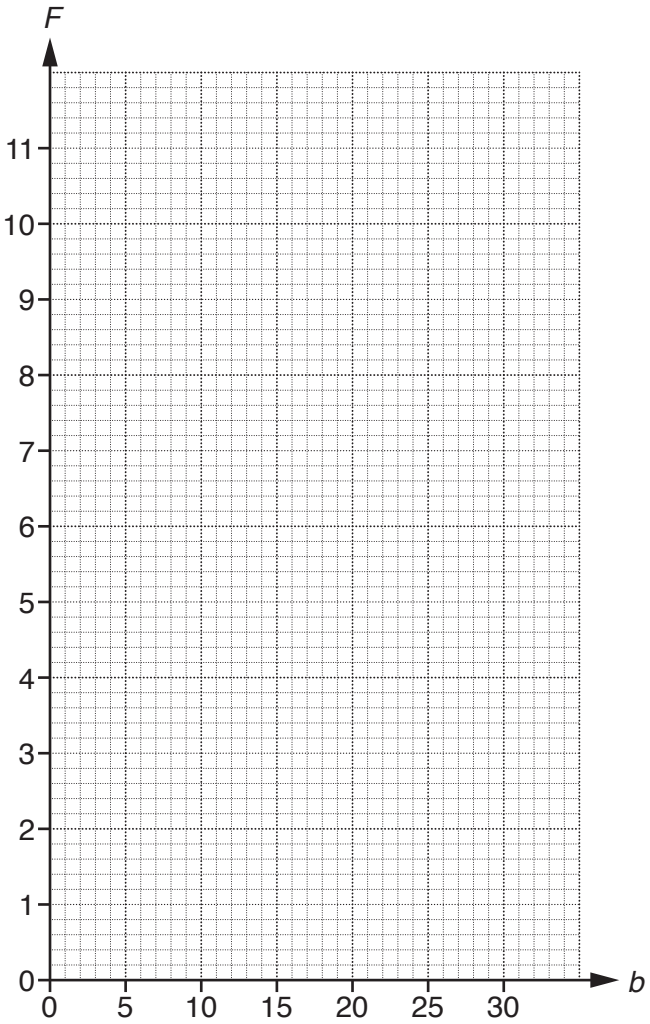
$$F = 0.4b$$

(i) Complete this table showing F for some values of b.

b (%)	5	10	15	20	25
F (litres)	2		6	8	

[1]

(ii) Plot the points in the table on this grid and draw the graph of $F = 0.4b$.



[2]

(iii) The formula for people weighing 50 kg is slightly different.

It is $F = 0.2b$.

If this were plotted like $F = 0.4b$ has been done on the grid above, how would it look the same and how would it look different to $F = 0.4b$?

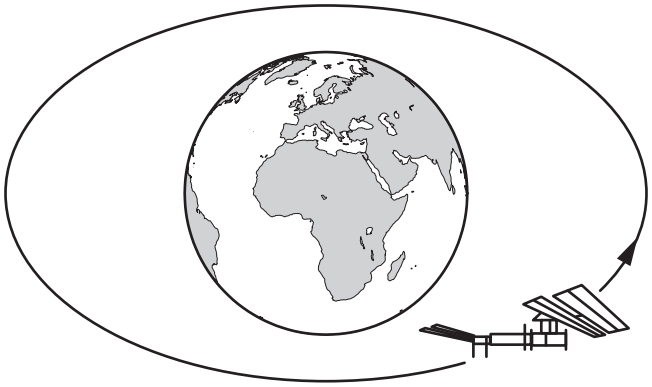
It would look the same .....

.....

It would look different .....

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

2 The ISS (International Space Station) travels in orbit around the Earth.



(a) It is very expensive to put people onto the ISS and keep them there.
The average cost of putting and keeping 1 person on the ISS for 1 day is $4 million!

How much would it cost to keep a crew of three people on the ISS for 10 days?

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

(b) A crew of three people needs 4 tonnes of supplies for a 6 month stay on the ISS.
(A tonne is 1000 kilograms.)

(i) How many tonnes of supplies would a crew of three need for a 9 month stay?

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

(ii) Approximately what mass of supplies does each crew member need each day?
Make clear any assumptions.
Give your answer to the nearest kilogram.

(ii) ..... kg **[4]**

(c) The height, h miles, of the ISS above the Earth varies between 200 miles and 250 miles.

Tick the **two** inequalities that show this.

$200 < h < 250$	$250 > h > 200$	$h < 200 < 250$ .....
$250 < h < 200$	$200 > h > 250$	$200 < 250 < h$ .....

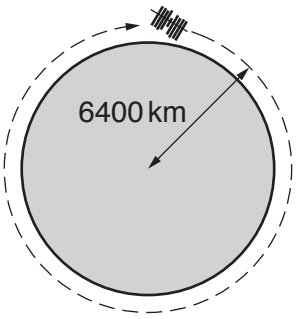
[2]

(d) The ISS orbits Earth in a circle with a radius 6400 km.

The distance once round the Earth is called the orbital distance.

Calculate the orbital distance for the ISS.

Use 3 for your value of π.



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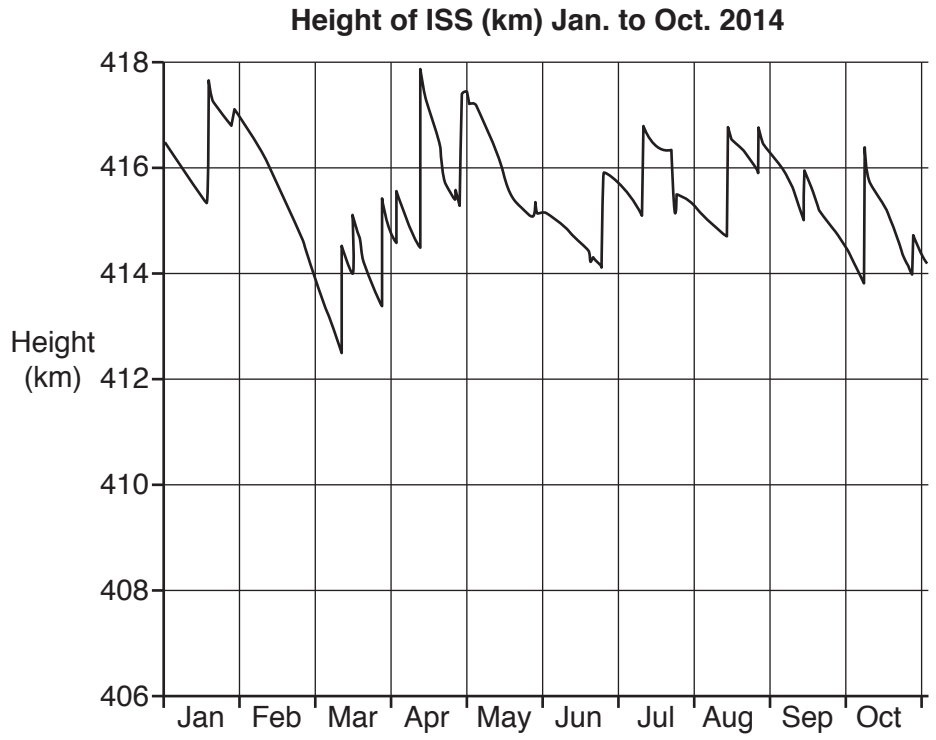
(d) ..... km **[2]**

(e) The ISS loses about 2 km in height each month.
Every so often it must be given an upward rocket boost to keep it in orbit.



(i) What was the ISS's minimum height in March 2014?

(e)(i) ..... km **[1]**

(ii) What was its maximum height in October 2014?

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

(iii) How many times were the booster rockets fired in August 2014?

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

(iv) Estimate the ISS's average height above the Earth in February 2014.
Make it clear how you found your estimate.

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

(v) What would have been the height of the ISS at the end of October 2014 if the booster rockets had not been fired at all during 2014?

Remember that the ISS loses about 2 km in height each month.

(v) ..... km **[3]**

(f) The ISS is travelling so fast that the astronauts age less than people on Earth!
This is a result of Special Relativity.

For a six month stay the difference in age is $\frac{1.56 \times 3.27}{1000}$ seconds.

Calculate how many seconds this is.
Give your answer correct to 1 significant figure.

(f) ..... seconds **[2]**

(g) The time to complete an orbit of the ISS (or any satellite) depends on the distance from the Earth's surface (the height).
There is a formula connecting height and orbit time.

Some values of the height, in km, and time for one orbit in minutes, are shown in this table. Use the table to answer the questions below.

Height (km)	Orbit time (minutes)
1000	104.96
2000	127.03
3000	150.46
4000	175.17
5000	201.11
6000	228.22
7000	256.45
8000	285.75
9000	316.09
10000	347.44
11000	379.75
12000	413.02
13000	447.2
14000	482.27
15000	518.22
16000	555.01
17000	592.64
18000	631.08
19000	670.32
20000	710.34

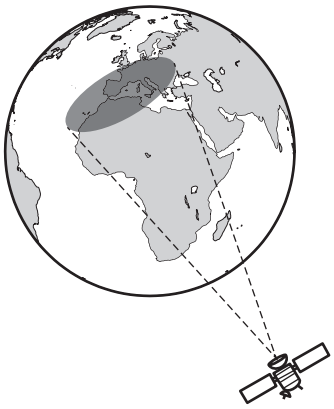
Height (km)	Orbit time (minutes)
21000	751.13
22000	792.67
23000	834.95
24000	877.95
25000	921.67
26000	966.09
27000	1011.2
28000	1056.99
29000	1103.46
30000	1150.58
31000	1198.36
32000	1246.78
33000	1295.84
34000	1345.52
35000	1395.83
36000	1446.74
37000	1498.26
38000	1550.38
39000	1603.09
40000	1656.38

(i) How long does it take a satellite in orbit 15000 km above the Earth to make an orbit?

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

(ii) Communication satellites need to have an orbit time of **24 hours** so that they stay over the same spot on Earth.
(The Earth turns once in 24 hours.)

Use the table to estimate how high a satellite should be so that it has an orbit time of **24 hours**.
Show how you arrived at your answer.



Not to scale

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

(iii) Use some numbers from the table to show whether or not orbit time is directly proportional to height of the satellite above the Earth.

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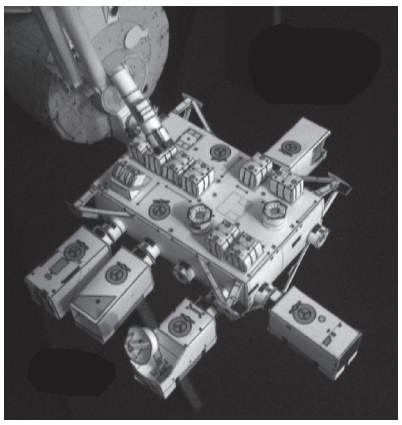
..... **[2]**

3 **(a)** On the outside of the ISS there are containers for experiments.

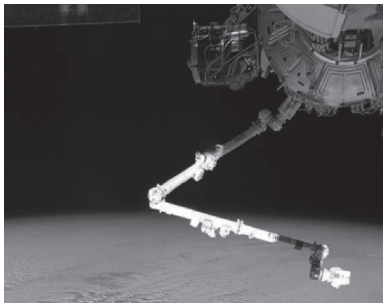


A popular size of these containers is a cuboid measuring 0.8 m by 1 m by 1.85 m.

What is the volume of one of these containers? Don't forget the units of your answer.

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

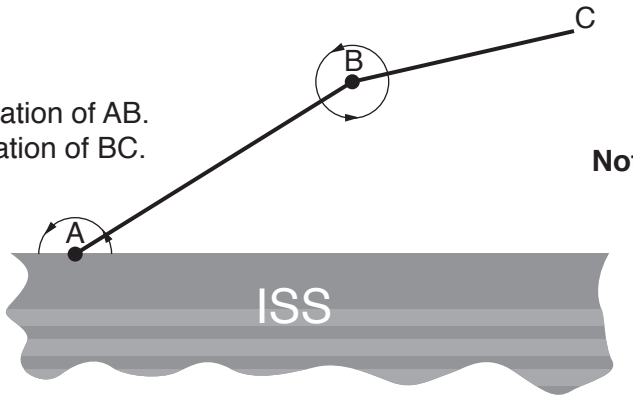
(b) Robotic arms are used to move materials outside the ISS.



Below is a simplified diagram of a robotic arm.

AB = 7 m and BC = 6 m.

The joint at A allows a half turn rotation of AB.
The joint at B allows a full turn rotation of BC.



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(i) What is the **maximum** distance that C can be from A?

(b)(i) ..... m **[1]**

(ii) What is the **minimum** distance that C can be from A?

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

(iii) There is a region close to A that C cannot reach.
Describe this region. A sketch may help.

.....

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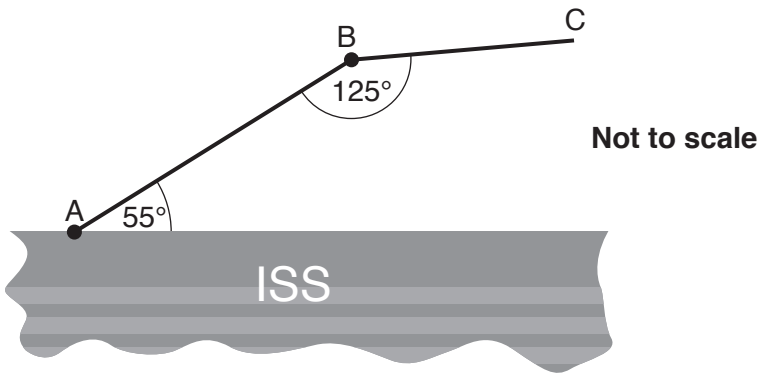
..... **[2]**

(iv) This diagram shows one position of the arm.
Decide whether BC is parallel to the side of the ISS.
Justify your decision.



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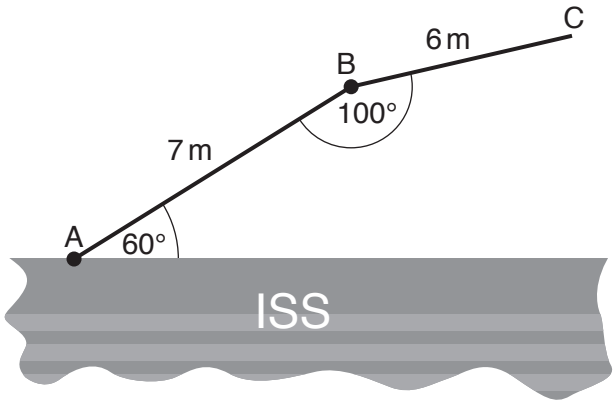
..... **[2]**

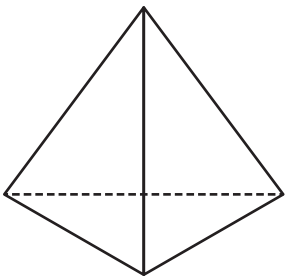
(v) This is a different position of the arm.
Use a scale diagram with a scale of 1 cm to represent 1 m to find the real distance AC.
Remember to state the units of your answer.



Not to scale

(v) .... **[4]**

(c) The ISS can be used to put satellites into space.
Small satellites in the shape of regular tetrahedrons have been tested.



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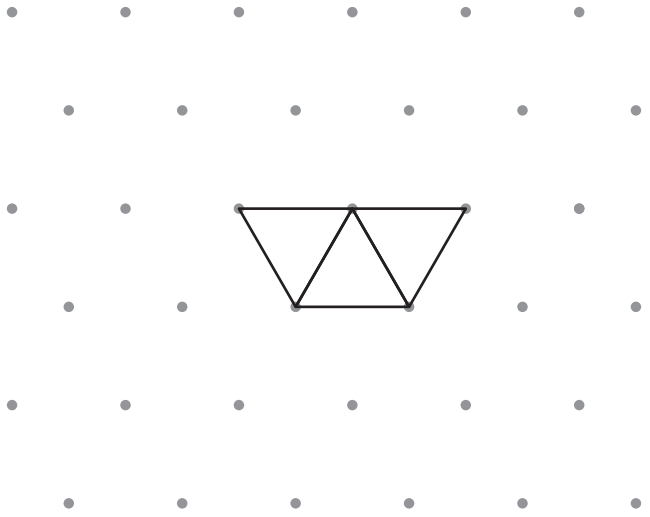
Regular Tetrahedron Facts

- 4 faces – all the same size
- Each face is an equilateral triangle
- Sometimes called a triangular based pyramid

(i) Complete this net of a regular tetrahedron.



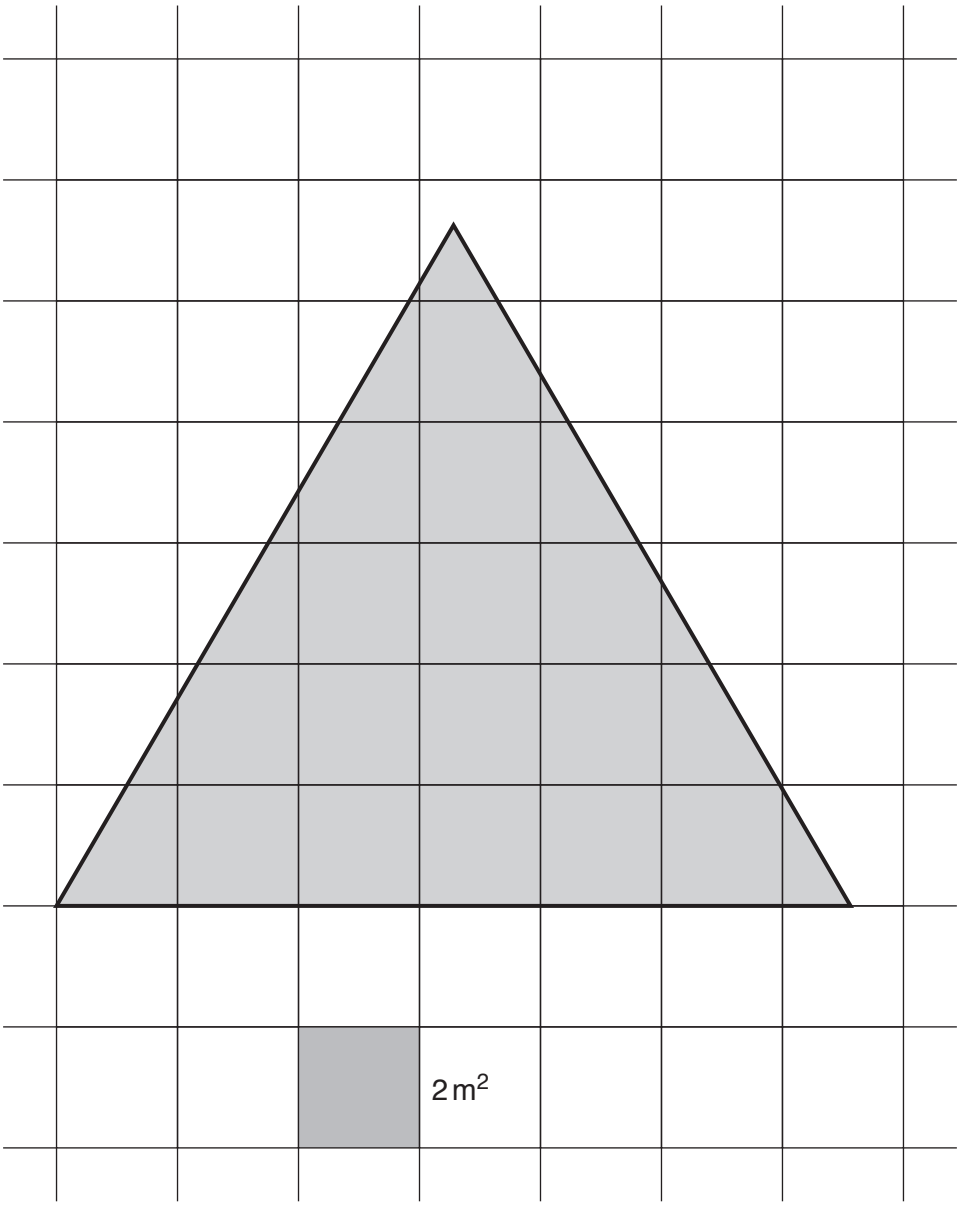
[2]

(ii) One of these satellites has edges of length 8 cm.

Draw a full-size drawing of one of the satellite's faces.
One edge has been drawn already.
You must use compasses. Leave in any arcs you draw.

[2]

(iii) Estimate the area of this satellite face.
Each grid square has an area of $2\,m^2$.



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

(d) Going into space is dangerous.
NASA uses probability and probability words to show risk.

Probability……	
as a number	**in words**
Less than 0.000001	Very low probability
0.000001 to less than 0.001	Low probability
0.001 to less than 0.01	Moderate probability
0.01 to less than 0.1	High probability
0.1 and above	Very likely

(i) The probability of the first manned moon flight failing was calculated to be 0.04.

Tick the words for this probability.

Very low probability ☐

Low probability ☐

Moderate probability ☐

High probability ☐

Very likely ☐

[1]

(ii) Unmanned spacecraft in the 1960s had a probability of failure of between 5% and 8%.

Tick the words for this probability.

Very low probability ☐

Low probability ☐

Moderate probability ☐

High probability ☐

Very likely ☐

[1]

(iii) The probability of computer failure on a satellite is 1 in 5 million.

Tick the words for this probability.

Very low probability	☐
Low probability	☐
Moderate probability	☐
High probability	☐
Very likely	☐

[1]

(e) Space shuttles have made a total of 135 flights.

Two of these flights resulted in LOCV (loss of crew and vehicle).

(i) Use these figures to estimate the probability of LOCV in a space shuttle flight.

Give your answer as a fraction.

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

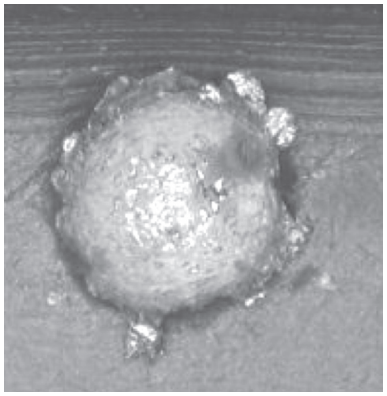
(ii) Management calculated that the probability of LOCV in a space shuttle flight was one in ten thousand.

Show whether this figure supports the probability of LOCV in **part (i)**.

[2]

(f) There are millions of small particles orbiting Earth.
This space junk comes from old rockets and satellites.
These particles travel at high speed (about 20 000 mph).
They make small dents or even holes when they hit the ISS.

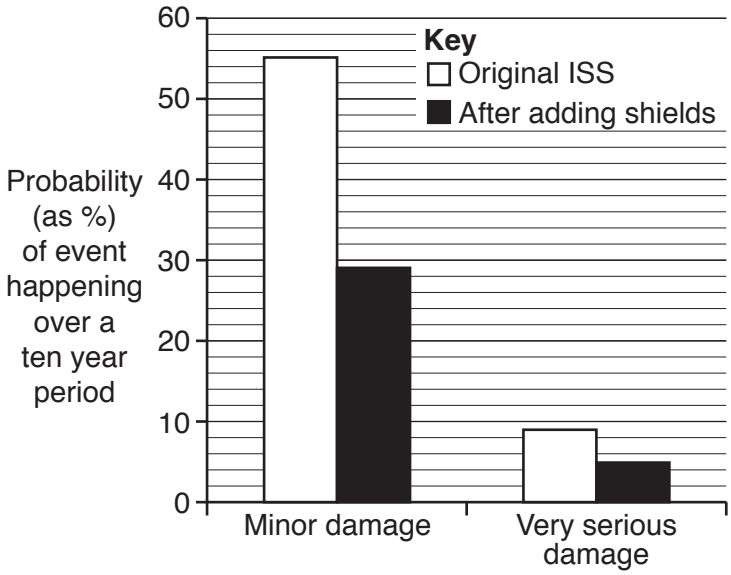
(i) Below is a photo of one of these holes. It is magnified 10 times.



What is the diameter of the actual hole?
Show any measurements you make.
Remember to state the units of your answer.

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

This chart shows the probability, over ten years, of minor or very serious damage being caused by particles of space junk hitting the ISS.
Shields have been added to make the ISS safer.



Use the chart to answer these questions.

(ii) Over 10 years what, in the original ISS, was the probability of minor damage as a result of particles of space junk?

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

(iii) By how much has the probability of very serious damage over 10 years dropped as a result of adding shields?

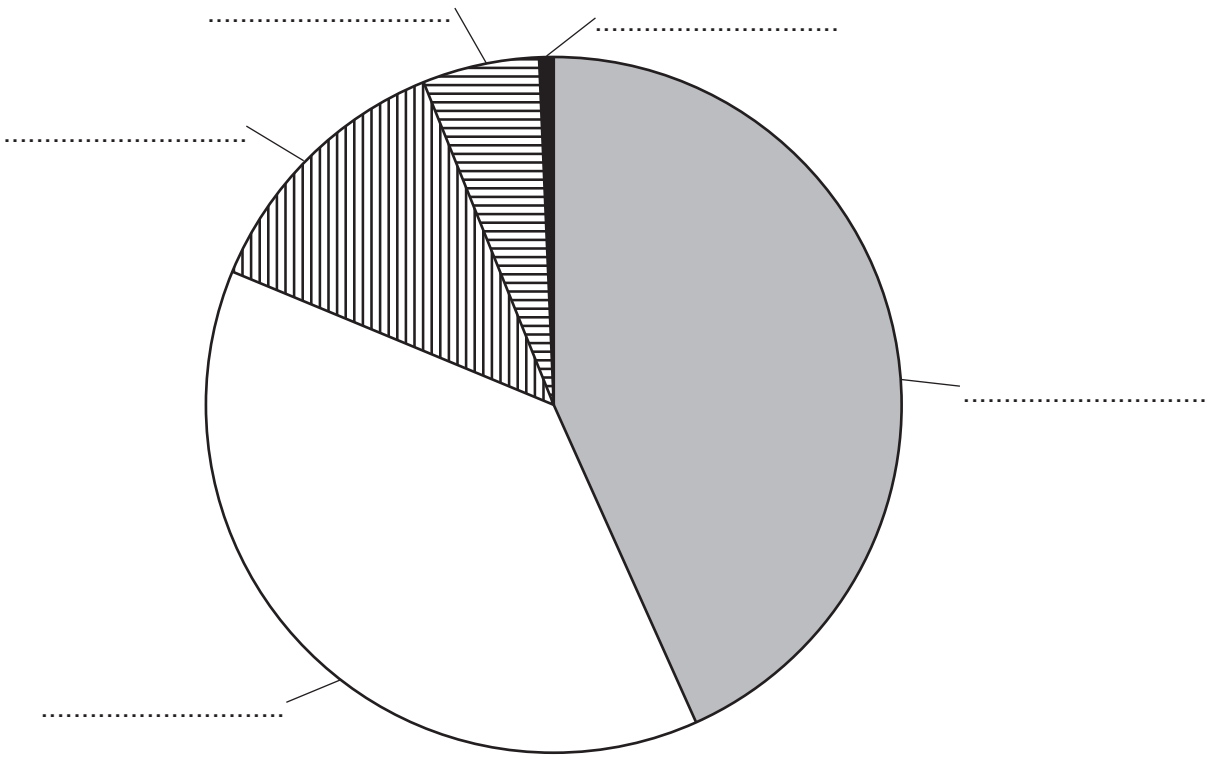
(iii) ..... % **[1]**

(iv) There are millions of small pieces of space junk.
This table shows the material making up these pieces.

Material	Percentage
Aluminium	43
Steel	12
Other metals	6
Paint	38
Plastic	1
Total =	100

Complete the labels on this pie chart showing these results.
You might find a protractor useful.

What makes up small pieces of space junk (less than 1 cm in size)



[2]

4 **(a)** Amy wants to buy a cheap printer.
She looks on the internet to see the star ratings of all printers under £50.

Printer	Text quality	Photo quality	Speed	Quietness	Cost
Ace Pro	✱✱✱	✱✱✱✱✱	✱✱	✱✱	£41.00
Bell Pro	✱✱	✱✱✱	✱✱	✱✱	£49.00
Derby 13	✱✱✱✱✱	✱✱✱✱	✱	✱✱	£48.00
Gun 650	✱✱✱✱✱	✱✱✱	✱✱✱✱✱	✱✱✱	£49.00
IQ X1	✱✱✱✱	✱✱✱✱	✱✱✱	✱✱✱✱✱	£47.00
Keon P2	✱✱✱✱✱	✱✱✱✱✱	✱✱✱	✱	£32.00
Kodiak IJ5	✱✱✱✱✱	✱✱✱✱✱	✱	✱	£47.50
Sampson X	✱✱	✱✱✱✱✱	✱✱✱	✱✱	£39.99
Sister J75	✱✱✱✱✱	✱✱✱✱✱	✱✱	✱	£45.50
Vesta ECO	✱✱	✱✱	✱✱✱✱✱	✱	£35.00

(i) She wants the printer with the most stars.
If two printers have the same number of stars she will choose the cheaper one.

Which printer does she choose and how many stars does it have?

(a)(i) ..... which has ..... stars **[2]**

(ii) Which different printer from the table would you choose?
Use star ratings to explain your choice.

..... because .....

.....

.....

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

(b) After looking on *What Computer*, Amy decides to buy a Kodiac Pro printer from Zambesi shopping.

She also has a £25 *Zambesi* gift card.

How much will she have to pay?

(b) £ ..... **[4]**

(c)* Amy also wants a Gaming Desktop PC.
She sees this on the internet.

Hollywood computers

The Ace Gaming Desktop PC
Only £1320
(Three year guarantee)

Amy hasn't got £1320, but she looks on the *Take The Waiting Out Of Wanting* website.

Change waiting into wanting – I did!

The Ace Gaming Desktop PC

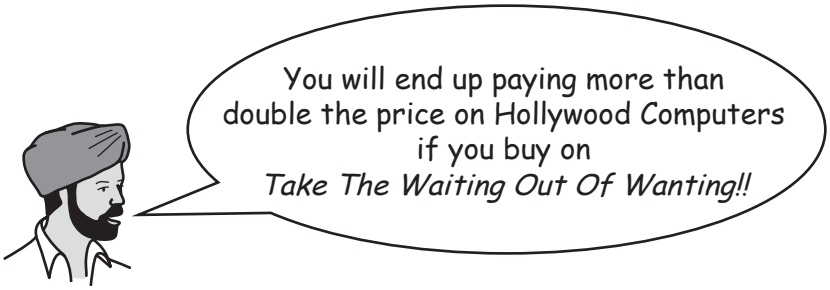
All you pay is £20.47 per week

plus

our cast iron insurance at just £3 a week
(we insist on this for your own protection)

Payments over 2 ½ years (130 weeks) and it's all yours

Tom, her brother, says.



Is Tom right?

Support your answer with clear calculations and reasons.

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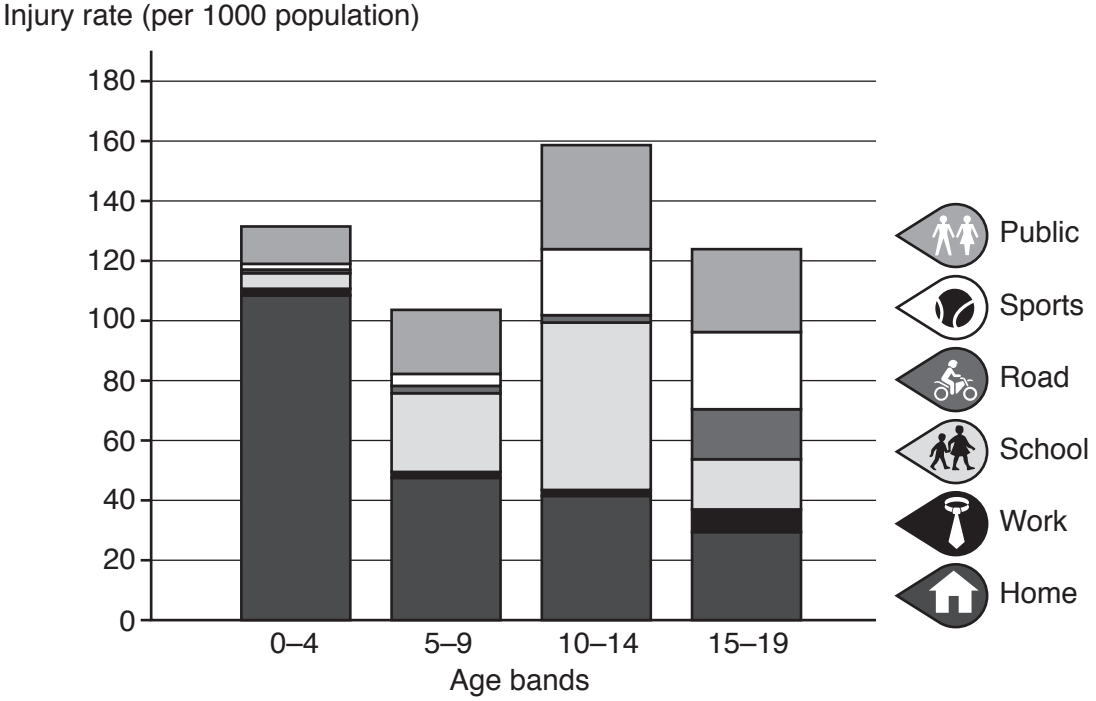
..... **[4]**

5 The bar chart is from 2008. It shows survey results for injury rate in a typical week for children and young people aged up to 19 years.



(a)* Emily says

'The bar chart shows that children aged 10–14 years are more likely to be injured at school than anywhere else.'

Hareen says

'Schools are not more risky places for 10–14 year olds to be injured as they spend more time at school than anywhere else.'

Using some results from the bar chart, explain if these statements are correct.
You must write down all assumptions you make, for example, about time awake and time at school.

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..... **[5]**

(b) Emily decides to conduct her own survey about where children get injured.
She wants to use the same age groups and the same place categories as the bar chart.

(i) Design a two way table for Emily to use to record the results of her survey. **[3]**

(ii) In her survey Emily found that 8 children aged 5–9 years were injured playing sports.

Enter this information in your table above. **[1]**

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).