Surname StemUp Model Solution	Centre Number	Candidate Number
First name(s)		0

GCSE

3310U50-1

S23-3310U50-1

FRIDAY, 19 MAY 2023 – MORNING

MATHEMATICS – NUMERACY
UNIT 1: NON-CALCULATOR
HIGHER TIER

1 hour 45 minutes

ADDITIONAL MATERIALS

The use of a calculator is not permitted in this examination.

A ruler, a protractor and a pair of compasses may be required.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** the questions in the spaces provided.

If you run out of space, use the additional page at the back of the booklet. Question numbers must be given for the work written on the additional page.

Take π as 3·14.

INFORMATION FOR CANDIDATES

You should give details of your method of solution when appropriate.

Unless stated, diagrams are not drawn to scale.

Scale drawing solutions will not be acceptable where you are asked to calculate.

The number of marks is given in brackets at the end of each question or part-question.

In question **1**, the assessment will take into account the quality of your linguistic and mathematical organisation, communication and accuracy in writing.

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**7**	
3.	**10**	
4.	**4**	
5.	**3**	
6.	**7**	
7.	**9**	
8.	**6**	
9.	**9**	
10.	**10**	
11.	**7**	
Total	**80**	

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01

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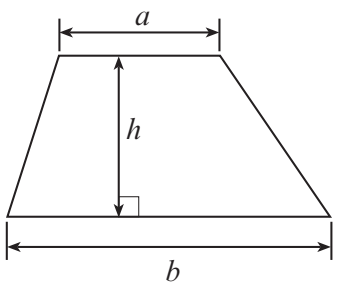
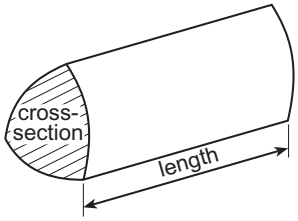
Formula List – Higher Tier

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

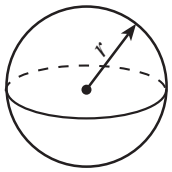


Volume of prism = area of cross-section × length



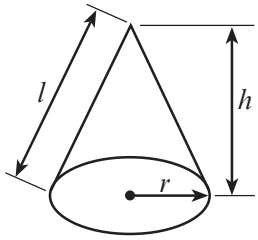
Volume of sphere = $\frac{4}{3}\pi r^3$

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



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

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

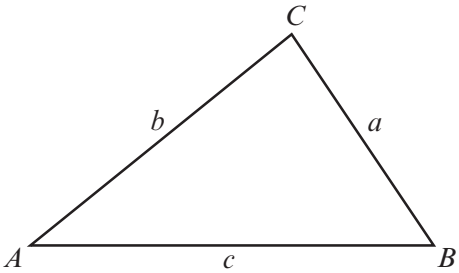


In any triangle ABC

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 = $\frac{1}{2}ab \sin C$



The Quadratic Equation

The solutions of $ax^2 + bx + c = 0$ where $a \neq 0$ are given by $x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$

Annual Equivalent Rate (AER)

AER, as a decimal, is calculated using the formula $\left(1 + \frac{i}{n}\right)^n - 1$, where i is the nominal interest rate per annum as a decimal and n is the number of compounding periods per annum.

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1. *In this question, you will be assessed on the quality of your organisation, communication and accuracy in writing.*

Mari and Huw share a prize of £2700 in the ratio 4 : 5 respectively.

Mari decides to donate 24% of her share of the prize to charity.
Huw decides to give the same amount of money as Mari to charity.

What fraction of Huw's share of the prize money does he give to charity?
Express your answer in its simplest form.
You must show all your working. [6 + 2 OCW]

Total parts = 4 + 5 = 9, one part = £2700 ÷ 9 = £300

Mari's share = 4 × £300 = £1200

Huw's share = 5 × £300 = £1500

Mari donates 24% of £1200:

10% = £120, 20% = £240, 1% = £12, 4% = £48

24% = £240 + £48 = £288

Huw gives the same amount as Mari, £288, to charity.

Fraction of Huw's share given = $\frac{288}{1500} = \frac{96}{500} = \frac{24}{125}$ (÷ 3, then ÷ 4)

Huw gives $\frac{24}{125}$ of his share of the prize money to charity.

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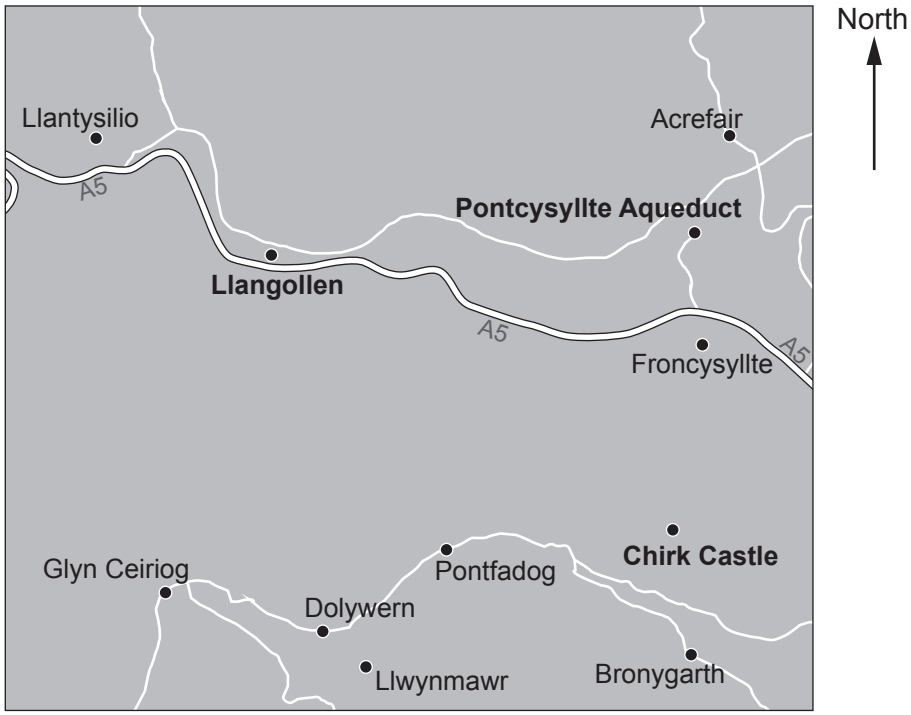
2. (a)



The direct straight-line distance between Llangollen and the Pontcysyllte Aqueduct is 5·6 km.
On the map this distance is 5·6 cm.
What is the scale of the map?
Circle your answer. [1]

1 : 10 1 : 1000 1 : 10 000 1 : 100 000 1 : 1 000 000

.....

.....

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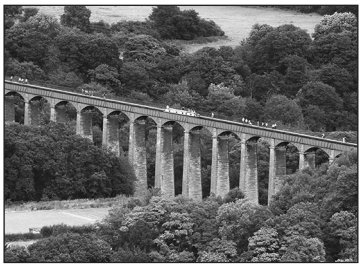
(b) The Pontcysyllte Aqueduct was built to carry the Llangollen canal over a valley.



The following facts about the section of the canal over the aqueduct were found on the internet.

- It has a rectangular uniform cross-section.
- It is 300 m in length.
- It holds 1 500 000 litres of water.
- It takes 2 hours to drain the water.

(i) The section of the canal over the aqueduct is to be drained.

Calculate the number of litres of water that drain from this section of the canal per minute.
You may assume that the water drains from the canal at a constant rate.
You must show all your working. [3]

2 hours = 2 × 60 = 120 minutes

Litres per minute = 1 500 000 ÷ 120

= 150 000 ÷ 12

= 12 500 litres per minute

(ii) Calculate the area of the canal's uniform cross-section.
Give your answer in cm^2. [3]

Length = 300 m = 30 000 cm

Volume = 1 500 000 litres = 1 500 000 000 cm^3 (1 litre = 1000 cm^3)

Area of cross-section = volume ÷ length

= 1 500 000 000 ÷ 30 000

= 150 000 ÷ 3 = 50 000 cm^2

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3. (a) A jar contains 300 g of chocolate spread.

In this spread:

- 58% of the mass is pure sugar,
- $\frac{1}{8}$ of the mass is cocoa,
- the mass of the milk powder is $\frac{4}{5}$ of the mass of cocoa,
- the remainder of the 300 g is palm oil.

Calculate the percentage of palm oil in the chocolate spread.
You must show all your working. [7]

Sugar = 58% of 300 g = 0.58 × 300 = 174 g

Cocoa = 300 ÷ 8 = 37.5 g

Milk powder = 4 × 37.5 ÷ 5 = 150 ÷ 5 = 30 g

Sugar + cocoa + milk powder = 174 + 37.5 + 30 = 241.5 g

Palm oil = 300 − 241.5 = 58.5 g

Percentage of palm oil = $\frac{58.5}{300} \times 100$

= 58.5 ÷ 3 = 19.5%

Palm oil is 19.5% of the chocolate spread.

(b) A different jar contains 840 g of chocolate spread.

The label on the jar says,

'Offer: includes 20% extra chocolate spread for free.'

How many grams of chocolate spread did a jar contain before the offer started? [3]

840 g = 100% + 20% = 120% of the original amount

1% = 840 ÷ 120 = 7 g

100% = 7 × 100 = 700 g

Before the offer the jar contained 700 g.

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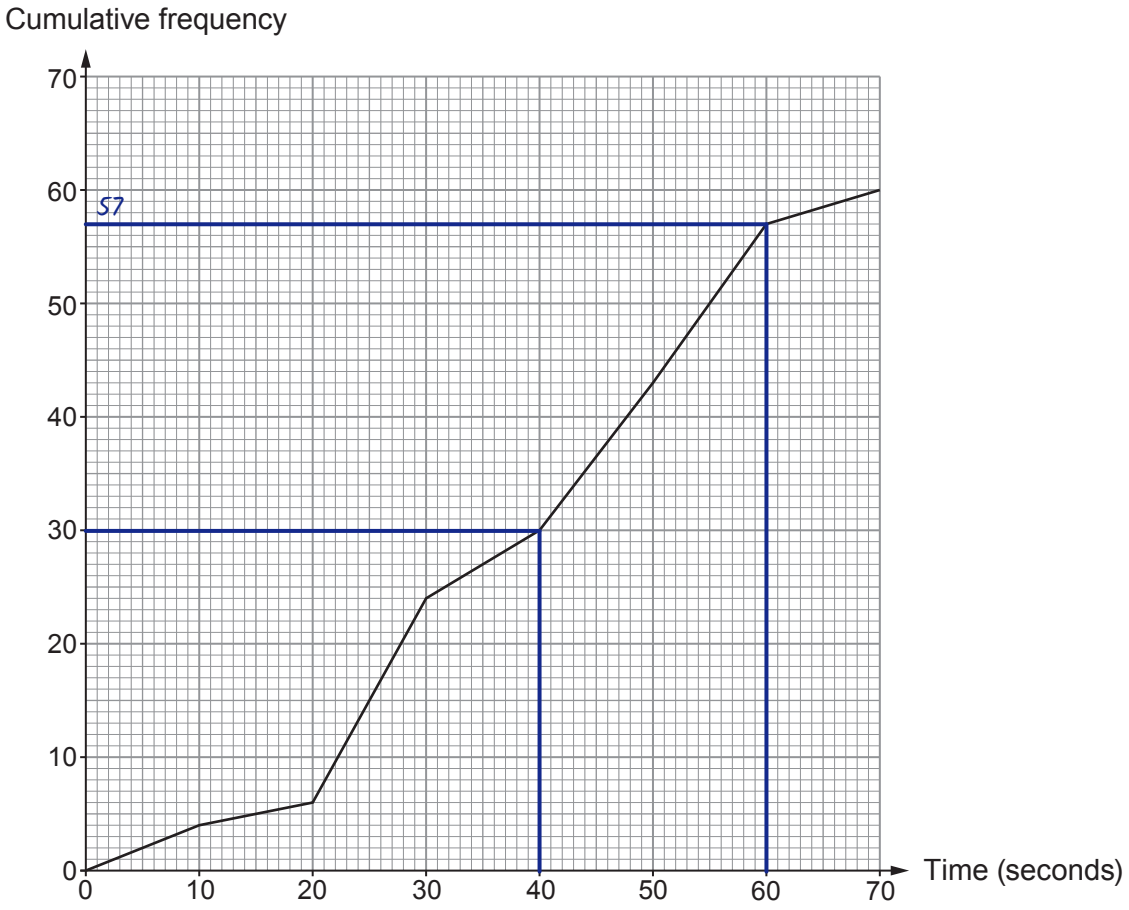
4. Deva Design Service employs 60 people.
Employees were asked to log on to their computer at 9 a.m. on Thursday.

The number of employees logged on was recorded every 10 seconds from 9 a.m.
The results are displayed in the cumulative frequency diagram shown below.



(a) Use the cumulative frequency diagram to estimate the median time taken by the employees to log on. [1]

.....40..... seconds

(b) Deva Design Service has a policy that states the following:

'90% of employees should be logged on to their computer by 9:01 a.m.'

Show that this policy was met on Thursday.
You must show all your working. [3]

90% of 60 = 0.9 × 60 = 54 employees

From the graph, 57 employees were logged on by 60 s (9:01 a.m.).

57 > 54 (57/60 = 95%, more than 90%), so the policy was met.

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5. Alan Frames is a company that employs 360 people.
6 of these people are to be selected to discuss changes to the company logo.

The manager has decided to use a systematic sampling method.
He has a numbered list of all 360 people.

(a) When using systematic sampling, where in the list **should** the manager start his selection of the 6 people?
Tick (✓) **one** of the boxes. [1]

The 60th name in the list	
At a randomly chosen name	✓
First person in the list	
Last person in the list	
A name by any multiple of 60 in the list	

(b) The manager actually starts by selecting the 4th name in his list.
Complete the table below to give the position in the list of the 6 people who would be selected using systematic sampling. [2]

360 ÷ 6 = 60, so select every 60th name

4, 4 + 60 = 64, 124, 184, 244, 304

Person selected	1st	2nd	3rd	4th	5th	6th
Position in the list	4th	64	124	184	244	304

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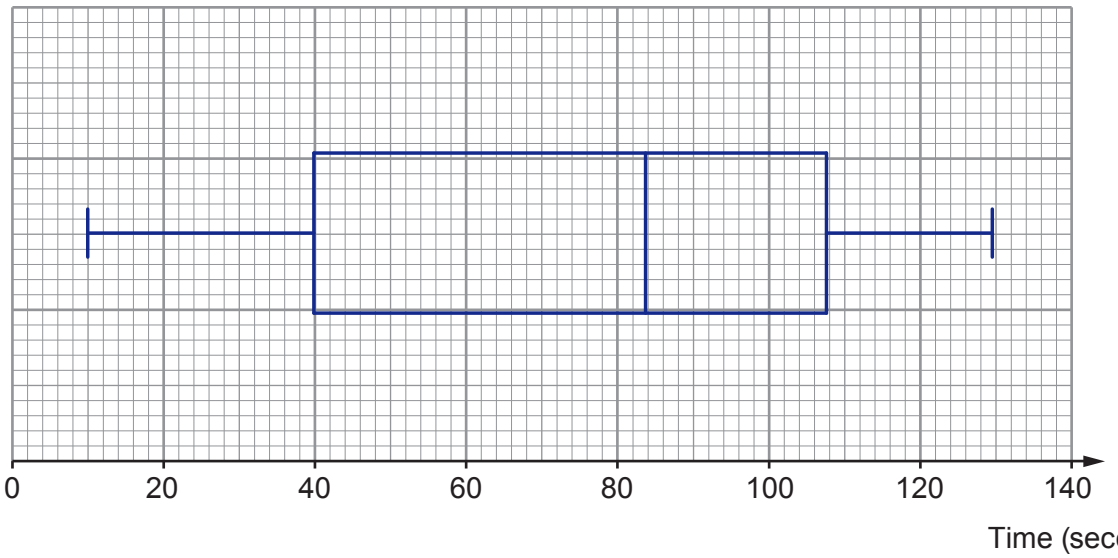
6. Dafydd works in a call centre.
On Monday, he made 200 phone calls.
He recorded the length of time he spent on each of these phone calls.

Dafydd noted the following about the times spent on each phone call.

- The greatest time was 2 minutes 10 seconds.
- The range of the times was 2 minutes.
- The median time was 84 seconds.
- The upper quartile was 108 seconds.
- The interquartile range was 68 seconds.

(a) Use the graph paper to draw a box-and-whisker diagram to represent Dafydd's data. [4]

Length of time on each of 200 phone calls



(b) Dafydd was set a target.
He had to complete half of his phone calls in less than 1 minute 30 seconds each.
By how many seconds did Dafydd beat this target?
Circle your answer. [1]

4 seconds 6 seconds 10 seconds 12 seconds 18 seconds

(c) On Monday, how many of Dafydd's phone calls lasted less than 108 seconds? [2]

108 s is the upper quartile, so 75% of calls were shorter.

75% of 200 = 0.75 × 200 = 150

150 phone calls

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7. (a) Cartons of soft drink are filled using an automated system.

(i) Each carton is a cuboid that has:
- a base area of exactly 40 cm^2,
- a height of 13 cm, **correct to the nearest cm**.

Calculate the least possible volume of a carton. [2]

Least height = 12.5 cm (lower bound)

Least volume = 40 × 12.5 = 500 cm^3

(ii) The empty cartons, moving on a conveyor belt, pass under a filling gun that pours soft drink into the cartons until they are full.

Drink is poured into each carton at a rate of 8000 cm^3 per minute, **correct to the nearest 1000 cm^3 per minute**.

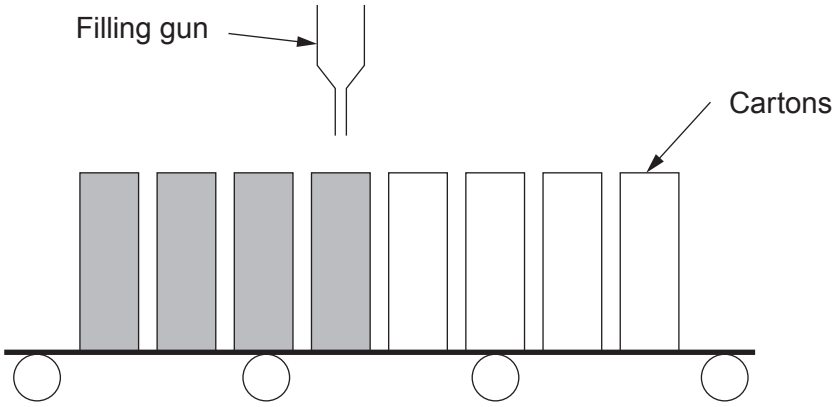

Diagram not drawn to scale

Calculate the greatest possible number of cartons that the automated system could fill in an hour.
You can ignore the time taken in moving from one full carton to the next empty one. [3]

Greatest rate = 8500 cm^3 per minute (upper bound)

Least volume of a carton = 500 cm^3

Greatest number per minute = 8500 ÷ 500 = 17

Greatest number in an hour = 17 × 60 = 1020

Greatest possible number = 1020 cartons

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(b) Cartons of a different size are also filled using the same system.
Each of these cartons has:

- a square base,
- a height of exactly 20 cm,
- a volume of exactly 960 cm^3.

Calculate the length of the side of the base of one of these cartons.

Give your answer in the form $a\sqrt{b}$, where a and b are integers and b is as small as possible. [4]

Area of square base = 960 ÷ 20 = 48 cm^2

$length^2 = 48$

length = $\sqrt{48}$

$= \sqrt{(16 \times 3)}$

$= \sqrt{16} \times \sqrt{3}$

Length of side = $4\sqrt{3}$ cm

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8. The mass of an atom of hydrogen is about $1{\cdot}7 \times 10^{-24}$ g.
The mass of an atom of oxygen is about $2{\cdot}7 \times 10^{-23}$ g.

(a) Using a suitable approximation, estimate how many atoms of hydrogen there are in 1000 g of hydrogen.
Give your answer in standard form. [3]

Mass of a hydrogen atom $\approx 2 \times 10^{-24}$ g

Number of atoms $\approx 1000 \div (2 \times 10^{-24})$

$= (1000 \div 2) \times 10^{24}$

$= 500 \times 10^{24}$

$= 5 \times 10^{26}$ atoms

(b) A molecule of water consists of two atoms of hydrogen and one atom of oxygen.

Calculate the mass of a molecule of water.
Give your answer in standard form. [3]

Mass of water molecule $= 2 \times (1.7 \times 10^{-24}) + 2.7 \times 10^{-23}$

$= 3.4 \times 10^{-24} + 27 \times 10^{-24}$

$= 30.4 \times 10^{-24}$

$= 3.04 \times 10^{-23}$ g

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9. (a) Dee-Odd makes cocktail glasses out of thin glass.
One of their cocktail glasses is shown below.
A hollow hemisphere forms the part of the glass which can hold the drink.

Diagram not drawn to scale

Before each hemisphere is attached to a stem, the surface area on the outside of each hemisphere is given a decorative coating.

The volume of each hemisphere is $\frac{128\pi}{3}$ cm^3.

Calculate the surface area that is given a decorative coating.
Give your answer in terms of π in its simplest form. [6]

Volume of hemisphere $= \frac{1}{2} \times \frac{4}{3}\pi r^3 = \frac{2}{3}\pi r^3 = \frac{128\pi}{3}$

$2\pi r^3 = 128\pi$

$r^3 = 64$

$r = \sqrt[3]{64} = 4$ cm

Outside surface area of hemisphere $= \frac{1}{2} \times 4\pi r^2 = 2\pi r^2$

$= 2 \times \pi \times 4^2$

Surface area coated $= 32\pi$ cm^2

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(b) Dee-Odd also makes another style of cocktail glass in two different sizes.
These glasses are mathematically similar.

Diagram not drawn to scale

The ratio of the volume of the smaller glass to the volume of the larger glass is 8 : 27.
The height of the larger glass is 18 cm.
Calculate the height of the smaller glass. [3]

Volume ratio = 8 : 27

Length ratio = $\sqrt[3]{8} : \sqrt[3]{27} = 2 : 3$

Height of smaller glass = $18 \times \frac{2}{3}$

= 12 cm

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10. A train completed a 16 000 m journey between two stations.

(a) Here is a description of the journey.

- The train accelerated uniformly from rest to 20 m/s in 40 seconds.
- It then remained at a constant speed of 20 m/s for a period of time.
- The train then decelerated uniformly for 80 seconds until it stopped.

A sketch of the velocity-time graph that represents this journey is shown below.

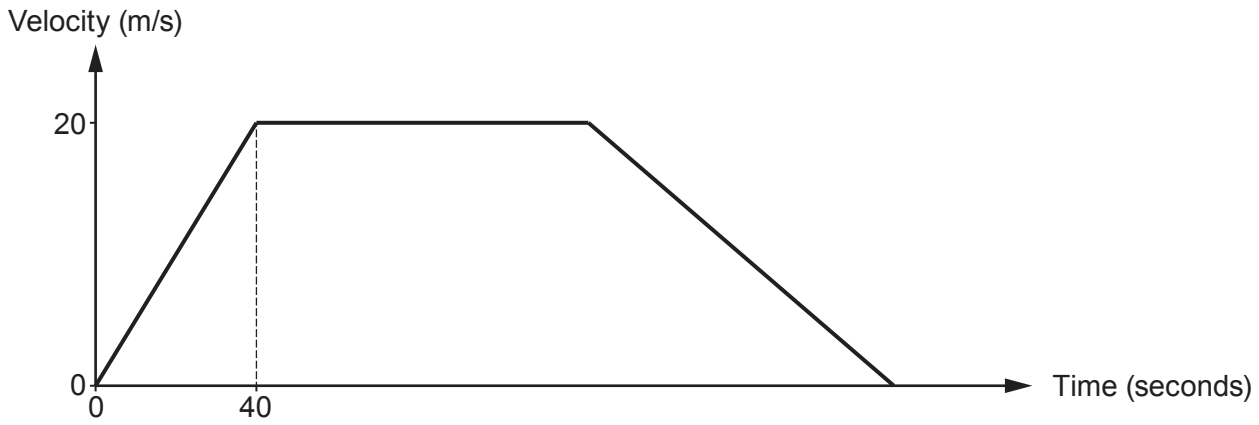

Diagram not drawn to scale

(i) Calculate the distance the train travelled in the first 40 seconds of the journey. [2]

Distance = area under graph = $\frac{1}{2} \times 40 \times 20$

= 400 m

(ii) Calculate the **total** time for this 16 000 m journey.
Give your answer in seconds. [5]

Distance while decelerating = $\frac{1}{2} \times 80 \times 20$ = 800 m

Distance at 20 m/s = 16 000 − 400 − 800

= 14 800 m

Time at 20 m/s = 14 800 ÷ 20 = 740 s

Total time = 40 + 740 + 80

= 860 s

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Total time for this 16 000 m journey is 860 seconds.

(b) When the train begins its next journey, it accelerates uniformly at $1{\cdot}0\dot{8}\dot{1}$ m/s^2.
Write this acceleration as a mixed number in its simplest form. [3]

Let $x = 1.08181...$

$10x = 10.8181...$

$1000x = 1081.8181...$

$1000x - 10x = 1081.8181... - 10.8181...$

$990x = 1071$

$x = \frac{1071}{990} = \frac{119}{110}$ $(\div 9)$

Acceleration $= 1\frac{9}{110}$ m/s^2

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11. Safety Cones is a company that makes traffic cones.
Its traffic cones have a base in the shape of an octagonal prism, with a hollow cone shape sitting on top of the base.
The bases of the traffic cones are symmetrical and have a circular hole in them to allow the traffic cones to be stacked.

The dimensions of the octagonal base are shown below.
The height of this octagonal base is 5 cm.

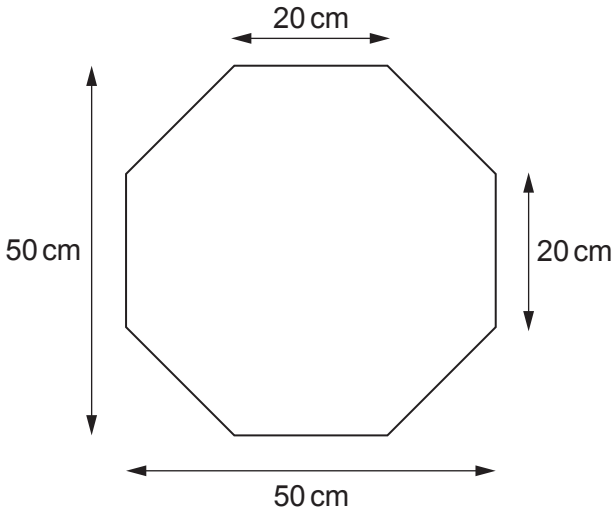

Diagram not drawn to scale

The cone that sits on top of the octagonal base is shown below.
It has a height of 60 cm and a circular base area of 800 cm^2.

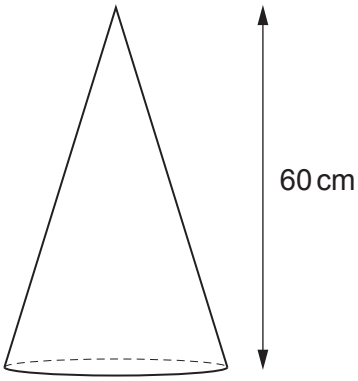

Diagram not drawn to scale

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Gary is transporting a stack of 10 of these traffic cones in the back of his van.

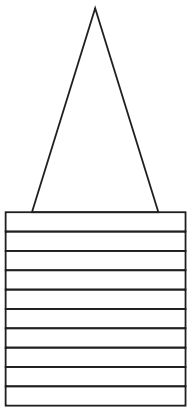

Diagram not drawn to scale

Calculate the volume of the space that this stack of 10 traffic cones takes up in the back of Gary's van.
Give your answer in cm^3.
You should assume that the space taken up includes the space underneath the bottom traffic cone and any gaps between the cones. [7]

Octagon = 50 cm by 50 cm square with 4 corner triangles removed

Each corner triangle has legs $(50 - 20) \div 2 = 15$ cm

Area of 4 triangles $= 4 \times \frac{1}{2} \times 15 \times 15 = 450\ cm^2$

Area of octagon $= 2500 - 450 = 2050\ cm^2$

Volume of one base $= 2050 \times 5 = 10\ 250\ cm^3$

Volume of 10 bases $= 10 \times 10\ 250 = 102\ 500\ cm^3$

The cones nest inside each other, so only the top cone adds space:

Volume of cone $= \frac{1}{3} \times 800 \times 60 = 16\ 000\ cm^3$

Total volume $= 102\ 500 + 16\ 000$

Space taken up $= 118\ 500\ cm^3$

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.	Examiner only

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