Name:	Register Number:	Class:

4E 5N

BEDOK GREEN SECONDARY SCHOOL

Preliminary Examination 2020

4E 5N

MATHEMATICS

4048/02

Paper 2

31 August 2020

2 hours 30 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The use of an approved scientific calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

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 100.

For Examiner's Use
100

This document consists of **25** printed pages including the cover page.

[Turn over

Mathematical Formulae

Compound interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

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

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

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

Arc length = $r\theta$, where θ is in radians

Sector area = $\frac{1}{2}r^2\theta$, where θ is in radians

Trigonometry

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

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

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

1 **(a)** The cash price of a camera is $1 880.
Amelia bought the camera on hire purchase. She paid a deposit of one fourth of the cash price and paid the rest by 24 equal monthly instalments of $65.

(i) Find the total amount that Amelia paid for the camera.

Answer $…… [1]

(ii) Calculate the extra cost of buying the camera on hire purchase as a percentage of the cash price.

Answer ……% [1]

(b) Alyssa bought an identical camera.
In order for her to pay for the camera, she borrowed a sum of $1 880 for 3 years at a compound interest rate of 4% per year.

Calculate the interest that Alyssa had to pay.

Answer $…… [2]

(c) On selling a camera at $1 880, the merchant made a profit of 113% of the cost which he paid for the camera.

Find the cost price of the camera.

Answer $…… [2]

2 **(a)** Microspheres are small spherical particles which transport drugs in the human body. The surface area of one microsphere is 1.54×10^{-10} m^2.

Find the radius of the microsphere.
Give your answer in standard form.

Answer ……..…...……m [1]

(b) Simplify $\frac{20m^4}{3n} \div \frac{12m}{5n^2}$.

Answer ……..…...…… [1]

(c) $y = \frac{1}{2p}\sqrt{q-r}$

(i) Evaluate y when $p = \frac{1}{2}$, $q = 12$ and $r = -4$.

Answer y = ……...…… [1]

(ii) Express r in terms of p, q and y.

Answer r = ……..…...…… [2]

2 **(d)** A cylindrical water dispenser, with uniform cross section, has a capacity of 30 litres.

(i) Water from Tap *A* fills the empty dispenser at a constant rate of x litres per second.

Write down, in terms of x, the time taken by Tap *A* to fill up the empty water dispenser.

Answer ……..…...……s [1]

(ii) Water from Tap *B* fills the same dispenser at a constant rate of $(x + 2)$ litres per second.

Write down, in terms of x, the time taken by Tap *B* to fill up the empty water dispenser.

Answer ……..…...……s [1]

(iii) Tap *B* takes 25 seconds less than Tap *A* to fill up the empty dispenser.

Write down an equation in x and show that it can be simplified to $5x^2 + 10x - 12 = 0$.

Answer

[2]

2 **(d)** **(iv)** Solve the equation $5x^2 + 10x - 12 = 0$.

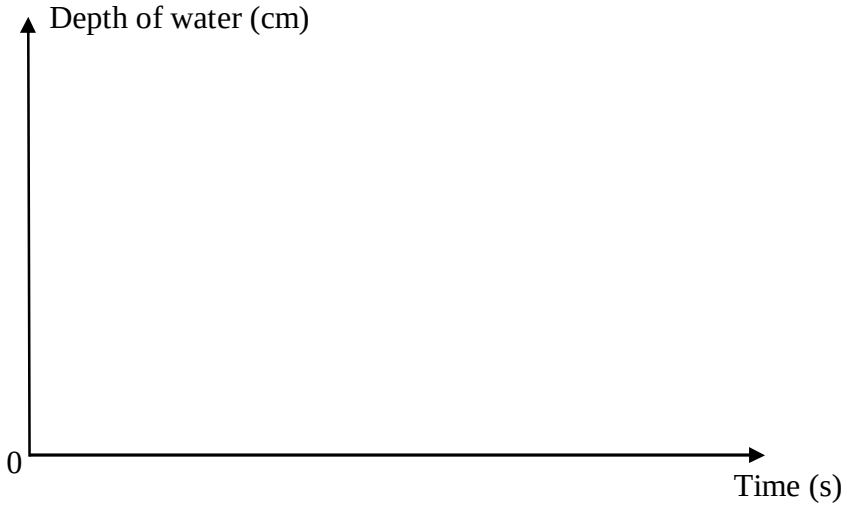
Answer x = ……..…....or ……..…..... [3]

(v) **Hence** find the amount of time taken by Tap *A* to fill up the water dispenser.

Answer ……..…...…….s [1]

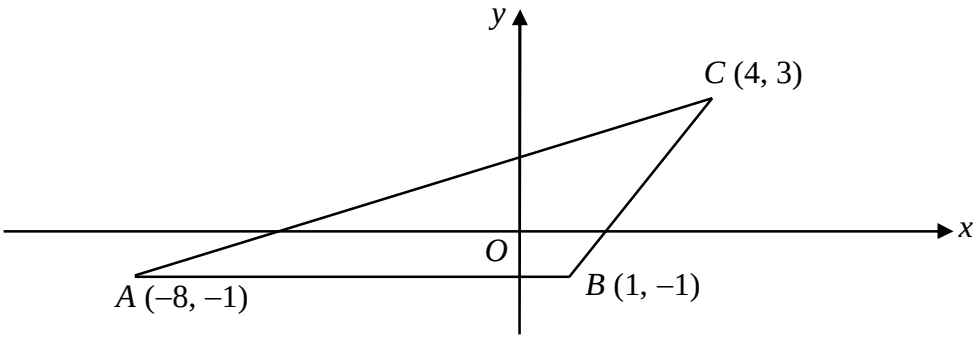
(vi) The cylindrical water dispenser has a height of 40 cm.

Sketch a graph showing how the depth of water varies with time as the empty water dispenser is filled up with water from Tap *A*.



[1]

3 Points A (–8, –1), B (1, –1) and C(4, 3) form a triangle as shown in the diagram.



(a) Given that the points A, B, C and D are vertices of a parallelogram, find the coordinates of all three possible positions of D.

Answer (……, ……), (……, ……) or (……, ……) [3]

(b) Find the length of BC.

Answer ……..…...…….units [1]

(c) Find, as a fraction in its simplest form, the value of $\cos A\hat{B}C$.

Answer ……..…...…….……. [1]

(d) Calculate the area of triangle ABC.

Answer ……...…….…….unit^2 [1]

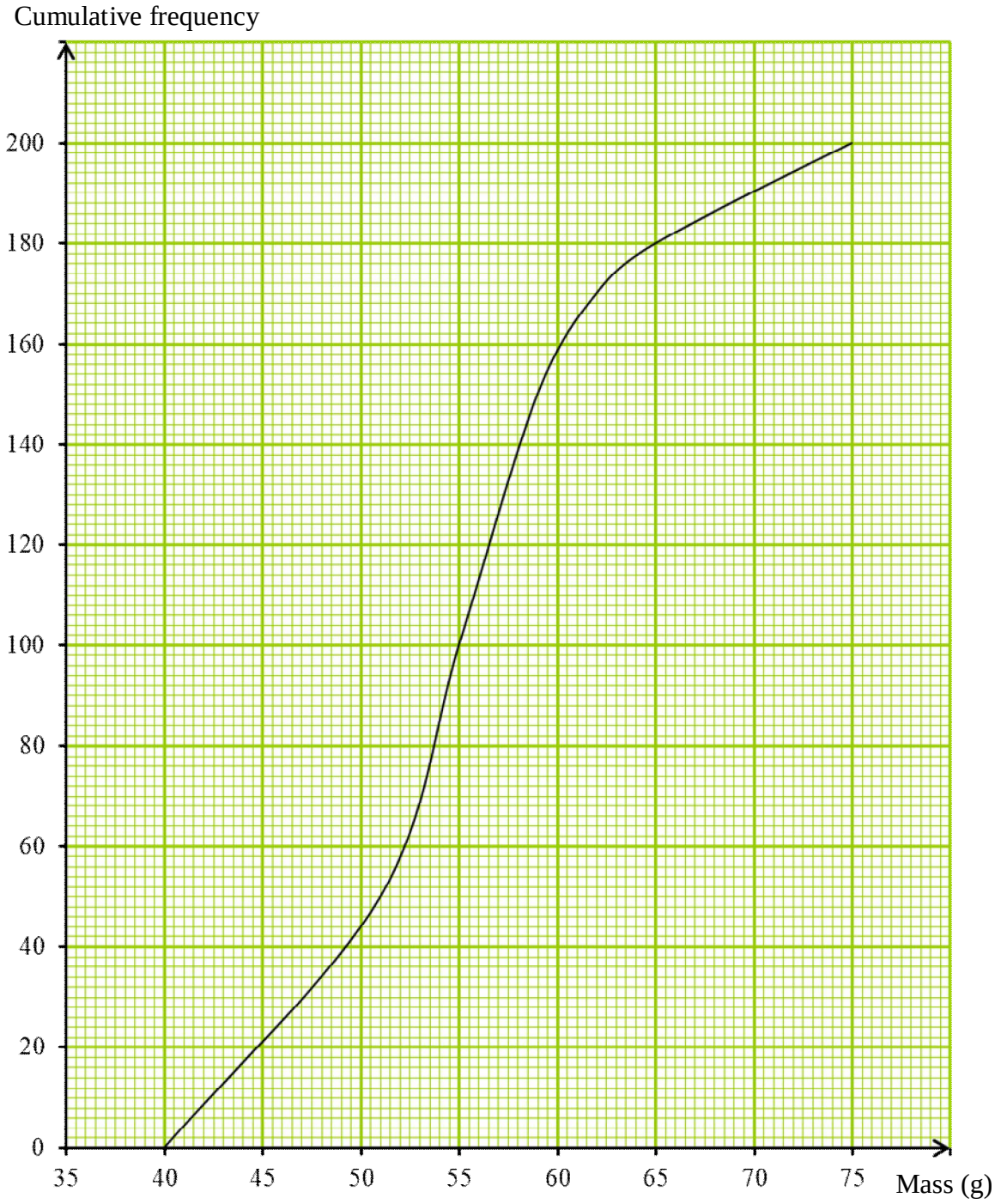
(e) Point E (m, n) lies on AC such that AE : AC = 1 : 4.

Find the values of m and n.

Answer m = ……...……

n = ……...……. [2]

4 **(a)** The cumulative frequency graph represents the masses of 200 eggs from Sunny Farm.



The eggs are grouped according to their masses.

Grade 1	: 62 g < mass ≤ 75 g
Grade 2	: 51 g < mass ≤ 62 g
Grade 3	: 40 g < mass ≤ 51 g

4 **(a)** Use the graph to find

(i) the median mass,

Answer ……..…...…….……g [1]

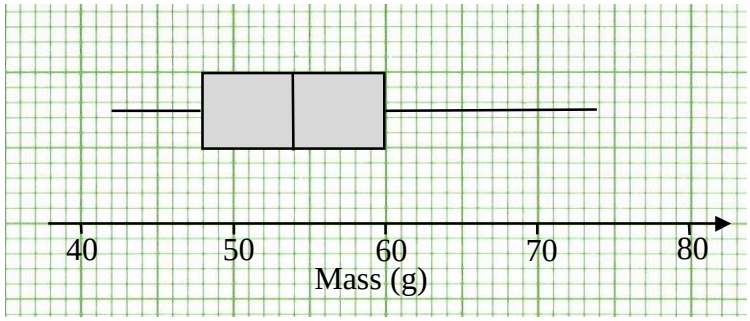
(ii) the percentage of eggs which are in Grade 2 category,

Answer ……..…...…….……% [2]

(iii) the interquartile range.

Answer ……..…...…….……g [1]

(b) The box and whisker plot shows the masses of 200 eggs from Happy Farm.



Fiego made two comparisons between the masses of eggs from Happy Farm and Sunny Farm.

State whether you agree with Fiego's statements.
Provide statistical evidence to support your answer.

(i) Statement 1: Generally, eggs from Sunny Farm have more consistent masses than eggs from Happy Farm.

_____

_____

_____

_____ [1]

4 **(b)** **(ii)** Statement 2: Happy Farm has a higher percentage of eggs in Grade 1 category than Sunny Farm.

_____

_____

_____

_____ [1]

(c) Thirty employees in Happy Farm work in either Administrative Department or Farming and Outdoors Department.

The table shows the breakdown of males and females employees in the departments.

	Administrative	Farming and Outdoors
Males	1	20
Females	3	6

(i) Two employees are selected randomly from the 30 employees to be the Chairperson and Deputy Chairperson of the Staff Well-being Committee.

Find, as a fraction in its simplest form, the probability that

(a) both of them are from the Administrative Department,

Answer ……..…...…….…… [1]

(b) at least one of them is from the Administrative Department,

Answer ……..…...…….…… [2]

(c) one of them is a male employee from Farming and Outdoors Department and the other person is a female employee from Farming and Outdoors Department.

Answer ……..…...…….…… [2]

5 **(a)** Complete Row 5 of the number pattern.

Row	Number series	Number of terms	Sum of terms	Pattern
1	1	1	1	$2^1 - 1$
2	1 + 2	2	3	$2^2 - 1$
3	1 + 2 + 4	3	7	$2^3 - 1$
4	1 + 2 + 4 + 8	4	15	$2^4 - 1$
5				

[1]

(b) Find the sum of $2^0 + 2^1 + 2^2 + 2^3 + \ldots + 2^{10}$.

Answer ……..…...…….….. [1]

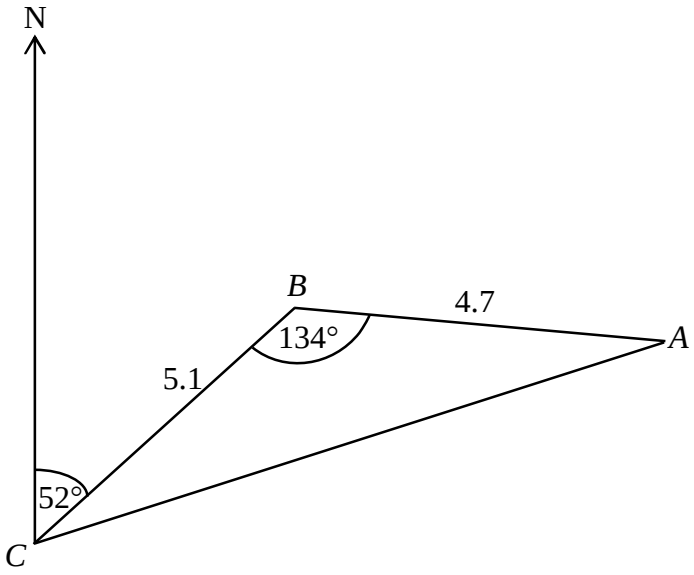
(c) **(i)** Find, in terms of n, the value of $2^0 + 2^1 + 2^2 + 2^3 + \ldots + 2^n$.

Answer ……..…...…….….. [1]

(ii) **Hence** find the sum of $1 + 3 + 7 + \ldots + (2^{200} - 1)$.
Leave your answer in the form $2^k + h$ where k and h are integers,
$1 \leq k \leq 500$ and $-500 \leq h \leq 500$.

Answer ……..…...…….….. [2]

6 *A*, *B*, and *C* are three points on level ground.
The bearing of *B* from *C* is 052°.
Angle *ABC* = 134°, *BC* = 5.1 km and *AB* = 4.7 km.



(a) Calculate the distance between *A* and *C*.

Answer ……..…...……..km [3]

(b) Find the bearing of *A* from *B*.

Answer ……..…...……..…° [2]

6 **(c)** A building of height 70 m stands vertically at *B*.
Damien walks along *AC* and stops at a point *D* where the angle of elevation of the top of the building from *D* is the greatest.

Find the angle of elevation of the top of the building from *D*.

Answer ……..…...…….…° [4]

(d) Sufi stands at a point due North of *C* such that he is equidistant from both points *B* and *C*.

Find the distance from point *C* to Sufi.

Answer ……..…...……..km [3]

7 The graph shows part of the speed-time graph of Selina's cycling journey.

(a) Describe the cycling journey between $t = 30$ and $t = 70$.

_____

_____ [1]

(b) Find the acceleration for the first 30 seconds of Selina's journey.

Answer ……..…...…..……m/s^2 [1]

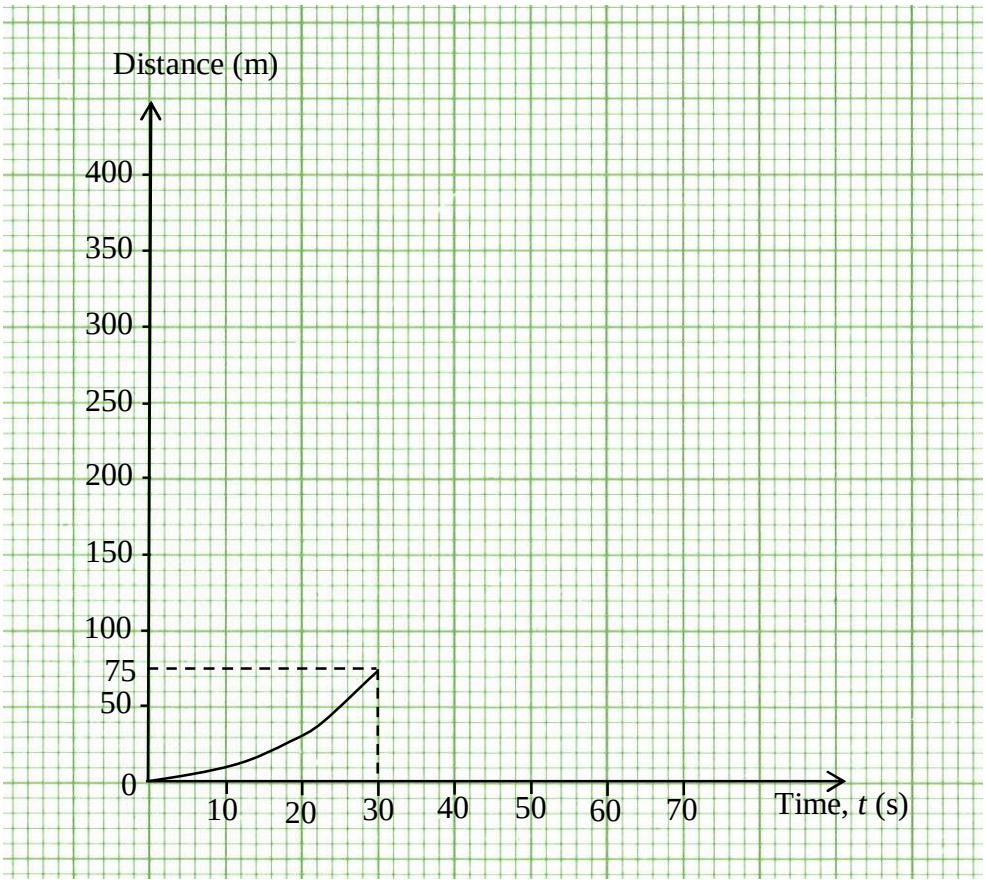
(c) After 90 seconds, Selina slowed to a stop with constant deceleration.
She travelled a further 192 m before stopping at $t = p$.

Find the value of p.

Answer p = ……..…...…..…… [3]

7 **(d)** The distance-time graph shows the graph for the first 30 seconds of Selina's cycling journey.

Draw the graph from $t = 30$ to $t = 70$ of the journey.
Indicate clearly on the graph the distance travelled in the first 70 seconds.



[2]

8 A closed cylindrical can of base radius r cm and height h cm has a capacity of 250π cm^3.

(a) Express h in terms of r.

Answer h =……..…..…….. [1]

(b) Show that the total external surface area, A cm^2, of the cylindrical can is given by $A = 2\pi r^2 + \frac{500\pi}{r}$.

Answer

[1]

(c) The table shows some of the values of r and the corresponding values of A, correct to the nearest integer, where $A = 2\pi r^2 + \frac{500\pi}{r}$.

r	2	3	4	5	6	7
A	p	580	493	471	488	532

(i) Find the value of p.

Answer p = ……..…..…..…….. [1]

(ii) On the axes given on the next page, draw the graph of $A = 2\pi r^2 + \frac{500\pi}{r}$ for $2 \leq r \leq 7$. [3]

(d) By drawing a tangent, find the gradient of the curve at $r = 6$.

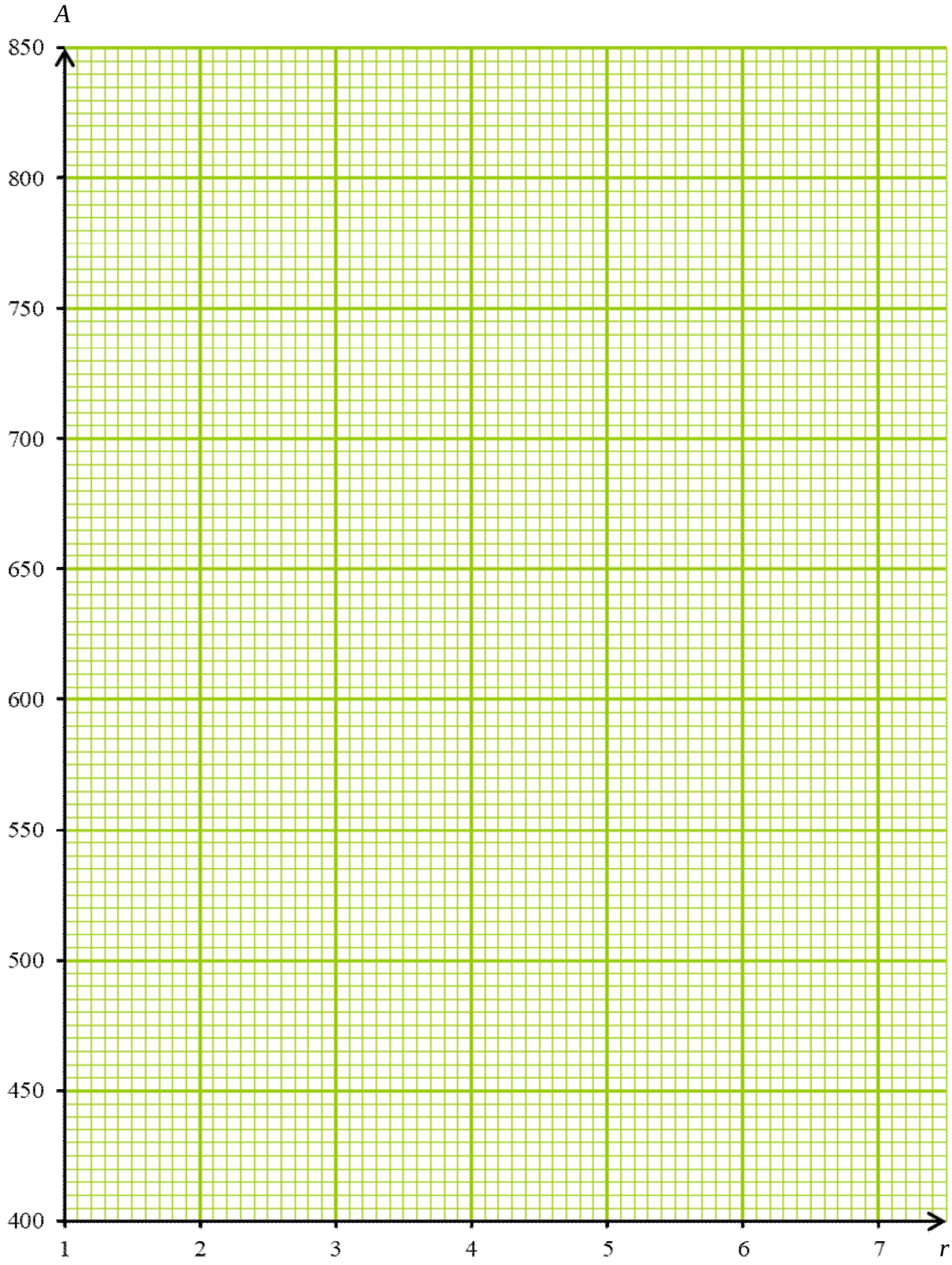
Answer ……..…..…..…….. [2]

(e) Given that the can has the least surface area, find the value of r and the value of h.

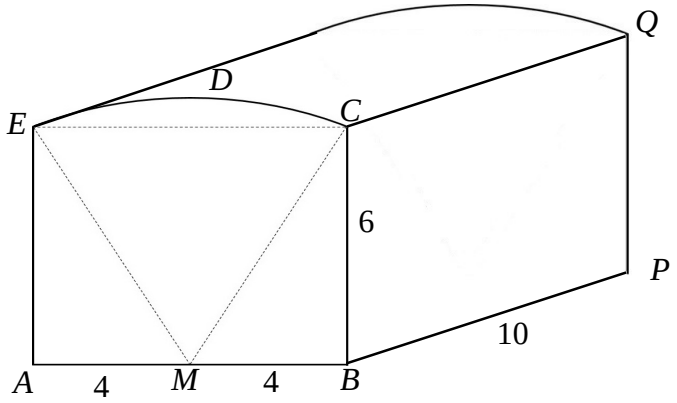
Answer r = ……..……

h = ……..…….…… [2]

8 (c) (ii)



9 **(a)** *ABCDE* is a uniform cross section of a warehouse model.
ABCE is a rectangle. *EDC* is an arc of a circle with centre *M*. *M* lies on *AB*.
AM = *MB* = 4 cm, *BC* = 6 cm and *BP* = 10 cm.



(i) Find angle *CME*.

Answer ……..…...……..…° [2]

(ii) Calculate the area of the cross section *ABCDE*.

Answer ……..…...…….…cm^2 [4]

(iii) A second geometrically similar warehouse model has a height which is half the height of the original warehouse model.

Find the volume of the second warehouse model.

Answer ……..…...…….…cm^3 [2]

9 **(b)** The diagram shows a broken piece of a round plate.

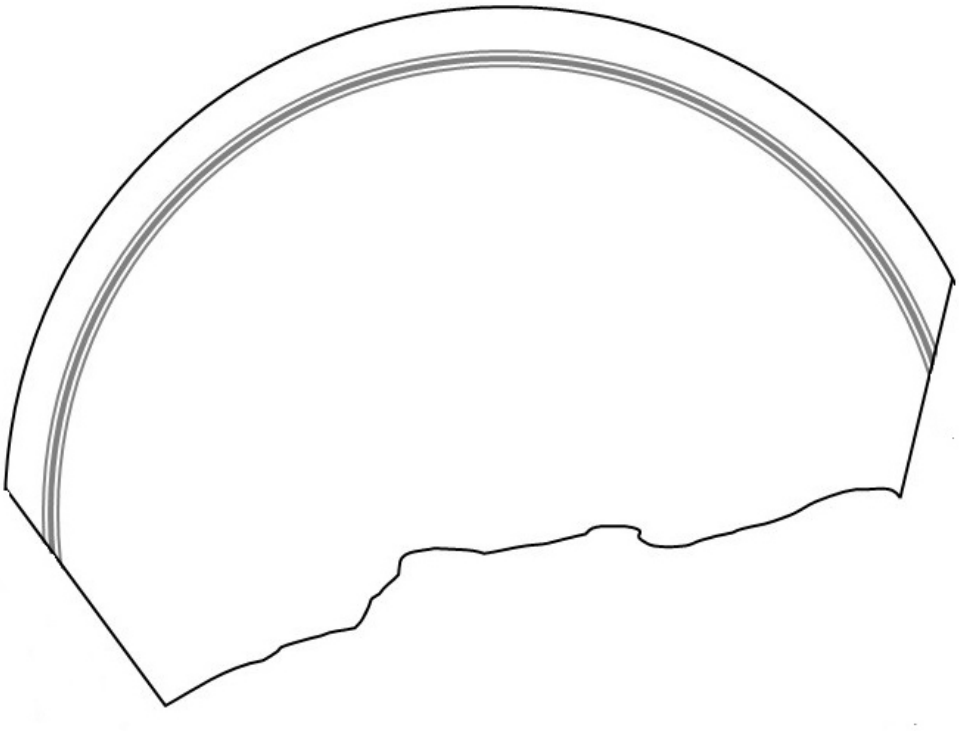
(i) State the property of circles you use in finding the centre of the plate.

Answer (i) _____

_____ [1]

(ii) Find, by constructing perpendicular bisectors, the centre of the plate. Label the centre of the plate *C*.

Answer (ii)



[2]

10 A is the point (5, –8) and B is the point (–10, 4).

(a) Find the equation of the line AB.

Answer ……..…...…….…... [2]

(b) The equation of the line l is $4x + 5y = 10$.

(i) Explain whether the line l intersects the line AB.

Answer

[2]

(ii) Explain whether the point C (10, –10) lies on the line l.

Answer

[2]

10 (b) (iii) Line l intersects the curve $y = \frac{x^3}{5} - x^2 - 2$ at point D.

The x-ccordinate of point D is a real solution of the equation $x^3 + px^2 + qx - 20 = 0$ where p and q are constants.

Find the values of p and q.

Answer p = ……..……

q = ……..…….…… [2]

BLANK PAGE

11 **(a)** Mr Tan has a medical condition which requires him to be on long-term prescribed medication.

On a particular day, he took a 200 mg dose of the prescribed drug at 8 o'clock in the morning. His body gradually broke down the drug so that one hour after taking the drug, only 80% of the drug would remain active.

This pattern continues: at the end of each hour, only 80% of the drug that was present at the end of the previous hour remains active.

To combat Mr Tan's illness effectively, the amount of the drug in the body should not fall below 30 mg.

There should not be more than 300 mg of the drug in the body, beyond which the drug becomes toxic.

The table shows the amount, x mg, of the drug present in Mr Tan's body t hours after taking the drug.

t (hours)	0	2	4	6	10
x (mg)	200	128	82	53	22

(i) Estimate the amount of the drug in Mr Tan's body 8 hours after he has taken it.

Answer ……..…...…….…….. mg [1]

(ii) Explain why the recommended dosage for the drug is 3 times a day. Show your calculations clearly.

[2]

11 (b) In Singapore, Ministry of Health provides subsidies for drugs at public specialist outpatient clinics (SOCs) and polyclinics to support Singapore citizens with healthcare costs.

The table below shows the per-capita household income (PCHI) criteria for subsidies at public SOCs and polyclinics.
(Source: https://www.moh.gov.sg/docs/librariesprovider5/default-document-library/annex-a---revision-to-pchi-criteria99abfc1511b54b6f87ddadb9114092f2.pdf)

Monthly PCHI* to qualify for subsidy (Singapore Citizens)	Subsidy tier** (Singapore Citizens)		
	Subsidised SOC services	Subsidised SOC drugs	Subsidised polyclinic drugs for adults
PCHI ≤ $1 200	70%	75%	75%
$1 200 < PCHI ≤ $2 000	60%		
PCHI > $2 000	50%	50%	50%

*Monthly PCHI is computed as the total gross household monthly income divided by the total number of family members living in the household.
** Subsidy tier shows the subsidy rate the Singapore Citizen is entitled to

Mr Tan, his wife and two children are Singapore Citizens. They live together in a 4-room HDB flat.

Member	Age	Gross Monthly Salary
Mr Tan	34	$3 500
Mrs Tan	32	$2 000
First Child	5	Nil
Second Child	3	Nil

Mr Tan's medication costs $1.90 per dose. Every 6 months, he receives outpatient services at a public SOC. Each visit at the public SOC costs $245.

Mr Tan decides to apply for both polyclinic drug subsidies and public SOCs service and drug subsidies.

Find, after Mr Tan is granted the subsidies, the amount he will save on the cost of drugs and outpatient treatment each year as a percentage of his annual gross salary.

11 (b) *Answer space*

[5]

End of Paper