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JURONG SECONDARY SCHOOL
2022 GRADUATION EXAMINATION 2
SECONDARY 4 EXPRESS/ SECONDARY 5 NORMAL (ACADEMIC)

CANDIDATE NAME	

CLASS		INDEX NUMBER	

MATHEMATICS **4048/01**

PAPER 1 **26 Aug 2022**
2 hours

Candidates answer on the Question paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index 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** the 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.

At the end of the examination, fasten all your work securely together.
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 80.

For Examiner's Use
80

This document consists of **23** printed pages, including this page.

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

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

Trigonometry

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

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

Statistics

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

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

1 Simplify $-2(-3x-4)+5$.

Answer .....[1]

---

2 The ratio of interior angle : exterior angle of a regular polygon is $5:1$.
Calculate the number of sides that the polygon has.

Answer .....sides [1]

---

3 A photocopier can photocopy at a rate of 30 double-sided papers per minute.

Calculate

(a) in minutes, the time taken to print 600 pages on double-sided setting,

Answer .....minutes [1]

(b) the number of double-sided papers that can be photocopied in 1 hour.

Answer .....double-sided papers [1]

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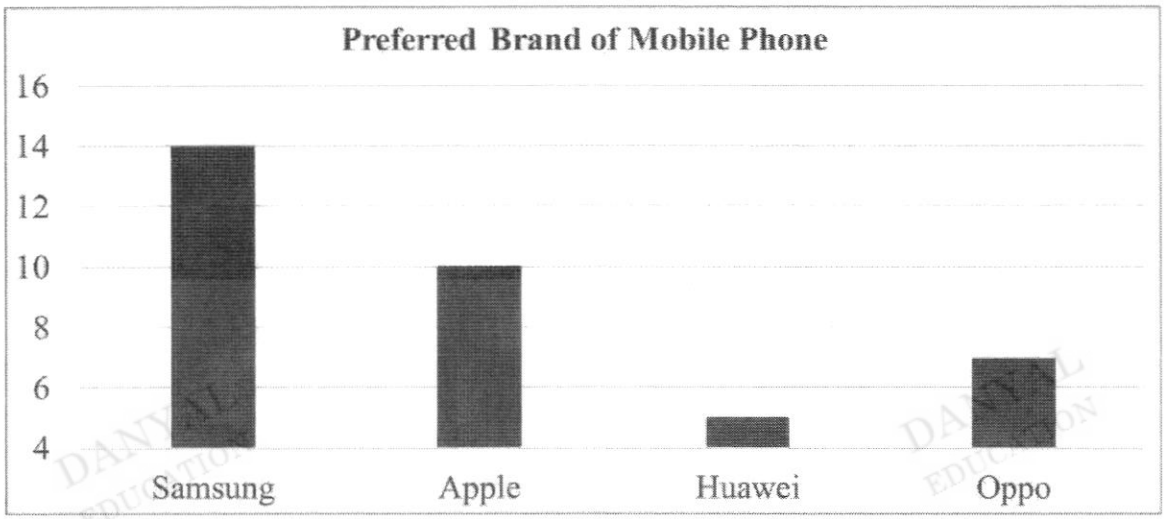
4 A survey was conducted to find out the preferred brand of mobile phone that secondary school students like.



State one aspect of the graph that may be misleading and explain how this may lead to a misinterpretation of the graph.

.....

.....

.....[2]

---

5 Solve the inequality $-2+x \leq 2-3x < 9+4x$.

Answer ..... [2]

---

6 Find a possible set of integer values of a and b such that the lines $x+y=1$ and $ax+by=1$

(a) do not intersect,

Answer $a=$.....

$b=$.....[1]

(b) intersect at exactly one point.

Answer $a=$.....

$b=$.....[1]

---

7 Factorise $4ax^2-4ay^2+2bx^2-2by^2$ completely.

Answer .....[2]

---

8 Simplify $\left(\frac{a^{16}}{b^{-6}}\right)^{\frac{3}{2}}$.

Answer .....[2]

---

9 Given that $25\times125^{x}=5$, find the value of x.

Answer $x=$.....[2]

---

10 Solve $\frac{5}{(2-x)^2}+\frac{1}{x-2}=4$.

Answer $x=$.....[3]

---

11 **(a)** Express $1+x^2-5x$ in the form of $(x+a)^2+b$.

Answer .....[1]

(b) Write down the equation of line of symmetry of the graph of $y=1+x^2-5x$.

Answer .....[1]

(c) Write down the coordinates of intersection between the line of symmetry and the graph of $y=1+x^2-5x$.

Answer (..... , ...) [1]

---

12 The area of triangle ABC is 7.5 cm^2. Two of the sides are of length 5 cm and 6 cm respectively. Find the length of the third side.

Answer .....cm [3]

---

13 The Ideal Gas Law

$$PV = 8.3145nT$$

relates pressure P (measured in Pascal), volume V (measured in metres^3), the number of moles of a gas n (measured in moles), and temperature T (measured in Kelvins).

One mole of gas is found to exert a pressure of 101 325 Pascal at room temperature 293 Kelvins. Find the volume of the gas in **cm^3**.

Answer .....cm^3 [2]

---

14 A map of the United States of America has a scale of 1 : 8 000 000 .

(a) The length of the Mississippi River is 3766 km.
Calculate the length, in centimetres, of Mississippi River on the map.

Answer .....cm [1]

(b) The area of California on the map is 66.25 cm^2.
Calculate the actual area, in square kilometres, of California.

Answer .....km^2 [2]

---

15 **(a)** n is a positive integer.
Show that, for all n, $6n^2 + 25n + 11$ is not a prime number.

.....

.....

.....[2]

(b) Hence, determine whether 16261 is a prime number. Show your working clearly.

.....

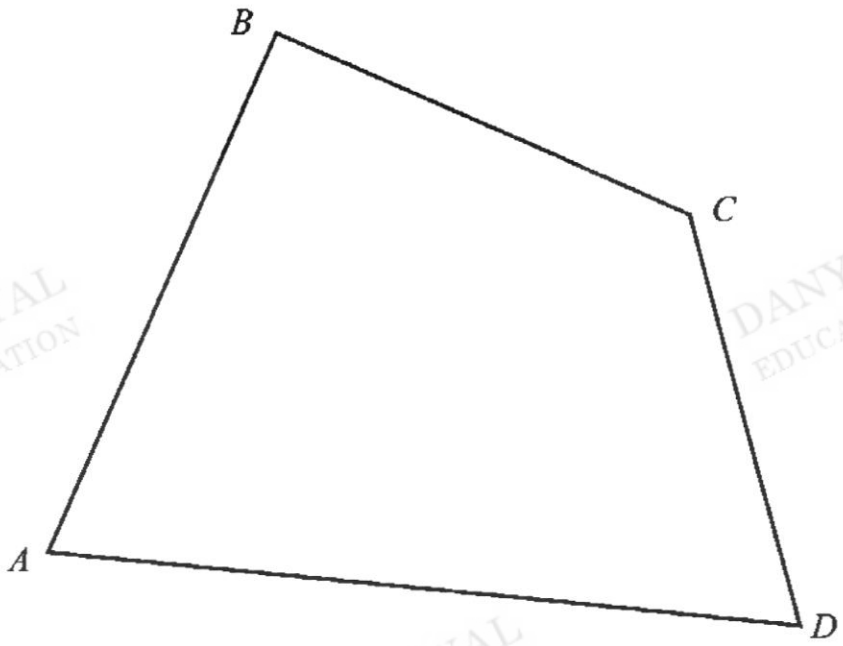
.....

.....[2]

---

16 The diagram represents a plot of land, *ABCD*. The police is looking for a robber hiding in the land.

Scale: 1 cm represents 1 km



Here are the accounts from three witnesses:
Witness 1: The robber is located more than 6 km away from *A*.
Witness 2: The robber is located nearer to *B* than *A*.
Witness 3: The robber is located nearer to *AD* than *AB*.

Shade the region where the robber is hiding. [4]

17 $\xi = \{\text{integers } x : 1 < x < 21\}$

$A = \{\text{integers that are perfect squares}\}$

$B = \{\text{integers that are not prime numbers}\}$

$C = \{\text{integers that are divisible by 5}\}$

(a) List down all the elements in A, B and C.

Answer $A =$ .....

$B =$ .....

$C =$ .....[2]

A number is chosen randomly from ξ.

(b) Find the number of elements in $B \cap C'$.

Answer ..... [1]

(c) Hence, find the probability that the chosen number is not a prime number and is not divisible by 5.

Answer ..... [1]

18 **(a)** The prime factorisation of 450 is $2\times3^2\times5^2$.
Express 648 as a product of its prime factors.

Answer 648 = ...[1]

(b) Using your answer to **part (a)**, determine whether 583200 is a perfect square.

.....

.....

.....[2]

(c) Find the smallest integer n such that $450n$ is a multiple of 648.

Answer n = ...[1]

19 **(a)** The points $A(0,2)$ and $B(1,0)$ lie on the graph $y = x^2 + ax + b$.
Find the values of a and b.

Answer $a =$ .....

$b =$ .....[2]

(b) C is another point on the graph such that the gradient of line AB is twice the gradient of AC. Find the coordinates of point C.

Answer (..... , ...) [3]

20 It is given that $\overrightarrow{AB} = \begin{pmatrix} -12 \\ a \end{pmatrix}$, $a > 0$ and $\left|\overrightarrow{BA}\right| = 37$ units.

(a) Find the value of a.

Answer $a =$ .....[2]

(b) C is a point $(0,10)$ and $\overrightarrow{AB} = \overrightarrow{DC}$.

Find the coordinates of D.

Answer (..... , ...) [2]

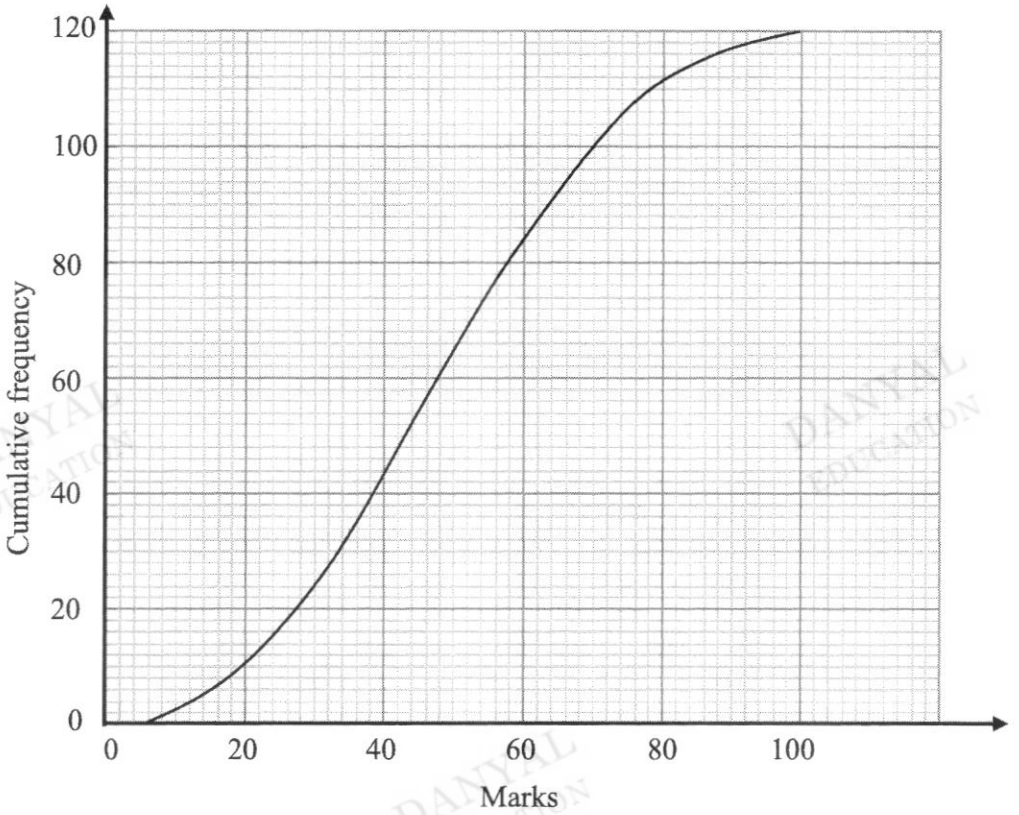
(c) What type of quadrilateral is $ABCD$? Explain your answer.

.....

.....

.....[1]

21 The cumulative frequency curve shows the marks obtained by the 120 students in a recent Mathematics Test. The maximum mark is 100.



(a) Complete the grouped frequency table for the marks obtained.

Marks obtained by students, x	Frequency
$0 \leq x < 20$	10
$20 \leq x < 40$	
$40 \leq x < 60$	
$60 \leq x < 80$	28
$80 \leq x < 100$	8

[1]

(b) Calculate an estimate of the mean mark.

$0 \leq x < 20$
$20 \leq x < 40$
$40 \leq x < 60$
$60 \leq x < 80$
$80 \leq x < 100$

Answer .....marks [1]

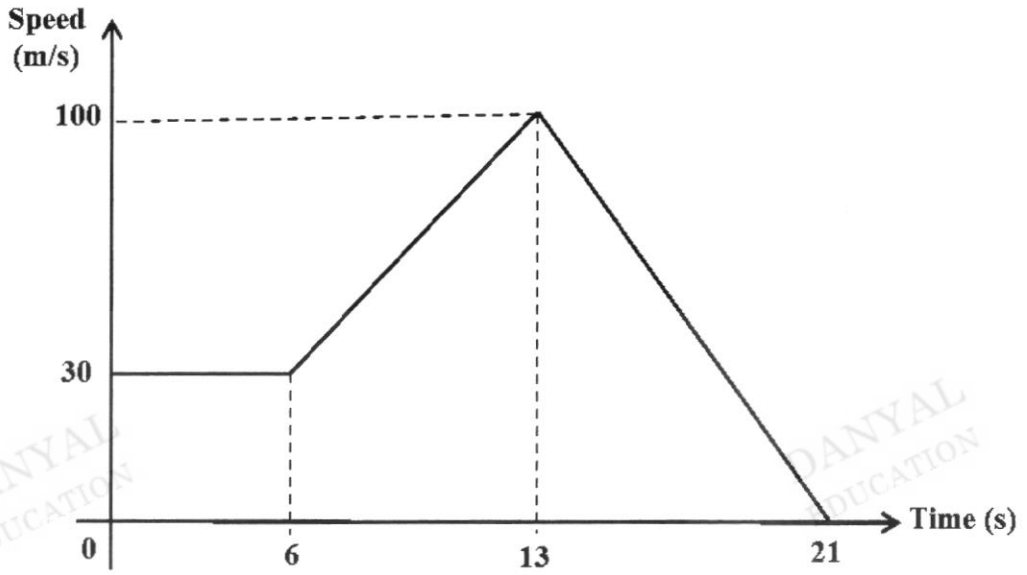
(c) Calculate an estimate of the standard deviation.

Answer .....marks [2]

(d) The passing mark is 50. Two students are chosen at random. Find the probability that both of them passed.

Answer ..... [1]

22 The diagram shows the speed-time graph of a particle.



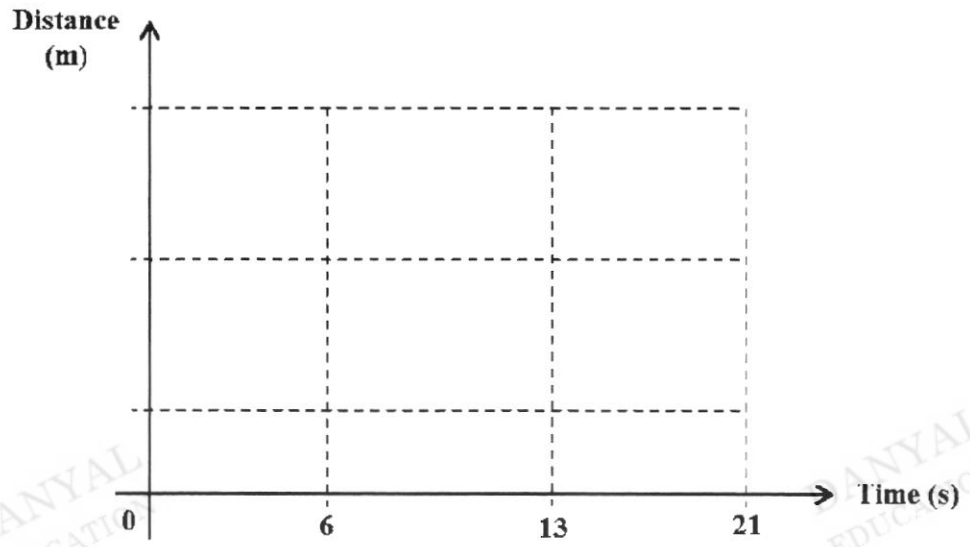
(a) Find the speed of the particle when t = 12s.

Answer .....m/s [2]

(b) Find the distance covered before the particle starts to slow down.

Answer .....m [2]

(c) Complete the distance-time graph of the particle. [1]



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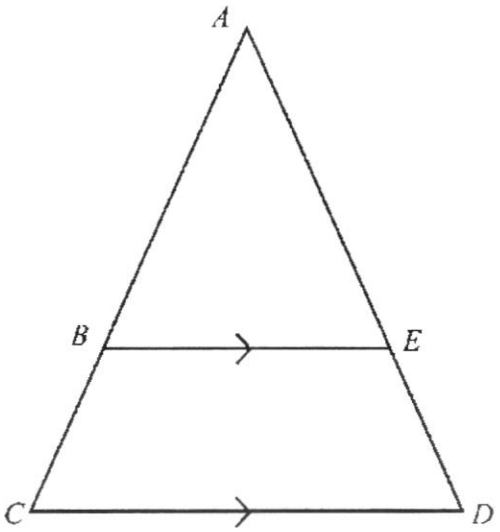


In the diagram, ABC and AED are straight lines and BE is parallel to CD.

(a) Show that triangle ABE is similar to triangle ACD. Give a reason for each statement you make.

.....

.....

.....[2]

(b) Show that $\frac{BC}{ED} = \frac{AB}{AE}$. [2]

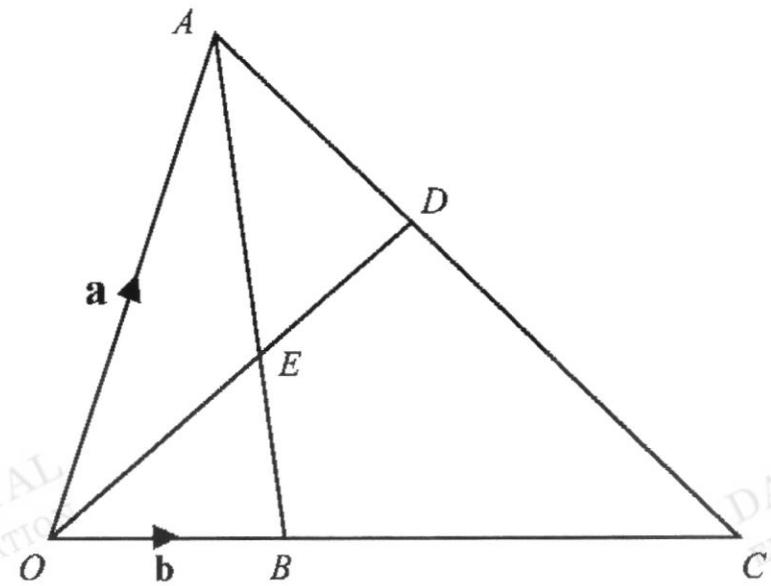
(c) A circle is drawn with points B, C and D on its circumference. It is further given that angle BCD + angle $BED > 180°$. Explain why point E is **inside** the circle.

.....

.....

.....[1]

24



OBC, ADC, AEB and OED are straight lines.

$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.

$OB = \frac{1}{3}OC$, $AE : EB = 3 : 2$ and $OE : ED = 1 : 1$.

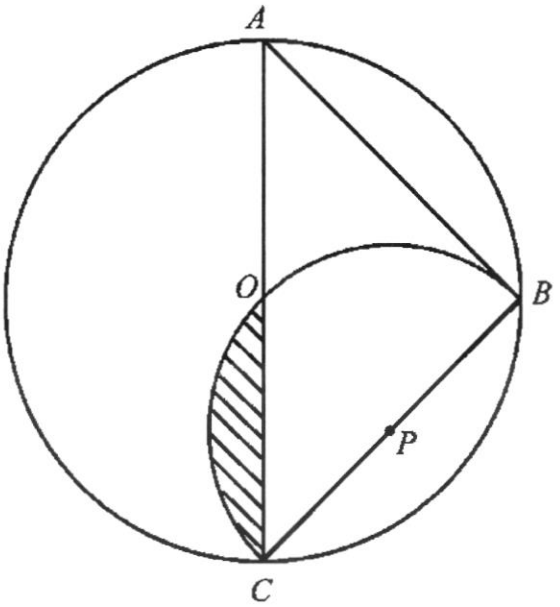
(a) Find $\overrightarrow{OE}$ in terms of **a** and/or **b** as simply as possible.

Answer: $\overrightarrow{OE} =$ .....[2]

(b) Find the value of $\frac{\text{area of } \Delta OBE}{\text{area of } BEDC}$.

Answer ..... [2]

25



AC is a diameter of a circle with centre O. $AC = \sqrt{2}r$ and $AB = BC$.
COB is a semi-circular arc, centre P.
What percentage of the circle is **not** shaded?

Answer .....% [5]

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JURONG SECONDARY SCHOOL
2022 GRADUATION EXAMINATION 2
SECONDARY 4 EXPRESS/
SECONDARY 5 NORMAL ACADEMIC

CANDIDATE NAME	

CLASS		INDEX NUMBER	

MATHEMATICS 4048/02

PAPER 2

24 August 2022
2 hour 30 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

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

Answer **all** the questions.
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At the end of the examination, fasten all your work securely together.
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 **26** printed pages including this page.

Mathematical Formulae

Compound interest

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

Mensuration

Curved surface area of a cone = πrl

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

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

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

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

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

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

Answer **all** the questions.

1 **(a)** It is given that $y = \dfrac{5x-2}{3x+1}$.

(i) Find y when $x = 7$.

Answer $y =$ ..... [1]

(ii) Express x in terms of y.

Answer $x =$ ..... [2]

(b) Solve $\dfrac{x-5}{3} - \dfrac{x+3}{2} = -4$.

Answer $x =$ ..... [2]

(c) Solve these simultaneous equations.

$$3x - 2y = 10$$
$$2x + y = 23$$

Answer $x =$ .....

$y =$ ..... [3]

(d) Simplify $\dfrac{4x^2 - 9}{6x^2 - x - 12}$.

Answer ..... [3]

2 Mrs Teo is a Mathematics tutor.
She offers tutorial sessions for Lower Secondary and Upper Secondary students on weekdays and on weekends.
Each student attends one session a week for 4 sessions in every month.

The matrix **N** shows the number of students she tutors every month.

$$\mathbf{N} = \begin{array}{c} \begin{matrix} \text{Lower Secondary} & \text{Upper Secondary} \end{matrix} \\ \begin{pmatrix} 7 & 6 \\ 4 & 3 \end{pmatrix} \end{array} \begin{matrix} \\ \text{Weekday} \\ \text{Weekend} \end{matrix}$$

(a) Evaluate the matrix $\mathbf{M} = 4\mathbf{N}$.

Answer ..... [1]

(b) Mrs Teo charges \$70 for each Lower Secondary session and \$80 for each Upper Secondary session.

Represent the session charges in a 2×1 column matrix **C**.

Answer $\mathbf{C} =$ [1]

(c) Evaluate the matrix $\mathbf{P} = \mathbf{M}\mathbf{C}$.

Answer $\mathbf{P} =$ [1]

(d) State what the elements of **P** represent.

Answer .....

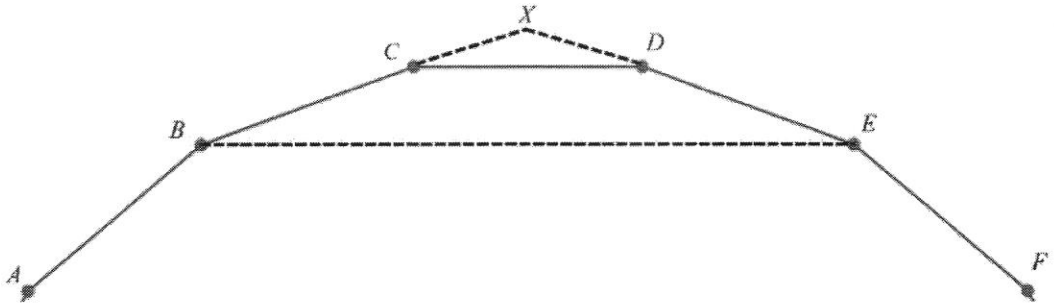
..... [1]

Mrs Teo wants to increase her tuition fees for the weekend sessions by 10% for the last 3 months before examinations start.
The number of students registered for the weekday sessions are 10 Lower Secondary students and 8 Upper Secondary students. On weekends she has 3 Lower Secondary students and 2 Upper Secondary students.

(e) Calculate the total amount of money she earns during this 3 month period.

Answer ..... [4]

3



The diagram below shows part of a regular 18-sided polygon, $ABCDEF\ldots\ldots$
The lines BC and ED are extended to meet at the point X such that $XC = XD$.

(a) Find $\angle XCD$.

Answer ..... [1]

(b) Find $\angle CXD$.

Answer ..... [1]

(c) Explain why $BX = EX$.

Answer

[2]

(d) Show that ΔXCD and ΔXBE are similar.

Answer

[2]

(e) What can we conclude about the side CD and the line BE?

Answer ..... [1]

4 The first four terms in a sequence of numbers are given below.

$T_1 = 5^2 - 18 = 7$

$T_2 = 6^2 - 22 = 14$

$T_3 = 7^2 - 26 = 23$

$T_4 = 8^2 - 30 = 34$

(a) Find T_5.

Answer ..... [1]

(b) Show that the nth term of the sequence, T_n, is given by $n^2 + 4n + 2$.

Answer

[2]

(c) Determine and explain if 962 is a term of the sequence.

Answer

[2]

(d) Find and simplify an expression, in terms of n, for $T_n - T_{n-1}$.

Answer ..... [3]

(e) Explain why the difference between consecutive terms in the sequence is always odd.

Answer .....

.....

..... [1]

5 The variables x and y are connected by the equation

$$y = x + \frac{5}{x^2} - 3$$

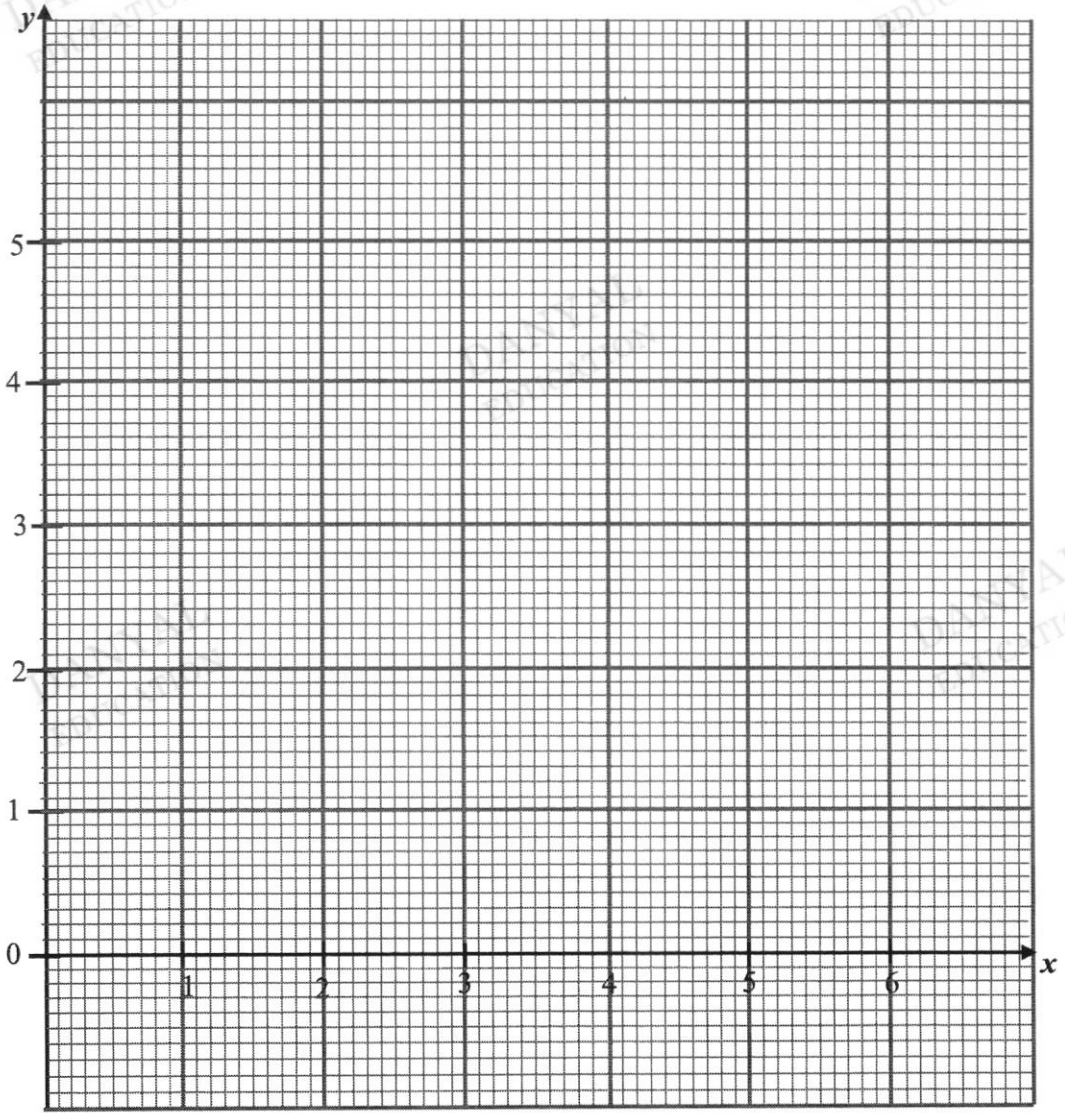
Some corresponding values of x and y are given in the table below.

x	1	1.5	2	2.5	3	4	5	6
y	3	0.7	0.3	0.3	0.6	1.3	p	3.1

(a) Find the value of p.

Answer $p =$ ..... [1]

(b) On the grid, draw the graph of $y = x + \frac{5}{x^2} - 3$ for $1 \leq x \leq 6$. [3]



(c) The equation $x+\frac{5}{x^2}-3=0$ has no solution.

Explain how this can be seen from your graph.

Answer .....

..... [1]

(d) By drawing a tangent, find the gradient of the curve when $x=1.5$.

Answer ..... [2]

(e) **(i)** On the same axes, draw the line with gradient 2 that passes through the point with coordinates $(0.5, 2)$. [2]

(ii) Write down the equation of this line.

Answer ..... [1]

(iii) Show, with mathematical justification, that the equation $5-4x^2-x^3=0$ can be solved by finding the points of intersection of the straight line and the curve.

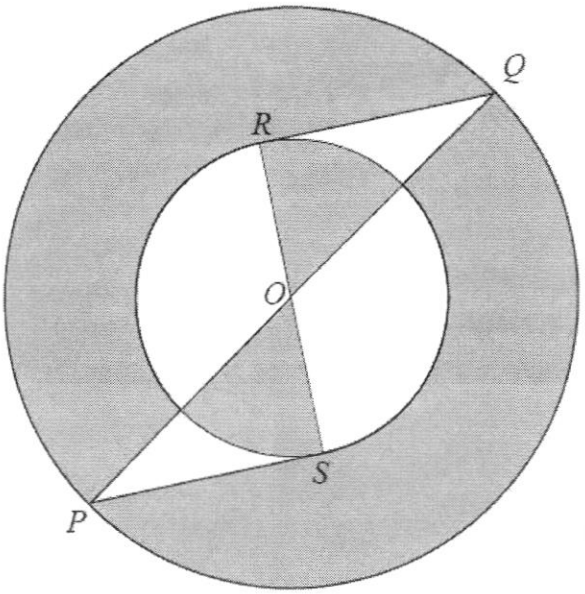
Answer

[2]

(iv) Use your graphs to solve the equation $5-4x^2-x^3=0$.

Answer ..... [1]

6



The diagram shows two concentric circles with centre O.
PQ is the diameter of the larger circle and RS is the diameter of the smaller circle.
PS and RQ are tangents to the smaller circle.

(a) Show that the triangle PSO is congruent to triangle QRO.
Give a reason for each statement you make.

Answer

[2]

(b) The radius of the larger circle is 8 cm and the radius of the smaller circle is 4.36 cm.

(i) Calculate the area of triangle *QRO*.

Answer ..... cm^2 [3]

(ii) Given that angle *QOR* is 0.995 radians, calculate the shaded area.

Answer ..... cm^2 [4]

7 The seating capacity of an auditorium is 300. The seats are categorised as 1, 2, 3 and 4. The costs of the tickets in the categories are in the table below.

CATEGORY	TICKET PRICES
CAT 1	S$ 348
CAT 2	S$ 288
CAT 3	S$ 228
CAT 4	S$ 148

(a) The number of seats are distributed in the ratio $1:2:4:5$ for CAT 1 to 4 respectively. If all the seats are sold out, calculate the ticket sales for category 4.

Answer $ ..... [2]

The auditorium has 2 entrances, front entrance F and back entrance B.
Entrance F is able to evacuate x people out of the auditorium per second.

(b) **(i)** Write down an expression, in terms of x, for the time taken in seconds for all 300 people to evacuate if only entrance F is open.

Answer ..... s [1]

(ii) Entrance F is able to let approximately 2 more people evacuate per second compared to entrance B.

Write down an expression, in terms of x, for the time taken in seconds for all 300 people to evacuate the auditorium if only entrance B is open.

Answer ..... s [1]

(iii) Usually, only one entrance is open at any time.

It takes approximately 3 seconds more for all the people to evacuate the auditorium using entrance B as compared to entrance F.

Form an equation in x and show that it reduces to $x^2 - 2x - 200 = 0$.

Answer

[3]

(iv) Solve the equation $x^2 - 2x - 200 = 0$.

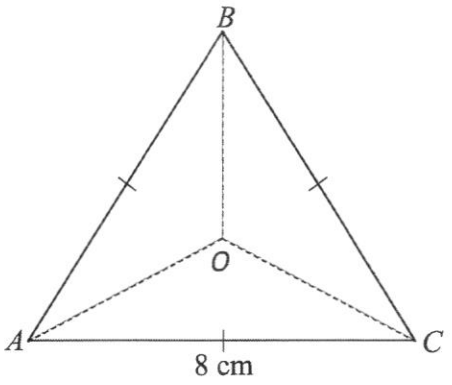
Answer $x =$ ..... or ..... [2]

(v) Find the number of people that can be evacuated in **1 minute** if only entrance F is opened.

Answer ..... people [2]

8 An equilateral triangle ABC, has sides of 8 cm.

O is the centre of the equilateral triangle.

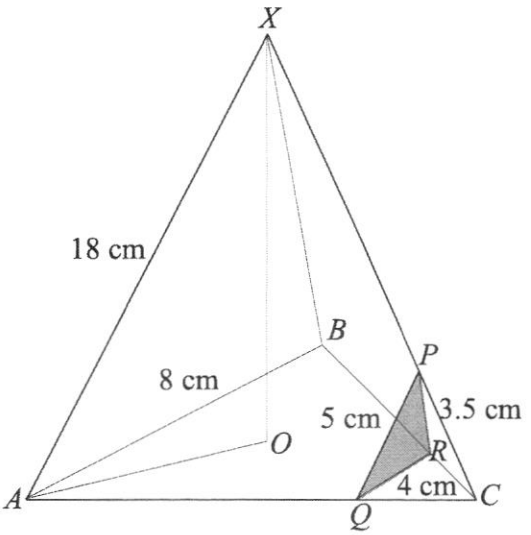


(a) Show that the length of OA is 4.619 cm, correct to 3 decimal places.

Answer

[2]

The triangle ABC forms the base of a pyramid.
The vertex, X is vertically above O and $AX = 18$ cm.



(b) Calculate the **total** surface area of the pyramid.

Answer ..... cm^2 [3]

(c) Part of the pyramid is cut off at triangle PQR such that P is a point on XC, Q is a point on AC and R is a point at BC.
$PQ = 5$ cm, $QR = 4$ cm and $PR = 3.5$ cm.
Find angle PQR.

Answer .....°. [2]

(d) The ratio of $AQ : QC = 3 : 1$.
Calculate the angle of elevation of X from Q.

Answer .....° [4]

9 (a) A group of 50 patients had their blood pressure taken.

The results are shown in the table below.

Blood Pressure (mmHg)	$100 < x \leq 120$	$120 < x \leq 140$	$140 < x \leq 160$	$160 < x \leq 180$
Frequency	27	12	6	5

(i) State the median class of blood pressure.

Answer ..... [1]

(ii) A blood pressure of 140 mmHg or higher indicates high blood pressure.
Find the percentage of patients who may have high blood pressure.

Answer ..... % [1]

(iii) Calculate the standard deviation of the blood pressures.

Answer ..... mmHg [2]

(iv) The standard deviation of the blood pressures taken by a second group of patients was 22.1 mmHg.

Comment on one difference between the two distributions, making reference to this information.

Answer .....

.....

..... [1]

(b) A drawer contains 2 blue socks and 6 white socks.
Two socks are taken from the drawer at random without replacement.
If the two socks are different colours, then a third sock is taken from the drawer.
Otherwise, no third sock is taken.

(i) Draw a tree diagram to show the probabilities of the possible outcomes.

Answer

[2]

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

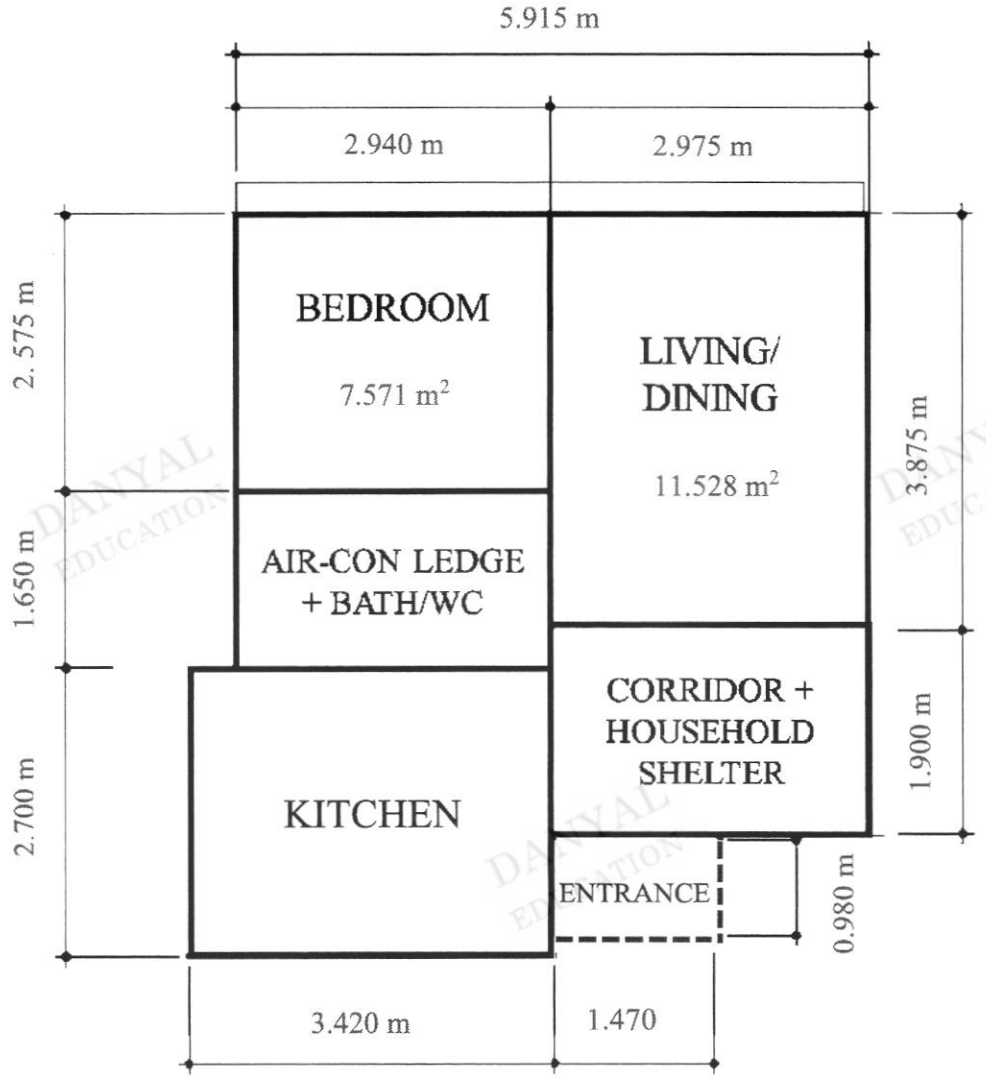
(a) the first two socks taken are the same colour,

Answer ..... [2]

(b) a third sock is taken and it is the same colour as the first sock.

Answer ..... [2]

10 Mr Graham bought a 2-room flat in Sembawang.
The floor plan can be modelled as five rectangles as shown below.

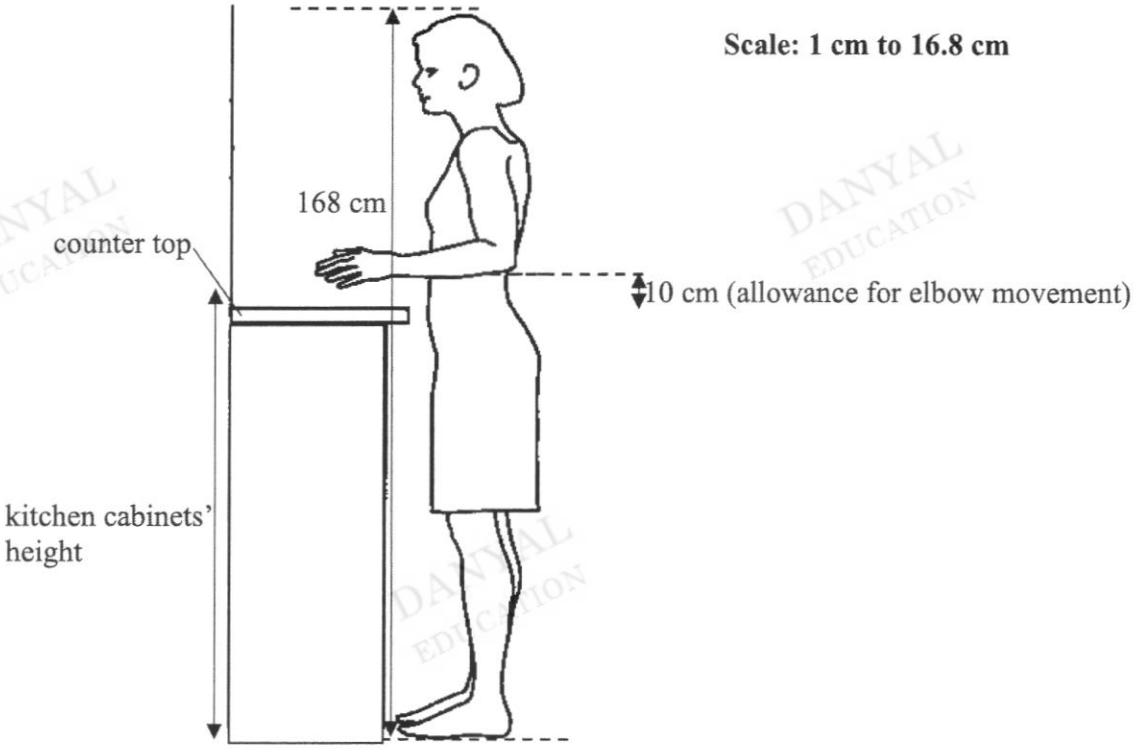


(a) Calculate the total floor area of Mr Graham's kitchen.

Answer ..... m^2 [1]

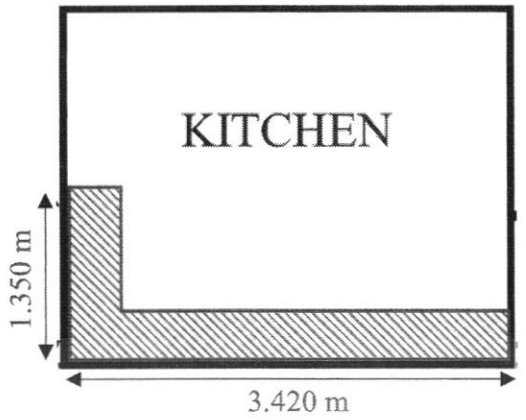
(b) The optimal kitchen cabinets' height, including the counter top, is calculated based on the concept of ergonomics. Ergonomics is the process of designing products that fit the people who use them.
Using the diagram as reference, kitchen cabinet designers view that optimal cabinet height should be the distance between one's elbow and the ground, with 10 cm allowance for elbow movement.
The diagram below shows a drawing of Mrs Graham whose height is 168 cm.

Calculate the range of optimal kitchen cabinets' heights, including the counter top, for Mrs Graham.



Answer ..... cm [2]

(c) Mr Graham plans to install a combination of kitchen cabinets along the L-shaped shaded area in the kitchen.



In the combination, he requires one of the cabinets to have a sink, a corner cabinet and at least one of the other cabinets to have wire basket shelves.
He wants to customise the height of the cabinets to suit Mrs Graham's height.
He also wishes to install a counter top for the top of the cabinet, considering to use either granite, ceramic or acrylic as its material.
He has a budget of $2200 to purchase the kitchen cabinets and L-shaped counter top.
Using the information in the tables given on the next page and your answer in **(b)**, propose a possible combination that will best suit Mr Graham's requirements that will optimise storage and space while maximising the use of his budget.

Answer

[7]

Table 1: Kitchen Cabinets

Cabinet	**1**	**2**	**3**	**4**	**5**	**6**
Description	Cabinet with sink, 1 drawer and 1 door (no shelves)	Corner cabinet	Cabinet with 4 drawers	Cabinet with 2 shelves and 2 doors	Cabinet with 1 door and wire basket shelves	Cabinet with 1 drawer, 3 shelves and 1 door.
Cost	$156	$166	$260	$290	$166	$193
Width	50 cm	60 cm	90 cm	80 cm	60 cm	70 cm
Depth	60 cm	60 cm	60 cm	60 cm	60 cm	60 cm

Table 2: Height Customisation for Kitchen Cabinet

Height	**Cost per cabinet**
50 cm	Free
up to 75 cm	$15
up to 105 cm	$25

Table 3: Materials for L-Shaped Counter Top

Materials	**Overall Cost**
Granite	$1200
Ceramic	$800
Acrylic	$600

End of Paper

O

JURONG SECONDARY SCHOOL
2022 GRADUATION EXAMINATION 2
SECONDARY 4 EXPRESS/ SECONDARY 5 NORMAL (ACADEMIC)

CANDIDATE NAME	

CLASS		INDEX NUMBER	

MATHEMATICS **4048/01**

PAPER 1 **26 Aug 2022**
2 hours

Candidates answer on the Question paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index 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** the 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.

At the end of the examination, fasten all your work securely together.
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 80.

For Examiner's Use
80

This document consists of **23** printed pages, including this page.

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

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

Trigonometry

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

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

Statistics

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

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

1 Simplify $-2(-3x-4)+5$.

$-2(-3x-4)+5 = 6x+8+5$

$= 6x+13$ **B1**

Answer .....[1]

---

2 The ratio of interior angle : exterior angle of a regular polygon is 5:1.
Calculate the number of sides that the polygon has.

Exterior angle $= \frac{1}{1+5} \times 180° = 30°$

Number of sides $= \frac{360°}{30°} = 12$ B1

Answer .....sides [1]

---

3 A photocopier can photocopy at a rate of 30 double-sided papers per minute.

Calculate

(a) in minutes, the time taken to print 600 pages on double-sided setting.

600 pages = 300 double sided papers

Time taken $= \frac{300}{30} = 10$ minutes B1

Answer .....minutes [1]

(b) the number of double-sided papers that can be photocopied in 1 hour.

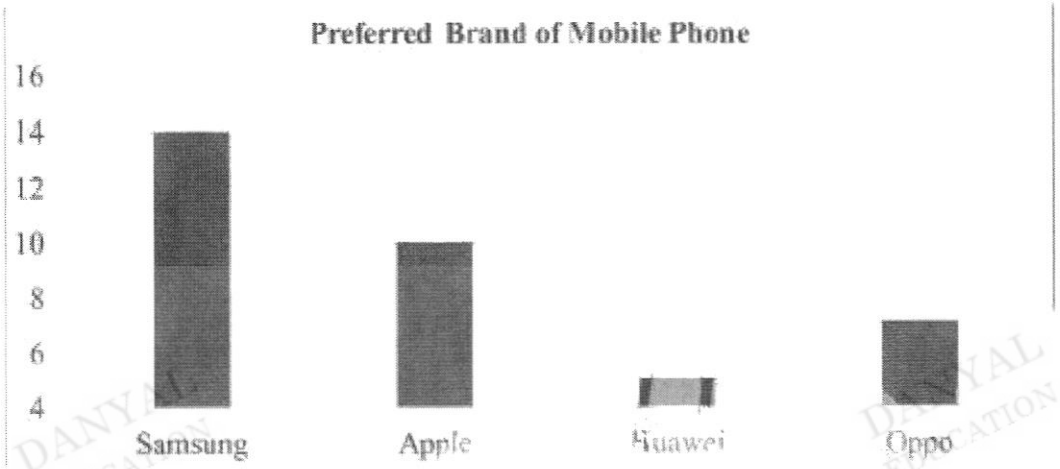
1 hour = 60 minutes

No. of pages printed $= 30 \times 60 = 1800$ **B1**

Answer .....double-sided papers [1]

---

4 A survey was conducted to find out the preferred brand of mobile phone that secondary school students like.



State one aspect of the graph that may be misleading and explain how this may lead to a misinterpretation of the graph

The y-axis does not start with 0. **B1**

Hence it looks like there are three times the number of students choosing Samsung than Oppo, which in fact is only two times. **B1** (14 students for Samsung, 7 students for Oppo)

.....

.....

.....[2]

---

5 Solve the inequality $-2+x \leq 2-3x < 9+4x$.

$-2+x \leq 2-3x < 9+4x$ **M1**: Split inequality

$-2+x \leq 2-3x$ AND $2-3x < 9+4x$

$4x \leq 4$ AND $-7 < 7x$

$x \leq 1$ AND $x > -1$

$\therefore -1 < x \leq 1$ **A1**: (Don't give if there is no AND)

Answer ..... [2]

---

6 Find a possible set of integer values of a and b such that the lines $x+y=1$ and $ax+by=1$

(a) do not intersect,

$a=2$
$b=2$

B1: Any integer values of a and b such that $a=b$ but $a\neq 0,1,\ b\neq 0,1$

Answer $a=$.....

$b=$.....[1]

(b) intersect at exactly one point.

$a=1$
$b=2$

B1: Any integer values of a and b such that $a\neq b$

Answer $a=$.....

$b=$.....[1]

---

7 Factorise $4ax^2-4ay^2+2bx^2-2by^2$ completely.

$4ax^2-4ay^2+2bx^2-2by^2$
$=4a\left(x^2-y^2\right)+2b\left(x^2-y^2\right)$
$=(4a+2b)\left(x^2-y^2\right)$ **B1**: $(x+y)(x-y)$
$=2(2a+b)(x-y)(x+y)$ **B1**

Answer .....[2]

---

8 Simplify $\left(\frac{a^{16}}{b^{-6}}\right)^{\frac{3}{2}}$.

$$\left(\frac{a^{16}}{b^{-6}}\right)^{\frac{3}{2}} = \frac{\left(a^{16}\right)^{\frac{3}{2}}}{\left(b^{-6}\right)^{\frac{3}{2}}}$$

$$= \frac{a^{24}}{b^{-9}}$$

$$= a^{24}b^{9}$$

M1: Correct multiplication of power to the indices respectively

A1: Must be in positive index notation

Answer .....[2]

---

9 Given that $25\times125^{x}=5$, find the value of x.

$25\times125^{x}=5$

$5^{2}\times\left(5^{3}\right)^{x}=5$

$5^{2}\times5^{3x}=5$

$5^{2+3x}=5^{1}$

$\therefore 2+3x=1$

$x=-\frac{1}{3}$

M1: Convert all bases to base 5 correctly

A1

Answer $x=$.....[2]

---

10 Solve $\frac{5}{(2-x)^2}+\frac{1}{x-2}=4$.

$\frac{5}{(2-x)^2}+\frac{1}{x-2}=4$

$\frac{5}{(x-2)^2}+\frac{1}{x-2}=4$

$\frac{5}{(x-2)^2}+\frac{x-2}{(x-2)^2}=4$

$\frac{5+x-2}{(x-2)^2}=4$

M1: Common denominator (only accept quadratic denominator)

$\frac{3+x}{(x-2)^2}=4$

$3+x=4(x-2)^2$

$3+x=4(x^2-4x+4)$

$3+x=4x^2-16x+16$

$4x^2-17x+13=0$

$(x-1)(4x-13)=0$

M1: Factorisation or quadratic formula

$x=1$ or $x=3.25$

A1

Answer $x=$ .....[3]

---

11 **(a)** Express $1+x^2-5x$ in the form of $(x+a)^2+b$.

$1+x^2-5x=x^2-5x+1$

$=\left(x-\frac{5}{2}\right)^2-\left(\frac{5}{2}\right)^2+1$

$=(x-2.5)^2-5.25$

$=\left[x+(-2.5)\right]^2+(-5.25)$

B1: Must be this form

Answer .....[1]

(b) Write down the equation of line of symmetry of the graph of $y=1+x^2-5x$.

Eqn of line of symmetry: $x=2.5$ **B1**

Answer .....[1]

(c) Write down the coordinates of intersection between the line of symmetry and the graph of $y = 1 + x^2 - 5x$.

Point of intersection is at the turning point.

$(2.5, -5.25)$ **B1**

Answer (..... , ...) [1]

---

12 The area of triangle ABC is 7.5 cm^2. Two of the sides are of length 5 cm and 6 cm respectively. Find the length of the third side.

Area of $\Delta = 7.5$ **M1**: Using Sine Rule correctly

$\frac{1}{2}(5)(6)\sin\theta = 7.5$

$\sin\theta = \frac{1}{2}$

$\theta = \sin^{-1}\frac{1}{2}$ or $180° - \sin^{-1}\frac{1}{2}$

$\theta = 30°$ or $150°$

Length of third side **M1**: Using Cosine Rule correctly (FT)

$= \sqrt{5^2 + 6^2 - 2(5)(6)\cos 30°}$

OR

$\sqrt{5^2 + 6^2 - 2(5)(6)\cos 150°}$

$\therefore$ Length of third side = 3.01 cm or 10.6 cm **A1**: Both correct

Answer .....cm [3]

---

13 The Ideal Gas Law

$$PV = 8.3145nT$$

relates pressure P (measured in Pascal), volume V (measured in metres^3), the number of moles of a gas n (measured in moles), and temperature T (measured in Kelvins).

One mole of gas is found to exert a pressure of 101 325 Pascal at room temperature 293 Kelvins. Find the volume of the gas in **cm^3**.

$V = \dfrac{8.3145(1)(293)}{101325}$

$= 0.0240 \text{ m}^3 \ (3 \text{ s.f})$

$= 24000 \text{ cm}^3$

M1: Correct substitution

A1

Answer .....cm^3 [2]

---

14 A map of the United States of America has a scale of 1 : 8 000 000 .

(a) The length of the Mississippi River is 3766 km.
Calculate the length, in centimetres, of Mississippi River on the map.

1 cm : 8000000 cm

1 cm : 80 km

80 km $\rightarrow$ 1 cm

3766 km $\rightarrow \dfrac{3766}{80} = 47.075$ cm

B1: 47.075

Answer .....cm [1]

(b) The area of California on the map is 66.25 cm^2.
Calculate the actual area, in square kilometres, of California.

1 cm : 8000000 cm

1 cm : 80 km

$\therefore 1 \text{ cm}^2 : 6400 \text{ km}^2$

$1 \text{ cm}^2 \rightarrow 6400 \text{ km}^2$

$66.25 \text{ cm}^2 \rightarrow 66.25(6400) = 424000 \text{ km}^2$

M1: Using proportion

A1

Answer .....km^2 [2]

---

15 **(a)** n is a positive integer.

Show that, for all n, $6n^2 + 25n + 11$ is not a prime number.

$6n^2 + 25n + 11 = (3n + 11)(2n + 1)$

B1

For all positive integer n, $3n + 11$ and $2n + 1$ are also integers **more than 1**. Hence for all positive n, $6n^2 + 25n + 11$ is a composite

number since it can be factorised into smaller integers greater than 1.

B1: With the idea of factors more than 1

.....

.....

.....[2]

(b) Hence, determine whether 16261 is a prime number. Show your working clearly.

$6n^2+25n+11=16261$

$6n^2+25n-16250=0$

$(n-50)(6n+325)=0$

$n=50$ or $n=-\frac{325}{6}$ (NA, since n is a positive integer)

By previous part, 16261 is a composite number.

M1: Can also use previous part to guess $n=50$ (No working required)

A1 (If solve equation never reject negative minus 1)

.....

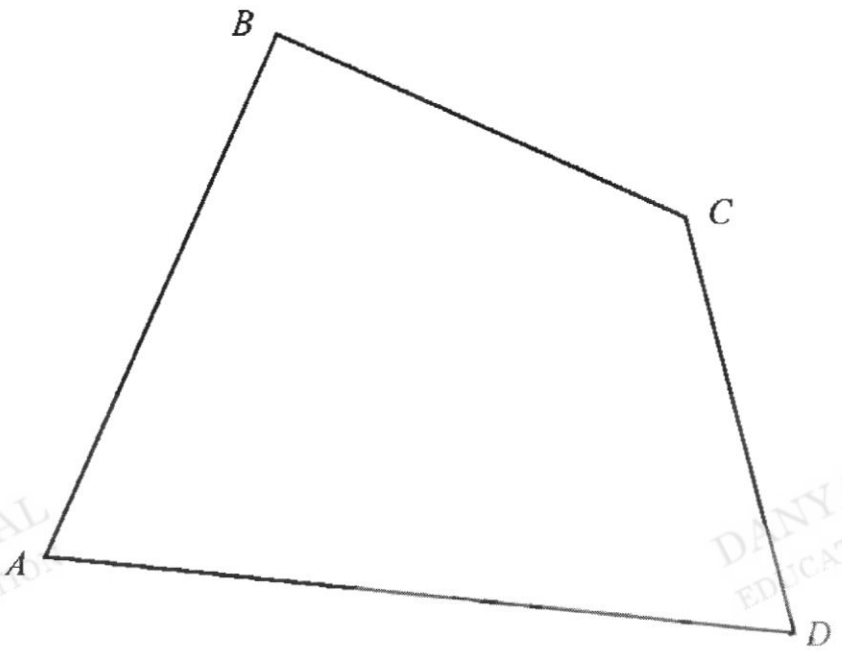
.....

.....[2]

---

16 The diagram represents a plot of land, *ABCD*. The police is looking for a robber hiding in the land.

Scale: 1 cm represents 1 km



Here are the accounts from three witnesses:
Witness 1: The robber is located more than 6 km away from A.
Witness 2: The robber is located nearer to B than A.
Witness 3: The robber is located nearer to AD than AB.

Shade the region where the robber is hiding. [4]

17 $\xi = \{\text{integers } x : 1 < x < 21\}$

$A = \{\text{integers that are perfect squares}\}$

$B = \{\text{integers that are not prime numbers}\}$

$C = \{\text{integers that are divisible by 5}\}$

(a) List down all the elements in A, B and C.

$A = \{4,9,16\}$

$B = \{4,6,8,9,10,12,14,15,16,18,20\}$

$C = \{5,10,15,20\}$

B2
Minus one mark per mistake

Answer $A =$ .....

$B =$ .....

$C =$ .....[2]

A number is chosen randomly from ξ.

(b) Find the number of elements in $B \cap C'$.

$B = \{4,6,8,9,10,12,14,15,16,18,20\}$

$C = \{5,10,15,20\}$

$B \cap C' = \{4,6,8,9,12,14,16,18\}$

$\therefore$ Required number $= 8$

B1

Answer ..... [1]

(c) Hence, find the probability that the chosen number is not a prime number and is not divisible by 5.

Required probability $= \frac{8}{19}$

B1: Follow through from part (b) answer, but denominator must be 19

Answer ..... [1]

---

18 **(a)** The prime factorisation of 450 is $2\times3^2\times5^2$.
Express 648 as a product of its prime factors.

$648 = 2^3\times3^4$ **B1**

Answer 648 = ...[1]

(b) Using your answer to **part (a)**, determine whether 583200 is a perfect square.

Note that $450\times648 = 291600$

$\therefore 583200 = 2\times450\times648 = 2^5\times3^6\times5^2$ **B1**

583200 is not a perfect square as the power (exponent) of base 2 in 583200 is not an even number. **B1**

.....

.....

.....[2]

(c) Find the smallest integer n such that $450n$ is a multiple of 648.

$$n = \frac{LCM(450, 648)}{450}$$
$$= \frac{2^3\times3^4\times5^2}{2\times3^2\times5^2}$$
$$= 2^2\times3^2$$
$$= 36$$ **B1**

Answer n = ...[1]

19 **(a)** The points $A(0,2)$ and $B(1,0)$ lie on the graph $y = x^2 + ax + b$.

Find the values of a and b.

When $x = 0$, $y = 2$:

$2 = b$ **B1**

When $x = 1$, $y = 0$:

$0 = 1^2 + a + 2$

$a = -3$ **B1**

Answer $a =$ .....

$b =$ .....[2]

(b) C is another point on the graph such that the gradient of line AB is twice the gradient of AC. Find the coordinates of point C.

Method 1

Let $C = (c, c^2 - 3c + 2)$

Gradient of $AB = 2 \times$ Gradient of AC

B1: Gradient of AB

$$\frac{2-0}{0-1} = 2\left(\frac{c^2 - 3c + 2 - 2}{c}\right)$$

M1: Formulating equation with gradients and solve

$$-2 = 2\left(\frac{c^2 - 3c}{c}\right)$$

$$-1 = \frac{c^2 - 3c}{c}$$

$$c^2 - 3c = -c$$

$$c^2 - 2c = 0$$

$$c(c-2) = 0$$

$c = 0$ (NA, since will get back point A) OR $c = 2$ **A1**

$\therefore C = (2, 2^2 - 3(2) + 2) = (2, 0)$

Method 2

Let $C=(x,y)$

Gradient of $AB = 2\times$ Gradient of AC

$\dfrac{2-0}{0-1}=2\left(\dfrac{y-2}{x-0}\right)$ **B1**: Gradient of AB

$\therefore y=-x+2$

Solve simultaneously with $y=x^2-3x+2$: **M1**: Formulating equations and solve simultaneously

$x^2-3x+2=-x+2$

$x^2-2x=0$

$x(x-2)=0$

$x=0$ (NA, since will get back point A) OR $x=2$

$\therefore C=(2,2^2-3(2)+2)=(2,0)$ **A1**

Answer (……, ……) [3]

---

20 It is given that $AB=\begin{pmatrix}-12\\ a\end{pmatrix}$, $a>0$ and $|BA|=37$ units.

(a) Find the value of a.

$|BA|=|AB|=37$

$\left|\begin{pmatrix}-12\\ a\end{pmatrix}\right|=37$

$\sqrt{(-12)^2+a^2}=37$ **M1**: Distance formula

$144+a^2=1369$

$a^2=1225$

$a=35$ or $a=-35$ (NA) **A1**

Answer $a=$……[2]

(b) C is a point $(0,10)$ and $\overrightarrow{AB} = \overrightarrow{DC}$.

Find the coordinates of D.

$\overrightarrow{AB} = \overrightarrow{DC}$

$\begin{pmatrix} -12 \\ 35 \end{pmatrix} = \overrightarrow{OC} - \overrightarrow{OD}$ **M1**: $OC - OD$

$\overrightarrow{OD} = \overrightarrow{OC} - \begin{pmatrix} -12 \\ 35 \end{pmatrix}$

$= \begin{pmatrix} 0 \\ 10 \end{pmatrix} - \begin{pmatrix} -12 \\ 35 \end{pmatrix}$

$= \begin{pmatrix} 12 \\ -25 \end{pmatrix}$

$\therefore$ Coordinates of $D = (12, -25)$ **A1**

Answer (.....) [2]

(c) What type of quadrilateral is $ABCD$? Explain your answer.

$AB = DC$

There is a pair of parallel sides with equal length.

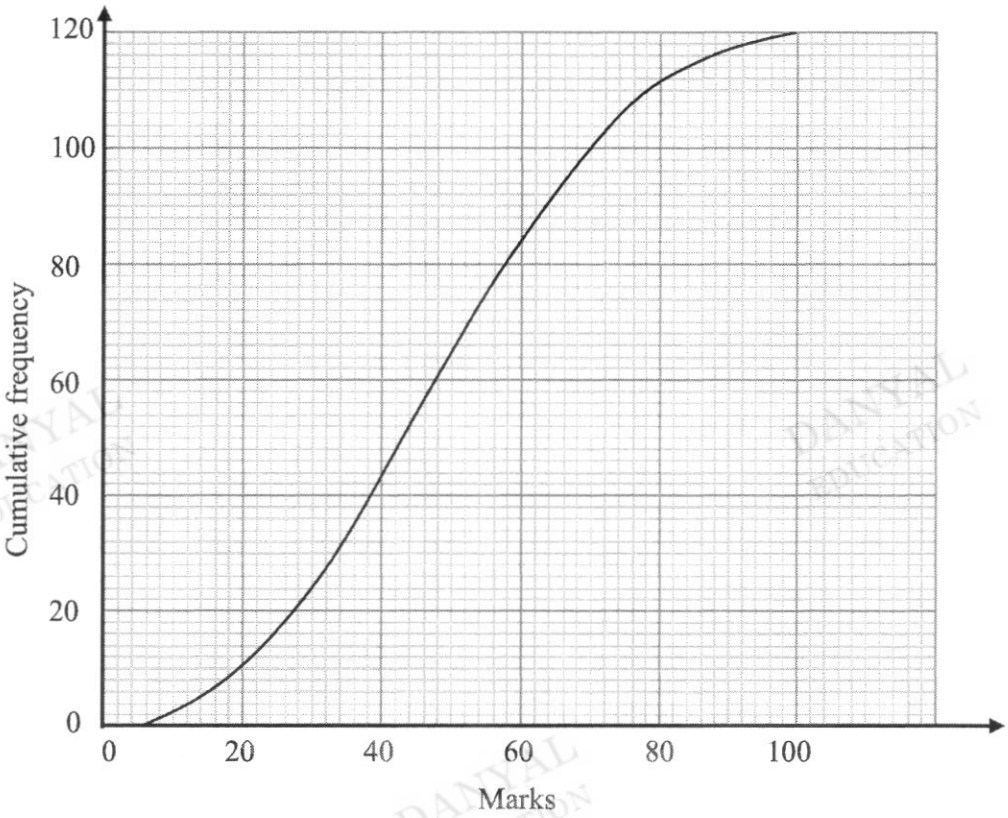
$\therefore$ $ABCD$ is a parallelogram. **B1**: Parallelogram

.....

.....

.....[1]

21 The cumulative frequency curve shows the marks obtained by the 120 students in a recent Mathematics Test. The maximum mark is 100.



(a) Complete the grouped frequency table for the marks obtained.

Marks obtained by students, x	Frequency
$0 \le x < 20$	10
$20 \le x < 40$	34
$40 \le x < 60$	40
$60 \le x < 80$	28
$80 \le x < 100$	8

[1]

(b) Calculate an estimate of the mean mark.

Required estimate

$$= \frac{(10)(10)+(30)(34)+(50)(40)+(70)(28)+(90)(8)}{120}$$

$$= 48\frac{1}{3} \text{ marks}$$

B1: Accept 48.7 marks

Answer .....marks [1]

(c) Calculate an estimate of the standard deviation.

Required estimate

$$= \sqrt{\frac{\Sigma fx^2}{\Sigma f} - \left(\frac{\Sigma fx}{\Sigma f}\right)^2}$$

$$= \sqrt{\frac{(10)^2(10)+(30)^2(34)+(50)^2(40)+(70)^2(28)+(90)^2(8)}{120} - \left(48\frac{1}{3}\right)^2}$$

M1: Using S.D formula

$$= \sqrt{2780 - \left(48\frac{1}{3}\right)^2}$$

A1

$= 21.1$ marks $(3$ s.f$)$

Answer .....marks [2]

(d) The passing mark is 50. Two students are chosen at random. Find the probability that both of them passed.

Within 10% of 50 means from 40 to 60.

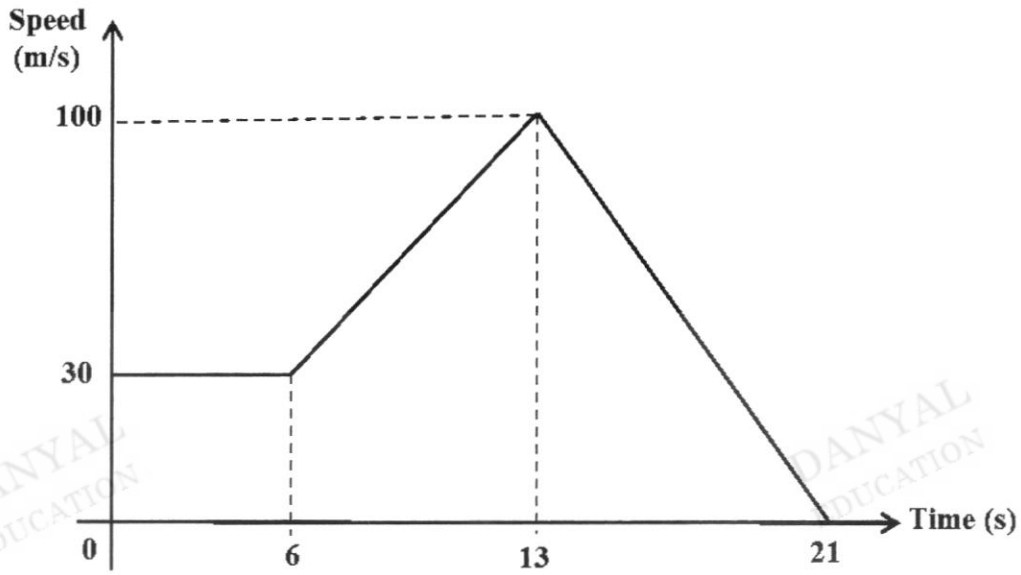
$$\text{Required probability} = \left(\frac{40}{120}\right)\left(\frac{39}{119}\right)$$

$$= \frac{13}{119}$$ **B1**

Answer ..... [1]

---

22 The diagram shows the speed-time graph of a particle.



(a) Find the speed of the particle when t = 12s.

Let the speed of the particle when $t = 12$ be v **M1**: Equating gradients

$$\frac{v-30}{12-6} = \frac{100-30}{13-6}$$

$\therefore v = 90$ m/s **A1**

Answer .....m/s [2]

(b) Find the distance covered before the particle starts to slow down.

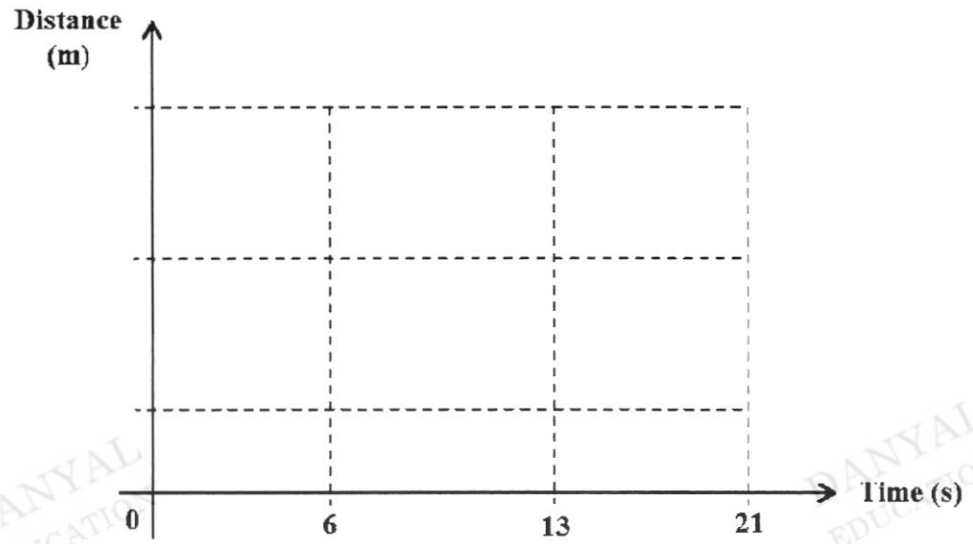
Distance = Area under the graph from 0s to 13s **M1**: Finding area under the graph using correct formula

$$= (6)(30) + \frac{1}{2}(30+100)(13-6)$$

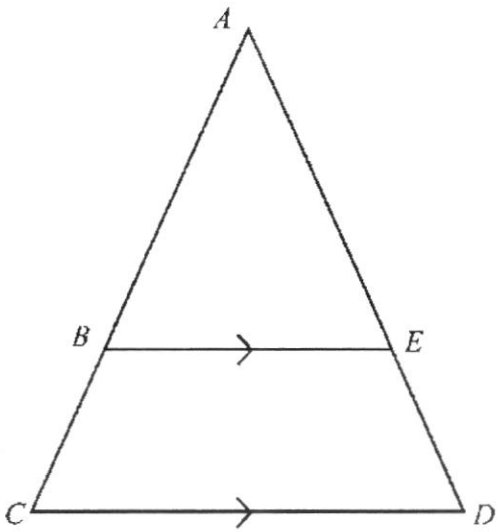
$= 635$ m **A1**

Answer .....m [2]

(c) Complete the distance-time graph of the particle. [1]



23



In the diagram, ABC and AED are straight lines and BE is parallel to CD.

(a) Show that triangle ABE is similar to triangle ACD. Give a reason for each statement you make.

$\angle BAE = \angle CAD$ (Common angle)

$\angle ABE = \angle ACD$ (Corresponding angles, BE parallel to CD)

$\angle AEB = \angle ADC$ (Corresponding angles, BE parallel to CD)

$\therefore$ By AA similarity test, ΔABE is similar to ΔACD

M1: Any two correct statements with complete reasons

A1: Conclusion with test

.....

.....

.....[2]

(b) Show that $\frac{BC}{ED} = \frac{AB}{AE}$. [2]

By similar Δs,

$$\frac{AC}{AB}=\frac{AD}{AE}$$

$$\frac{AB+BC}{AB}=\frac{AE+ED}{AE}$$

$$\frac{AB}{AB}+\frac{BC}{AB}=\frac{AE}{AE}+\frac{ED}{AE}$$

$$1+\frac{BC}{AB}=1+\frac{ED}{AE}$$

$$\therefore \frac{BC}{AB}=\frac{ED}{AE}$$

$$\therefore \frac{BC}{ED}=\frac{AB}{AE}$$

M1: Correct ratio with corresponding sides

A1 (AG)

(c) A circle is drawn with points B, C and D on its circumference. It is further given that angle BCD + angle $BED > 180°$. Explain why point E is **inside** the circle.

If point E is on the circumference of the circle, $BCDE$ will be a cyclic quadrilateral. Due to angles in opposite segments, $\angle BCD + \angle BED = 180°$.

Hence, E is not on circumference of the circle.

As E moves further away from the center of circle, $\angle BED$ will decrease in magnitude. Since $\angle BCD + \angle BED > 180°$, E will be in the circle.

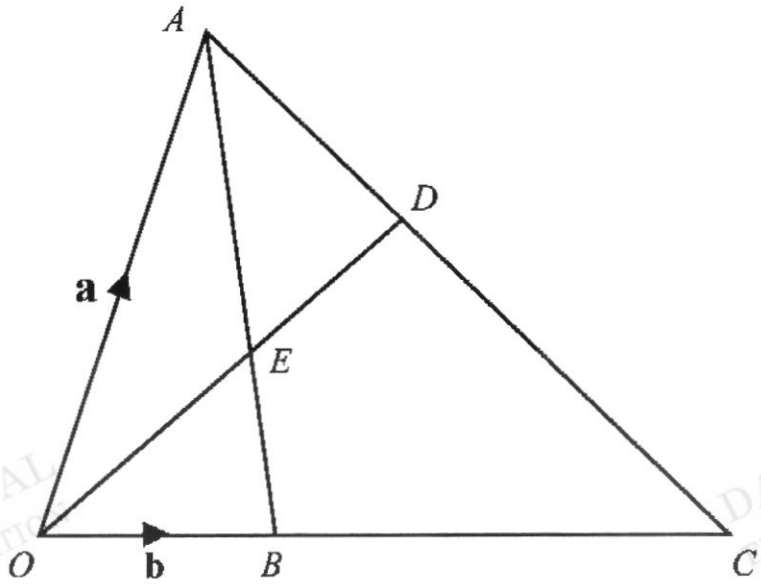
B1: Accept drawing to aid explanation

.....

.....

.....[1]

24



OBC, ADC, AEB and OED are straight lines.

$OA = \mathbf{a}$ and $OB = \mathbf{b}$.

$OB = \frac{1}{3}OC$, $AE : EB = 3 : 2$ and $OE : ED = 1 : 1$.

(a) Find OE in terms of **a** and/or **b** as simply as possible.

$$OE = OA + AE$$

$$= OA + \frac{3}{5}AB$$

M1: $OA + \frac{3}{5}AB$

$$= OA + \frac{3}{5}\left(OB - OA\right)$$

$$= \mathbf{a} + \frac{3}{5}\left(\mathbf{b} - \mathbf{a}\right)$$

$$= \frac{2}{5}\mathbf{a} + \frac{3}{5}\mathbf{b}$$

A1

Answer: $OE =$ .....[2]

(b) Find the value of $\frac{\text{area of } \Delta OBE}{\text{area of } BEDC}$.

Let area of ΔOBE be x

$\therefore$ area of $\Delta OAE = \frac{3}{2}x$ (Ratio of bases)

$\therefore$ area of $\Delta OAB = \frac{5}{2}x$ and area of $\Delta AED = \frac{3}{2}x$ (Ratio of bases)

$\therefore$ area of $\Delta ABC = 2\left(\frac{5}{2}x\right) = 5x$ (Ratio of bases)

$\therefore \frac{\text{area of } \Delta OBE}{\text{area of } BEDC} = \frac{x}{5x - \frac{3}{2}x} = \frac{2}{7}$

M1: Using ratio of bases to find area of ΔOAE

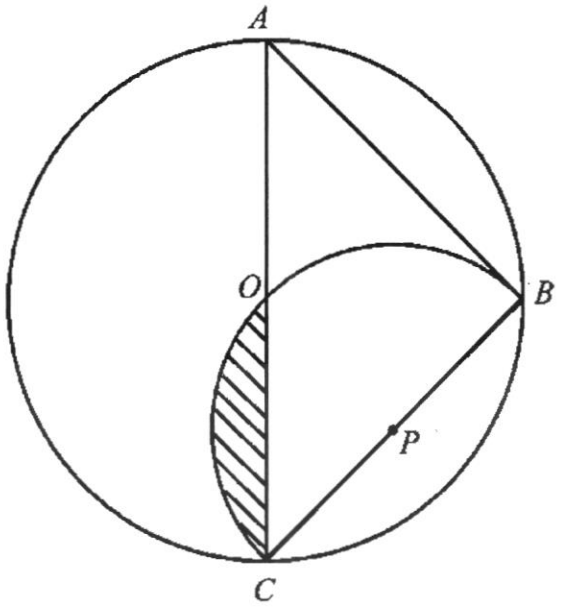
OR

Using ratio of bases to find area of ΔAED or ΔABC

A1

Answer ..... [2]

25



AC is a diameter of a circle with centre O. $AC = \sqrt{2}r$ and $AB = BC$.
COB is a semi-circular arc, centre P.
What percentage of the circle is **not** shaded?

$\angle ABC = 90°$ (Right angle in semicircle) **B1**: Need to show $\angle ABC = 90°$

$AB = BC$,

$(AB)^2 + (BC)^2 = (\sqrt{2}r)^2$

$2(BC)^2 = 2r^2$

$(BC)^2 = r^2$ **M1**: Finding AB or BC

$\therefore BC = r$ (Reject -ve)

$OC = \frac{1}{2}AC = \frac{\sqrt{2}}{2}r$

$CP = PO = \frac{1}{2}BC = \frac{r}{2}$

$OC^2 = CP^2 + PO^2$

$\therefore$ By converse of Pythagoras' Theorem,

Method 1: ΔOPC is a right angled Δ. **B1**: Need to show ΔOPC is a right angled Δ

Method 2:

THE END

Note that P and O are midpoints of BC and AC respectively.

$\therefore$ By midpoint theorem,

OP is parallel to AB,

and $\angle OPC = \angle ABC$

$\angle ABC = 90°$ (Right angle in semicircle)

$\therefore \angle OPC = 90°$

$\therefore \Delta OPC$ is a right angled Δ.

M1: Using midpoint theorem

A1: $\angle OPC = \angle ABC$

B1: Need to show ΔOPC is a right angled Δ

Percentage of circle shaded

$$= \frac{\text{Sector OPC} - \text{Triangle OPC}}{\text{Area of big circle}} \times 100\%$$

$$= \frac{\frac{1}{2}\left(\frac{r}{2}\right)^2\left(\frac{\pi}{2}\right) - \frac{1}{2}\left(\frac{r}{2}\right)^2 \sin\left(\frac{\pi}{2}\right)}{\pi\left(\frac{\sqrt{2}}{2}r\right)^2} \times 100\%$$

$$= \frac{\frac{1}{16}\pi r^2 - \frac{1}{8}r^2}{\frac{1}{2}\pi r^2} \times 100\%$$

$$= \frac{\frac{1}{16}\pi - \frac{1}{8}}{\frac{1}{2}\pi} \times 100\%$$

$= 4.542252845\%$

Percentage of circle shaded $= 100\% - 4.542252845\%$

$= 95.5\%$ (3 s.f)

M1: Correct percentage formula with the relevant shapes found using the correct formula (FT)

A1

Answer .....% [5]

O

JURONG SECONDARY SCHOOL
2022 GRADUATION EXAMINATION 2
SECONDARY 4 EXPRESS/
SECONDARY 5 NORMAL ACADEMIC

CANDIDATE NAME	MARKING SCHEME

CLASS		INDEX NUMBER	

MATHEMATICS 4048/02

PAPER 2

24 August 2022
2 hour 30 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

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

Answer **all** the 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.

At the end of the examination, fasten all your work securely together.
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 **26** printed pages including this page.

1	(a)	(i)	$\frac{3}{2}$	B1
		(ii)	$y=\frac{5x-2}{3x+1}$ $3xy+y=5x-2$ $5x-3xy=y+2$ $x(5-3y)=y+2$ $x=\frac{y+2}{5-3y}$	M1 – simplify + group A1
	(b)		$\frac{x-5}{3}-\frac{x+3}{2}=-4$ $\frac{2(x-5)-3(x+3)}{6}=-4$ $2x-10-3x-9=-24$ $x=5$	M1 – same denominator A1
	(c)		$2x+y=23$ $y=23-2x$ $3x-2(23-2x)=10$ $3x-46+4x=10$ $7x=56$ $x=8$ $y=7$	M1 – substitution A1 A1
	(d)		$\frac{4x^2-9}{6x^2-x-12}$ $=\frac{(2x-3)(2x+3)}{(2x-3)(3x+4)}$ $=\frac{2x+3}{3x+4}$	M1 – numerator M1 – denominator A1
				Total: 11 marks

2	(a)	$\begin{pmatrix} 28 & 24 \\ 16 & 12 \end{pmatrix}$	B1
	(b)	$\begin{pmatrix} 70 \\ 80 \end{pmatrix}$	B1
	(c)	$\begin{pmatrix} 3880 \\ 2080 \end{pmatrix}$	B1
	(d)	The elements represent the total amount Mrs Teo collected in a month from the weekday and weekend sessions respectively.	B1
	(e)	Total amount of money per session $= \begin{pmatrix} 10 & 8 \\ 3 & 2 \end{pmatrix}\begin{pmatrix} 70 \\ 80 \end{pmatrix} = \begin{pmatrix} 1340 \\ 370 \end{pmatrix}$ Total after 10% increase $= \begin{pmatrix} 1 & 1.1 \end{pmatrix}\begin{pmatrix} 1340 \\ 370 \end{pmatrix} = (1747)$ $1747 \times 4 \times 3 = \$20964$	M1 M1 M1 A1 Accept non-matrices working
			Total: 8 marks

3	(a)	$\angle XCD = \frac{360°}{18} = 20°$	B1
	(b)	$\angle XCD = \angle XDC$ $\angle CXD = 180° - 20° - 20°$ (isos. Δ) $= 140°$	A1 (with reason)
	(c)	$BC = ED$ (sides of regular polygon) $XC = XD$ (given) $\therefore BC + CX = ED + DX$ $BX = EX$	M1 – evidence A1
	(d)	$\angle BXE = \angle CXD$ (common) $\angle XBE = \frac{180° - 140°}{2} = 20°$ $\therefore \angle XCD = \angle XBE$ ΔXCD and ΔXBE are similar (AA)	M1 – evidence A1
	(e)	They are parallel.	B1
			Total: 7 marks

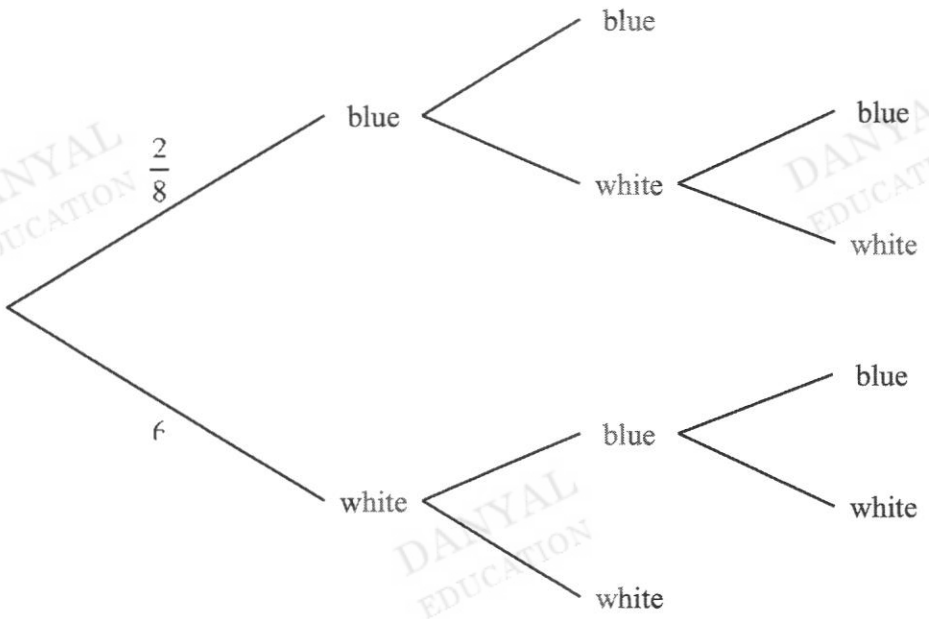
4	(a)	$T_5 = 9^2 - 34 = 47$	B1 (with working)
	(b)	$T_n = (n+4)^2 - 18 - 4(n-1)$ $= n^2 + 8n + 16 - 18 - 4n + 4$ $= n^2 + 4n + 2$	M1 – n+4 and $18 + 4(n-1)$ A1
	(c)	$n^2 + 4n + 2 = 962$ $n^2 + 4n - 960 = 0$ $n = \dfrac{-4 \pm \sqrt{4^2 - 4(1)(-960)}}{2(1)}$ $= 29.048$ or -33.048 Since n is not an integer, 962 is not a term of the sequence.	 M1 – find value of n A1
	(d)	$T_n - T_{n-1}$ $= (n^2 + 4n + 2) - [(n-1)^2 + 4(n-1) + 2]$ $= n^2 + 4n + 2 - (n^2 - 2n + 1 + 4n - 4 + 2)$ $= n^2 + 4n + 2 - n^2 + 2n - 1 - 4n + 4 - 2$ $= 2n + 3$	 M1 – correct expression M1 – correct expansion A1
	(e)	The difference between two consecutive terms is $2n+3$. Since $2n$ is always even for all values of n, the sum of an even integer and an odd constant 3 will always give an odd integer.	B1 – always even + add to odd
			Total: 8 marks

5	(a)	$p = 2.2$		B1
	(b)	Refer to last page		G3
	(c)	The graph of $y = x + \frac{5}{x^2} - 3$ does not meet the line $y = 0$/does not have any x-intercepts/ the minimum y-value is , which is more than 0		B1
	(d)	Draw tangent Gradient = -1.96 ± 0.7		B1 B1
	(e)	(i)	Draw line with gradient 2 passing through $(0.5, 2)$ (y-intercept = 1)	B1 - passes through $(0.5, 2)$ B1 – correct gradient (& y-int)
		(ii)	$y = 2x + 1$	B1
		(iii)	$x + \frac{5}{x^2} - 3 = 2x + 1$ $\frac{5}{x^2} = x + 4$ $5 = x^3 + 4x^2$ $x^3 + 4x^2 - 5 = 0$	M1 – sim. eqn. A1 – final eqn
		(iv)	$x = 1$	B1 (ecf – accept answer from intersection of curve and line)
				Total: 13 marks

6	(a)		$OS = OR$ (radii of smaller circle) $\angle POS = \angle QOR$ (vert. opp. $\angle$) $OP = OQ$ (radii of larger circle) $\therefore \Delta PSO$ is congruent to ΔQRO (SAS) **Alternatives:** RHS, AAS	M1 A1
	(b)	(i)	$\angle ORQ = 90°$ (tan $\perp$ rad) $QR = \sqrt{8^2 - 4.36^2}$ $= 6.7075$ Area of $\Delta QRO = \frac{1}{2}(4.36)(6.7075)$ $= 14.62235$ $\approx 14.6 \text{ cm}^2$	M1 – with evidence M1 A1
		(ii)	Area of shaded minor sector $= \frac{1}{2}(4.36)^2(0.995)$ $= 9.457276$ Area of ring between the circles $= \pi(8)^2 - \pi(4.36)^2$ $= 141.3415$ Area of unshaded in ΔQRO $= 14.62235 - 9.457276$ $= 5.165074$ Shaded area $= 141.3415 + 2(9.457276) - 2(5.165074)$ $= 149.925904$ $\approx 150 \text{ cm}^2$	M1 M1 M1 A1
				Total: 9 marks

7	(a)	$\frac{5}{1+2+4+5}\times 300\times \$148 = \$18500$		M1 A1
	(b)	(i)	$\frac{300}{x}$ min	B1
		(ii)	$\frac{300}{x-2}$ min	B1
		(iii)	$\frac{300}{x-2}-\frac{300}{x}=3$ $\frac{300x-300(x-2)}{x(x-2)}=3$ $x^2-2x-200=0$ (shown)	M1 – form eqn M1 – combine fractions A1
		(iv)	$x=\frac{-(-2)\pm\sqrt{(-2)^2-4(1)(-200)}}{2(1)}$ $=15.17744$ or -13.17744 ≈ 15.2 or -13.2	M1 A1 (3sf, no rej.)
		(v)	Reject -13.2 $x=15.2$ $15.17744\times 60=910.6464$ ≈ 910	M1 A1 (round down) (Reject 3 x 60)
				Total: 11 marks

8	(a)	$\angle AOB = 120°, \angle ABO = 30°$ $\frac{OA}{\sin 30°} = \frac{8}{\sin 120°}$ $OA = \frac{8}{\sin 120°} \times \sin 30°$ ≈ 4.6188 cm $= 4.619$ cm (to 3 d.p.) **OR** $OA = \frac{2}{3}\sqrt{8^2 - 4^2}$ $= 4.61880$ ≈ 4.619	M1 – sine rule A1 M1 A1
	(b)	Base area $\Delta ABC = \frac{1}{2}(8)(8)\sin 60°$ ≈ 27.7128 cm^2 Height of ΔAXB, $l = \sqrt{18^2 - 4^2}$ ≈ 17.5499 cm Total surface area $= 3 \times \frac{1}{2}(8)(17.5499) + 27.7128$ ≈ 238.31 cm^2 $= 238$ cm^2 (to 3 s.f.)	M1 – base M1 – lateral height A1
	(c)	$\cos \angle PQR = \frac{5^2 + 4^2 - 3.5^2}{2(5)(4)}$ $\angle PQR = \cos^{-1}\left(\frac{23}{32}\right)$ $= 44.0°$ (to 1 d.p.)	M1 – cosine rule A1
	(d)	$AQ = 6$ cm $OQ = \sqrt{4.619^2 + 6^2 - 2(4.619)(6)\cos 30°}$ ≈ 3.055 cm $XO = \sqrt{18^2 - 4.619^2}$ ≈ 17.397 cm $\tan\theta = \frac{17.397}{3.055}$ Angle of elevation of X from Q $= \tan^{-1}\left(\frac{17.397}{3.055}\right)$ $= 80.0°$ (to 1 d.p.)	M1 – find OQ M1 – Pythagoras' thm M1 A1
			Total: 11 marks

9	(a)	(i)	$100 < x \leq 120$		B1
		(ii)	22%		B1
		(iii)	$\text{S.D.} = \sqrt{\frac{809000}{50} - (\frac{6280}{50})^2}$ $= 20.11566$ ≈ 20.1		M1 – working (show substitution) A1
		(iv)	The blood pressures of the second group of patients is less consistent than that of the first group of patients, since it has a SD of 22.1 which is higher than the SD of the first group (20.1)		B1 – compare SD and comment on consistency
	(bi)				B2 -1 for each wrong pair of branches
		(ii)	(a)	$(\frac{6}{8} \times \frac{5}{7}) + (\frac{2}{8} \times \frac{1}{7}) = \frac{4}{7}$	M1 – either both W or both B A1 FT from tree diagram
			(b)	$\left(\frac{2}{8} \times \frac{6}{7} \times \frac{1}{6}\right) + \left(\frac{6}{8} \times \frac{2}{7} \times \frac{5}{6}\right)$ $= \frac{3}{14}$	M1 – either WBW or all BWB A1
					Total: 11 marks

10	(a)	$3.42 \times 2.7 = 9.234\ m^2$	B1 Reject 3s.f.
	(b)	10 cm represents 168 cm 1 cm represent 16.8 cm Elbow to ground = 6.4 cm (accept 6.3cm and 6.5cm) $6.4 \times 16.8 = 107.52$cm Range of optimal kitchen cabinets height $107.52 - 10 = 97.52$ cm to 107.52 cm	M1 – measure distance from elbow to ground A1 Measured 6.3 cm, 95.84 cm to 105.84 cm Measured 6.5 cm, 99.2 cm to 109.2 cm
	(c)	**Kitchen Cabinet** Compulsory: Sink + corner cabinet + wire basket shelves Cabinet 1 + Cabinet 2 (must go at the junction of the wall) + Cabinet 5 Remaining length = $342-50-60-50=172$ cm Remaining width = $135-60=75$ cm Current total cost = $\$156+\$166+\$166=\$488$ Along the length – 1 Cabinet 3 + 1 Cabinet 4 (90 cm + 80 cm) Along the width – 1 Cabinet 6 (70 cm) in order to optimise storage Total cost of cabinets = $\$488+\$193+\$260+\$290=\$1231$ Height customisation = $\$25\times6=\$150$ Remaining budget = $\$2200-\$1231-\$150=\$819$ $\therefore$ Ceramic or acrylic for materials Mr Graham should choose the **Ceramic** counter top and his kitchen cabinet combination is one of cabinets **1, 2, 3, 4, 5, 6** with \$19 remaining in his budget.	M1 (Cabinet 1+2+5) M1 (remaining space) M1 (combination of cabinets) M1 – total cost of cabinets M1 – height M1 – budget + conclusion for type of material A1 (relate to budget)
			Total: 10 marks