Name:_____ ( )	Class:_____

SERVE·LEAD·EXCEL

80

GREENDALE SECONDARY SCHOOL
End-of-Year Examination 2021

MATHEMATICS **4048/01**

Paper 1 11 October 2021

Secondary 3 Express **2 hours**

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
Write in dark or blue pen.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, 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 may result in loss of marks.
You are expected to use a scientific calculator to evaluate explicit numerical expressions.
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**.

Question	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Strand	N1	N1	G1	S1	P2	G2	A7	N2	A7	A5	A5	G2
Marks												
Question	**Q13**	**Q14**	**Q15**	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**	**Q21**	**Q22**	**Q23**	**Q24**
Strand	A6	G1	G4	A7	N1	N10	N2	M5	A6	N10	G2	G1
Marks												

No of additional booklets/ writing paper used		**No of additional graph paper used**	

This document consists of 19 printed pages, including this cover page.

For Examiner's Use Only

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

For Examiner's Use Only

Answer **all** questions.

1 The enrolment of a school is given as 1000, correct to the nearest thousand.
Find the maximum enrolment of the school.

Answer _____ [1]

---

2 $<$ $=$ $>$

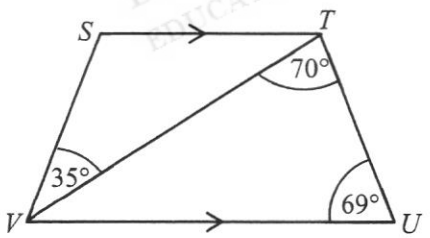
Choose a symbol from the list to make a correct statement.

Answer (a) $\frac{1}{9}$ _____ 0.111 [1]

Answer (b) 1 _____ $3a^0$ [1]

---

3 Find angle VST.



Answer _____ ° [2]

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4 The stem-and-leaf diagram shows the time taken, in minutes, taken by some adults to finish their lunch.

0	8	9			
1	2	3	5	7	7
2	0	2			
3	9				

Key: 1|2 represents 12 minutes

(a) Find the median time taken.

Answer (a) _____ min [1]

(b) Explain why mean might not be an appropriate average to use to summarise the times taken by these adults. [1]

Answer

---

5 A bag contains 10 red marbles, 5 green marbles and x blue marbles.

Write down an expression in terms of x,

(a) the total number of marbles,

Answer (a) _____ [1]

(b) the probability of selecting a green marble.

Answer (b) _____ [1]

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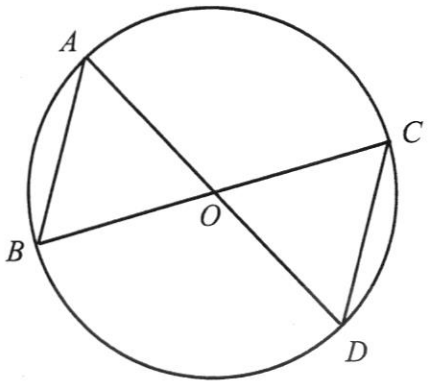
6 The diagram below shows a circle with centre O.
AD and BC are diameters of the circle.



Show that triangle AOB and triangle COD are congruent. [2]

Answer

7 Solve the inequalities $5 \leq 4x - 7 \leq 2x$.

Answer _____ [3]

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8 Anne and Cheryl shared a sum of money between them in the ratio 3 : 7.
After Cheryl gave $255 to Anne, the ratio of the amount of money that Anne and Cheryl have is 5 : 6.
Find the original sum of money.

Answer $ _____ [3]

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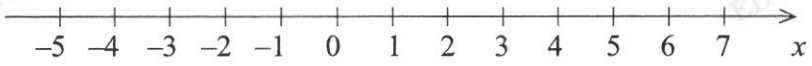
9 **(a)** Solve the inequalities $-5 < \frac{5}{2}x \leq 10$.

Answer (a) _____ [1]

(b) Represent your solution for (a) on the number line below. [1]



(c) x is a prime number.

Write down the possible value(s) of x that satisfies $-5 < \frac{5}{2}x \leq 10$.

Answer (c) _____ [1]

---

10 **(a)** Simplify $6-2(x-1)$.

Answer (a) _____ [1]

(b) Factorise completely $3ax+bx-6ay-2by$.

Answer (b) _____ [2]

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11 **(a)** Simplify $a^3b^2 \times a^{-4}b^2$.

Answer (a) _____ [1]

(b) Given that $8 \times 4^m = 2^m$, find m.

Answer (b) $m =$ _____ [1]

(c) Given that $\frac{3}{3^k} = 3^n$, express n in terms of k.

Answer (c) $n =$ _____ [1]

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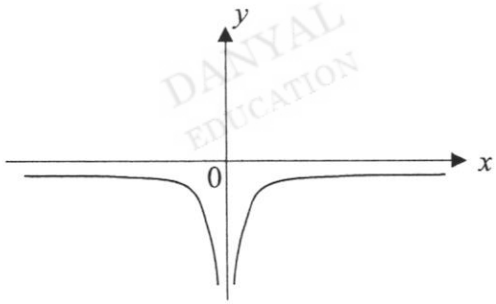
12 Two containers are geometrically similar.
The height of the smaller container is 15 cm and the height of the larger container is 20 cm.

It takes 3 minutes to fill the smaller container completely with water.
Find the time taken to fill the larger container completely with water.
Give your answer in minutes and seconds, to the nearest second.

Answer _____ min _____ s [3]

---

13 The graph of $y = ax^n$ is shown below.



(a) Write down a possible value for a and for n.

Answer (a) $a =$ _____

$n =$ _____ [2]

(b) Using the graph, explain why there is no solution to the equation $ax^n = 3$. [1]

Answer

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14 A n-sided polygon has two interior angles measuring 124° and 140° and the remaining **exterior** angles measuring 33° each.
Find the value of n.

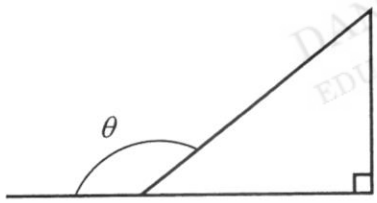
Answer $n =$ _____ [3]

---

15 **(a)** The sine of an angle is 0.235.
Give two possible values for the angle.

Answer (a) _____ ° or _____ ° [2]

(b) θ is an obtuse angle.
Given that $\sin\theta = \frac{4}{5}$, without using a calculator, find the value of $\cos\theta$.



Answer (b) _____ [2]

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16 **(a)** Express $x^2 - 6x + 3$ in the form $(x-h)^2 + k$.

Answer (a) _____ [1]

(b) **Hence**, solve the equation $x^2 - 6x + 3 = 0$, giving your answers correct to two decimal places.

Answer (b) $x =$ _____ or _____ [3]

For Examiner's Use Only

17 When written as the product of their prime factors,

$$m = 2^{12} \times 3^{12},$$
$$n = 2^{10} \times 5^{13}.$$

(a) Using the information above, explain why m is a perfect square. [1]

Answer

(b) Giving your answers as the product of its prime factors, find

(i) the HCF of m and n,

Answer (bi) _____ [1]

(ii) the LCM of m and n.

Answer (bii) _____ [1]

(c) p is a composite number, q is a prime number and $p < q$.

Find the values of p and q such that $n \times \frac{p}{q}$ is a perfect cube.

Answer (c) $p =$ _____

$q =$ _____ [1]

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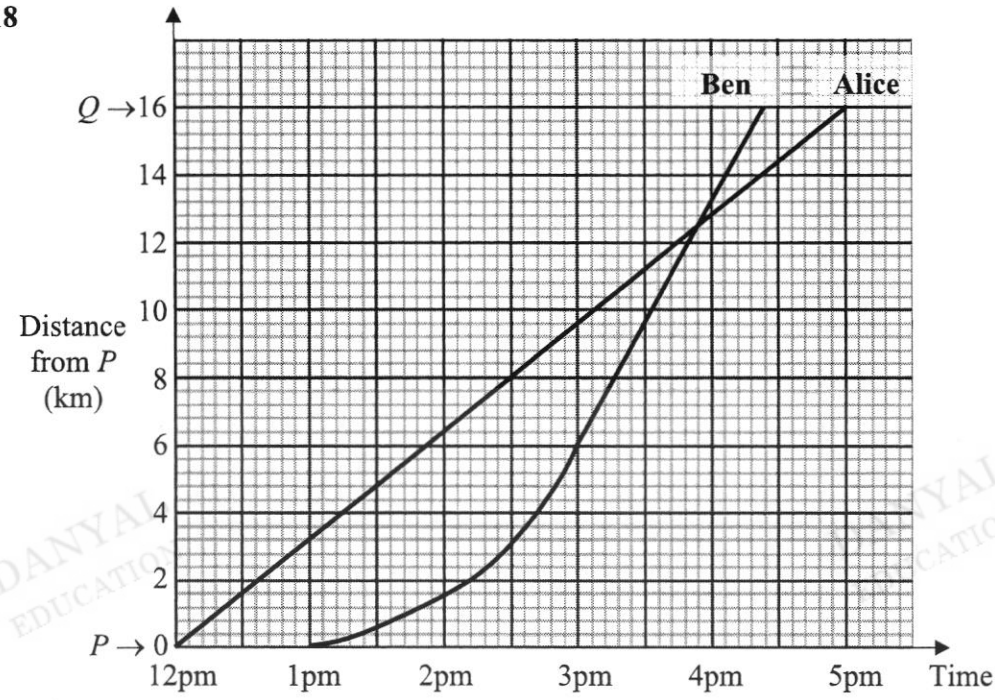
18



The distance-time graph shows the journey for Alice and Ben, between point P and Q.

(a) Find Alice's speed for the journey.

Answer (a) _____ km/h [1]

(b) What time did Alice and Ben meet each other?

Answer (b) _____ pm [1]

(c) Describe Ben's speed from 1 pm to 3 pm.

Answer

_____

_____ [1]

(d) Find Ben's average speed from 1 pm to 3 pm.

Answer (d) _____ km/h [1]

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19 The volume of a container, v cm^3, is directly proportional to the cube of its radius, r cm.
The volume of the container is 2500 cm^3 when the radius is 10 cm.

(a) Find a formula for v in terms of r.

Answer (a) $v =$ _____ [2]

(b) Find the radius of the container when the volume is 1000 cm^3.

Answer (b) _____ cm [1]

(c) Find the percentage increase in volume when the radius is doubled.

Answer (c) _____ % [1]

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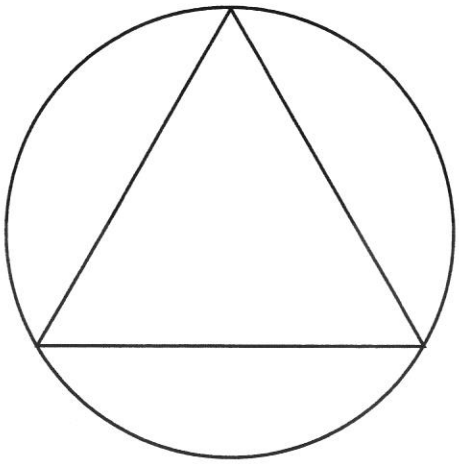
20 A logo consists of an equilateral triangle inscribed in a circle.
The area of the triangle is 50 cm^2.
Find the area of the circle.



Answer _____ cm^2 [4]

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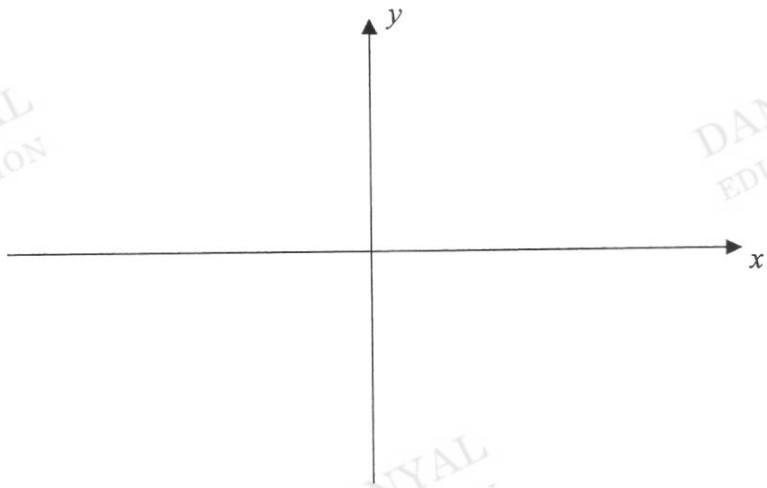
21 **(a)** Factorise $x^2 - 4x + 3$.

Answer (a) _____ [1]

(b) Hence, sketch the graph of $y = x^2 - 4x + 3$ on the axes below.
Indicate clearly the values where the graph crosses the x- and y-axes. [2]



(c) Write down the equation of the line of symmetry.

Answer (c) _____ [1]

(d) Find the coordinates of the minimum point.

Answer (d) (_____ , _____) [1]

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22 **(a)** A light year is the distance that light travels in one year.
The speed of light is 3×10^8 m/s and 1 light year = x metres.
Calculate the value of x.
Give your answer in standard form, correct to 3 significant figures.

Answer (a) _____ [2]

(b) The current distance between Earth and Mars is 388 million km.
A space probe travels at 55 000 km/h.
Calculate the time taken for the space probe to travel from Earth to Mars.
Give your answer in days, correct to the nearest day.

Answer (b) _____ days [3]

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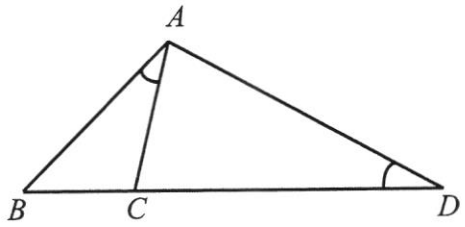
23 The diagram below shows triangle ABD.

Point C lies on BD such that angle BAC = angle BDA.



(a) Show that triangle ABC and triangle DBA are similar. [2]

Answer

(b) Given that $AB = 7$ cm and $BC = 4$ cm, find BD.

Answer (b) _____ cm [1]

(c) Find the value of

(i) $\dfrac{\text{area of triangle } ABC}{\text{area of triangle } DBA}$,

Answer (ci) _____ [1]

(ii) $\dfrac{\text{area of triangle } ABC}{\text{area of triangle } ACD}$.

Answer (cii) _____ [1]

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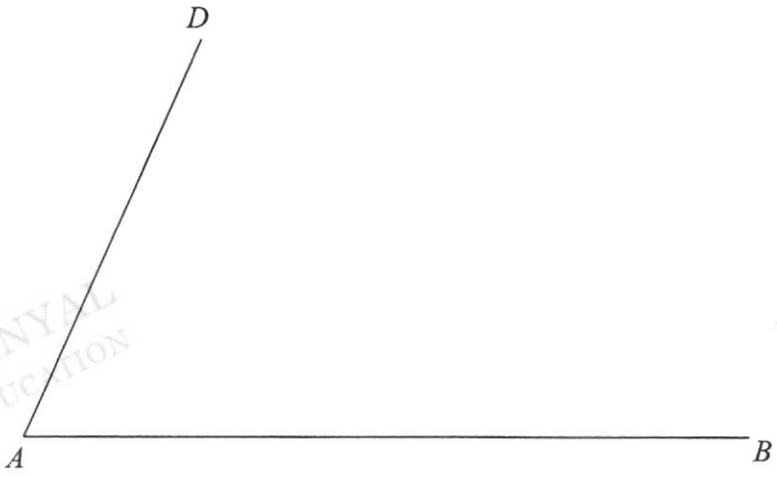
24 $ABCD$ is a field in the shape of a trapezium whereby AB is parallel to DC.
B is due east of A and C is on a bearing of 330° from B.



(a) Points A, B and D are shown in the diagram above.
Complete the drawing for field $ABCD$. [1]

(b) Construct the perpendicular bisector of AB. [1]

(c) Construct the angle bisector of angle DAB. [1]

(d) Point P is equidistant from points A and B and equidistant from lines DA and AB.
Mark and label point P. [1]

(e) The diagram is drawn to a scale of 1 cm : 2 km.
Find the actual distance of AP.

Answer (e) _____ km [2]

-End of Paper-

Name:_____ ( )	Class:_____

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100

GREENDALE SECONDARY SCHOOL
End-of-Year Examination 2021

MATHEMATICS **4048/02**

Paper 2 **04 Oct 2021**

Secondary 3 EXPRESS **2 hours 30 minutes**

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your index number and name in the spaces at the top of this page.
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.
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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.**

Question	Q1a, d	Q1b, c	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Strand	A5	A7	S1	G6	A6	A5	M5	G4	M5	A7	N10
Marks											

No of additional booklets/ writing paper used		No of additional graph paper used	

This document consists of 23 printed pages, including this cover page and 1 blank page.

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

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[Turn over for Question 1]

Answer **all** questions.

1 **(a)** It is given that $a = \dfrac{4b+5c}{b-c}$.

(i) Find a when $b = 1$ and $c = -2$.

Answer $a =$ _____ [1]

(ii) Express b in terms of a and c.

Answer $b =$ _____ [2]

(b) Solve these simultaneous equations.

$$4x - 3y = 28$$
$$6x + y = 9$$

Answer $x =$ _____

$y =$ _____ [3]

(c) Solve the equation $\frac{2x-1}{4}+\frac{x}{3}=1$.

Answer $x=$ _____ [2]

(d) Simplify $\frac{x^2-8x}{x^2-64}$.

Answer _____ [3]

2 The number of goals scored in 20 football matches were

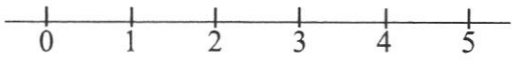
5	0	5	4	1	0	5	5	1	3
4	5	0	0	5	5	3	2	5	4

(a) **(i)** Complete the table below.

Number of goals	Frequency
0	
1	
2	
3	
4	
5	

[1]

(ii) Represent the information as a dot diagram in the space below.



[2]

Number of Goals

(iii) State the mode.

Answer _____[1]

(iv) Calculate the mean number of goals.

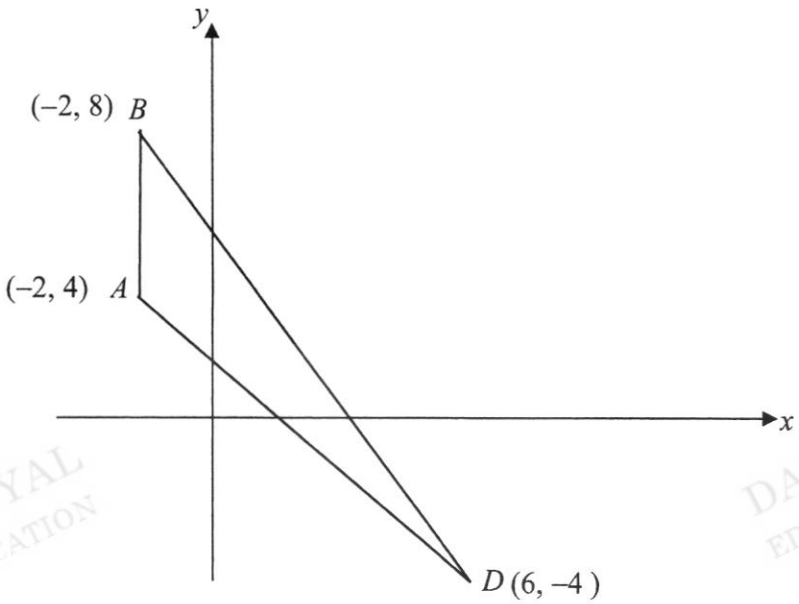
Answer _____ [2]

(b) A pie chart was drawn to illustrate the number of goals scored in the 20 matches.

Calculate the angle of the sector which represented 5 goals scored.

Answer _____ ° [2]

3



The points A, B and D are (–2, 4), (–2, 8) and (6, –4) respectively.

Find

(a) the gradient of the line BD,

Answer Gradient = _____[1]

(b) the equation of the line through A which is parallel to BD,

Answer y = _____[2]

(c) the length of BD,

Answer BD = _____units [2]

(d) the area of triangle ABD,

Answer _____ units^2 [2]

(e) the perpendicular distance of A to the line BD,

Answer _____ units [2]

(f) the coordinates of C if $ABCD$ is a parallelogram.

Answer C (_____, _____) [1]

4 Temperatures were recorded over a nine hour period.
The table below shows the temperature, y°C, at various times.

Time (x hours)	0	1	2	3	4	5	6	7	8	9
Temperature (y°C)	2	–1	–2	–1.4	0	2	3.5	3.4	2.4	0.6

(a) On the grid opposite, plot the points given in the table with a smooth curve.

[3]

(b) Use your graph to estimate

(i) the temperature when $x = 5.5$,

Answer $y =$ _____ $^\circ$C [1]

(ii) how long, in hours, the temperature was above 2°C.

Answer _____ hours [2]

(c) **(i)** By drawing a tangent, estimate the gradient of the curve at $x = 8$.

Gradient = _____ [2]

(ii) State briefly what this gradient represents.

_____

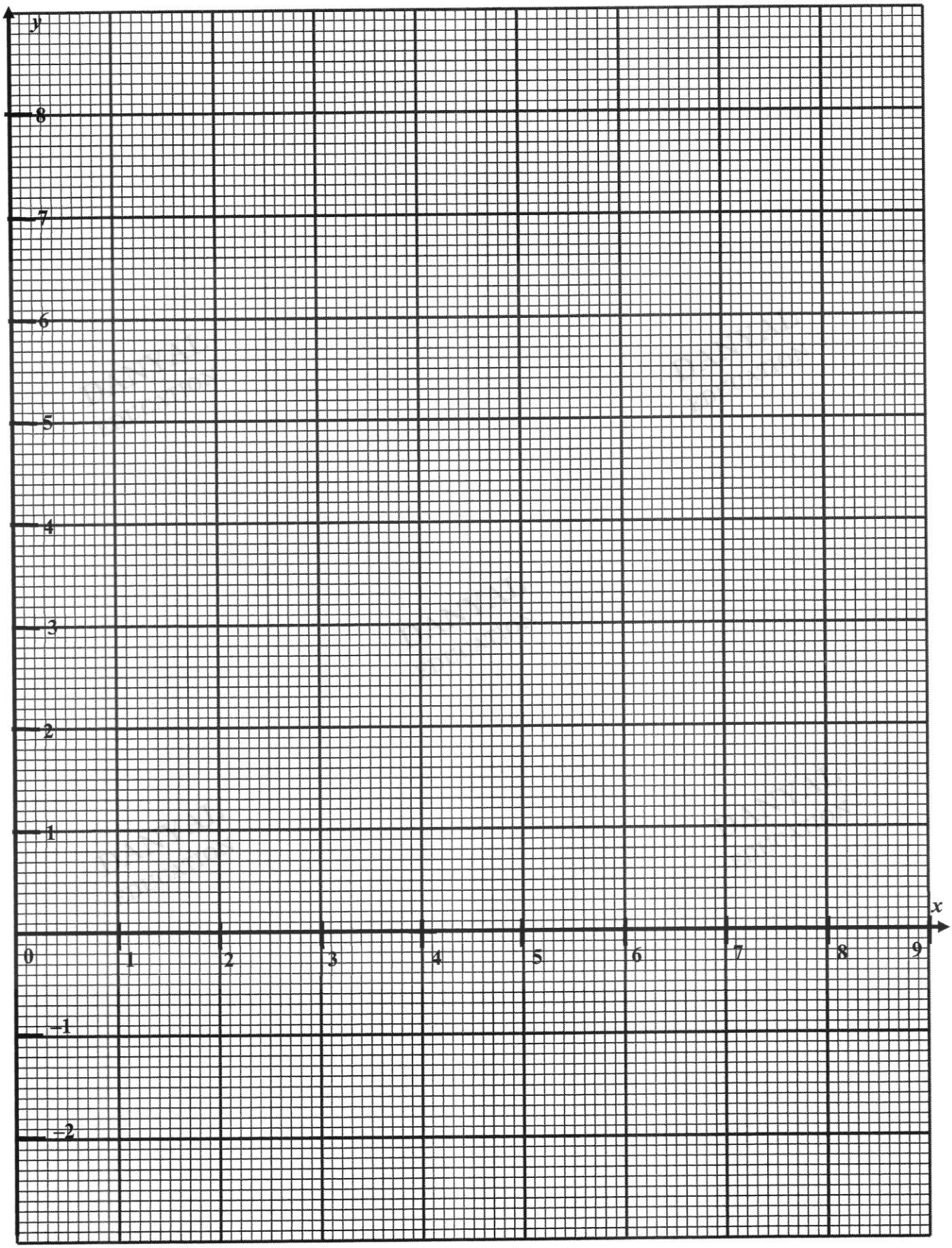
_____ [1]

(d) The curve from $x = 0$ to $x = 2$ has the equation $y = x^2 + Ax + B$.

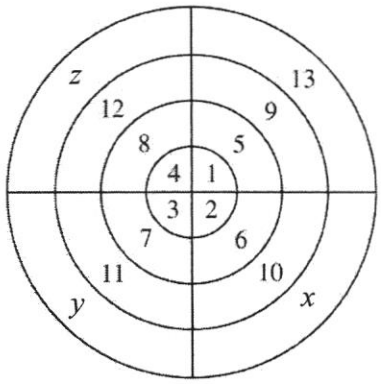
Find the value of A and of B.

Answer $A =$ _____

$B =$ _____ [2]


y
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
x
−1
−2

5



The natural numbers 1, 2, 3, … are written, in a clockwise direction, on a circular grid as shown in the diagram.
The numbers 1, 2, 3, and 4 are in the first ring.
The numbers 5, 6, 7 and 8 are in the second ring.
The following numbers fill up the other rings in the same way.

(a) Write down the numbers in the fourth ring.

Answer $x =$ _____, $y =$ _____, $z =$ _____ [1]

(b) Write down the largest number in the tenth ring.

Answer _____ [1]

(c) The sum, S_n, of the four numbers in the nth ring, where $n = 1, 2$ and 3, is given in the table below.

n	1	2	3	4
S_n	10	26	42	

(i) Write down the value of S_4.

Answer $S_4 =$ _____ [1]

(ii) Find, in its simplest form, an expression, in terms of n, for S_n.

Answer $S_n =$ _____ [2]

(iii) In which ring is the sum of the four numbers equal to 1018?

Answer _____ [1]

6 A closed container is made by joining together a cylinder of radius 9 cm and a hemisphere of radius 9 cm as shown in Diagram I.
The length of the cylinder is 18 cm.
The container rests on a horizontal surface and is exactly half full of water.

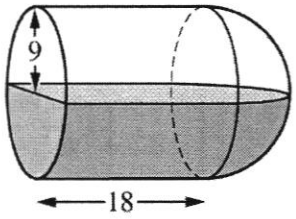


Diagram I

(a) Calculate the surface area of the inside of the container that is in contact with the water. Give your answer in terms of π.

Answer _____ cm^2 [4]

(b) Show that the volume of the water is 972π cm^3.
Answer

[2]

(c) The container is now placed with its circular end on a horizontal surface as shown in Diagram II.
Find the depth of the water.

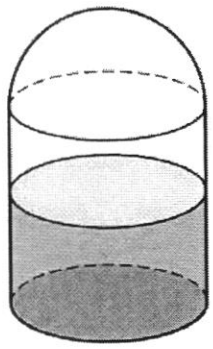


Diagram II

Answer _____cm [2]

(d) The container is then held with its axis vertical, the hemisphere being at the bottom, as shown in Diagram III.
Calculate the depth of the water.

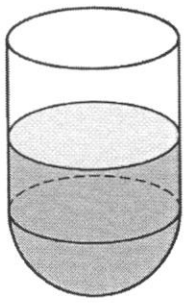
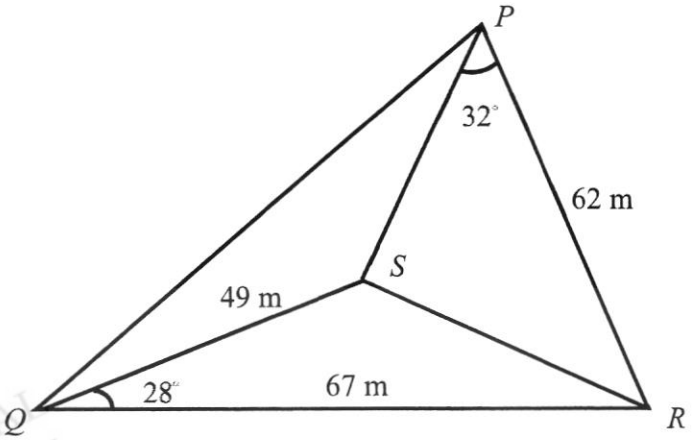


Diagram III

Answer _____cm [4]

7 The diagram shows four points P, Q, R and S on horizontal ground.
$PR = 62$ m, $QR = 67$ m, $QS = 49$ m, angle $RQS = 28°$ and angle $RPS = 32°$.



(a) Calculate the

(i) length of RS,

Answer _____ m [3]

(ii) angle PSR,

Answer _____ ° [2]

(iii) area of triangle QRS,

Answer _____ m^2 [2]

(iv) shortest distance from S to QR.

Answer _____ m [2]

(b) A vertical flagpole stands at point S. The angle of elevation of the top of the flagpole from point Q is 35°.

Calculate the angle of elevation of the top of the flagpole from R.

Answer _____ $^\circ$ [3]

8

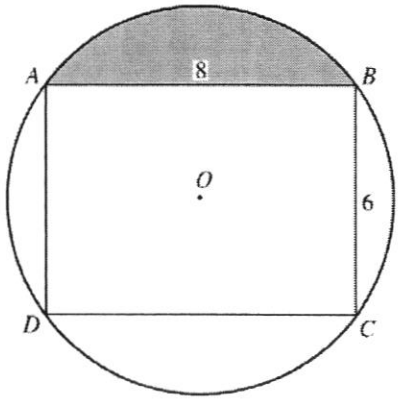


Diagram I

$ABCD$ is a rectangle in which $AB = 8$ cm and $BC = 6$ cm.
A circular piece of wire, centre O, passes through the vertices of the rectangle as shown in Diagram I.

(a) Show that the radius of the circular wire is 5 cm.
Answer

[1]

(b) Show that angle $AOB = 106.3^{\circ}$, correct to 1 decimal place.
Answer

[2]

(c) Calculate the area of the shaded segment.

Answer _____ cm^2 [3]

(d) The circular wire is cut at A, B, C, D, and four pieces joined to form the shape shown in Diagram II.

Calculate the area enclosed by the wires in Diagram II.

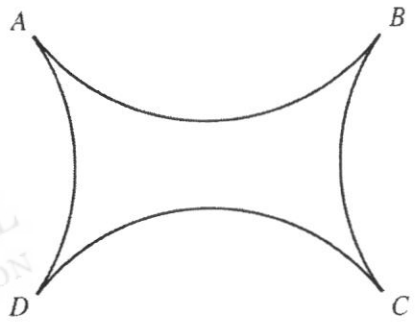


Diagram II

Answer _____ cm^2 [3]

9

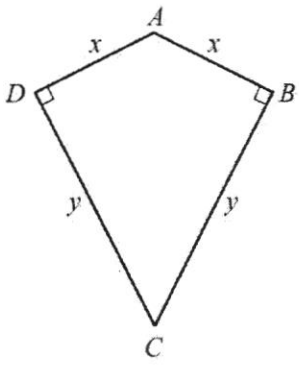


Diagram I

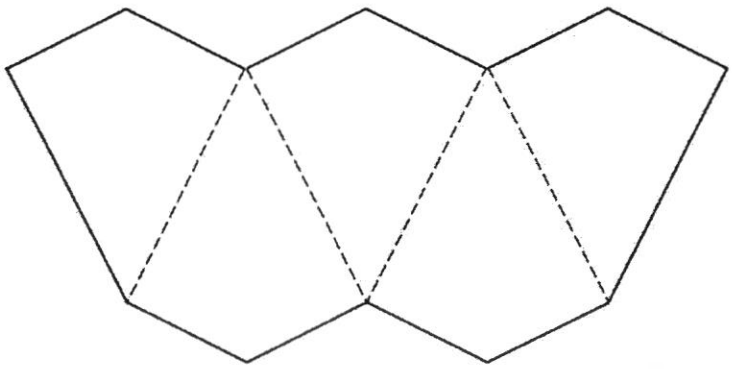


Diagram II

Diagram I shows a quadrilateral, $ABCD$, in which $DA = AB = x$ centimetres and $BC = CD = y$ centimetres. Angle ABC = Angle $CDA = 90^\circ$.

(a) Show that the area of this quadrilateral is xy square centimetres.
Answer

[1]

(b) Five of these quadrilaterals are joined together to make the shape shown in Diagram II. The total area of this shape is 80 cm^2.

(i) Show that the outside perimeter, P, centimetres, of this shape is given by $P = 10x + \frac{32}{x}$.
Answer

[2]

(ii) Given that $P = 38$,

(a) show that $5x^2 - 19x + 16 = 0$,

Answer

[2]

(b) solve the equation $5x^2 - 19x + 16 = 0$, giving both answers correct to 2 decimal places.

Answer _____ or _____ [3]

(c) find the two possible values of y.

Answer $y =$ _____ or _____ [2]

(iii) **(a)** Calculate the value of P when $x = y$.

Answer _____ [1]

(b) What is the special name given to the quadrilateral $ABCD$ when $x = y$?

Answer _____ [1]

10 Mike has gotten a job that pays him a salary of $60 000 **annually**.

He plans to purchase a car but has prudently decided that he should only set aside 30% of his **monthly** salary for all the expenses that would be incurred to own the car.

(a) Calculate the sum of money that Mike should set aside **monthly** for the expenses that would be incurred to own the car.

Answer $_____ [1]

Mike is deciding between 2 cars. He will take a loan from a bank for the purchase and the details of the loan are given below:

Table 1	**Car A**	**Car B**
Engine capacity	1600 cc	1400 cc
Cost price	$80 000	$90 000
Intended loan amount	50% of cost price	60% of cost price
Intended loan period	5 years	5 years
Type of interest	compound interest at 2.5% per year, compounded yearly	simple interest at 3% per year

(b) Calculate the

(i) simple interest that Mike has to pay if he were to choose Car B,

Answer $_____ [1]

(ii) monthly instalment that Mike has to pay if he were to choose Car B.

Answer $_____ [1]

Other than the costs in Table 1, the other major expenses in maintaining a car are as follows:

	Car A	**Car B**
Monthly parking fees	\$90	\$90
Monthly petrol expenditure	\$300	\$250
Annual road tax	\$744	\$624
Annual insurance	\$800	\$780
Car servicing (twice a year)	\$600 each round	\$510 each round

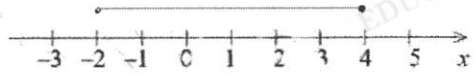
(c) By finding the total monthly cost for each car, recommend the car that Mike can purchase based on the sum of money he can afford to set aside monthly from **part (a)**.

Justify the decision you make and show your calculations clearly.
Answer

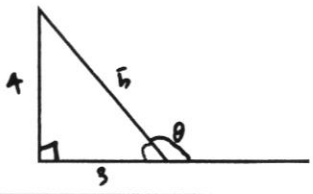
[6]

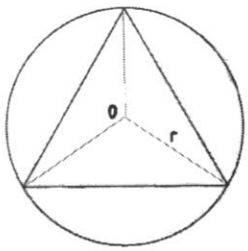
Mark Scheme – 3Exp Math EOY P1

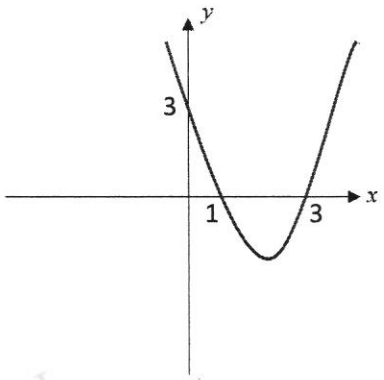
Question	Solution	Mark Scheme
1	1499	B1
2a	$\frac{1}{9} > 0.111$	B1
2b	$1 < 3a^0$	B1
3	$STV = 180 - 70 - 69$ (int s) $= 41°$ $VST = 180 - 41 - 35$ (sum of Δ) $= 104°$	M1 A1
4a	Median position = 5.5^{th} → 5^{th} & 6^{th} Median = $\frac{15+17}{2} = 16$ min	B1
4b	The mean time will be affected by the outlier (extreme value) 39 min.	B1
5a	$15 + x$	B1
5b	P(Green) = $\frac{5}{15+x}$	B1
6	$AOB =$ COD (vert. opp s) $OA = OB = OC = OD$ (radius) $\therefore$ By SAS, ΔAOB & ΔCOD are congruent.	M1 A1
7	$5 \le 4x - 7 \le 2x$ $5 \le 4x - 7$ | $4x - 7 \le 2x$ $12 \le 4x$ | $2x \le 7$ $3 \le x$ | $x \le 3.5$ Ans: $3 \le x \le 3.5$	 M2 A1

Question	Solution	Mark Scheme
8	Let the original amount that Anne received be $\$3x$ & Cheryl received $\$7x$.	
	$\frac{3x+255}{7x-255}=\frac{5}{6}$	M1
	$6(3x+255)=5(7x-255)$	
	$35x-18x=1530+1275$	
	$17x=2805$	
	$x=165$	M1
	original sum of money = \$165 × 10 = \$1650	A1
	OR	
	(Before) A : C = 3 : 7 = 33 : 77	
	(After) A : C = 5 : 6 = 50 : 60 [total 110 units]	M1
	$50-33u=17u=\$255$	
	$1u=\$15$	M1
	$110u=\$1650$	A1
9a	$-5<\frac{5}{2}x\leq 10$	
	$-10<5x<20$	
	$-2<x\leq 4$	B1
9b		B1 *ECF*
9c	2, 3	B1 *ECF for logical ans*
10a	$6-2(x-1)$	
	$=6-2x+2$	
	$=8-2x$	B1
10b	$3ax+bx-6ay-2by$	
	$=x(3a+b)-2y(3a+b)$	M1
	$=(3a+b)(x-2y)$	A1

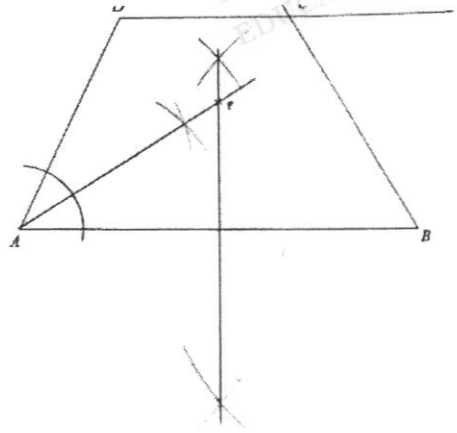
Question	Solution	Mark Scheme
11a	$a^3b^2 \times a^{-4}b^2$ $= a^{-1}b^4$ $= \dfrac{b^4}{a}$	 B1
11b	$8 \times 4^m = 2^m$ $2^3 \times 2^{2m} = 2^m$ $3 + 2m = m$ $m = -3$	 B1
11c	$\dfrac{3}{3^k} = 3^n$ $3^{1-k} = 3^n$ $n = 1 - k$	 B1
12	$\dfrac{v_1}{v_2} = \left(\dfrac{15}{20}\right)^3$ $= \dfrac{27}{64}$ Time taken (large) $= \dfrac{3}{27} \times 64$ $= 7\dfrac{1}{9}\text{min}$ $= 7\text{min}\,7s$	M1 M1 A1
13a	a = any negative number $n = -2$	B1 B1
13b	The line $y = 3$ does not intersect the curve $y = ax^n$ and hence there is no solution to the equation $ax^n = 3$.	B1
14	2 ext. angles: $180 - 124 = 56°$ $180 - 140 = 40°$ $56 + 40 + (n-2) \times 33 = 360$ (ext sum of polygons) $96 + 33n - 66 = 360$ $33n = 330$ $n = 10$	 M1 M1 A1

Question	Solution	Mark Scheme
15a	13.6° and 166.4°	B1B1
15b	$\sin\theta = \frac{4}{5}$ $\sqrt{5^2-4^2} = 3$ $\cos\theta = -\frac{3}{5}$ 	M1 A1
16a	x^2-6x+3 $=(x-3)^2-3^2+3$ $=(x-3)^2-6$	B1
16b	$(x-3)^2-6=0$ $(x-3)^2=6$ $x-3=\pm\sqrt{6}$ $x=0.55$ or 5.45	M1 *Deduct 1m for rounding errors* A2
17a	Since $m=2^{12}\times3^{12}=(2^6\times3^6)^2$, m is a perfect square.	B1 *Accept "...all powers are even."*
17bi	HCF $=2^{10}$	B1
17bii	LCM $=2^{12}\times3^{12}\times5^{13}$	B1
17c	$2^{10}\times5^{13}\times\frac{p}{q}=$ perfect cube $p=2^2=4$ $q=5$	B1
18a	Alice's Speed$=\frac{16\text{km}}{5\text{h}}$ $=3.2$ km/h	B1
18b	3.54pm	B1
18c	Ben is travelling at <u>increasing speed</u> from 1 pm to 3 pm.	B1
18d	Ben's speed $=\frac{6\text{ km}}{2\text{ h}}$ $=3$ km/h	B1

Question	Solution	Mark Scheme
19a	$v = kr^3$ $2500 = k(10)^3$ $k = 2.5$ $v = 2.5r^3$	 M1 A1
19b	$1000 = 2.5r^3$ $r^3 = 400$ $r = 7.37$ (3sf)	 B1
19c	Original $v = 2.5r^3$ New $v = 2.5(2r)^3$ $= 20r^3$ Percentage Increase $= \frac{20r^3 - 2.5r^3}{2.5r^3} \times 100\%$ $= 700\%$	 B1
20	 Area of Triangle = 50 $3 \times \frac{1}{2}(r)(r)\sin 120° = 50$ $r^2 = 38.4900$ $r = 6.204$ Area of Circle $= \pi(6.2040)^2$ $= 120.9199$ $= 121 \text{ cm}^2$ (3sf)	 M2 M1 A1

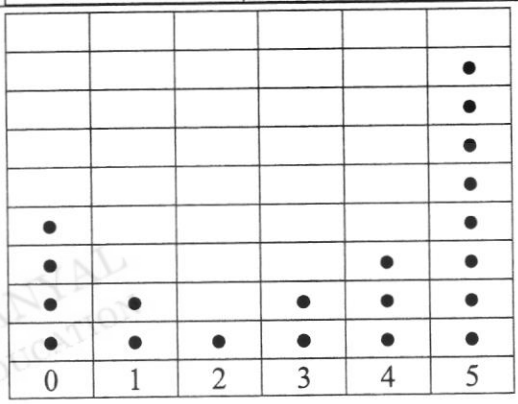
Question	Solution	Mark Scheme
21a	$x^2-4x+3=(x-3)(x-1)$	M1
21b		*ECF* B1 *Shape & y-int* B1 *x-ints*
21c	$x=2$	B1 *Ecf*
21d	$(2,-1)$	B1 *Ecf*
22a	$x=3\times10^8$ m/s $\times$ 60 $\times$60 $\times$24 $\times$365 $=9.4608\times10^{15}$ m $=9.46\times10^{15}$ m (Accept 9.47×10^{15} m)	M1 A1
22b	time taken $=\dfrac{388\times10^6}{55000}$ $=7054.545$ hours $=293.939$ days $=294$ days	M1 M1 A1

Question	Solution	Mark Scheme
23a	$\angle BAC = \angle BDA$ (given) $\angle B$ is a common angle. $\therefore$ By AA, ΔABC & ΔDBA are similar.	M1 A1
23b	$\frac{BD}{AB} = \frac{AB}{BC}$ $\frac{BD}{7} = \frac{7}{4}$ $BD = 12.25\,\text{cm}$	B1
23ci	$\frac{\text{area of triangle } ABC}{\text{area of triangle } DBA} = \left(\frac{4}{7}\right)^2 = \frac{16}{49}$	B1
23cii	$\frac{\text{area of triangle } ABC}{\text{area of triangle } ACD} = \frac{4}{12.25-4} = \frac{16}{33}$ **or** $\frac{\text{area of triangle } ABC}{\text{area of triangle } ACD} = \frac{16}{49-16} = \frac{16}{33}$	B1 B1 *Ecf 23ci, only for this method*
24	a) Construct Field ABCD b) Construct perpendicular bisector of AB c) Construct angle bisector of angle DAB d) Mark Point P e) Length of AP = 5.9 ×2 =11.8 km (±0.2km)	B1 B1 B1 B1 ecf B1

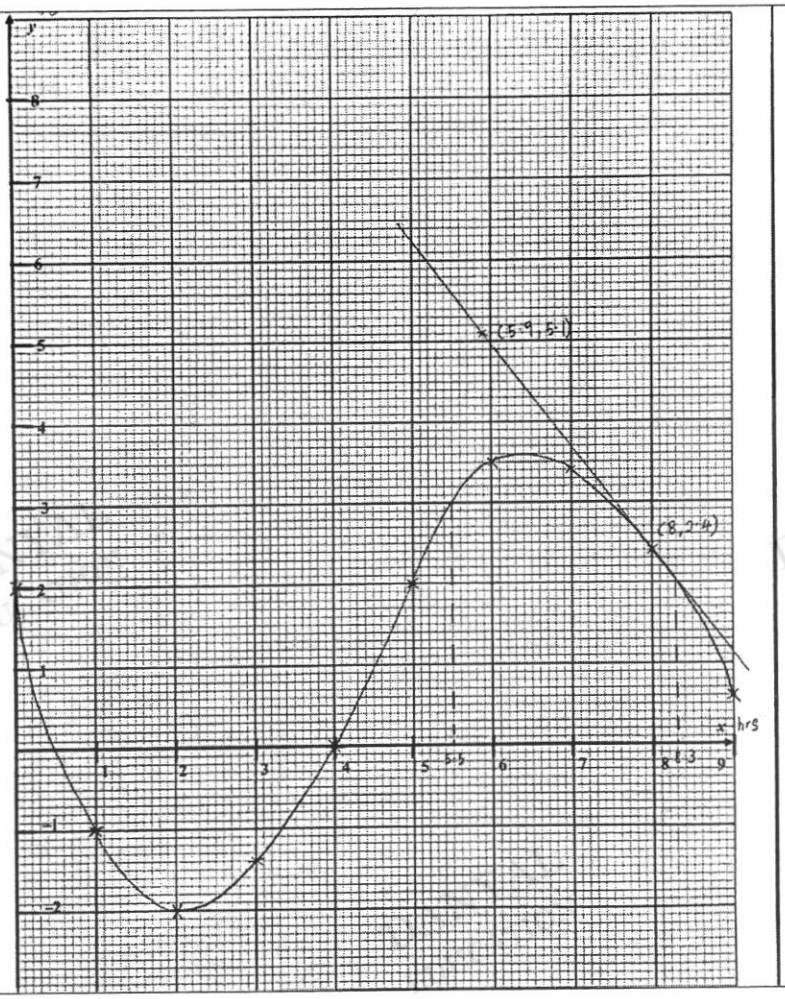


Marking Scheme for 3 Express 2021 EOY Paper 2

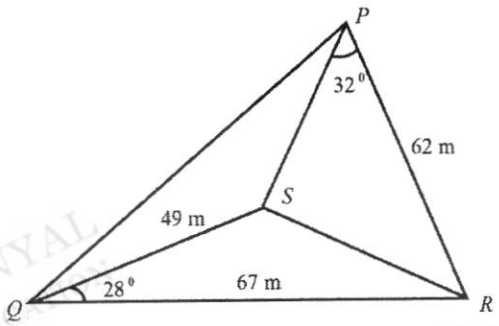
1ai	$a=\frac{4b+5c}{b-c}$ $a=\frac{4(1)+5(-2)}{(1)-(-2)}$ $=\frac{-6}{3}$ $=-2$	B1
1aii	$\frac{a}{1}=\frac{4b+5c}{b-c}$ $a(b-c)=4b+5c$ $ab-ac=4b+5c$ $ab-4b=ac+5c$ $b(a-4)=ac+5c$ $b=\frac{ac+5c}{(a-4)}$	M1 A1
1b	$4x-3y=28$ .....eqn 1 $6x+y=9$ .....eqn 2 eqn 2 x 3: $18x+3y=27$ ....eqn 3 eqn 1 + eqn 3: $22x=55$ $x=2.5$ sub $x=2.5$ into eqn 1, $y=-6$	M1 A1 A1
1c	$\frac{2x-1}{4}+\frac{x}{3}=1$ $\frac{6x-3+4x}{12}=\frac{1}{1}$ $10x=15$ $x=1.5$	M1 A1
1d	$\frac{x^2-8x}{x^2-64}$ $=\frac{x(x-8)}{(x+8)(x-8)}$ $=\frac{x}{(x+8)}$	M1 (for correct factorisation of numerator or denominator) A1

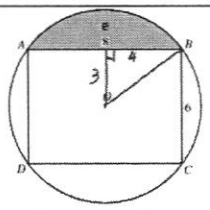
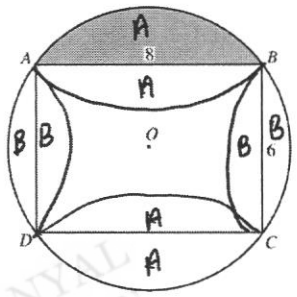
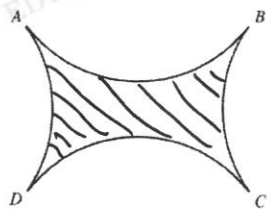
2ai	<table><tr><th>Number of goals</th><th>Frequency</th></tr><tr><td>0</td><td>4</td></tr><tr><td>1</td><td>2</td></tr><tr><td>2</td><td>1</td></tr><tr><td>3</td><td>2</td></tr><tr><td>4</td><td>3</td></tr><tr><td>5</td><td>8</td></tr></table>	B1
2aii		B2 (minus 1 mark for each error)
2aiii	5	B1
2aiv	Mean $= \frac{62}{20} = 3.1$	M1 / A1
2b	$\frac{8}{20} \times 360 = 144$	Their number of 5-goals (ecf) M1/A1

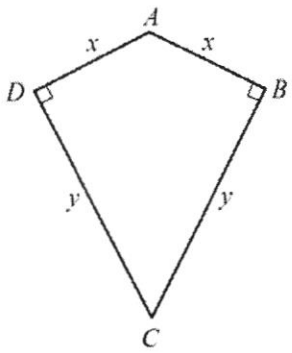
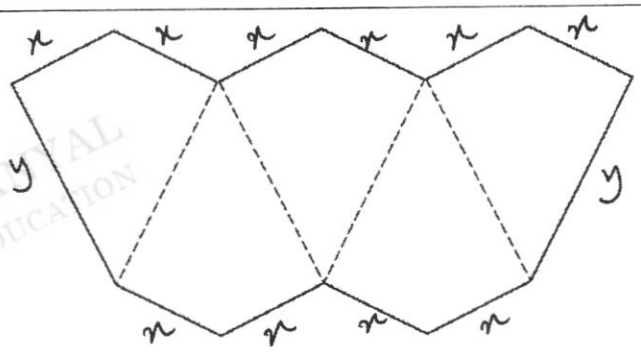
3a	Gradient BD $\frac{-4-8}{6-(-2)}$ $=\frac{-12}{8}$ $=\frac{-3}{2}$	 B1
3b	$y=mx+c$ $4=-\frac{3}{2}(-2)+c$ $c=1$ $y=-\frac{3}{2}x+1$	 M1 A1
3c	Length BD $=\sqrt{(-2-6)^2+(8-(-4))^2}$ $=\sqrt{\quad+144}$ $=\sqrt{\quad}$ $=14.4$	 M1 A1
3d	Area ABD $=\frac{1}{2}\times BA\times \perp height$ $=\frac{1}{2}\times 4\times 8$ $=16 \quad units^2$	 M1 (o.e) A1
3e	Let the perpendicular distance from A to BD be h. Area ABD = $\frac{1}{2}$ x BD x h $16=\frac{1}{2}$ x $\sqrt{208}$ x h h = 2.22 units	 M1 (o.e) A1
3f	C (6, 0)	B1

4a		B2 – all points correctly plotted, else B1 for 5 correctly plotted points B1 – smooth curve
4bi	3 C (Accept $2.8 \le t \le 3.3$)	B1
4bii	8.3 – 5 hrs = 3.3 hrs (accept 3.2 to 3.4 hrs)	M1 A1
4ci	$\frac{5.1-2.4}{5.9-8} = -1.29$ (Accept $-1.4 \le g \le -1.1$)	M1/A1
4cii	The gradient represents the rate of cooling in C per hour	B1
4d	When $x = 0, y = 2$ $y = x^2 + Ax + B$ $2 = (0)^2 + A(0) + B$ $B = 2$ When $x = 2, y = -2$ $y = x^2 + Ax + B$ $-2 = (2)^2 + A(2) + 2$ $A = -4$	B1 B1

5a	14, 15, 16	B1
5b	40	B1
5ci	58	B1 (their values in 5a)
5cii	Difference of 16 => $16n$ $S_n = 16n - 6$	M1 A1
5ciii	$S_n = 1018$ $16n - 6 = 1018$ $n = 64$	 B1
6a	Surface area in contact with the water $= \frac{\pi(9)^2}{2} + \frac{2\pi(9)(18)}{2} + \frac{2\pi(9)^2}{2}$ $= 40.5\pi + 162\pi + 81\pi$ $= 283.5\pi \ \ cm^3$	M1/M1/M1 A1
6b	Volume of water $= \frac{1}{2}\left[\pi(9)^2(18) + \frac{4}{3}\pi(9)^3 \times \frac{1}{2}\right]$ $= 972\pi$	 M1 A1
6c	Let the height of the water in the cylinder be y $972\pi = \pi(9)^2 y$ $y = 12cm$	M1 (ecf) A1
6d	Volume of hemisphere $= \frac{1}{2}\left[\frac{4}{3}\pi(9)^3\right]$ $= 486\pi$ Volume of water in the cylinder $= 972\pi - 486\pi$ $= 486\pi$ Let the height of the water in the cylinder be x. $486\pi = \pi(9)^2 x$ $x = 6cm$ Depth of water = 9 + 6 = 15 cm	M1 M1 (ecf) M1 (ecf) A1

7ai	$RS^2 = 49^2 + 67^2 - 2(49)(67)\cos 28^\circ$ $RS = \sqrt{49^2 + 67^2 - 2(49)(67)\cos 28^\circ}$ $RS = 33.0538...$ $RS = 33.1 \quad (3sf)$  	M1 A1
7aii	$\frac{\sin PSR}{62} = \frac{\sin 32}{33.05398}$ $\sin PSR = \frac{62\sin 32}{33.05398}$ $angle \quad PSR = 83.70981$ $angle \quad PSR = 83.7 \quad (1dp)$	M1 (their RS (ecf)) M1 (their RS (ecf)) A1 [accept obtuse angle]
7aiii	Area $QRS =$ $= \frac{1}{2}(49)(67)\sin 28$ $= 770.6375 \quad m^2$ $= 771 \quad m^2$	M1 A1
7aiv	Let the shortest distance be x. $770.6375 \quad m^2 = \frac{1}{2}(67)x$ $x = 23.004 \quad m$ $x = 23.0 \quad m$	M1 A1
7b	Let the top of the flagpole be T. $\tan 35 = \frac{TS}{49}$ $TS = 34.310m$ $\tan TRS = \frac{34.310}{33.0538}$ $angle \quad TRS = 46.1 \quad (1dp)$	 M1 M1 (their RS (ecf)) A1

8a	 Pythagoras Theorem, $OB^2 = 4^2 + 3^2$ $OB = 5cm$	B1 (as long as PT is used)
8b	$\tan BOE = \frac{4}{3}$ $BOE = \tan^{-1}\frac{4}{3}$ $AOB = 2BOE$ $AOB = 2(\tan^{-1}\frac{4}{3})$ $AOB = 106.26$ $AOB = 106.3$	M1 A1 106.26 should be seen.
8c	Area of shaded segment = sector OAB – triangle OAB $= \frac{106.26}{360} \times \pi \times 5^2 - \frac{1}{2}(5)(5)\sin 106.26$ $= 11.182$ $= 11.2cm^2$	M1/M1 A1
8d	 Diagram I  Diagram II Angle $AOD = \frac{360 - 106.26 - 106.26}{2} = 73.74$ Area of segment B $= \frac{73.74}{360} \times \pi \times 5^2 - \frac{1}{2}(5)(5)\sin 73.74$ $= 4.08755$ Area enclosed in Diagram II = rectangle – (2A+2B) $= (8 \times 6) - [2 \times 11.182 + 2 \times 4.08755]$ $= 17.5cm^2$	M2 – for finding area of 4 segments (area of circle – rectangle) M1 M1 A1 Accept 17.4cm^2

9a	Area of quadrilateral = 2 x area of triangle ADC $= 2 \times \frac{1}{2} xy$ $= xy$  	B1
9bi	 $5xy = 80$ $y = \frac{80}{5x}$ $y = \frac{16}{x}$ $P = 10x + 2y$ $P = 10x + 2(\frac{16}{x})$ $P = 10x + \frac{32}{x}$	M1 or M1 for both $5xy = 80$ $P = 10x + 2y$ A1
9bii a	$38 = 10x + \frac{32}{x}$ $38x = 10x^2 + 32$ $10x^2 - 38x + 32 = 0$ $5x^2 - 19x + 16 = 0$	M1 (ecf) A1
9bii b	$5x^2 - 19x + 16 = 0$ $x = \frac{-(-19) \pm \sqrt{(-19)^2 - 4(5)(16)}}{2(5)}$ $x = 1.2596$ *or* 2.5403 $x = 1.26$ *or* 2.54	M1 A1/A1

9bii c	$y = \frac{16}{x}$ $y = \frac{16}{1.2596}$ *or* $\frac{16}{2.5403}$ $y = 12.7$ *or* 6.30	B1/B1 (ecf)
9biii a	$5xy = 80$ $x = y$ $\therefore 5x^2 = 80$ $x^2 = 16$ $x = 4$ $P = 12x$ $P = 12(4) = 48$	B1
9biii b	Square	B1

10a	$[\frac{30}{100}\times 60000]\div 12 = \$1500$	B1
10bi	$[\frac{60}{100}\times 90000] = \$54000$ $\$54000\times\frac{3}{100}\times 5 = \$8100$	 B1
10bii	$\frac{(\$54000+\$8100)}{5\times 12} = \$1035$	B1 (ecf)
10c	**Car B** Monthly road tax = $\frac{624}{12} = \$52$ Monthly insurance = $\frac{780}{12} = \$65$ Monthly servicing costs = $\frac{510\times 2}{12} = \$85$	B1 for any of the calculations for monthly road tax or insurance or servicing
	Total monthly cost for Car B = 1035 + 90 + 250 + 52 + 65 +85 = \$1577 > \$1500 He cannot afford Car B	B1 adding up total costs for Brand B.
	Car A Monthly instalment = $\frac{40000(1+\frac{2.5}{100})^5}{5\times 12} = \$754.27214$	B1 for monthly instalment for Brand A
	Monthly road tax = $\frac{744}{12} = \$62$ Monthly insurance = $\frac{800}{12} = \$66.6666$ Monthly servicing costs = $\frac{600\times 2}{12} = \$100$	B1 for any of the calculations for monthly road tax or insurance or servicing x
	Total monthly cost for Car A = \$754.27214 + 90 + 300 + 62+ 66.66666 + 100 = \$1372.94 < \$1500	B1 for adding up all the costs
	Since the total monthly cost for Car A is less then \$1500, he should purchase Car A.	B1 for final statement *Link to budget \$1500

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