

Caringbah High School

Year 12 2020

Mathematics Standard 2

HSC Course

TRIAL HIGHER SCHOOL CERTIFICATE

General Instructions

- Reading time – 10 minutes
- Working time – 2 ½ hours
- Write using black or blue pen
- Board-approved calculators may be used
- A formulae sheet is provided at the back of this paper
- In Questions 16 - 40, show relevant mathematical reasoning and/or calculations
- Marks may not be awarded for partial or incomplete answers

Total marks – 100

Section I 15 marks

Attempt Questions 1 - 15
Mark your answers on the answer sheet provided. You may detach the sheet and write your name on it.

Section II 85 marks

Attempt Questions 16 - 40
Write in spaces provided.
Extra writing space is provided at the back of the paper. If you use this space, clearly indicate which question you are answering.

Name: Solutions

Class: 12MAS1 – Mr Monahan

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Section I - 15 marks

Attempt Questions 1 - 15

Allow about 25 minutes for this section

Use the multiple choice answer sheet for Questions 1 - 15

- 1 What is the solution to the equation $\frac{2x-6}{4} = 3 - x$

(A) $x = 3$

(B) $x = -3$

(C) $x = 9$

(D) $x = -9$

- 2 Lauren and Andy work in the same restaurant, they each earned \$576 last week. Andy worked 4 more hours than Lauren, and was paid time-and-a-half for these extra hours. If Lauren is paid \$16/hour, find Andy's hourly pay rate?

(A) \$12

(B) \$13.71

(C) \$14.40

(D) \$24

- 3 A football match begins at 8:00pm Friday local time in New York, which has a Coordinated Universal Time (UTC) of -5 . Rowan lives in Perth (UTC $+8$), if he wants to watch the match, what time will he need to turn on his television?

(A) 9:00am Friday

(B) 7:00am Saturday

(C) 9:00pm Saturday

(D) 9:00am Saturday

- 4 At a party Charlotte begins drinking at 6:45pm and has 7 standard drinks before she stops drinking at 11:15pm. If Charlotte has a weight of 58kg, calculate her BAC to 3 decimal places using the formula:

$$BAC_{FEMALE} = \frac{10N - 7.5H}{5.5M}$$

where N = number of standard drinks

H = number of hours drinking

M = Mass in kg

(A) 0.024

(B) 0.090

(C) 0.113

(D) 0.114

- 5 Calculate the interquartile range for the following data set

12, 23, 31, 46, 47/53, 55, 65, 66, 70

(A) 34

(B) 58

(C) 31

(D) 50

- 6 Elise is playing in a chess tournament, in each match she plays, Elise has a 40% chance of winning. Which of the following, calculates the probability she will win exactly one of the next 2 matches?

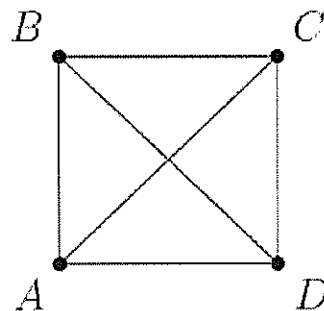
(A) 0.4

(B) 0.4×0.6

(C) $(0.4 \times 0.6)^2$

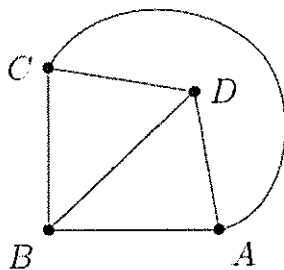
(D) $0.4 \times 0.6 \times 2$

- 7 A network of four points A, B, C and D is drawn below

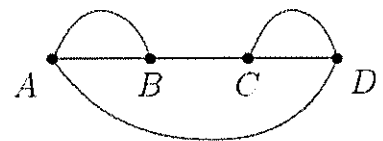


Which of the following diagrams is NOT an equivalent graph of the network above?

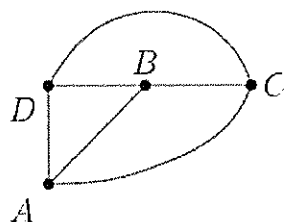
A.



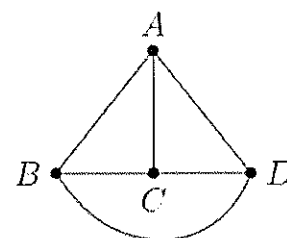
B.



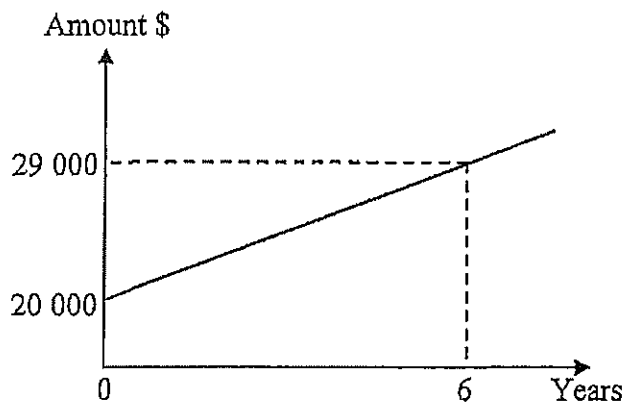
C.



~~D.~~



- 8 This graph shows the growth of a \$20 000 investment over a 6 year period



What was the annual rate of interest paid on the investment?

- (A) 1.5%
(B) 7.5%
(C) 7.31%
(D) 5.5%
- 9 Based on the equation $P = \frac{36}{Q^2}$
which of the following correctly expresses Q as the subject of the equation

(A) $Q = \frac{6}{P}$

(B) $Q = \frac{36}{P}$

(C) $Q = \frac{6}{\pm\sqrt{P}}$

(D) $Q = \frac{36}{\pm\sqrt{P}}$

- 10 A 400 W desktop computer is run on average for 4 hours per day. If electricity is charged at \$0.18/kWh, calculate the electricity cost of running the computer per year.

(A) \$584

(B) \$105.12

(C) \$26.28

(D) \$105 120

- 11 A university exam has its marks normally distributed with a mean of 70 and standard deviation of 8. What percentage of students scored between 78 and 94?

(A) 15.85%

(B) 99.7%

(C) 16%

(D) 13.5%

- 12 James purchases 2400 bank shares at a cost of \$19.50/share. He was paid a dividend yield of 5.5% on his shares and then sold them for \$20/share. Given there were zero brokerage fees, calculate his profit.

(A) \$2574
(B) \$3774
(C) \$2640
(D) \$45360

- 13 Two friends share a secret on Monday (Day 1) and promise not to tell anyone. Unfortunately on Tuesday (Day 2), they both individually tell 3 friends, and on Wednesday, these friends each tell 3 more people and the secret continues to spread in this manner.

The spread of the secret can be modelled with the equation:

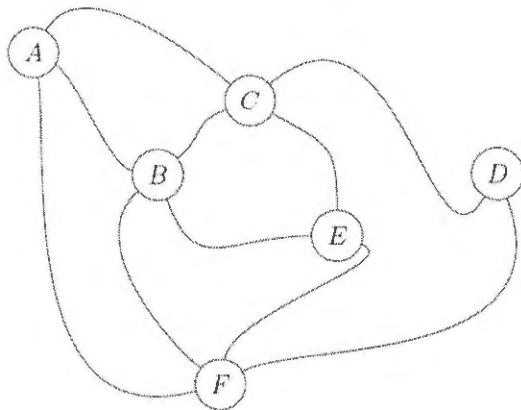
$$y = 3^x - 1$$

Where: x = the number of the day on which the secret is told
and y = the total number of people who know the secret

How many people were told the secret on the following Monday?

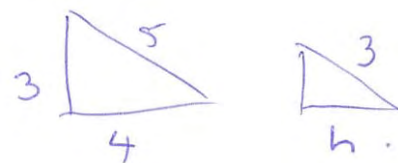
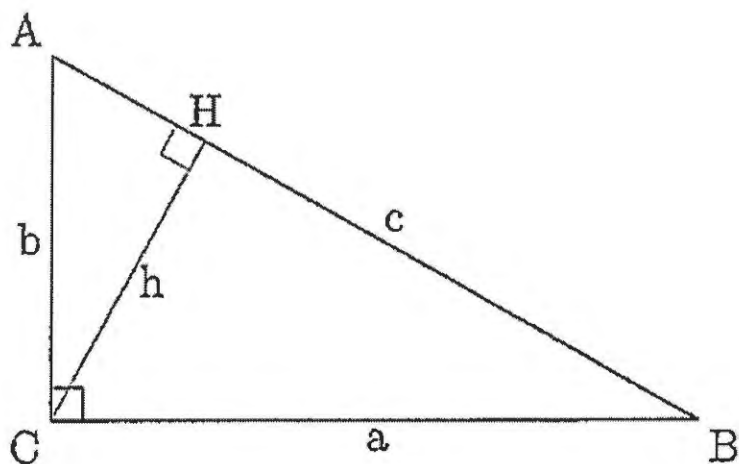
(A) 2186
(B) 2187
(C) 4374
(D) 6560

- 14 A collection of bushwalking tracks is modelled by the network below. There are 6 lookout points, labelled A, B, C, D, E and F. Which two edges should be removed so that a bushwalker can walk along every track exactly once and still visit every lookout?



(A) AB and BE
(B) CB and BF
(C) CD and DF
(D) CE and BF

- 15 A triangle ABC has $AB = c$, $BC = a$ and $AC = b$, as shown in the diagram. The point H is on AB so that CH is perpendicular to AB and has length h.



If $a = 4\text{cm}$ and $b = 3\text{cm}$, find the length of h

(A) 1.8 cm

(B) 2.4 cm

(C) 3.2 cm

(D) 3.4 cm

$$\frac{h}{4} = \frac{3}{5}$$

$$h = \frac{12}{5}$$

End of Section 1

Section II - 85 marks

Attempt Questions 16 - 40

Allow about 2 hours and 5 minutes for this section

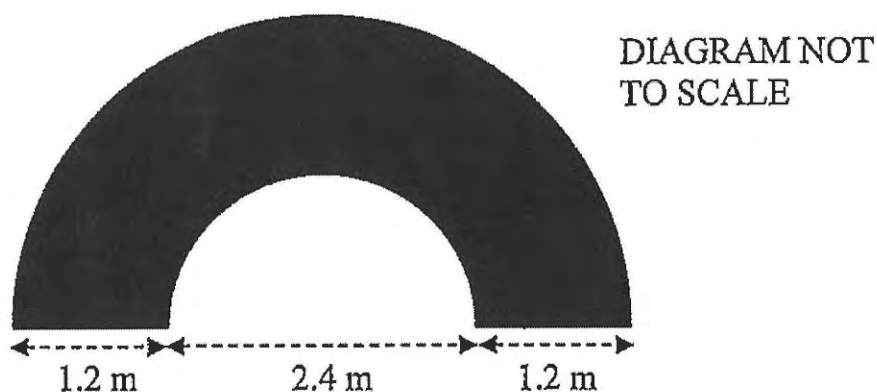
Answer in the spaces provided. Your responses should include relevant mathematics reasoning and/or calculations.

Extra writing space is provided on pages 23 and 24. If you use this space, clearly indicate which question you are answering.

Question 16

2

A semicircular archway has been built and the front face is shown below, find the perimeter of the archway to one decimal place



$$2.4 + \left(\frac{1}{2} \times 2 \times \pi \times 1.2\right) + \left(\frac{1}{2} \times 2 \times \pi \times 2.4\right)$$

$$= 13.7 \text{ m}$$

Question 17

2

If $a = 3$, $b = -4$ and $c = 1$, find the value of $\frac{-b + \sqrt{b^2 - 4ac}}{2a}$

$$\frac{4 + \sqrt{16 - 4 \times 3}}{6}$$

$$= \frac{4 + 2}{6} = 1$$

Question 18

19 people had their heart rate measured (in beats per minute) both before and after an exercise class.

Heart Rate												
Before Exercise							After Exercise					
		9	8	8	8	6						
8	6	6	4	1	1	0	7					
		8	8	6	2	8	8	6	7	8	8	
				6	0	9	0	2	2	4	5	8
					4	10	0	4	4			9
					0	11	8					
						12	4	4				
						13						
						14	6					

a) By how many beats per minute did the median heart rate increase after exercise?

1

$$98 - 76 = 22$$

b) Calculate the interquartile range after exercise

1

$$14$$

c) Is 146 an outlier? Show by mathematical calculation

2

$$104 + 1.5 \times 14 = 125$$

$\therefore 146$ is an outlier.

d) Describe the skewness of the data after exercise (positive, negative or symmetrical)

1

positive skew

Question 19

A car is travelling at a constant speed of 75 km/h, at this speed the car uses 8.125 L of petrol per 100 km. If the petrol tank holds 65 L of petrol;

- a) How far can the car travel on one tank of petrol whilst travelling at 75 km/h?

1

$$65 \div 8.125 = 8 \times 100$$

$$= 800 \text{ km}$$

- b) If petrol costs 119.9 c/L, how much will it cost in petrol to travel 300km?

1

$$8.125 \times 3 \times 1.199$$

$$= \$29.23$$

- c) When the speed of the car is 110 km/h, the petrol consumption is increased by 20%, how much petrol would be used to travel 200 km at a speed of 110km/h?

2

$$8.125 \times 1.2 \times 2$$

$$= 19.5 \text{ L}$$

Question 20

2

In a normal distribution of scores, 50 people have a z-score which is greater than 2. How many people are in the population?

$$2.5\% = 50$$

$$1\% = 20$$

$$\therefore \text{population} = 2000 \text{ people}$$

Question 21

2

The heights of Alex and Barry are in the ratio 5:4, whilst the heights of Barry and Chris are in the ratio 6:5. If their combined heights add to 4.44m, find Barry's height.

$$A:B \quad B:C$$

$$5:4 \quad 6:5$$

$$15:12:10$$

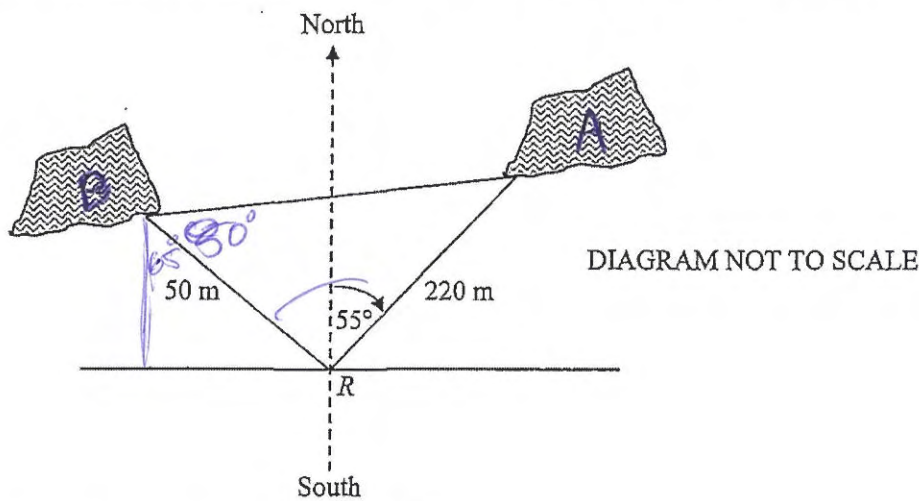
$$4.44 \div 37 = 0.12 \times$$

$$12$$

$$= 1.44 \text{ m}$$

Question 22

From a recreational area (R), a lake A is 220m away on a bearing of 055° whilst lake B is 50m away on a bearing of 295° , as shown in the diagram below



a) Find the size of angle ARB

1

$$55 + 65 = 120^\circ$$

b) Calculate the length between the two lakes (nearest whole number)

2

$$c^2 = 220^2 + 50^2 - 2 \times 220 \times 50 \times \cos 120^\circ$$

$$c = \sqrt{61900}$$

$$c = 249 \text{ m}$$

c) Using the Sine rule in your working, find the bearing of A from B (nearest degree)

3

$$\frac{\sin \theta}{220} = \frac{\sin 120}{249}$$

$$\theta = \sin^{-1} \left(\frac{220 \times \sin 120}{249} \right)$$

$$\theta = 50^\circ$$

$$\text{Bearing } 180 - 65 - 50 = 065^\circ$$

d) Find the area of the triangle ARB (1 decimal place)

1

$$\frac{1}{2} \times 220 \times 50 \times \sin 120^\circ$$

$$= 4763.1 \text{ m}^2$$

Question 23

Liam purchases a lawn mower on his credit card on 6th August, the lawn mower costs \$2300. On the 18th August he then purchases a whipper snipper for \$900. He makes no other purchases on this card which charges interest at 19% p.a compound daily, including the day of purchase and the day of payment with no interest free period. If he repays the full amount on the 5th September, how much will he pay in total?

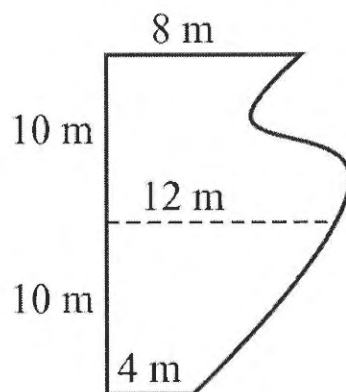
$$2300 \left(1 + \frac{19\%}{365} \right)^{31}$$

$$+ 900 \left(1 + \frac{19\%}{365} \right)^{19}$$

$$= \$3246.35$$

Question 24

On Billy's property, there is a lake with the dimensions shown in the diagram



- a) Calculate an estimate for the area of the lake using the Trapezoidal rule

2

$$\frac{10}{2} (8 + 12 + 12 + 4)$$

$$= 180 \text{ m}^2$$

- b) If the entire lake has a depth of 95 cm, calculate the capacity of the lake in litres

2

$$180 \times 0.95 = 171 \times$$

$$1000$$

$$171000 \text{ L}$$

Question 25

2

Solve the equation

$$5y + 3(2 - y) = \frac{2y}{3} + 12$$

$$5y + 6 - 3y = \frac{2y}{3} + 12$$

$$2y + 6 = \frac{2y}{3} + 12$$

$$6y + 18 = 2y + 36$$

$$4y = 18$$

$$y = 4.5$$

Question 26

This is a square based pyramid, the side lengths of the square are 24cm, the perpendicular height of the pyramid is h cm

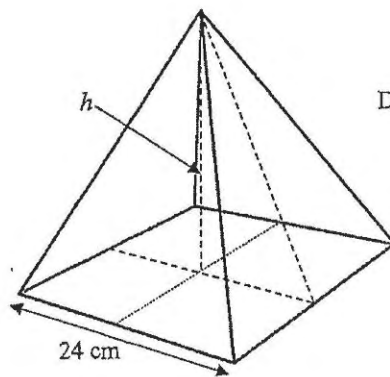


DIAGRAM NOT TO SCALE

- a) The volume is 3072 cm^3 , find the value of h

2

$$3072 = \frac{1}{3} \times 24^2 \times h$$

$$\frac{9216}{24^2} = h$$

$$h = 16 \text{ cm}$$

- b) Using your answer from part a, find the surface area of the pyramid

3

$$l = 20$$

$$\frac{1}{2} \times 24 \times 20 \times 4 + 24^2$$

$$= 1536 \text{ cm}^2$$

Question 27

The table below is used by the Commonwealth Bank to calculate home loan repayments.

Monthly Repayments on a \$1000 loan						
Rate p.a.	10 years	12 years	15 years	17 years	20 years	25 years
8.25%	\$12.27	\$10.96	\$9.70	\$9.13	\$8.52	\$7.88
8.5%	\$12.40	\$11.10	\$9.85	\$9.28	\$8.68	\$8.05
8.75%	\$12.53	\$11.24	\$9.99	\$9.43	\$8.84	\$8.22
9%	\$12.67	\$11.38	\$10.14	\$9.59	\$9.00	\$8.39
9.25%	\$12.80	\$11.52	\$10.29	\$9.74	\$9.16	\$8.56
9.5%	\$12.94	\$11.66	\$10.44	\$9.90	\$9.32	\$8.74
9.75%	\$13.08	\$11.80	\$10.59	\$10.05	\$9.49	\$8.91
10%	\$13.22	\$11.95	\$10.75	\$10.21	\$9.65	\$9.09
12%	\$14.35	\$13.15	\$12.00	\$10.55	\$11.01	\$10.35

- a) A bank will not allow a customer to borrow money if the repayments are more than 30% of the persons gross wage. Show with calculations that if Daniel earns \$7400 per month, he will be able to borrow \$250000 at 8.5% for 20 years

2

$$0.3 \times 7400 = \$2220$$

$$8.68 \times 250 = \$2170$$

\therefore Daniel can borrow \$250000

- b) Calculate the amount of interest that Daniel will pay over the entirety of this loan

1

$$2170 \times 12 \times 20 - 250000 = \$270800$$

- c) Calculate the equivalent flat rate of interest as a percentage (1 decimal place)

2

$$270800 = 250000 \times R \times 20$$

$$\frac{270800}{250000 \times 20} = R$$

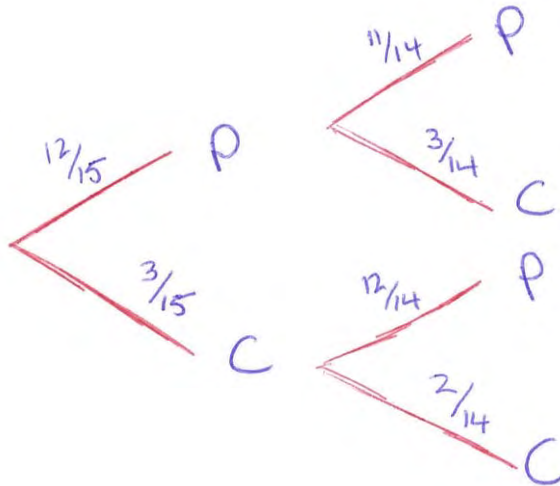
$$R = 5.4\%$$

Question 28

A fridge contains 12 cans of Pepsi and 3 cans of Coke. Carla takes one can from the fridge without looking, and then takes a second can (without replacing the first).

a) Draw a tree diagram showing the probabilities of all outcomes

2



b) Find the probability of taking at least one Coke

1

$$1 - \left(\frac{12}{15} \times \frac{11}{14} \right) = \frac{13}{35}$$

Question 29

to
↑

3

The weight (W) of a metallic ball is directly proportional to the cube of its radius (r). A ball that has a radius of 2 cm has a weight of 78.96 g. By first finding the value of the constant k , calculate the radius of a ball that weighs 631.68 g.

$$W = kr^3$$

$$78.96 = 8k$$

$$k = \frac{78.96}{8}$$

$$k = 9.87$$

$$W = 9.87r^3$$

$$\frac{631.68}{9.87} = r^3$$

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

$$r = 4 \text{ cm}$$

Question 30

2

The table below shows Lily's marks as well as the cohorts mean and standard deviation across Science and English exams

<u>Subject</u>	<u>Lily's Mark</u>	<u>Mean</u>	<u>Standard Deviation</u>
Science	86	73	8
English	83	74	5.5

In comparison to the cohort, which of the subjects did Lily perform best in? Justify your answer with relevant mathematical calculations

Science $\frac{86-73}{8} = 1.625$

English $\frac{83-74}{5.5} = 1.636$

\therefore She performed best in English.

Question 31

This table shows the future values of a \$1 annuity.

Future values of annuity of \$1					
Period	Interest Rate				
	1%	2%	3%	4%	8%
3	3.0301	3.0604	3.0909	3.1216	3.2464
6	6.1520	6.3081	6.4684	6.6330	7.3359
9	9.3685	9.7546	10.1591	10.5828	12.4876
12	12.6825	13.4121	14.1920	15.0258	18.9771
18	19.6147	21.4123	23.4144	25.6454	37.4502
24	26.9735	30.4219	34.4265	39.0826	66.7648
30	34.7849	40.5681	47.5754	56.0849	113.2832
36	43.0769	51.9944	63.2759	77.5983	187.1021

- a) Emily invests \$550 into an account every three months which has an interest rate of 8% p.a compound quarterly. Find the future value of her investment after 6 years

2

$550 \times 30.4219 = \$16732.05$

- b) Jaye would like to have \$40000 for a home deposit in 3 years time. Find the amount he would need to contribute to his account each year if interest is earned at 4% p.a compound annually

2

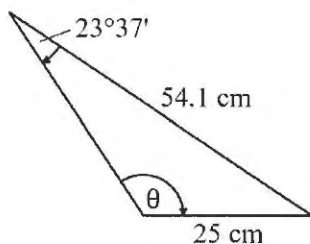
$x \times 3.1216 = 40000$

$x = \frac{40000}{3.1216} = \12813.94

Question 32

3

In the following triangle, find the value of θ to the nearest minute, note that in this triangle, θ is an obtuse angle



$$\frac{\sin \theta}{54.1} = \frac{\sin 23^\circ 37'}{25}$$

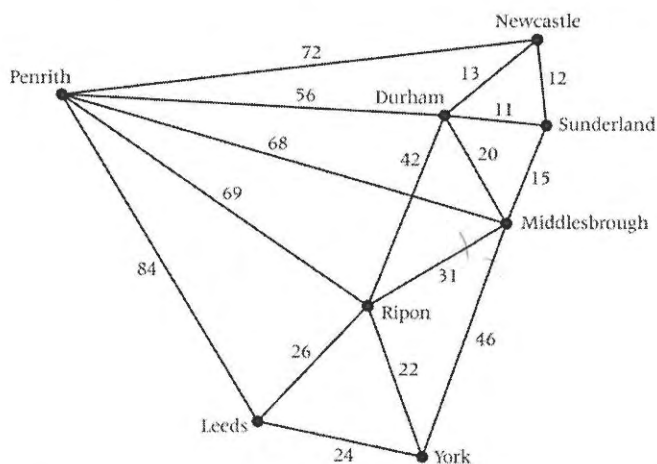
$$\theta = \sin^{-1} \left(\frac{54.1 \times \sin 23^\circ 37'}{25} \right)$$

$$= 60^\circ 6' \text{ (acute)}$$

$$\therefore \theta = 119^\circ 54'$$

Question 33

This network shows the distance, in kilometres, between certain English towns



- a) What is the degree of the vertex at Middlesbrough?

1

5

- b) Iris lives in Penrith, she is going to pick up her friend in Newcastle and then drive to Leeds, find the shortest path, and its distance, to complete her trip

2

P-D-N-D-R-L

150 km

Question 34

The table shows the results for a group of people to see how many push-ups and how many sit-ups they could each do in a minute

Push-ups	Sit-ups
8	18
10	17
17	22
22	30
29	25
36	47
40	50
48	48
51	57
60	81

- a) The value of the correlation coefficient (r) is 0.95, explain what this means in the context of his data-set

1

Strong positive relationship.

Fitness levels correlate between push-ups/sit-ups

- b) Use your calculator to find the equation of the least squares line of best fit in the form $y = mx + c$ (or $y = Bx + A$) (Round each number to 1 decimal place)

1

$$y = 1.1x + 4.3$$

- c) If a person was able to perform 32 sit-ups, use your equation in part b, to calculate the expected number of push-ups they could perform. (nearest whole number)

2

$$32 = 1.1x + 4.3$$

$$27.7 = 1.1x$$

$$x = 25.18$$

\therefore 25 push-ups.

Question 35

Screws are made in a factory by a machine, the lengths are normally distributed, the screws have a mean length of 4.5 cm and a standard deviation of 2.5 mm.

- a) If a screw is less than 4 cm long or greater than 5.25 cm long, it will not be sold. If 6000 screws are made per day, how many are able to be sold? 2

$$97.35\% \times 6000 = 5841 \text{ screws.}$$

- b) Find the length of a screw that has a z-score of -1.25 to 3 significant figures 2

$$\begin{aligned} -1.25 &= \frac{x - 4.5}{0.25} \\ -0.3125 &= x - 4.5 \\ &= 4.19 \text{ cm or } 41.9 \text{ mm} \end{aligned}$$

Question 36

A box contains 6 balls that are a mixture of red and pink (not necessarily 3 Red and 3 Pink). Let R be the number of red balls in the box.

- a) When 2 balls are drawn randomly from the box, the probability that they are both Red is $\frac{2}{5}$. Show that $R^2 - R = 12$ 2

$$\frac{R}{6} \times \frac{R-1}{5} = \frac{2}{5}$$

$$\frac{R(R-1)}{30} = \frac{2}{5}$$

$$R^2 - R = 12$$

- b) Given the solution to $R^2 - R = 12$ is $R = 4$ (ie, there are 4 red balls), determine the probability of randomly selecting 2 Pink balls from the box 2

$$\frac{2}{6} \times \frac{1}{5} = \frac{2}{30} = \frac{1}{15}$$

Question 37

2

Lydia borrowed \$465 000 at 8% p.a reducible interest. Interest is charged monthly and the monthly repayment is \$3550. The table shows the amounts owing during the first 3 months

Months	Principal	Interest	Principal + Interest	Principal + Interest - Repayments
1	\$465 000	\$3100	\$468 100	\$464 550
2	\$464 550	\$3097	\$467 647	\$464 097
3	\$464 097			X

Calculate the value of X, which would be the principal at the beginning of the 4th month

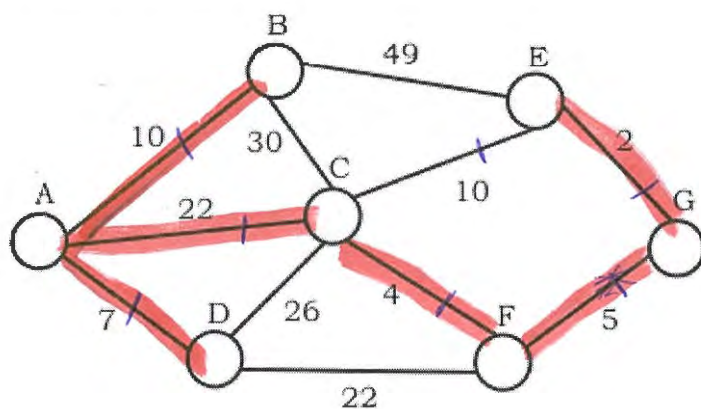
$$464097 \times \frac{8\%}{12} = 3093.98 + 464097 - 3550$$

$$= \$463640.98$$

Question 38

2

The following network shows the distance in metres between cabins (labelled A, B, C, D, E, F and G) in a holiday park. The park wants to run pipes between cabins using the existing roads shown in the network. If piping costs \$450/m, what is the minimum cost to run pipes to all of the cabins?



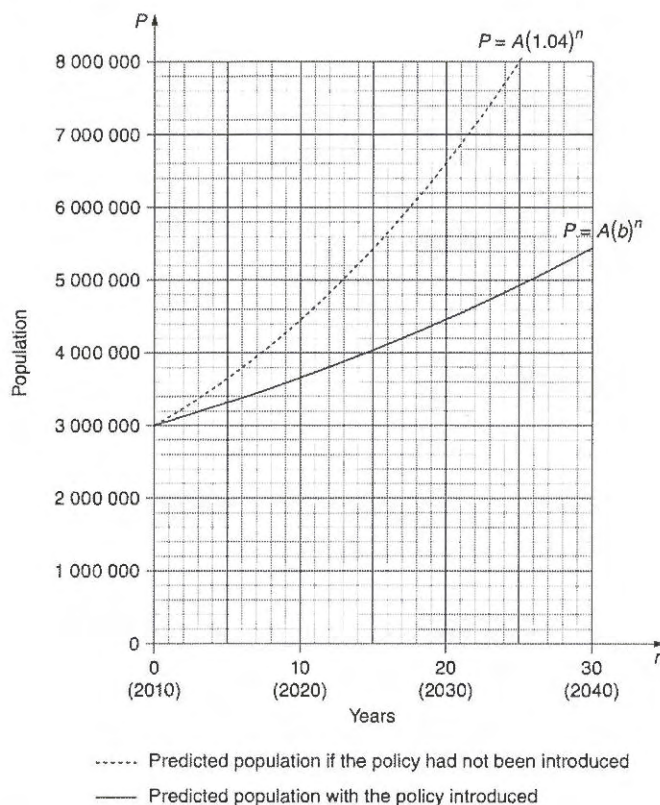
$$\text{Minimum spanning tree} = 50\text{m}$$

$$50 \times 450$$

$$= \$22500$$

Question 39

In 2010, the city of Thagoras used the equation $P = A(1.04)^n$ to predict its future population. The city introduced a new policy to slow its population growth and the new equation used was $P = A(b)^n$. In both equations P is the predicted population and n is the number of years since 2010.



- a) In both equations, A is 3 000 000, what does A represent?

1

initial population (or population in 2010)

- b) Explain why 1.05 is not a suitable estimate for the value of b

1

Would speed up population growth, not slow down as intended.

- c) Find the predicted population in 2030 if the new policy had NOT been introduced

1

$$P = 3000000(1.04)^{20}$$

$$= 6573369$$

- d) Given that in the year 2030, the new policy predicts a population of 4 460 000, find the value of b to 2 decimal places.

2

$$4460000 = 3000000(b)^{20}$$

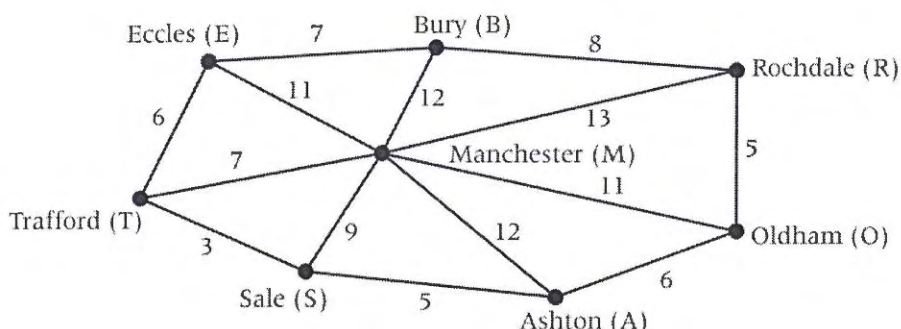
$$\frac{4460000}{3000000} = b^{20}$$

$$\sqrt[20]{\frac{446}{300}} = b$$

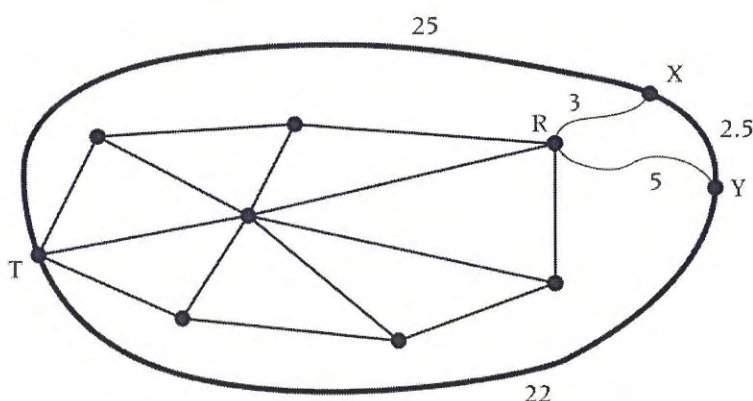
$$b = 1.02$$

Question 40

The first diagram shows the distance between towns in kilometres. Nick lives in Rochdale, and drives to work in Trafford. On each road shown on the first diagram, the speed limit is 50km/h.



A new orbital road is created as seen in the diagram below, in which the speed limit is 120km/h. New roads connecting R to X and R to Y have a speed limit of 60km/h.



How much time will Nick save by driving to work on the orbital road compared to the quickest route he could have taken using the original roads?

$$\begin{aligned}
 &\text{Original route } 19 \times 1.2 \text{ min/km} = 22.8 \text{ mins} \\
 &\text{new route } R \rightarrow X = 3 \text{ mins} + X \rightarrow T = 0.5 \times 24.5 \\
 &\text{total} = 15.25 \text{ mins} \\
 &\text{Difference } 22.8 - 15.25 = 7.55 \text{ mins} \\
 &= 7 \text{ mins } 33 \text{ secs saved.}
 \end{aligned}$$

END OF EXAM

Section I Multiple Choice Answer Sheet

Name _____

If you detach this sheet, please make sure your name is written above.

Completely fill the response oval representing the most correct answer.

Sample: $2 + 4 = ?$ (A) 2 (B) 6 (C) 8 (D) 9

A ☒ B ☐ C ☐ D ☐

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ☒ B ☒ C ☐ D ☐

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

correct
↓
A ☒ B ☒ C ☐ D ☐

1	A <input checked="" type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
2	A <input type="radio"/>	B <input checked="" type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
3	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input checked="" type="radio"/>
4	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input checked="" type="radio"/>
5	A <input checked="" type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
6	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input checked="" type="radio"/>
7	A <input type="radio"/>	B <input checked="" type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
8	A <input type="radio"/>	B <input checked="" type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
9	A <input type="radio"/>	B <input type="radio"/>	C <input checked="" type="radio"/>	D <input type="radio"/>
10	A <input type="radio"/>	B <input checked="" type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
11	A <input checked="" type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
12	A <input type="radio"/>	B <input checked="" type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
13	A <input type="radio"/>	B <input type="radio"/>	C <input checked="" type="radio"/>	D <input type="radio"/>
14	A <input checked="" type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
15	A <input type="radio"/>	B <input checked="" type="radio"/>	C <input type="radio"/>	D <input type="radio"/>