

HSC Pastpaper Wizard

Past Paper Topic Sort

Mathematics Standard 2

Topics Selected:

- *types-of-relationships*
- *rates-and-ratios*
- *bivariate-data-analysis*
- *bivariate-data-and-analysis*
- *network-concepts*
- *investments-and-loans*
- *critical-path-analysis*
- *money-matters*
- *applications-of-measurement*
- *the-normal-distribution*
- *annuities*
- *non-right-angled-trigonometry*

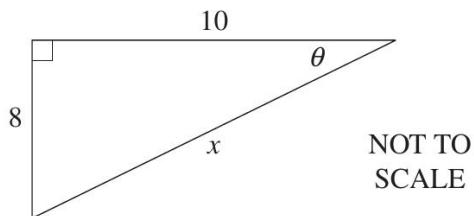
Papers Used:

- *2020_hsc.pdf*

types of relationships

Question 16 (4 marks)

Consider the triangle shown.



- (a) Find the value of θ , correct to the nearest degree.

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- (b) Find the value of x , correct to one decimal place.

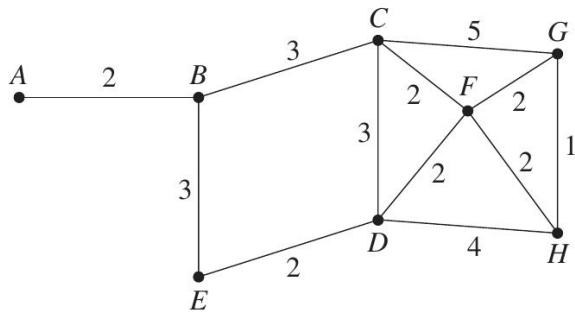
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Question 18 (4 marks)

The diagram represents a network with weighted edges.



- (a) Draw a minimum spanning tree for this network in the space below and determine its length.

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Minimum length of spanning tree =

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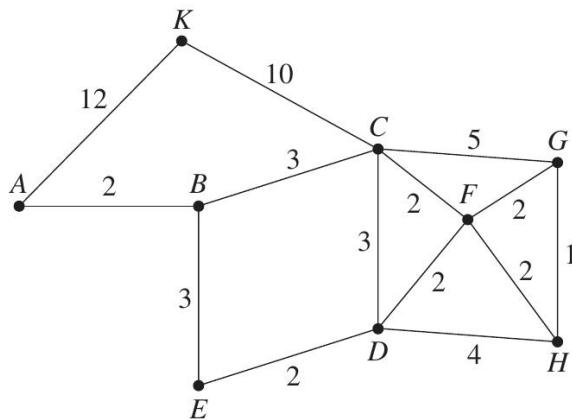
Question 18 continues on page 13

2020_hsc q18 (continued)

Question 18 (continued)

- (b) The network is revised by adding another vertex, K . Edges AK and CK have weights of 12 and 10 respectively, as shown.

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What is the length of the minimum spanning tree for this revised network?

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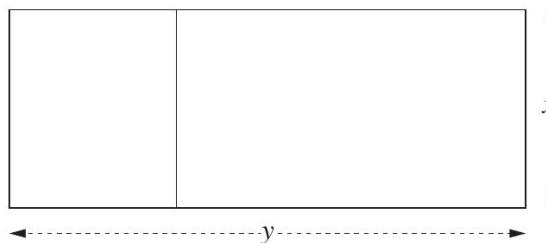
End of Question 18

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Question 19 (4 marks)

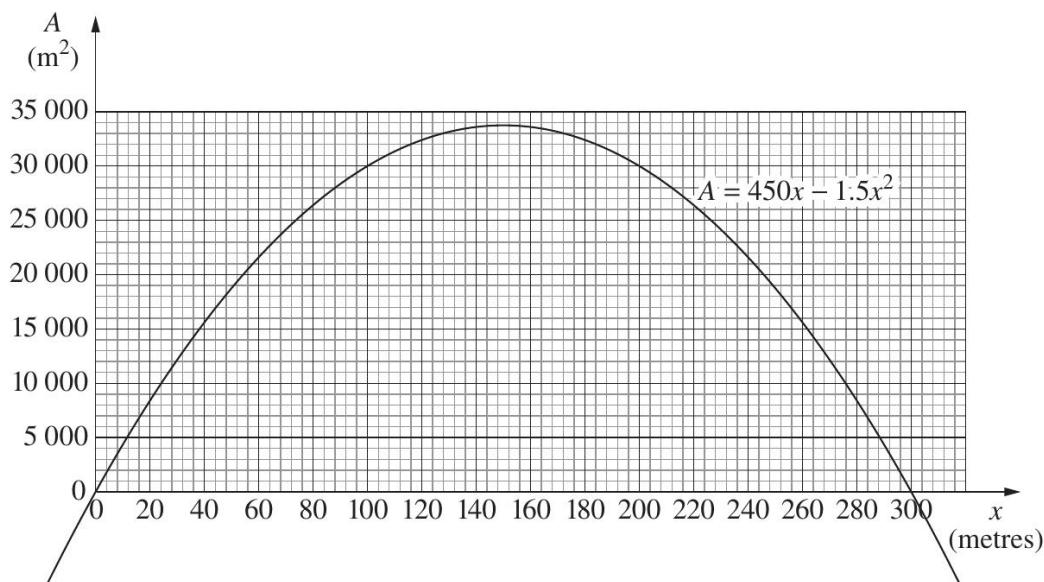
A fence is to be built around the outside of a rectangular paddock. An internal fence is also to be built.

The side lengths of the paddock are x metres and y metres, as shown in the diagram.



A total of 900 metres of fencing is to be used. Therefore $3x + 2y = 900$.

The area, A , in square metres, of the rectangular paddock is given by $A = 450x - 1.5x^2$.
The graph of this equation is shown.



- (a) If the area of the paddock is $30\ 000\ m^2$, what is the largest possible value of x ? 1

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Question 19 continues on page 15

2020_hsc_q19 (continued)

Question 19 (continued)

- (b) Find the values of x and y so that the area of the paddock is as large as possible.

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- (c) Using your values from part (b), find the largest possible area of the paddock.

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End of Question 19

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2020_hsc q24

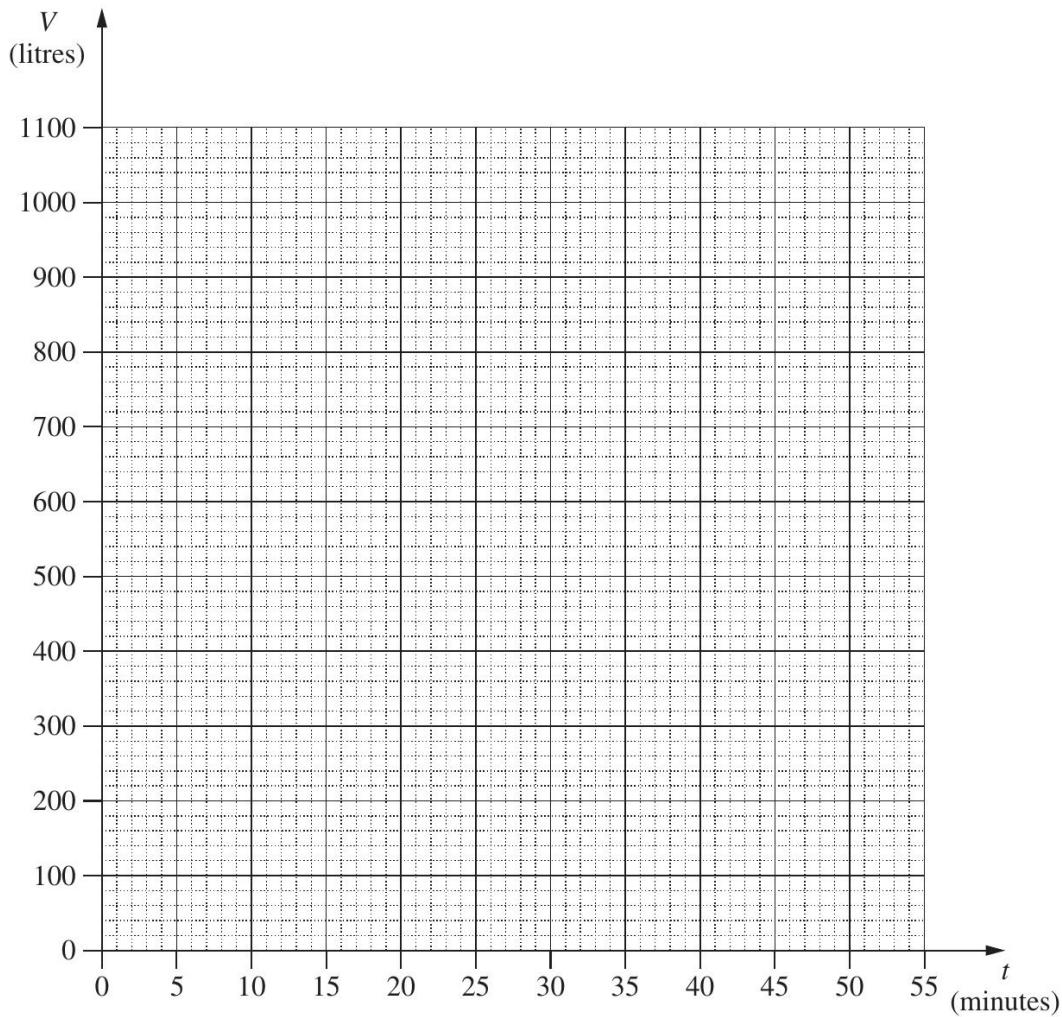
Question 24 (4 marks)

There are two tanks on a property, Tank A and Tank B. Initially, Tank A holds 1000 litres of water and Tank B is empty.

- (a) Tank A begins to lose water at a constant rate of 20 litres per minute. The volume of water in Tank A is modelled by $V = 1000 - 20t$ where V is the volume in litres and t is the time in minutes from when the tank begins to lose water.

1

On the grid below, draw the graph of this model and label it as Tank A.



Do NOT write in this area.

Question 24 continues on page 21

2020_hsc q24 (continued)

Question 24 (continued)

- (b) Tank B remains empty until $t = 15$ when water is added to it at a constant rate of 30 litres per minute.

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By drawing a line on the grid on the previous page, or otherwise, find the value of t when the two tanks contain the same volume of water.

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- (c) Using the graphs drawn, or otherwise, find the value of t (where $t > 0$) when the total volume of water in the two tanks is 1000 litres.

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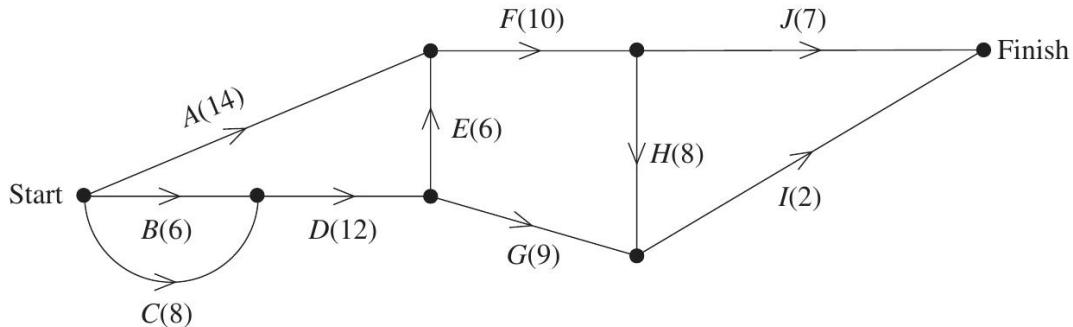
End of Question 24

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2020_hsc q26

Question 26 (5 marks)

The preparation of a meal requires the completion of all ten activities *A* to *J*. The network diagram shows the activities and their completion times in minutes.



- (a) What is the minimum time needed to prepare the meal?

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- (b) List the activities which make up the critical path for this network.

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- (c) Complete the table below, showing the earliest start time and float time for activities *A* and *G*.

2

Activity	Earliest start time (minutes)	Float time (minutes)
<i>A</i>		
<i>G</i>		

Question 28 (4 marks)

Consider the following dataset.

4

1 5 9 10 15

Suppose a new value, x , is added to this dataset, giving the following.

1 5 9 10 15 x

It is known that x is greater than 15. It is also known that the difference between the means of the two datasets is equal to ten times the difference between the medians of the two datasets.

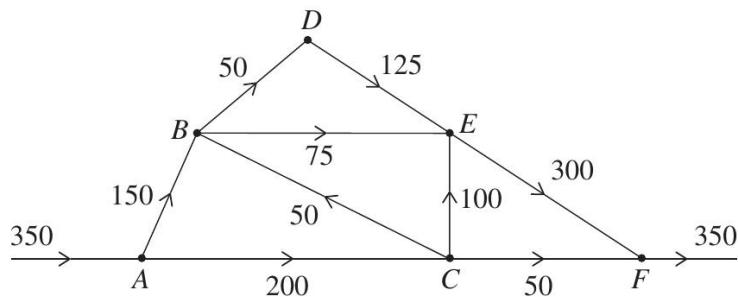
Calculate the value of x .

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2020_hsc q30

Question 30 (3 marks)

The network diagram shows a series of water channels and ponds in a garden. The vertices A , B , C , D , E and F represent six ponds. The edges represent the water channels which connect the ponds. The numbers on the edges indicate the maximum capacity of the channels.



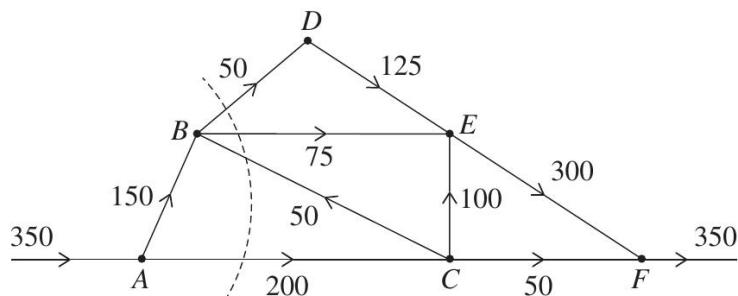
- (a) Determine the maximum flow of the network.

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- (b) A cut is added to the network, as shown.

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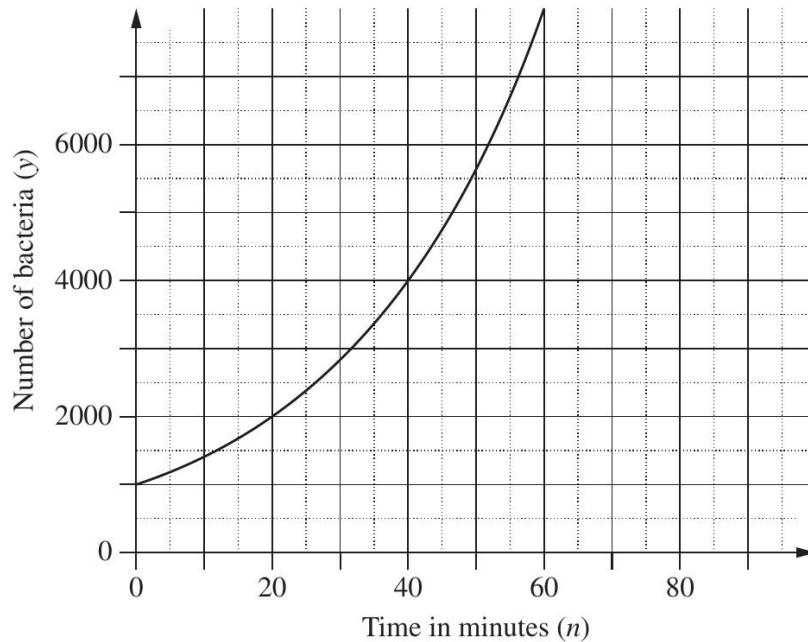


Is the cut shown a minimum cut? Give a reason for your answer.

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Question 33 (3 marks)

The graph shows the number of bacteria, y , at time n minutes. Initially (when $n = 0$) the number of bacteria is 1000.



- (a) Find the number of bacteria at 40 minutes.

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Question 33 continues on page 35

2020_hsc q33 (continued)

Question 33 (continued)

- (b) The number of bacteria can be modelled by the equation $y = A \times b^n$, where A and b are constants. 2

Use the guess and check method to find, to two decimal places, an upper and lower estimate for the value of b . The upper and lower estimates must differ by 0.01.

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End of Question 33

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Question 34 (4 marks)

Tina inherits \$60 000 and invests it in an account earning interest at a rate of 0.5% per month. Each month, immediately after the interest has been paid, Tina withdraws \$800.

The amount in the account immediately after the n th withdrawal can be determined using the recurrence relation

$$A_n = A_{n-1}(1.005) - 800,$$

where $n = 1, 2, 3, \dots$ and $A_0 = 60\,000$.

- (a) Use the recurrence relation to find the amount of money in the account immediately after the third withdrawal.

2

Do NOT write in this area

Question 34 continues on page 37

2020_hsc q34 (continued)

Question 34 (continued)

- (b) Calculate the amount of interest earned in the first three months.

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Do NOT write in this area.

End of Question 34

Please turn over

2020_hsc q35

Question 35 (7 marks)

The Intelligence Quotient (IQ) scores for adults in City *A* are normally distributed with a mean of 108 and a standard deviation of 10.

The IQ scores for adults in City *B* are normally distributed with a mean of 112 and a standard deviation of 16.

- (a) Yin is an adult who lives in City *A* and has an IQ score of 128. 2

What percentage of the adults in this city have an IQ score higher than Yin's?

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- (b) There are 1 000 000 adults living in City *B*. 2

Calculate the number of adults in City *B* that would be expected to have an IQ score lower than Yin's.

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Question 35 continues on page 39

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2020_hsc q35 (continued)

Question 35 (continued)

- (c) Simon, an adult who lives in City A , moves to City B . The z -score corresponding to his IQ score in City A is the same as the z -score corresponding to his IQ score in City B .

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By first forming an equation, calculate Simon's IQ score. Give your answer correct to one decimal place.

End of Question 35

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2020_kambala q18

Question 18 (4 marks)

The length of the Sydney Harbour Bridge has been measured as 1149 m, correct to the nearest metre.

- (a) What is the precision of this measurement?

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- (b) What is the absolute error of this measurement?

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- (c) Calculate the percentage error for this measurement?

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Give your answer correct to 2 decimal places.

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2020_kambala q21

Ellie borrowed \$17 450 to complete payment for a used car. Reducible interest on the loan was charged at 4.2% p.a., with repayments of \$395.57 due at the end of every month. The table below sets out her monthly repayment schedule for the first four months.

Month	Amount owing at start of month	Interest charged at end of month	Repayment	Amount owing at end of month
1	A	61.08	395.57	17 115.51
2	17 115.51	X	395.57	16 779.84
3	16 779.84	58.73	395.57	16 443.00
4	16 443.00	57.55	395.57	B

- (a) Some values in the table are missing. Write down the values for A and B .

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- (b) Calculate the interest (X) charged on the loan at the end of the second month.

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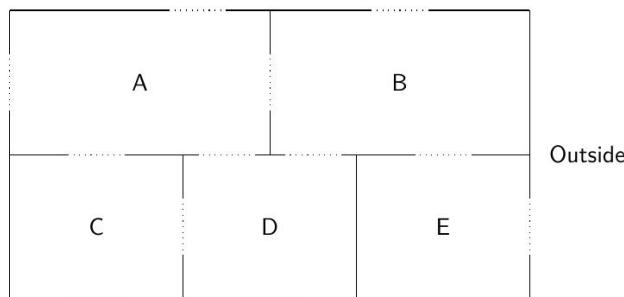
- (c) Ellie repays this loan after 4 years. What is the total amount that she spends on the loan? 1

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2020_kambala q28

Question 28 (4 marks)

The diagram below shows a floor plan of a new building with five rooms. Each room has a number of doors to another room or to the outside.



- (a) Complete the matrix below, indicating the number of possible doors between each room and an adjacent room or the outside (O). 2

	A	B	C	D	E	O
A	-					
B		-				
C			-			
D				-		
E					-	
O						-

- (b) Bob the builder needs to inspect each door. He wants to start outside the building, 2 then check every door, and finish outside the building again, passing through each doorway once and once only. Is this possible? Use your answer to (a) or the floor plan to justify your answer.

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2020_kambala q29

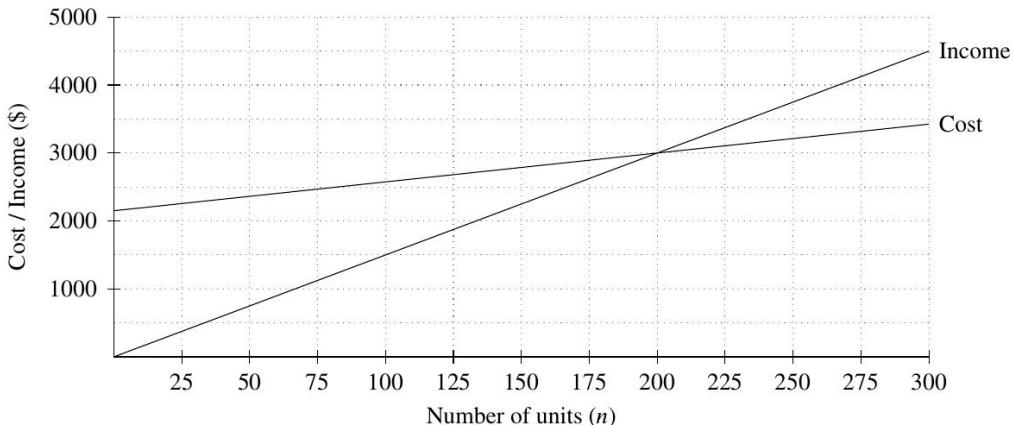
Question 29 (5 marks)

The cost (C) and income (I) equations for the Super Product Company are given below.

Cost: $C = 2150 + \frac{17n}{4}$

Income: $I = 15n$

where the value is measured in dollars and n is the number of units produced or sold.



- (a) How many units need to be sold for the company to break even?

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- (b) What are the costs for the company when the break-even point has been reached?

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- (c) What is the gradient of the cost line, and what does that value represent in the context of this question?

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- (d) Calculate the profit made by the company when 360 units are produced and sold.

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2020_kambala q31

Question 31 (4 marks)

A petroleum company offered share packages to its shareholders. No brokerage fees or stamp duty was charged. Shares were offered according to the following schedule.

Number of shares (n)	Cost of shares (\$C)
55	1485
111	2997
148	3996
185	4995

- (a) The cost (C) of purchasing shares varies directly with the number of shares (n) purchased. **2**
Find an equation in the form $C = kn$ that relates n to C .

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- (b) Explain the significance of k , the constant of proportionality, in your equation in part (a). **1**

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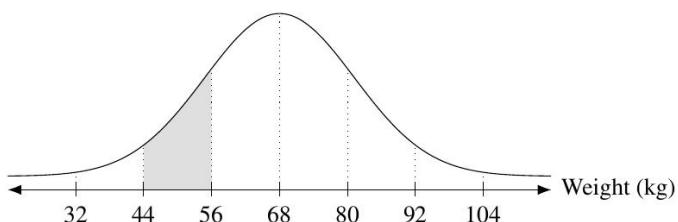
- (c) How much would it cost to purchase 800 shares under this plan? **1**

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2020_kambala q33

Question 33 (5 marks)

The diagram below shows the spread of weights, in kilograms, of 800 students. The spread is normally distributed and has a mean of 68 kg.



- (a) Show that the standard deviation of the distribution is 12.

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- (b) How many students have a weight within the shaded region?

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- (c) Elizabeth is part of the group of students. Her weight is 62 kg. What is her corresponding z-score?

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- (d) A student from the group is selected at random. What is the probability that they have a weight less than 80 kg?

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2020_kambala q34

Question 34 (4 marks)

Alex purchased a new car for \$15 000. After 3 years, using the straight line method of depreciation, the salvage value of the car is \$9213.

- (a) Find the annual amount of depreciation, D , according to the straight line method of depreciation. 2

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- (b) If Alex decided to use the declining balance method instead, what would be the annual rate of depreciation, r , if the car was worth the same amount after 3 years? 2

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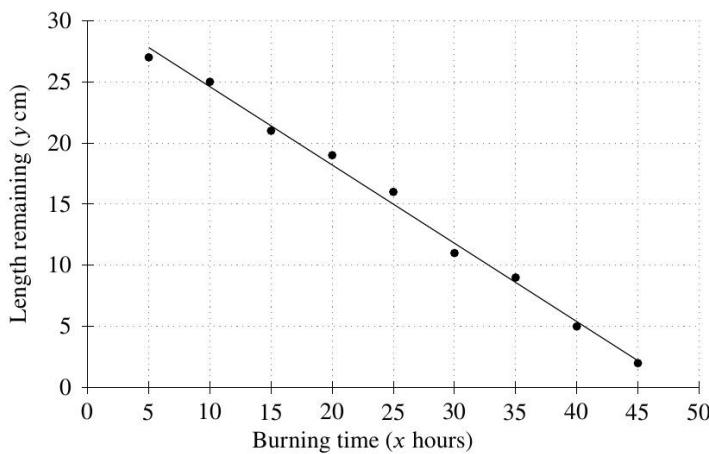
2020_kambala q36

Question 36 (5 marks)

Peter, a church warden, decides to investigate the lifetime of a particular brand of wax candle. Each candle is 30 cm in length. From a box containing a large number of wax candles, he selects one candle at random. He lights the candle and, after it has burned continuously for x hours, he records its remaining length, y cm, to the nearest centimetre. His results are shown in the table below.

Burning time (x hours)	5	10	15	20	25	30	35	40	45
Length remaining (y cm)	27	25	21	19	16	11	9	5	2

The points from the table are plotted in the scatterplot below and the least-squares line of best fit has been added to the scatterplot.



- (a) The equation of the least-squares line of best fit can be written in the form $y = c - mx$. 2
Use your calculator to find the values of c and m .

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- (b) What does your value of m represent in the context of this question? 1

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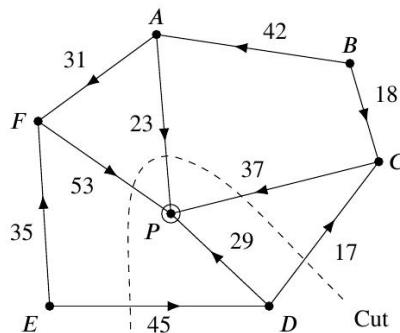
- (c) It is claimed by the candle manufacturer that the total length of time that such candles are likely to burn for is at least 50 hours. Comment on this claim, using appropriate calculations and reasoning to justify your answer. 2

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2020_kambala q37

Question 37 (4 marks)

The network below shows the routes along corridors from two arrival gates to the passport control area, P , in an airport. The number on each edge represents the maximum number of passengers that can travel along a particular corridor in one minute.



- (a) Which vertices represent the two arrival gates?

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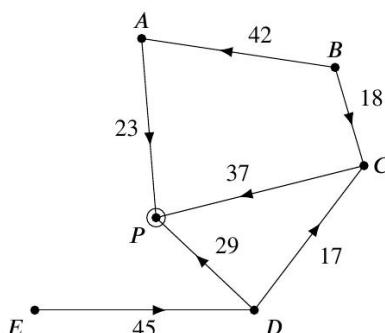
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- (b) Find the value of the cut shown in the diagram above.

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- (c) On a particular day, there is an obstruction at F so corridors in and out of that intersection cannot be used. The diagram below shows the available network for that day.



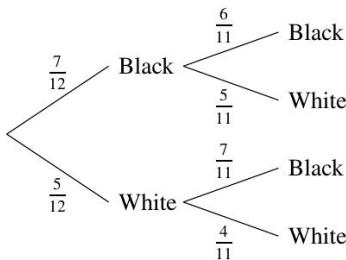
Calculate the maximum flow of passengers in one minute through this network while this obstruction is occurring.

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2020_kambala q38

Question 38 (5 marks)

Georgie's sock drawer contains 7 black socks and 5 white socks. She selects two socks at random from the drawer. A tree diagram for this situation is shown below.



- (a) Calculate the probability that the socks Georgie selects are the same colour.

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- (b) Georgie washes and dries her socks and puts them back in the drawer. The following week she adds 8 more socks to the drawer. All of the additional socks are black or white. After this has been done, Georgie selects a sock at random from the drawer. The probability that this sock is black is $\frac{3}{5}$. How many black socks and white socks were added to the drawer?

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rates and ratios

Question 17 (2 marks)

Ayla wishes to estimate the number of trees on a square block of land measuring 1000 m by 1000 m. She counts the number of trees on a 5 m by 5 m section of the block and finds there are 8 trees.

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Based on this, estimate the number of trees on the entire square block of land.

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2020_hsc q21

Question 21 (2 marks)

The inflation rate over the year from January 2019 to January 2020 was 2%. 2

The cost of a school jumper in January 2020 was \$122.

Calculate the cost of the jumper in January 2019 assuming that the only change in the cost of the jumper was due to inflation.

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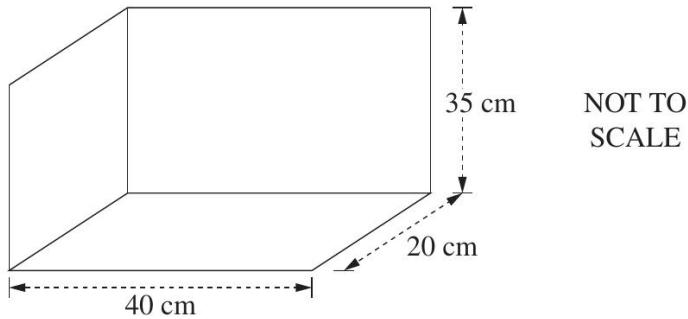
Question 23 (5 marks)

In a tropical drink, the ratio of pineapple juice to mango juice to orange juice is 15 : 9 : 4.

- (a) How much orange juice is needed if the tropical drink is to contain 3 litres of pineapple juice? 2

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- (b) The internal dimensions of a drink container, in the shape of a rectangular prism, are shown. 3



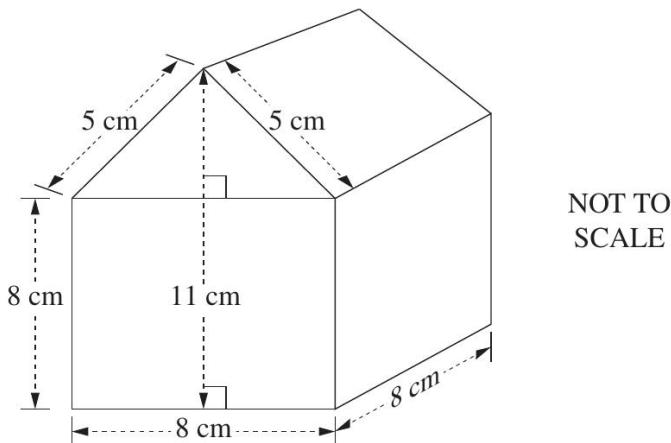
To completely fill the container with the tropical drink, how many litres of mango juice are required?

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Question 25 (3 marks)

A composite solid consists of a triangular prism which fits exactly on top of a cube, as shown.

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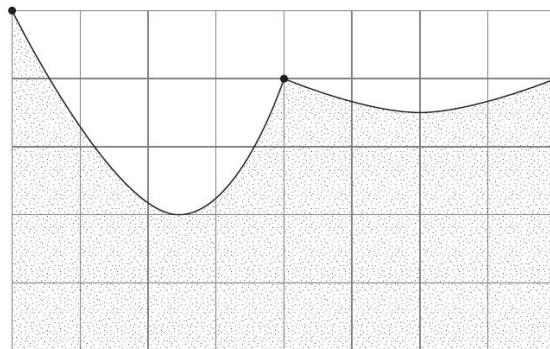


Find the surface area of the composite solid.

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Question 27 (5 marks)

The shaded region on the diagram represents a garden. The scale is 1 cm = 5 m.



- (a) Use two applications of the trapezoidal rule to calculate the approximate area of the garden. 3

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- (b) Should the answer to part (a) be more than, equal to or less than the actual area of the garden? Referring to the diagram above, briefly explain your answer. 2

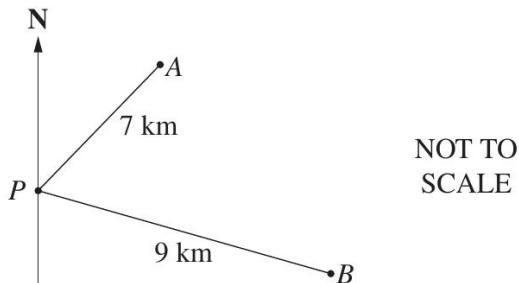
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Questions 16–27 are worth 44 marks in total

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Question 31 (5 marks)

Mr Ali, Ms Brown and a group of students were camping at the site located at P . Mr Ali walked with some of the students on a bearing of 035° for 7 km to location A . Ms Brown, with the rest of the students, walked on a bearing of 100° for 9 km to location B .



- (a) Show that the angle APB is 65° .

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- (b) Find the distance AB .

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- (c) Find the bearing of Ms Brown's group from Mr Ali's group. Give your answer correct to the nearest degree.

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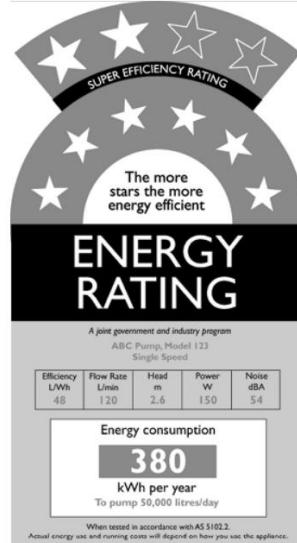
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2020_kambala q16

Question 16 (2 marks)

The cost of a new water pump is \$435. It uses energy according to the following energy label. 2



Energy is charged at the rate of \$0.36 per kWh.

How much will it cost in total to purchase and then run this pump for 6 months.

2020_kambala q26

Question 26 (3 marks)

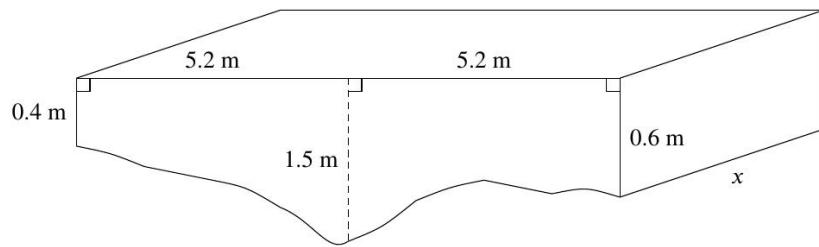
Fiona is driving at 45 km/h. A bus suddenly pulls out into the road ahead and she decides to apply the brakes. Her reaction time is 1.8 seconds. Her braking distance (D metres) is given by $D = 0.01v^2$, where v is her speed in km/h.

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What is Fiona's stopping distance? Give your answer correct to the nearest metre.

Question 27 (4 marks)

Gaynor has a dam on her property which has a uniform cross-section, as shown in the diagram below.



- (a) Use two applications of the trapezoidal rule to show that the area of the cross section is 2 approximately 10.4 m^2 .

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bivariate data analysis

2020_hsc q36

Question 36 (5 marks)

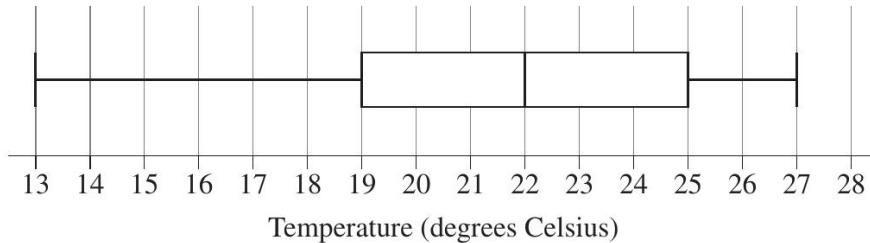
A cricket is an insect. The male cricket produces a chirping sound.

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A scientist wants to explore the relationship between the temperature in degrees Celsius and the number of cricket chirps heard in a 15-second time interval.

Once a day for 20 days, the scientist collects data. Based on the 20 data points, the scientist provides the information below.

- A box-plot of the temperature data is shown.



- The mean temperature in the dataset is 0.525°C below the median temperature in the dataset.
- A total of 684 chirps was counted when collecting the 20 data points.

The scientist fits a least-squares regression line using the data (x, y) , where x is the temperature in degrees Celsius and y is the number of chirps heard in a 15-second time interval. The equation of this line is

$$y = -10.6063 + bx,$$

where b is the slope of the regression line.

The least-squares regression line passes through the point (\bar{x}, \bar{y}) where \bar{x} is the sample mean of the temperature data and \bar{y} is the sample mean of the chirp data.

Question 36 continues on page 41

2020_hsc q36 (continued)

Question 36 (continued)

Calculate the number of chirps expected in a 15-second interval when the temperature is 19° Celsius. Give your answer correct to the nearest whole number.

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End of Question 36

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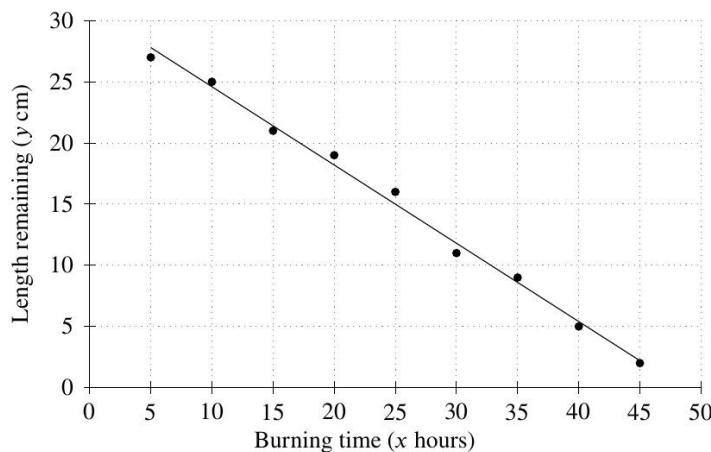
2020_kambala q36

Question 36 (5 marks)

Peter, a church warden, decides to investigate the lifetime of a particular brand of wax candle. Each candle is 30 cm in length. From a box containing a large number of wax candles, he selects one candle at random. He lights the candle and, after it has burned continuously for x hours, he records its remaining length, y cm, to the nearest centimetre. His results are shown in the table below.

Burning time (x hours)	5	10	15	20	25	30	35	40	45
Length remaining (y cm)	27	25	21	19	16	11	9	5	2

The points from the table are plotted in the scatterplot below and the least-squares line of best fit has been added to the scatterplot.



- (a) The equation of the least-squares line of best fit can be written in the form $y = c - mx$. 2
Use your calculator to find the values of c and m .

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- (b) What does your value of m represent in the context of this question? 1

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- (c) It is claimed by the candle manufacturer that the total length of time that such candles are likely to burn for is at least 50 hours. Comment on this claim, using appropriate calculations and reasoning to justify your answer. 2

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bivariate data and analysis

Question 20 (3 marks)

The table shows the income tax rates for the 2019–2020 financial year.

3

<i>Taxable income</i>	<i>Tax on this income</i>
0–\$18 200	Nil
\$18 201–\$37 000	19c for each \$1 over \$18 200
\$37 001–\$90 000	\$3572 plus 32.5c for each \$1 over \$37 000
\$90 001–\$180 000	\$20 797 plus 37c for each \$1 over \$90 000
\$180 001 and over	\$54 097 plus 45c for each \$1 over \$180 000

For the 2019–2020 financial year, Wally had a taxable income of \$122 680. During the year, he paid \$3000 per month in Pay As You Go (PAYG) tax.

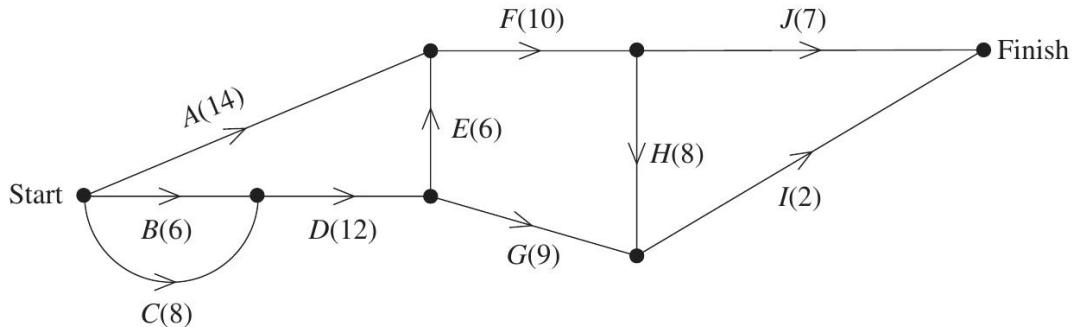
Calculate Wally's tax refund, ignoring the Medicare levy.

Do NOT write in this area

2020_hsc q26

Question 26 (5 marks)

The preparation of a meal requires the completion of all ten activities A to J . The network diagram shows the activities and their completion times in minutes.



- (a) What is the minimum time needed to prepare the meal?

1

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- (b) List the activities which make up the critical path for this network.

2

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- (c) Complete the table below, showing the earliest start time and float time for activities A and G .

2

Activity	Earliest start time (minutes)	Float time (minutes)
A		
G		

Question 29 (3 marks)

Jana owns a share portfolio. Details of her share portfolio at 30 June 2020 are given in the table.

<i>Company name</i>	<i>Number of shares in Jana's portfolio</i>	<i>Dividend yield (per annum)</i>	<i>Market price per share</i>
<i>ABC</i>	200	6.0%	\$5.50
<i>XYZ</i>	?	4.0%	\$6.00

Jana received a total annual dividend of \$149.52 from her share portfolio.

Calculate the number of shares Jana has in company XYZ on 30 June 2020.

Do NOT write in this area

2020_hsc q36

Question 36 (5 marks)

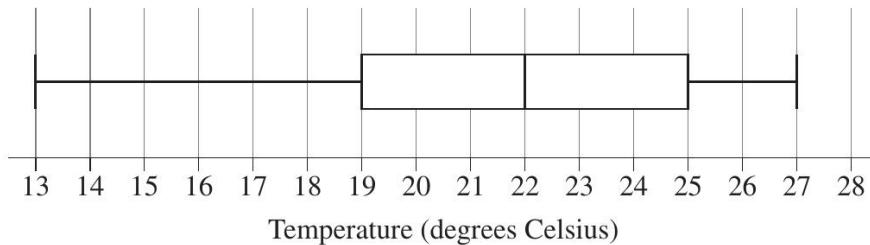
A cricket is an insect. The male cricket produces a chirping sound.

5

A scientist wants to explore the relationship between the temperature in degrees Celsius and the number of cricket chirps heard in a 15-second time interval.

Once a day for 20 days, the scientist collects data. Based on the 20 data points, the scientist provides the information below.

- A box-plot of the temperature data is shown.



- The mean temperature in the dataset is 0.525°C below the median temperature in the dataset.
- A total of 684 chirps was counted when collecting the 20 data points.

The scientist fits a least-squares regression line using the data (x, y) , where x is the temperature in degrees Celsius and y is the number of chirps heard in a 15-second time interval. The equation of this line is

$$y = -10.6063 + bx,$$

where b is the slope of the regression line.

The least-squares regression line passes through the point (\bar{x}, \bar{y}) where \bar{x} is the sample mean of the temperature data and \bar{y} is the sample mean of the chirp data.

Do NOT write in this area.

Question 36 continues on page 41

2020_hsc q36 (continued)

Question 36 (continued)

Calculate the number of chirps expected in a 15-second interval when the temperature is 19° Celsius. Give your answer correct to the nearest whole number.

Do NOT write in this area.

End of Question 36

Please turn over

Question 37 (3 marks)

Wilma deposited a lump sum into a new bank account which earns 2% per annum compound interest.

3

Present value interest factors for an annuity of \$1 for various interest rates (r) and numbers of periods (N) are given in the table.

Table of present value interest factors

N	r	Interest rate per period as a decimal			
		0.01	0.015	0.02	0.025
10	9.471	9.222	8.983	8.752	
20	18.046	17.169	16.351	15.589	
30	25.808	24.016	22.396	20.930	

Wilma was able to make the following withdrawals from this account.

- \$1000 at the end of each year for twenty years (starting one year after the account is opened)
 - \$3000 each year for ten years starting 21 years after the account is opened.

Calculate the minimum lump sum Wilma must have deposited when she opened the new account.

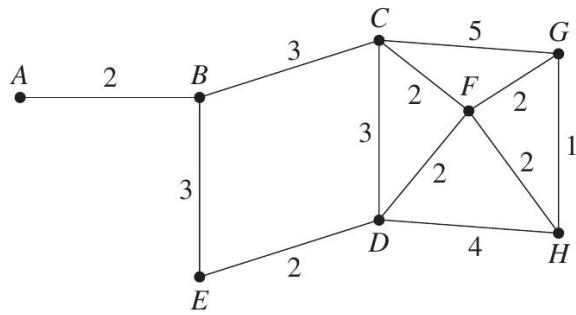
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network concepts

Question 18 (4 marks)

The diagram represents a network with weighted edges.



- (a) Draw a minimum spanning tree for this network in the space below and determine its length.

3

Minimum length of spanning tree =

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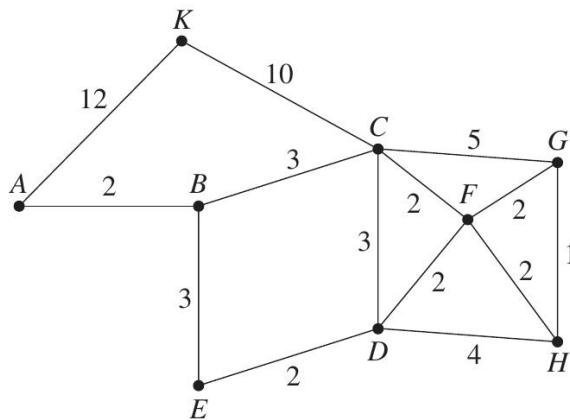
Question 18 continues on page 13

2020_hsc q18 (continued)

Question 18 (continued)

- (b) The network is revised by adding another vertex, K . Edges AK and CK have weights of 12 and 10 respectively, as shown.

1



What is the length of the minimum spanning tree for this revised network?

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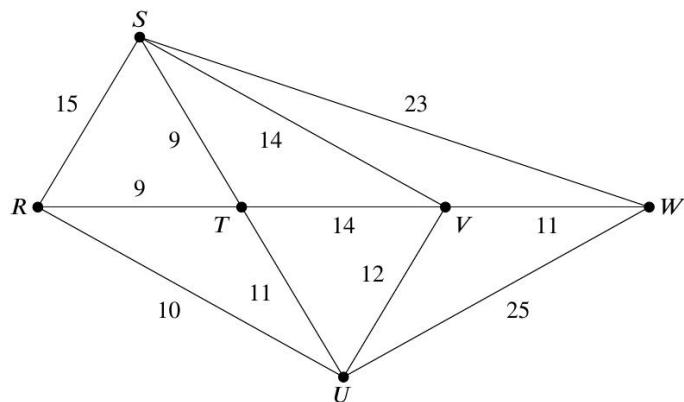
End of Question 18

Please turn over

2020_kambala q32

Question 32 (4 marks)

The diagram below shows a train network through six towns, Roseby, Southside, Tivoli, Upton, Vineyard and Wentworth. The numbers on each edge represent the cost (in dollars) of a train ticket between the two towns. Portia lives in Roseby and will be travelling by train to have a holiday in Wentworth.



- (a) Portia considers travelling by train from Roseby to Wentworth via Southside only.
What would be the cost of that train journey?

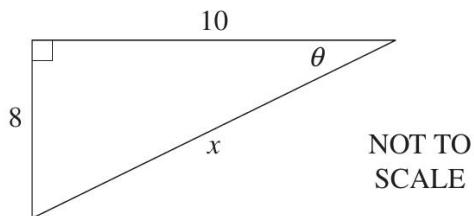
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- (b) Portia finds the cheapest route from Roseby to Wentworth. How much would that journey cost and through which other towns will she pass on that journey? **3**

investments and loans

Question 16 (4 marks)

Consider the triangle shown.



- (a) Find the value of
- θ
- , correct to the nearest degree.

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- (b) Find the value of
- x
- , correct to one decimal place.

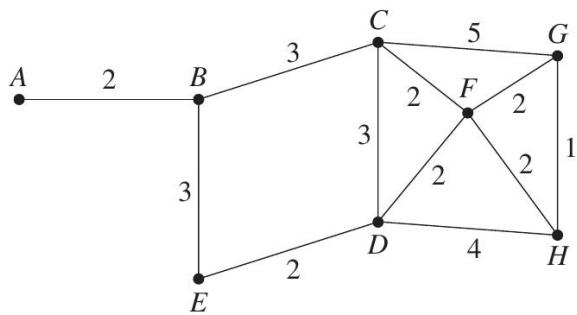
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Do NOT write in this area.

Question 18 (4 marks)

The diagram represents a network with weighted edges.



- (a) Draw a minimum spanning tree for this network in the space below and determine its length.

3

Minimum length of spanning tree =

Do NOT write in this area.

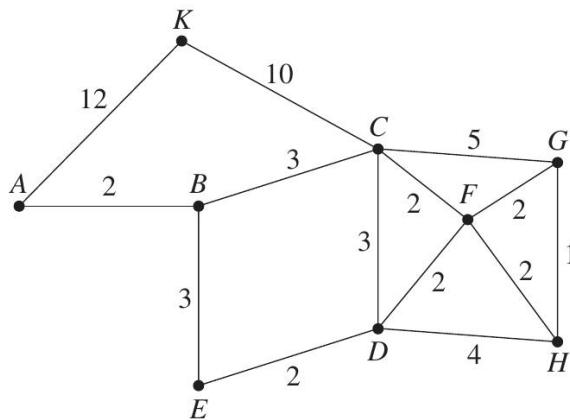
Question 18 continues on page 13

2020_hsc q18 (continued)

Question 18 (continued)

- (b) The network is revised by adding another vertex, K . Edges AK and CK have weights of 12 and 10 respectively, as shown.

1



What is the length of the minimum spanning tree for this revised network?

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Do NOT write in this area.

End of Question 18

Please turn over

Question 20 (3 marks)

The table shows the income tax rates for the 2019–2020 financial year.

3

<i>Taxable income</i>	<i>Tax on this income</i>
0–\$18 200	Nil
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\$90 001–\$180 000	\$20 797 plus 37c for each \$1 over \$90 000
\$180 001 and over	\$54 097 plus 45c for each \$1 over \$180 000

For the 2019–2020 financial year, Wally had a taxable income of \$122 680. During the year, he paid \$3000 per month in Pay As You Go (PAYG) tax.

Calculate Wally's tax refund, ignoring the Medicare levy.

Do NOT write in this area

Question 22 (3 marks)

Nisa has a credit card on which interest at 17% per annum, compounded daily, is charged on the amount owing.

3

At the beginning of the month, Nisa owes \$500 on her credit card. She makes no other purchases using the credit card, but fifteen days later, she repays \$250.

Assuming that interest is charged for the fifteen days, calculate the amount owing on the credit card immediately after the \$250 payment is made.

Do NOT write in this area.

Question 29 (3 marks)

Jana owns a share portfolio. Details of her share portfolio at 30 June 2020 are given in the table.

3

<i>Company name</i>	<i>Number of shares in Jana's portfolio</i>	<i>Dividend yield (per annum)</i>	<i>Market price per share</i>
<i>ABC</i>	200	6.0%	\$5.50
<i>XYZ</i>	?	4.0%	\$6.00

Jana received a total annual dividend of \$149.52 from her share portfolio.

Calculate the number of shares Jana has in company XYZ on 30 June 2020.

Do NOT write in this area

Question 37 (3 marks)

Wilma deposited a lump sum into a new bank account which earns 2% per annum compound interest.

3

Present value interest factors for an annuity of \$1 for various interest rates (r) and numbers of periods (N) are given in the table.

Table of present value interest factors

N	r	Interest rate per period as a decimal			
		0.01	0.015	0.02	0.025
10	9.471	9.222	8.983	8.752	
20	18.046	17.169	16.351	15.589	
30	25.808	24.016	22.396	20.930	

Wilma was able to make the following withdrawals from this account.

- \$1000 at the end of each year for twenty years (starting one year after the account is opened)
 - \$3000 each year for ten years starting 21 years after the account is opened.

Calculate the minimum lump sum Wilma must have deposited when she opened the new account.

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End of paper

2020_kambala q17

Question 17 (2 marks)

A seven year old child weighs 28 kg. He needs to have the correct dosage of medicine.

2

The dosage (D) is calculated using the formula:

$$D = \frac{mA}{70}$$

where m is the mass of the child in kilograms and A is the adult dosage.

The adult dosage is 5 mL three times a day. For how many days will a 240 mL bottle of medicine last for the child?

2020_kambala q19

Question 19 (2 marks)

The table below shows the fortnightly Abstudy allowances available to independent indigenous students.

2

Fortnightly Abstudy Allowances

Conditions for Eligibility	Maximum Fortnightly Payment
Single, no children, living at home	
Under 16	\$34.80
16–17 years	\$253.30
18–21 years	\$304.60
22 years or older	\$565.70
Single, no children, living away from home	
Under 16	\$462.50
16–21 years	\$462.50
22 years or older	\$565.70
Partnered, no children	
16–21 years	\$462.50
22 years or older	\$510.80
Single, with dependent child	
16–21 years	\$606.00
22 years or older	\$612.00
Partnered, with dependent child	
16–21 years	\$507.90
22 years or older	\$510.80

Source: Services Australia

Cory and Emma are indigenous students in a de facto relationship with no children. Cory is 24 while Emma is 21. Calculate their combined fortnightly allowance.

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2020_kambala q21

Ellie borrowed \$17 450 to complete payment for a used car. Reducible interest on the loan was charged at 4.2% p.a., with repayments of \$395.57 due at the end of every month. The table below sets out her monthly repayment schedule for the first four months.

Month	Amount owing at start of month	Interest charged at end of month	Repayment	Amount owing at end of month
1	A	61.08	395.57	17 115.51
2	17 115.51	X	395.57	16 779.84
3	16 779.84	58.73	395.57	16 443.00
4	16 443.00	57.55	395.57	B

- (a) Some values in the table are missing. Write down the values for A and B .

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- (b) Calculate the interest (X) charged on the loan at the end of the second month.

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- (c) Ellie repays this loan after 4 years. What is the total amount that she spends on the loan? 1

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2020_kambala q23

Question 23 (4 marks)

The formula below can be used to estimate the blood alcohol content (*BAC*) for females.

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

4

where N is the number of standard drinks consumed, H is the number of hours of drinking, and M is the person's weight in kilograms.

The number of hours required for a person to reach a zero *BAC* after they stop drinking alcohol is given by the formula:

$$\text{Time} = \frac{BAC}{0.015}$$

The number of standard drinks in a typical serving is shown in the table below.

	Number of Standard Drinks
Beer (1 glass)	1.1
Spirits (1 shot)	1
Wine (1 glass)	1.2

Lucy was out on Saturday night celebrating her team's win. The celebrations started at 8 pm and continued until the team's 11:30 pm curfew. During this time, she consumed 5 glasses of wine and 2 shots of spirits. She then stopped drinking alcohol. Using the information and formulas above, and the fact that Lucy weighs 72 kg, determine what day and time her BAC should reach zero.

2020_kambala q24

Question 24 (3 marks)

Angela owns a credit card that has no annual fee and charges 17.2% p.a. interest, compounded daily, on all purchases. Interest is charged from the day of purchase up until the day that purchase is fully repaid.

- (a) Show that the daily interest rate is approximately 0.0471%. 1

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- (b) On 28 July, Angela bought a flatscreen TV for \$699 using her credit card. Angela paid her credit card account in full on 8 August. How much interest was she charged for the television? 2

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2020_kambala q25

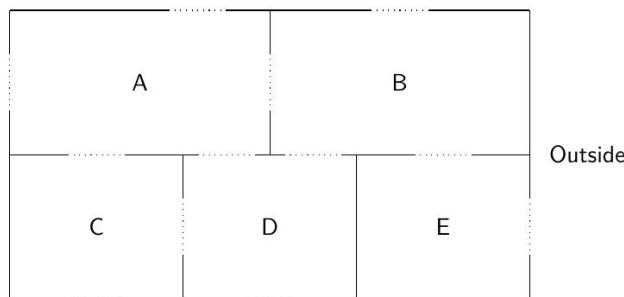
Question 25

A tap is dripping water at a rate of 70 drops per minute. Each drop is 0.2 mL. How many litres of water drip from the tap in a day? 2

2020_kambala q28

Question 28 (4 marks)

The diagram below shows a floor plan of a new building with five rooms. Each room has a number of doors to another room or to the outside.



- (a) Complete the matrix below, indicating the number of possible doors between each room and an adjacent room or the outside (O). 2

	A	B	C	D	E	O
A	-					
B		-				
C			-			
D				-		
E					-	
O						-

- (b) Bob the builder needs to inspect each door. He wants to start outside the building, 2 then check every door, and finish outside the building again, passing through each doorway once and once only. Is this possible? Use your answer to (a) or the floor plan to justify your answer.

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2020_kambala q34

Question 34 (4 marks)

Alex purchased a new car for \$15 000. After 3 years, using the straight line method of depreciation, the salvage value of the car is \$9213.

- (a) Find the annual amount of depreciation, D , according to the straight line method of depreciation. 2

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- (b) If Alex decided to use the declining balance method instead, what would be the annual rate of depreciation, r , if the car was worth the same amount after 3 years? 2

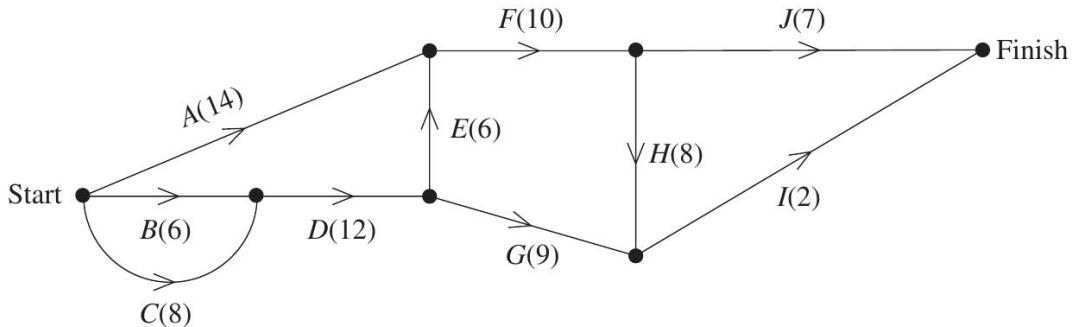
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critical path analysis

2020_hsc q26

Question 26 (5 marks)

The preparation of a meal requires the completion of all ten activities *A* to *J*. The network diagram shows the activities and their completion times in minutes.



- (a) What is the minimum time needed to prepare the meal?

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- (b) List the activities which make up the critical path for this network.

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- (c) Complete the table below, showing the earliest start time and float time for activities *A* and *G*.

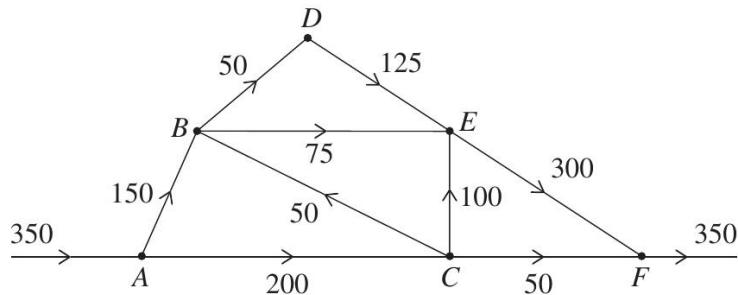
2

Activity	Earliest start time (minutes)	Float time (minutes)
<i>A</i>		
<i>G</i>		

2020_hsc q30

Question 30 (3 marks)

The network diagram shows a series of water channels and ponds in a garden. The vertices A , B , C , D , E and F represent six ponds. The edges represent the water channels which connect the ponds. The numbers on the edges indicate the maximum capacity of the channels.



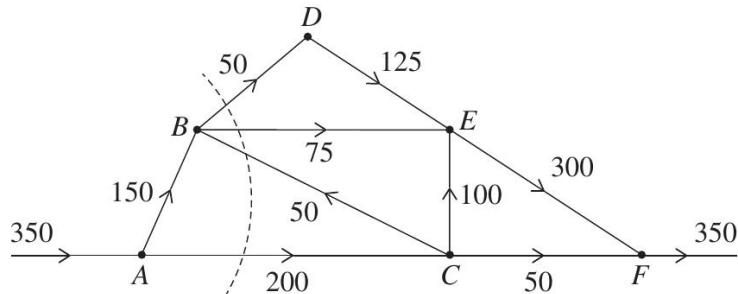
- (a) Determine the maximum flow of the network.

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- (b) A cut is added to the network, as shown.

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Is the cut shown a minimum cut? Give a reason for your answer.

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2020_kambala q35

Question 35 (5 marks)

A project requires activities *A* to *G* to be completed. The activity table shows the immediate prerequisite(s) and duration (in days) for each activity.

Activity	Duration (days)	Immediate Prerequisite(s)
<i>A</i>	5	—
<i>B</i>	4	—
<i>C</i>	3	<i>A</i>
<i>D</i>	7	<i>B</i>
<i>E</i>	8	<i>B</i>
<i>F</i>	2	<i>C</i>
<i>G</i>	6	<i>D, E</i>

- (a) In the space below draw an activity chart to represent the information in the table above. **2**

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- (b) Determine the minimum time (in days) for the project to be completed. **2**

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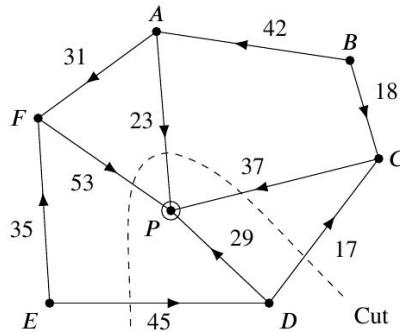
- (c) Calculate the float time of activity *D*. **1**

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2020_kambala q37

Question 37 (4 marks)

The network below shows the routes along corridors from two arrival gates to the passport control area, P , in an airport. The number on each edge represents the maximum number of passengers that can travel along a particular corridor in one minute.



- (a) Which vertices represent the two arrival gates?

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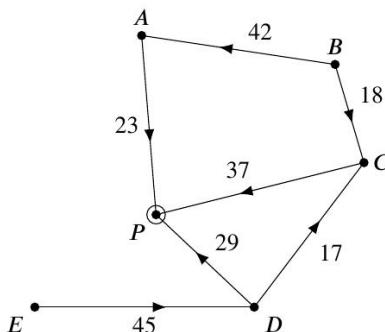
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- (b) Find the value of the cut shown in the diagram above.

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- (c) On a particular day, there is an obstruction at F so corridors in and out of that intersection cannot be used. The diagram below shows the available network for that day.



Calculate the maximum flow of passengers in one minute through this network while this obstruction is occurring.

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money matters

Question 20 (3 marks)

The table shows the income tax rates for the 2019–2020 financial year.

3

<i>Taxable income</i>	<i>Tax on this income</i>
0–\$18 200	Nil
\$18 201–\$37 000	19c for each \$1 over \$18 200
\$37 001–\$90 000	\$3572 plus 32.5c for each \$1 over \$37 000
\$90 001–\$180 000	\$20 797 plus 37c for each \$1 over \$90 000
\$180 001 and over	\$54 097 plus 45c for each \$1 over \$180 000

For the 2019–2020 financial year, Wally had a taxable income of \$122 680. During the year, he paid \$3000 per month in Pay As You Go (PAYG) tax.

Calculate Wally's tax refund, ignoring the Medicare levy.

Do NOT write in this area

2020_kambala q22

Question 22 (5 marks)

Arissa has a gross annual income of \$81 797. She has allowable deductions of \$6947. She must pay tax on all taxable income. Her employer has deducted \$19 100 in PAYG tax throughout the financial year.

- (a) Show that Arissa's taxable income is \$74 850. 1

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- (b) Using the tax table below, calculate the income tax that Arissa must pay. 2

Taxable Income	Tax on Taxable Income
\$1 – \$6000	Nil
\$6001 – \$25 000	15¢ for each \$1 over \$6000
\$25 001 – \$75 000	\$2850 plus 30¢ for each \$1 over \$25 000
\$75 001 – \$150 000	\$17 850 plus 40¢ for each \$1 over \$75 000
\$150 001 and over	\$47 850 plus 45¢ for each \$1 over \$150 000

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- (c) The Medicare levy is charged at 2% of taxable income. Calculate Arissa's Medicare levy. 1

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- (d) Will Arissa receive a refund or will she need to pay an additional amount in tax? What is the amount of her refund or tax bill? 1

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applications of measurement

Question 17 (2 marks)

Ayla wishes to estimate the number of trees on a square block of land measuring 1000 m by 1000 m. She counts the number of trees on a 5 m by 5 m section of the block and finds there are 8 trees.

2

Based on this, estimate the number of trees on the entire square block of land.

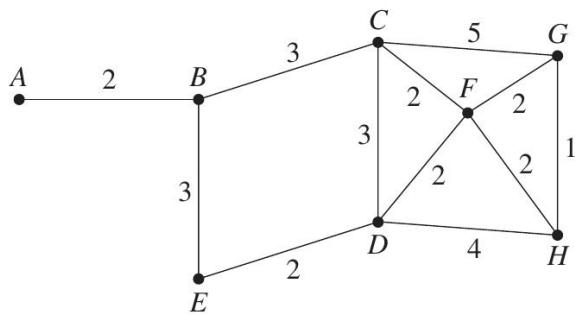
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Please turn over

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Question 18 (4 marks)

The diagram represents a network with weighted edges.



- (a) Draw a minimum spanning tree for this network in the space below and determine its length.

3

Minimum length of spanning tree =

Do NOT write in this area.

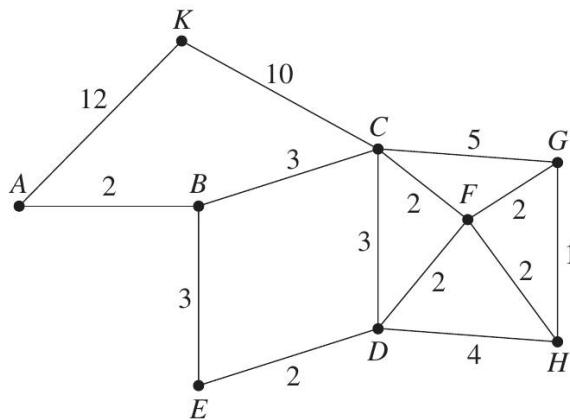
Question 18 continues on page 13

2020_hsc q18 (continued)

Question 18 (continued)

- (b) The network is revised by adding another vertex, K . Edges AK and CK have weights of 12 and 10 respectively, as shown.

1



What is the length of the minimum spanning tree for this revised network?

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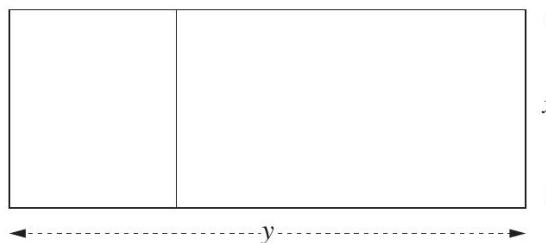
End of Question 18

Please turn over

Question 19 (4 marks)

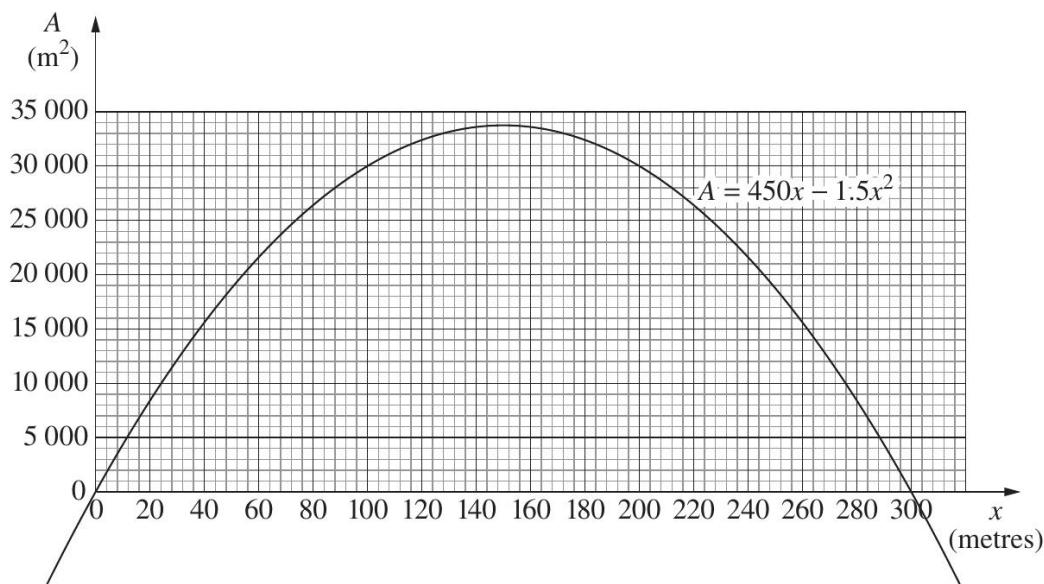
A fence is to be built around the outside of a rectangular paddock. An internal fence is also to be built.

The side lengths of the paddock are x metres and y metres, as shown in the diagram.



A total of 900 metres of fencing is to be used. Therefore $3x + 2y = 900$.

The area, A , in square metres, of the rectangular paddock is given by $A = 450x - 1.5x^2$.
The graph of this equation is shown.



- (a) If the area of the paddock is $30\ 000\ m^2$, what is the largest possible value of x ? 1

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Question 19 continues on page 15

2020_hsc_q19 (continued)

Question 19 (continued)

- (b) Find the values of x and y so that the area of the paddock is as large as possible.

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- (c) Using your values from part (b), find the largest possible area of the paddock.

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End of Question 19

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Please turn over

Question 21 (2 marks)

The inflation rate over the year from January 2019 to January 2020 was 2%. 2

The cost of a school jumper in January 2020 was \$122.

Calculate the cost of the jumper in January 2019 assuming that the only change in the cost of the jumper was due to inflation.

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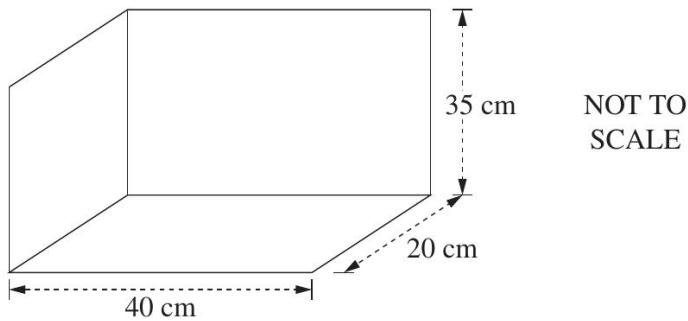
Question 23 (5 marks)

In a tropical drink, the ratio of pineapple juice to mango juice to orange juice is 15 : 9 : 4.

- (a) How much orange juice is needed if the tropical drink is to contain 3 litres of pineapple juice? 2

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- (b) The internal dimensions of a drink container, in the shape of a rectangular prism, are shown. 3



To completely fill the container with the tropical drink, how many litres of mango juice are required?

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2020_hsc q24

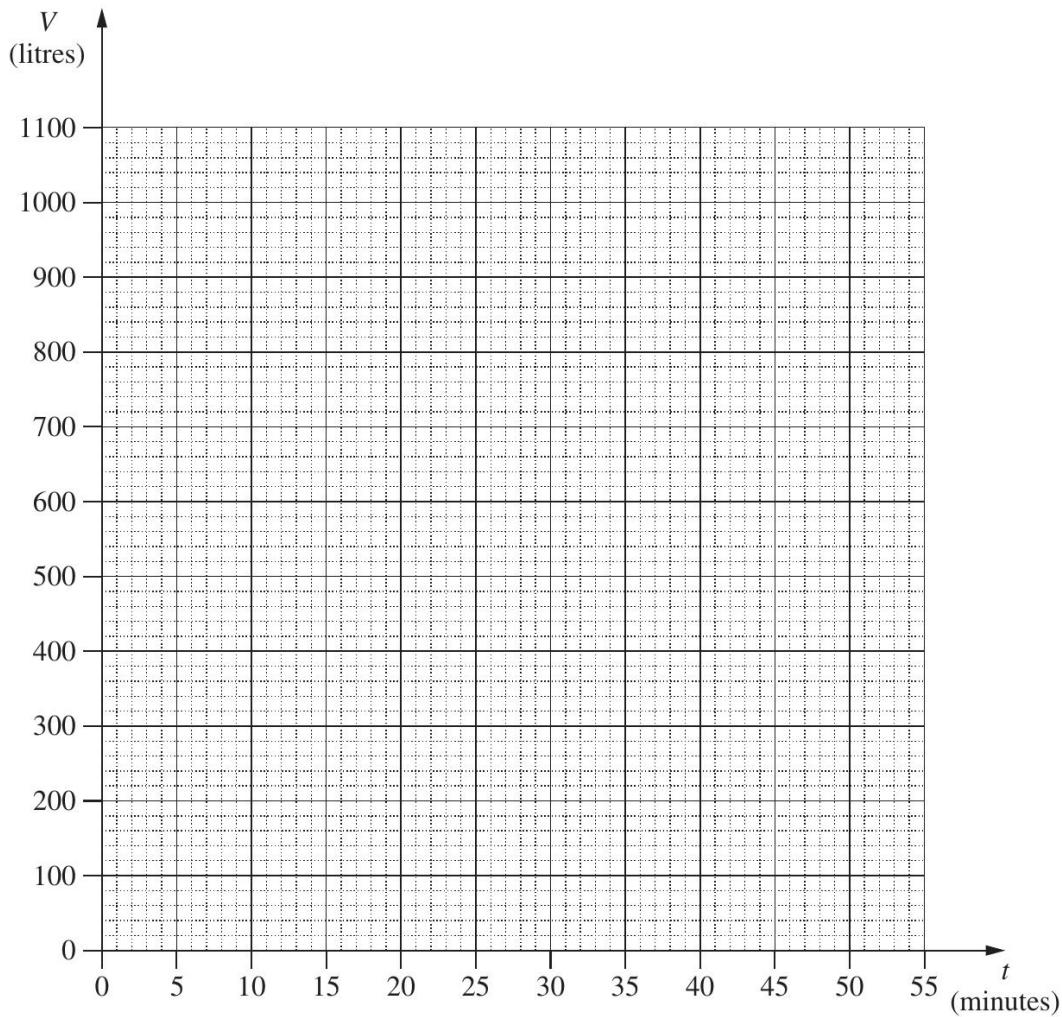
Question 24 (4 marks)

There are two tanks on a property, Tank A and Tank B. Initially, Tank A holds 1000 litres of water and Tank B is empty.

- (a) Tank A begins to lose water at a constant rate of 20 litres per minute. The volume of water in Tank A is modelled by $V = 1000 - 20t$ where V is the volume in litres and t is the time in minutes from when the tank begins to lose water.

1

On the grid below, draw the graph of this model and label it as Tank A.



Do NOT write in this area.

Question 24 continues on page 21

2020_hsc q24 (continued)

Question 24 (continued)

- (b) Tank B remains empty until $t = 15$ when water is added to it at a constant rate of 30 litres per minute.

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By drawing a line on the grid on the previous page, or otherwise, find the value of t when the two tanks contain the same volume of water.

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- (c) Using the graphs drawn, or otherwise, find the value of t (where $t > 0$) when the total volume of water in the two tanks is 1000 litres.

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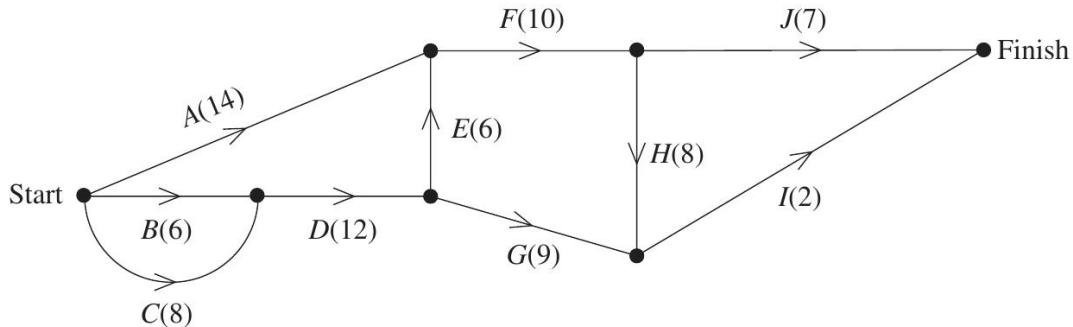
End of Question 24

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2020_hsc q26

Question 26 (5 marks)

The preparation of a meal requires the completion of all ten activities *A* to *J*. The network diagram shows the activities and their completion times in minutes.



- (a) What is the minimum time needed to prepare the meal?

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- (b) List the activities which make up the critical path for this network.

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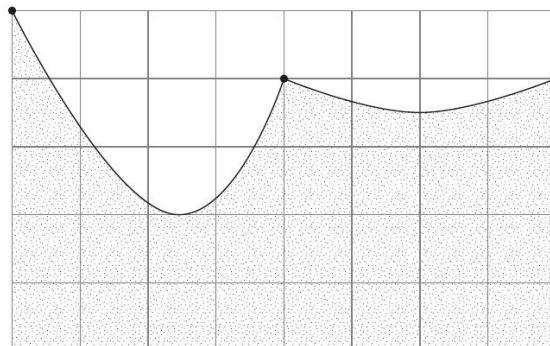
- (c) Complete the table below, showing the earliest start time and float time for activities *A* and *G*.

2

Activity	Earliest start time (minutes)	Float time (minutes)
<i>A</i>		
<i>G</i>		

Question 27 (5 marks)

The shaded region on the diagram represents a garden. The scale is 1 cm = 5 m.



- (a) Use two applications of the trapezoidal rule to calculate the approximate area of the garden. 3

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- (b) Should the answer to part (a) be more than, equal to or less than the actual area of the garden? Referring to the diagram above, briefly explain your answer. 2

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Questions 16–27 are worth 44 marks in total

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Question 28 (4 marks)

Consider the following dataset.

4

1 5 9 10 15

Suppose a new value, x , is added to this dataset, giving the following.

1 5 9 10 15 x

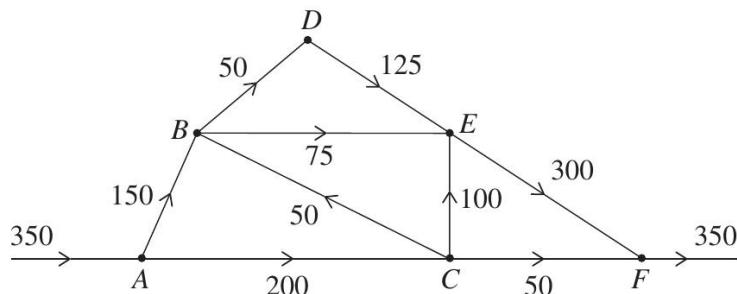
It is known that x is greater than 15. It is also known that the difference between the means of the two datasets is equal to ten times the difference between the medians of the two datasets.

Calculate the value of x .

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Question 30 (3 marks)

The network diagram shows a series of water channels and ponds in a garden. The vertices A , B , C , D , E and F represent six ponds. The edges represent the water channels which connect the ponds. The numbers on the edges indicate the maximum capacity of the channels.



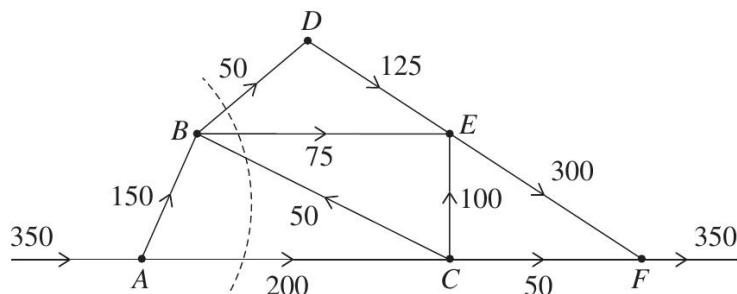
- (a) Determine the maximum flow of the network.

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- (b) A cut is added to the network, as shown.

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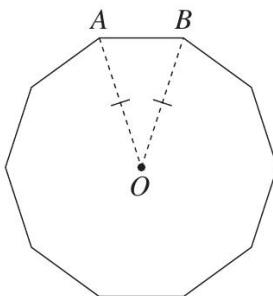
Is the cut shown a minimum cut? Give a reason for your answer.

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Question 32 (4 marks)

The diagram shows a regular decagon (ten-sided shape with all sides equal and all interior angles equal). The decagon has centre O .

4



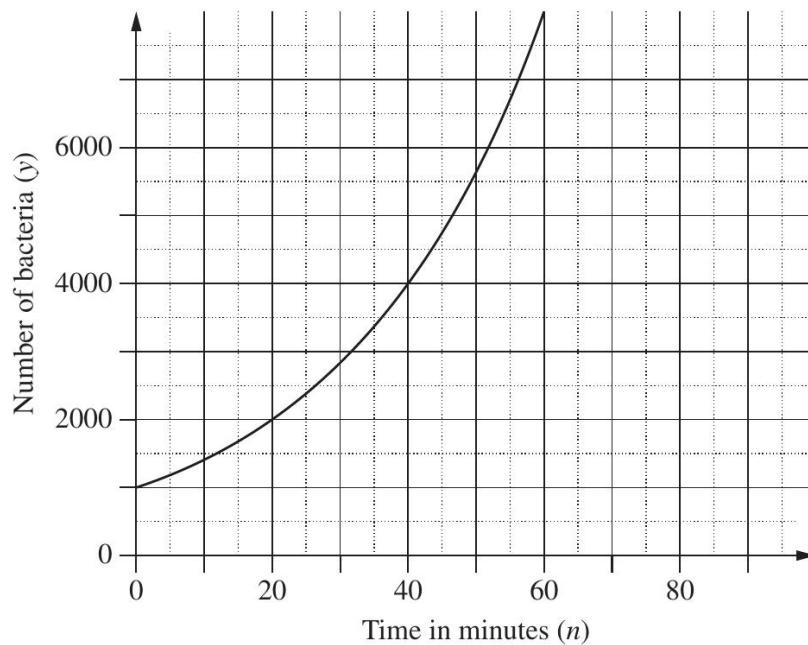
The perimeter of the shape is 80 cm.

By considering triangle OAB , calculate the area of the ten-sided shape. Give your answer in square centimetres correct to one decimal place.

Do NOT write in this area.

Question 33 (3 marks)

The graph shows the number of bacteria, y , at time n minutes. Initially (when $n = 0$) the number of bacteria is 1000.



- (a) Find the number of bacteria at 40 minutes.

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Question 33 continues on page 35

2020_hsc q33 (continued)

Question 33 (continued)

- (b) The number of bacteria can be modelled by the equation $y = A \times b^n$, where A and b are constants.

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Use the guess and check method to find, to two decimal places, an upper and lower estimate for the value of b . The upper and lower estimates must differ by 0.01.

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End of Question 33

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Question 34 (4 marks)

Tina inherits \$60 000 and invests it in an account earning interest at a rate of 0.5% per month. Each month, immediately after the interest has been paid, Tina withdraws \$800.

The amount in the account immediately after the n th withdrawal can be determined using the recurrence relation

$$A_n = A_{n-1}(1.005) - 800,$$

where $n = 1, 2, 3, \dots$ and $A_0 = 60\,000$.

- (a) Use the recurrence relation to find the amount of money in the account immediately after the third withdrawal.

2

Do NOT write in this area

Question 34 continues on page 37

2020_hsc q34 (continued)

Question 34 (continued)

- (b) Calculate the amount of interest earned in the first three months.

2

End of Question 34

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Question 35 (7 marks)

The Intelligence Quotient (IQ) scores for adults in City *A* are normally distributed with a mean of 108 and a standard deviation of 10.

The IQ scores for adults in City *B* are normally distributed with a mean of 112 and a standard deviation of 16.

- (a) Yin is an adult who lives in City *A* and has an IQ score of 128. 2

What percentage of the adults in this city have an IQ score higher than Yin's?

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- (b) There are 1 000 000 adults living in City *B*. 2

Calculate the number of adults in City *B* that would be expected to have an IQ score lower than Yin's.

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Question 35 continues on page 39

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2020_hsc q35 (continued)

Question 35 (continued)

- (c) Simon, an adult who lives in City A , moves to City B . The z -score corresponding to his IQ score in City A is the same as the z -score corresponding to his IQ score in City B .

3

By first forming an equation, calculate Simon's IQ score. Give your answer correct to one decimal place.

End of Question 35

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2020_hsc q36

Question 36 (5 marks)

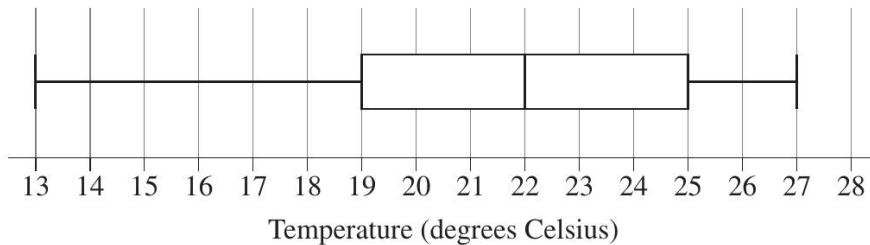
A cricket is an insect. The male cricket produces a chirping sound.

5

A scientist wants to explore the relationship between the temperature in degrees Celsius and the number of cricket chirps heard in a 15-second time interval.

Once a day for 20 days, the scientist collects data. Based on the 20 data points, the scientist provides the information below.

- A box-plot of the temperature data is shown.



- The mean temperature in the dataset is 0.525°C below the median temperature in the dataset.
- A total of 684 chirps was counted when collecting the 20 data points.

The scientist fits a least-squares regression line using the data (x, y) , where x is the temperature in degrees Celsius and y is the number of chirps heard in a 15-second time interval. The equation of this line is

$$y = -10.6063 + bx,$$

where b is the slope of the regression line.

The least-squares regression line passes through the point (\bar{x}, \bar{y}) where \bar{x} is the sample mean of the temperature data and \bar{y} is the sample mean of the chirp data.

Question 36 continues on page 41

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2020_hsc q36 (continued)

Question 36 (continued)

Calculate the number of chirps expected in a 15-second interval when the temperature is 19° Celsius. Give your answer correct to the nearest whole number.

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Question 36 (continued)

Calculate the number of chirps expected in a 15-second interval when the temperature is 19° Celsius. Give your answer correct to the nearest whole number.

End of Question 36

Please turn over

2020_kambala q18

Question 18 (4 marks)

The length of the Sydney Harbour Bridge has been measured as 1149 m, correct to the nearest metre.

- (a) What is the precision of this measurement?

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- (b) What is the absolute error of this measurement?

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- (c) Calculate the percentage error for this measurement?

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Give your answer correct to 2 decimal places.

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2020_kambala q20

Using a scale of 1 : 1 000 000, what length on a scale drawing would represent an actual length 2
of 160 km? Give your answer to the nearest cm.

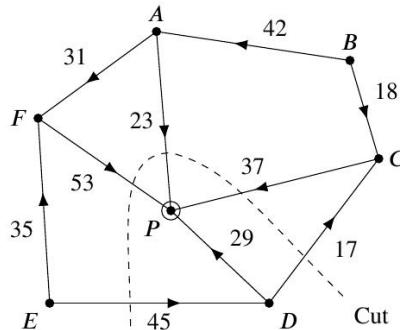
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Question 21 (5 marks)

2020_kambala q37

Question 37 (4 marks)

The network below shows the routes along corridors from two arrival gates to the passport control area, P , in an airport. The number on each edge represents the maximum number of passengers that can travel along a particular corridor in one minute.



- (a) Which vertices represent the two arrival gates?

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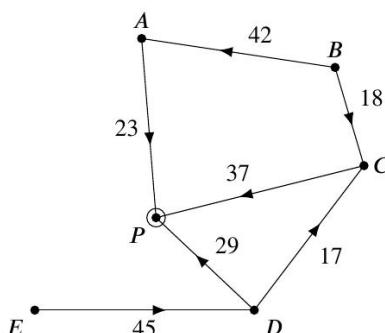
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- (b) Find the value of the cut shown in the diagram above.

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- (c) On a particular day, there is an obstruction at F so corridors in and out of that intersection cannot be used. The diagram below shows the available network for that day.



Calculate the maximum flow of passengers in one minute through this network while this obstruction is occurring.

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the normal distribution

Question 35 (7 marks)

The Intelligence Quotient (IQ) scores for adults in City *A* are normally distributed with a mean of 108 and a standard deviation of 10.

The IQ scores for adults in City *B* are normally distributed with a mean of 112 and a standard deviation of 16.

- (a) Yin is an adult who lives in City *A* and has an IQ score of 128. 2

What percentage of the adults in this city have an IQ score higher than Yin's?

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- (b) There are 1 000 000 adults living in City *B*. 2

Calculate the number of adults in City *B* that would be expected to have an IQ score lower than Yin's.

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Question 35 continues on page 39

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2020_hsc q35 (continued)

Question 35 (continued)

- (c) Simon, an adult who lives in City A , moves to City B . The z -score corresponding to his IQ score in City A is the same as the z -score corresponding to his IQ score in City B .

3

By first forming an equation, calculate Simon's IQ score. Give your answer correct to one decimal place.

End of Question 35

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annuities

Question 34 (4 marks)

Tina inherits \$60 000 and invests it in an account earning interest at a rate of 0.5% per month. Each month, immediately after the interest has been paid, Tina withdraws \$800.

The amount in the account immediately after the n th withdrawal can be determined using the recurrence relation

$$A_n = A_{n-1}(1.005) - 800,$$

where $n = 1, 2, 3, \dots$ and $A_0 = 60\,000$.

- (a) Use the recurrence relation to find the amount of money in the account immediately after the third withdrawal.

2

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Question 34 continues on page 37

2020_hsc q34 (continued)

Question 34 (continued)

- (b) Calculate the amount of interest earned in the first three months.

2

End of Question 34

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Question 37 (3 marks)

Wilma deposited a lump sum into a new bank account which earns 2% per annum compound interest.

3

Present value interest factors for an annuity of \$1 for various interest rates (r) and numbers of periods (N) are given in the table.

Table of present value interest factors

N	r	Interest rate per period as a decimal			
		0.01	0.015	0.02	0.025
10	9.471	9.222	8.983	8.752	
20	18.046	17.169	16.351	15.589	
30	25.808	24.016	22.396	20.930	

Wilma was able to make the following withdrawals from this account.

- \$1000 at the end of each year for twenty years (starting one year after the account is opened)
 - \$3000 each year for ten years starting 21 years after the account is opened.

Calculate the minimum lump sum Wilma must have deposited when she opened the new account.

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2020_kambala q30

Question 30 (2 marks)

Sophie opens an investment account on the day of her 18th birthday. She decides to deposit \$120 at the end of every month until she reaches her 25th birthday. At this time, Sophie intends to withdraw the money and use it as a deposit for a new car. The financial institution where the account is held pays interest at 6% p.a., compounded monthly. How much will Sophie be able to use as a deposit for a new car? 2

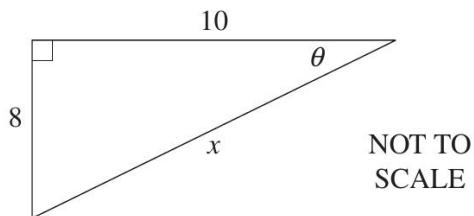
Future value of an Annuity of \$1

Number of Periods	Interest rate per period				
	0.25%	0.3%	0.5%	0.75%	1%
6	6.04	6.05	6.08	6.11	6.15
7	7.05	7.06	7.11	7.16	7.21
8	8.07	8.08	8.14	8.21	8.29
9	9.09	9.11	9.18	9.27	9.37
12	12.17	12.20	12.34	12.51	12.68
24	24.70	24.85	25.43	26.19	26.97
36	37.62	37.96	39.34	41.15	43.08
48	50.93	51.55	54.10	57.52	61.22
60	64.65	65.63	69.77	75.42	81.67
72	78.78	80.23	86.41	95.01	104.71
84	93.34	95.37	104.07	116.43	130.67
96	108.35	111.06	122.83	139.86	159.93

non right angled trigonometry

Question 16 (4 marks)

Consider the triangle shown.



- (a) Find the value of θ , correct to the nearest degree.

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- (b) Find the value of x , correct to one decimal place.

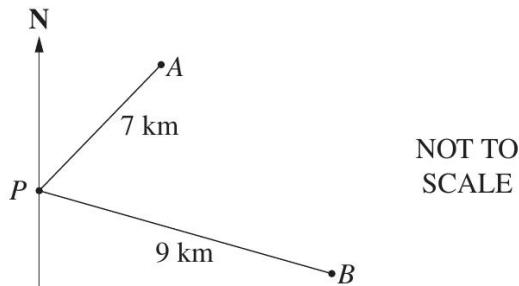
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Question 31 (5 marks)

Mr Ali, Ms Brown and a group of students were camping at the site located at P . Mr Ali walked with some of the students on a bearing of 035° for 7 km to location A . Ms Brown, with the rest of the students, walked on a bearing of 100° for 9 km to location B .



- (a) Show that the angle APB is 65° .

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- (b) Find the distance AB .

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- (c) Find the bearing of Ms Brown's group from Mr Ali's group. Give your answer correct to the nearest degree.

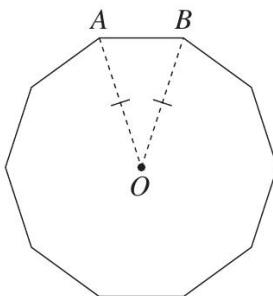
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Question 32 (4 marks)

The diagram shows a regular decagon (ten-sided shape with all sides equal and all interior angles equal). The decagon has centre O .

4



The perimeter of the shape is 80 cm.

By considering triangle OAB , calculate the area of the ten-sided shape. Give your answer in square centimetres correct to one decimal place.

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