Government of **Western Australia**
**Curriculum Council**

WACE
Western Australian Certificate of Education

# MATHEMATICS

# 2A/2B

# Calculator-assumed

# WACE Examination 2011

# Marking Key

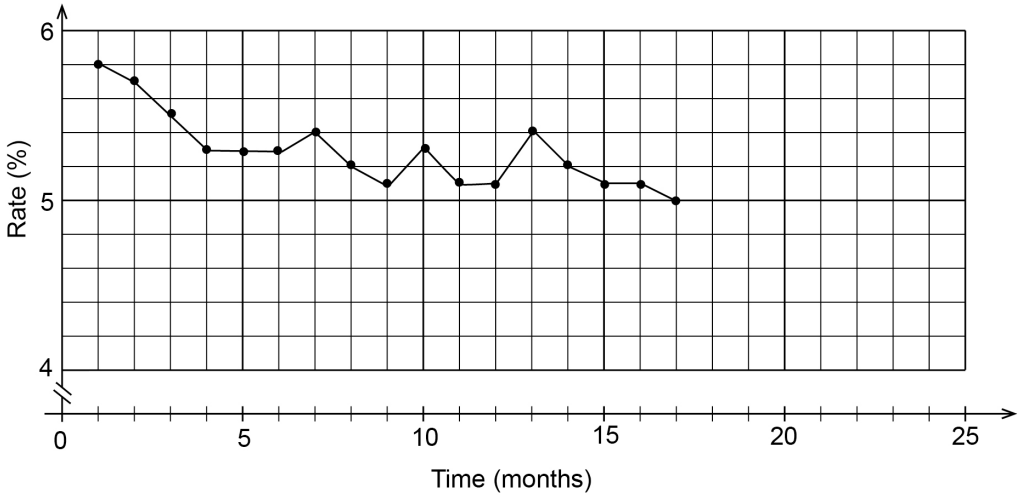
Marking keys are an explicit statement about what the examiner expects of candidates when they respond to a question. They are essential to fair assessment because their proper construction underpins reliability and validity.

When examiners design an examination, they develop provisional marking keys that can be reviewed at a marking key ratification meeting and modified as necessary in the light of candidate responses.

**Question 7** **(6 marks)**

The graph below shows the Australian unemployment rates over a 17-month period from October 2009 ($t$ = 1) to February 2011.

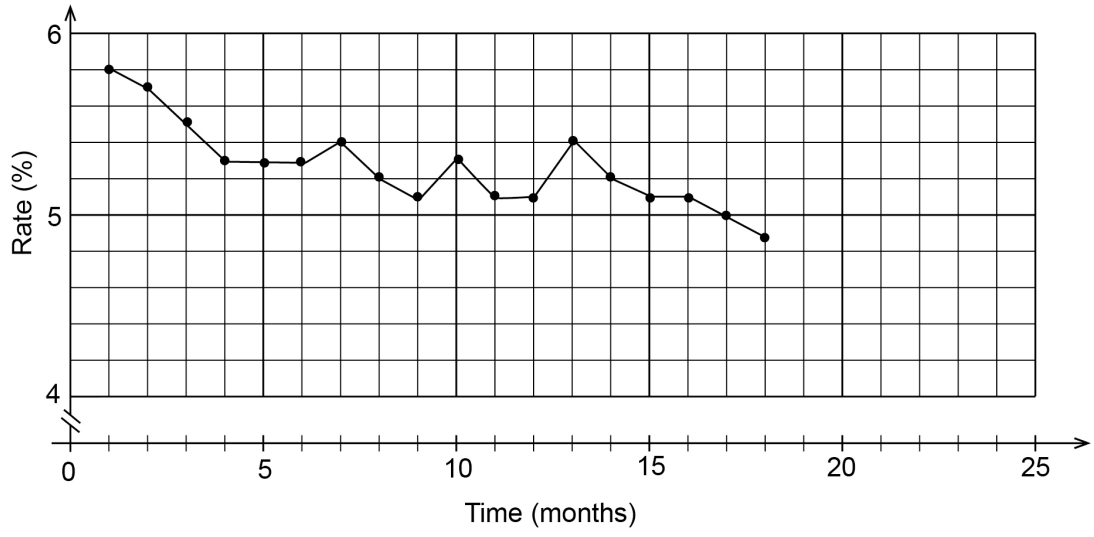
**Australian unemployment rates**



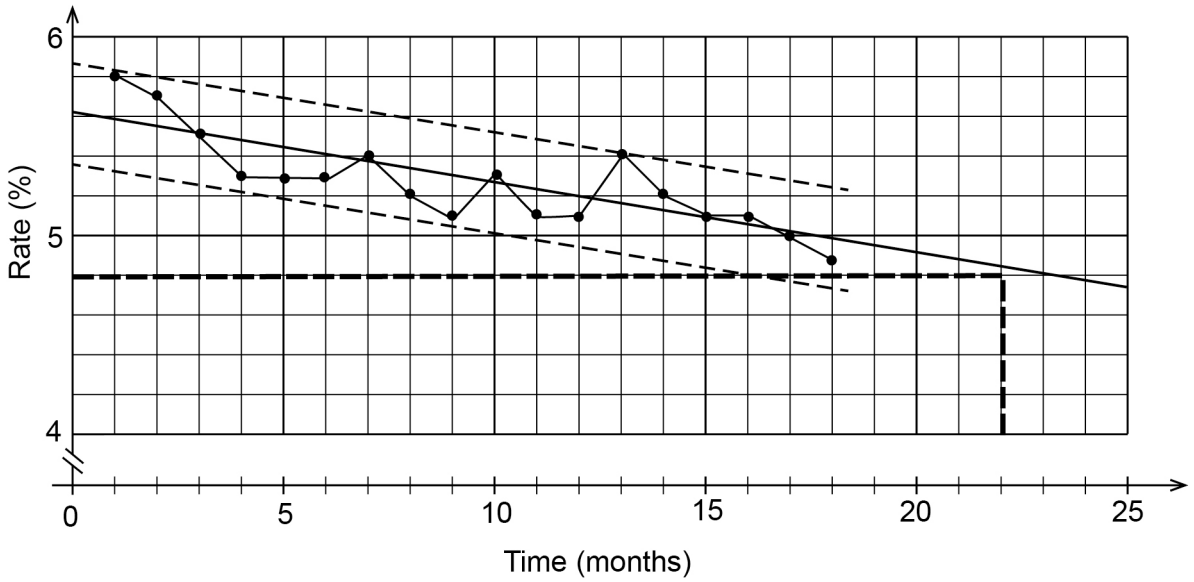

(a) Describe the trend in the Australian unemployment rate against time. (1 mark)

| **Solution** |
|---|
| Decreasing |
| **Specific Behaviours** |
| ✓ states the trend correctly |

(b) The unemployment rate for March 2011 was 4.9%. Plot this point on the graph above. (1 mark)

| **Solution** |
|---|
| Plots the point (18, 4.9)<br>**Australian unemployment rates**<br>  <br> |
| **Specific Behaviours** |
| ✓ plots point correctly |

(c) By drawing a trend line on the graph above, predict the unemployment rate for July 2011. (3 marks)

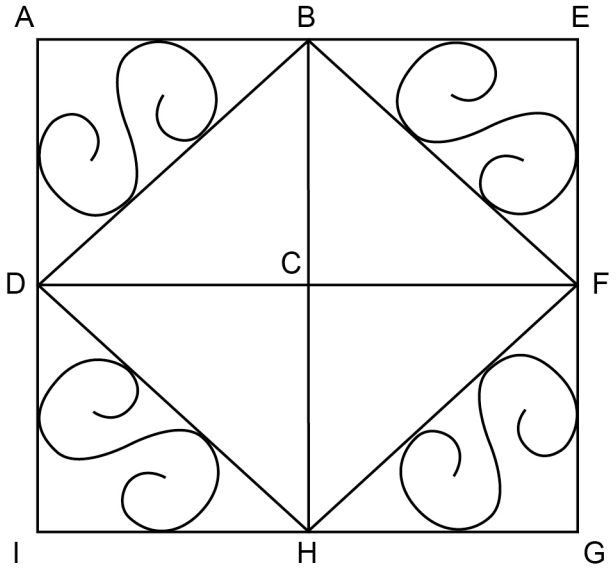
| **Solution** |
|---|
| **Australian unemployment rates**<br>  <br><br>July prediction of 4.8% |
| **Specific Behaviours** |
| ✓ draws in a trend line by eye which is within bounds of the dotted lines<br>✓ identifies July as Month 22<br>✓ indicates the answer using the trend line |

(d) Explain why your prediction in (c) may need to be treated with caution. (1 mark)

| **Solution** |
|---|
| Extrapolating way beyond the last known data point. Anything could happen in such a long period of time (e.g. Global Financial Crisis) |
| **Specific Behaviours** |
| ✓ comments on unreliability of prediction due to extrapolation |

**Question 8** **(5 marks)**

Charlotte designs a wrought iron gate as shown below.




The gate is to be constructed by transforming the same square piece, ABCD.

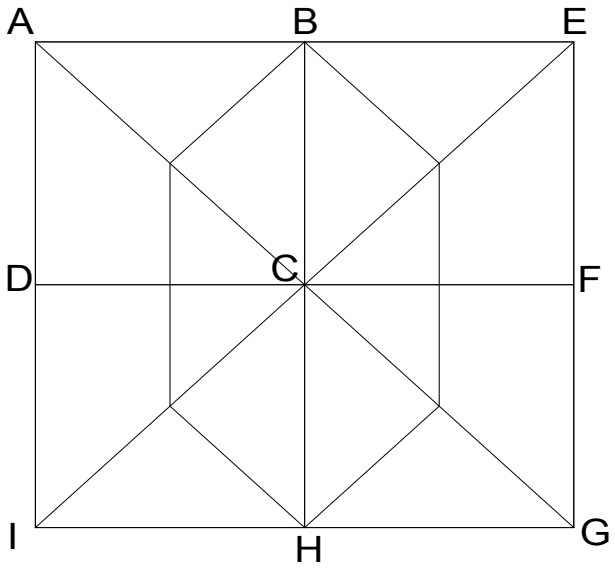
(a) Describe the transformation of the square piece ABCD required to construct the square BEFC. (2 marks)

| **Solution** |
|---|
| Rotation 90 degrees clockwise about the point C |
| **Specific Behaviours** |
| ✓ identifies the transformation as a rotation<br>✓ gives at least two of angle, direction and point of rotation correctly |

(b) How many lines of symmetry does this gate have? (1 mark)

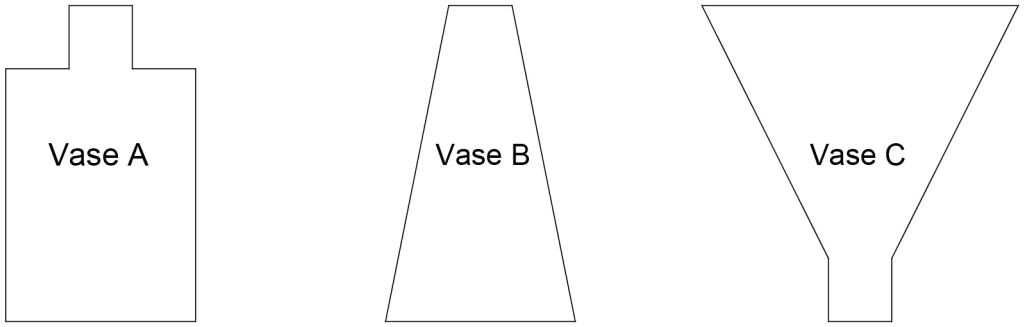
| **Solution** |
|---|
| none |
| **Specific Behaviours** |
| ✓ identifies that the shape has no lines of symmetry |

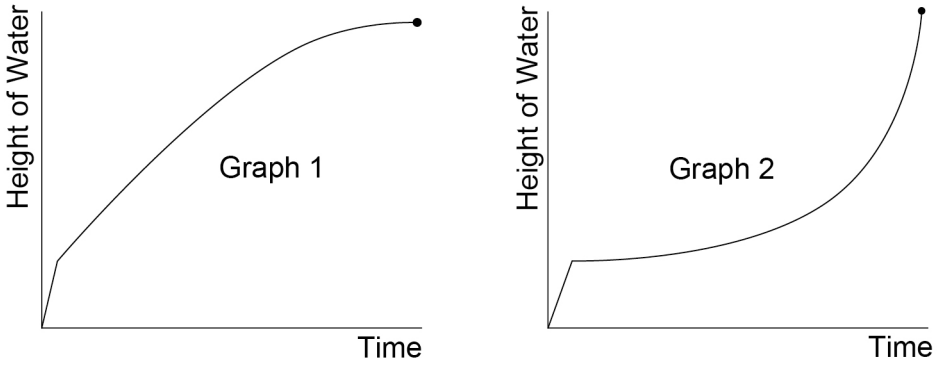
(c) Noella starts with the same sized small square ABCD as Charlotte but changes its design as shown below. She reflects the small square ABCD about the line BC and then she reflects the whole rectangle AEFD about the line DF. Complete the details of Noella's gate on the diagram below. (2 marks)

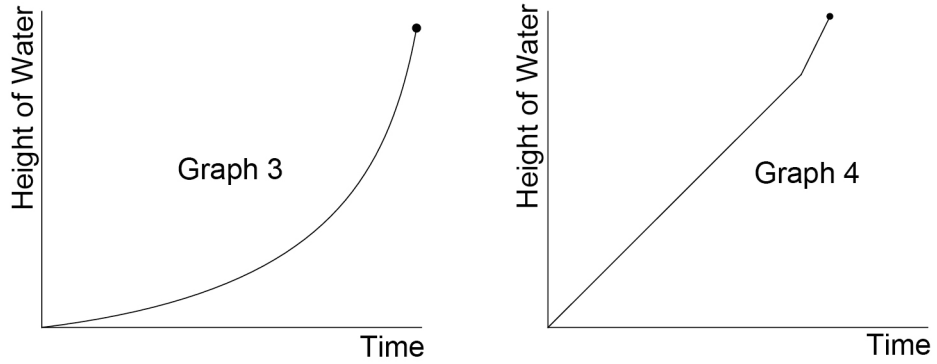
| **Solution** |
|---|
|  |
| **Specific Behaviours** |
| ✓ reflects the square ABCD about line BC correctly<br>✓ reflects the rectangle AEFD about line DF correctly |

**Question 9** **(4 marks)**

(a) Water is poured at a constant rate into the three vases, A, B and C. The height of the water level is plotted against time in Graphs 1 – 4. Match each vase with the graph that best represents the height of the water in that vase against time. (3 marks)



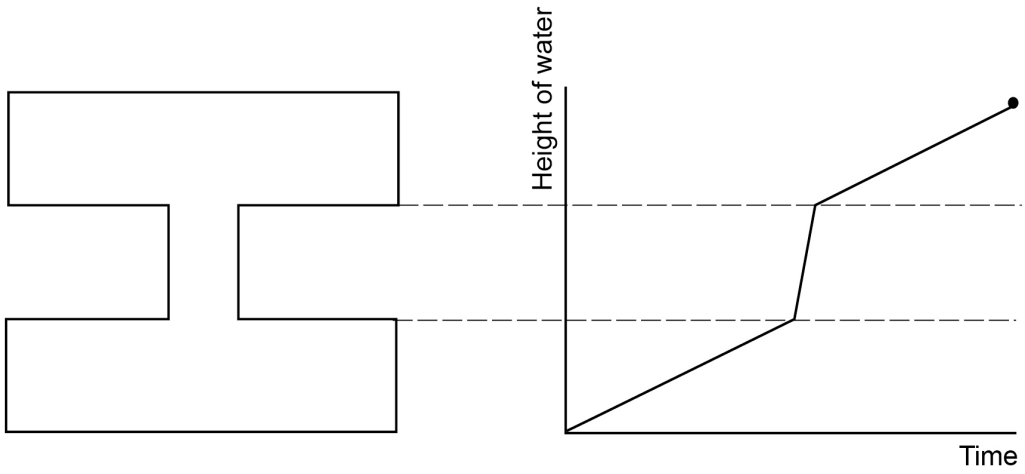




| **Solution** |
|---|
| Vase A best matches with Graph 4<br><br>Vase B best matches with Graph 3<br><br>Vase C best matches with Graph 1 |
| **Specific Behaviours** |
| ✓ matches vase A correctly<br>✓ matches vase B correctly<br>✓ matches vase C correctly |

(b) Water is poured at a constant rate into the vase below. Draw a graph that represents the height of the water level against time.

(2 marks)

| **Solution** |
| --- |
|  |
| **Specific Behaviours** |
| ✓ recognises changes of rates of the three sections<br>✓ uses three distinct lines |

**Question 10** **(9 marks)**

Children's snack packs are sold at the school canteen with a small toy inside each pack. There is an equal chance that the toy inside each snack pack is either a dinosaur (D), a teddy bear (T) or a bouncy ball (B). A toy is placed at random in each pack.

Mrs Reed buys a snack pack from the canteen for each of her 24 students.

(a) How many snack packs would you expect to contain teddy bears? (1 mark)

| **Solution** |
|---|
| $\frac{1}{3} \times 24 = 8$ |
| **Specific Behaviours** |
| ✓ calculates expected value correctly |

(b) Once collected Mrs Reed checked all of her 24 snack packs and wrote down the type of toy from each pack. They are listed below.

T T T T B D B D T D B D T D D T D B T T B T B B

(i) Draw a frequency table to summarise these data. Include a total row to check the accuracy of the recordings. (2 marks)

| **Solution** |
|---|
| **Animal** \| **Frequency**<br>T \| 10<br>B \| 7<br>D \| 7<br>Total \| 24 |
| **Specific Behaviours** |
| ✓ draws a frequency table correctly, including categories and frequencies<br>✓ shows correct entries and total |

(ii) Explain why your prediction for the number of teddy bears from (a) may not necessarily be the same as the actual results collected by Mrs Reed. (1 mark)

| **Solution** |
|---|
| Prediction in (a) is based on long run probabilities and the law of large number of trials, whereas Mrs Reed only collected 24 toys which is a small number and unlikely to have exactly one-third of each toy<br>Or uses the language of chance, such as experimental probabilities, small number in sample, likelihood, randomness or chance to describe the results. |
| **Specific Behaviours** |
| ✓ gives reason based on long run probabilities, small number in sample, likelihood, randomness or chance |

(iii) Jane selects a snack pack from the 24 on Mrs Reed's desk. What is the probability that the toy she obtains is a bouncy ball? (1 mark)

| **Solution** |
|---|
| $\frac{7}{24}$ |
| **Specific Behaviours** |
| ✓ calculates the probability correctly |

(iv) Nick's favourite toy is a dinosaur. He will be very disappointed if he does not get a dinosaur in his snack pack. What is the probability that his snack pack from Mrs Reed's desk does not contain a dinosaur? (1 mark)

| **Solution** |
|---|
| $\frac{17}{24}$ |
| **Specific Behaviours** |
| ✓ calculates the probability correctly |

(c) Mr May also bought a snack pack for each of his 24 students. After counting the number of dinosaurs in his sample of 24, Mr May states that the probability a pack contains a dinosaur is $\frac{1}{6}$.

(i) Write down a possible list of toys from Mr May's snack packs. (1 mark)

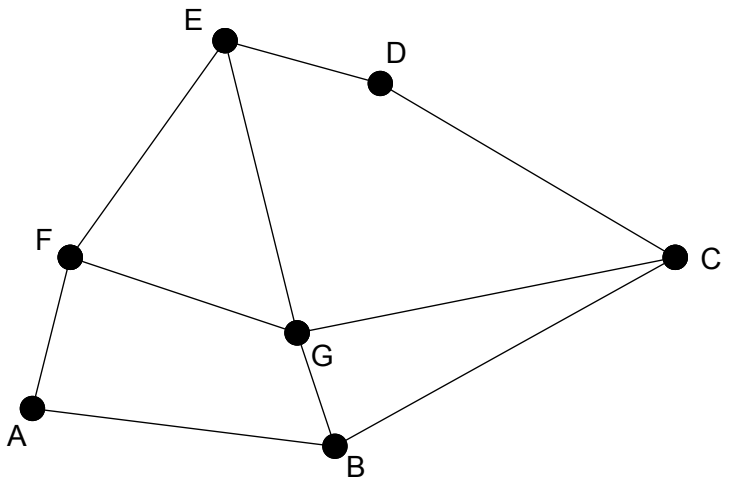
| **Solution** |
|---|
| 4 D's and any combination of a total of 20 T and B's |
| **Specific Behaviours** |
| ✓ writes a list correctly including four D's |

(ii) If 25% of Mr May's snack packs contain teddy bears and $\frac{1}{6}$ contain dinosaurs, how many bouncy balls must there be in Mr May's collection of 24 snack packs? (2 marks)

| **Solution** |
|---|
| $25\% \times 24 = 6$<br>$\frac{1}{6} \times 24 = 4$<br>$24 - 6 - 4 = 14$ |
| **Specific Behaviours** |
| ✓ calculates 25% correctly<br>✓ calculates the number of bouncy balls correctly |

**Question 11** **(5 marks)**

(a) A vertex in a network can be described as either odd or even depending on the number of arcs that meet at the vertex; an even vertex has an even number of arcs meeting at the vertex.




(i) Use the network above to complete the table by determining whether each verticex is odd or even. (1 mark)

| **Solution** | |
|---|---|
| **vertices** | **odd/even** |
| A | even |
| B | odd |
| C | odd |
| D | even |
| E | odd |
| F | odd |
| G | even |
| **Specific Behaviours** | |
| ✓ classifies each vertex correctly | |

(ii) Explain whether the network is traversable using the information in the table in (a)(i). (1 mark)

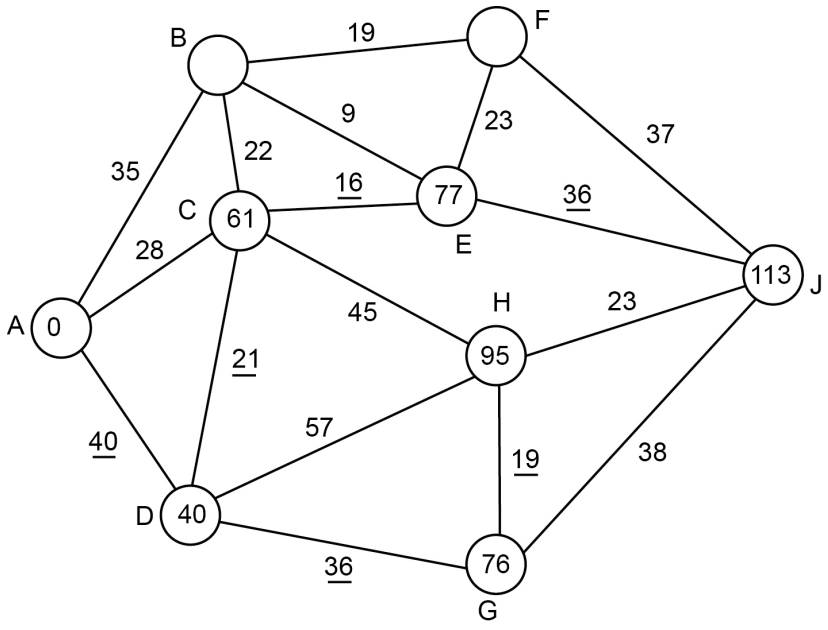
| **Solution** |
|---|
| The network is not transversable as it has more than two odd nodes/vertices |
| **Specific Behaviours** |
| ✓ reasons to say that the network is not traversable. |

(b) A local park has nine main attractions. The paths connecting these attractions are shown on the network below, along with the distances, in metres, between each attraction.

Jason is at the children's playground (A) and Sandra is at the barbecue area (D). Sandra calls Jason on his mobile phone and says that she wants to go with him to the waterfall (J). She will wait for him at the barbecue area (D).

What is the shortest way for Jason to travel from the children's playground (A) to the waterfall (J), picking up Sandra at the barbecue area (D) on the way? State both the path and distance. (3 marks)

**Solution**




Path ADCEJ
Distance 113 metres

**Specific Behaviours**

- ✓ identifies D as the starting point with 40 metres already walked
- ✓ states the path correctly
- ✓ states the distance of the path correctly
  (except the trivial case of 80 m for path ACEJ)

**Question 12** **(11 marks)**

A school was interested in how much money parents were paying for extra-curricular activities during the year. They surveyed families of children aged between 6 and 9 years. The table below shows a summary of the data obtained.

| Expenditure ($/year) | Number of families | Relative frequency |
|---|---|---|
| $0 \leq x < 200$ | 3 | 0.04 |
| $200 \leq x < 400$ | 12 | 0.16 |
| $400 \leq x < 600$ | 18 | 0.24 |
| $600 \leq x < 800$ | 12 | 0.16 |
| $800 \leq x < 1000$ | 9 | 0.12 |
| $1000 \leq x < 1200$ | 6 | ***0.08*** |
| $1200 \leq x < 1400$ | 6 | ***0.08*** |
| $1400 \leq x < 1600$ | 6 | ***0.08*** |
| $1600 \leq x < 1800$ | 3 | ***0.04*** |
| **Total** | 75 | ***1.00*** |

(a) Complete the relative frequency column and explain what it represents. (2 marks)

| **Solution** |
|---|
| Completes table as above.<br>The relative frequency represents the proportion of families that have spent a given sum of money in the year on their child. |
| **Specific Behaviours** |
| ✓ completes the table correctly<br>✓ explains the meaning of 'relative frequency' in this context |

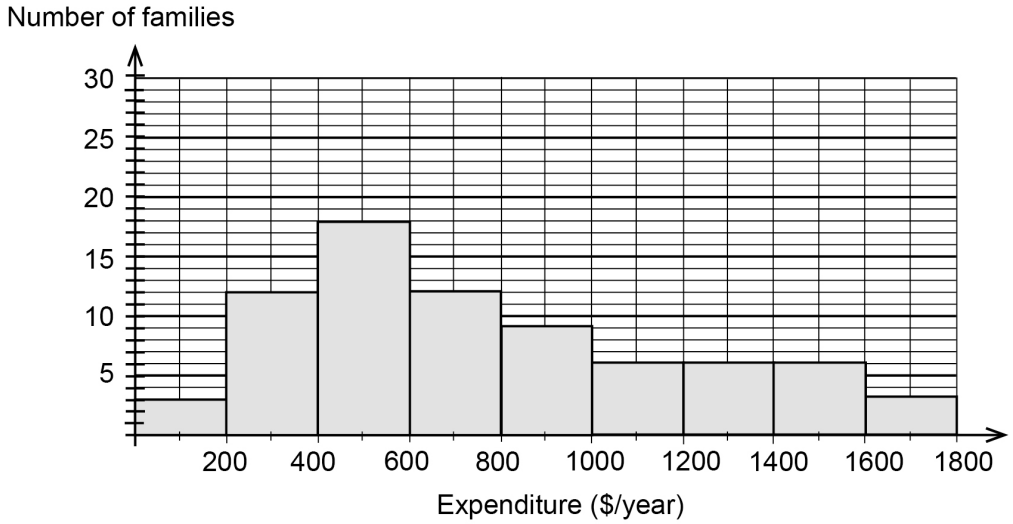
(b) Determine the class interval that contains the median. (1 mark)

| **Solution** |
|---|
| $600 \leq x < 800$ |
| **Specific Behaviours** |
| ✓ states the class interval correctly |

(c) Determine an approximation for the mean amount of money spent per year on extra-curricular activities for this group of children. (1 mark)

| **Solution** |
|---|
| $772 |
| **Specific Behaviours** |
| ✓ calculates the mean correctly |

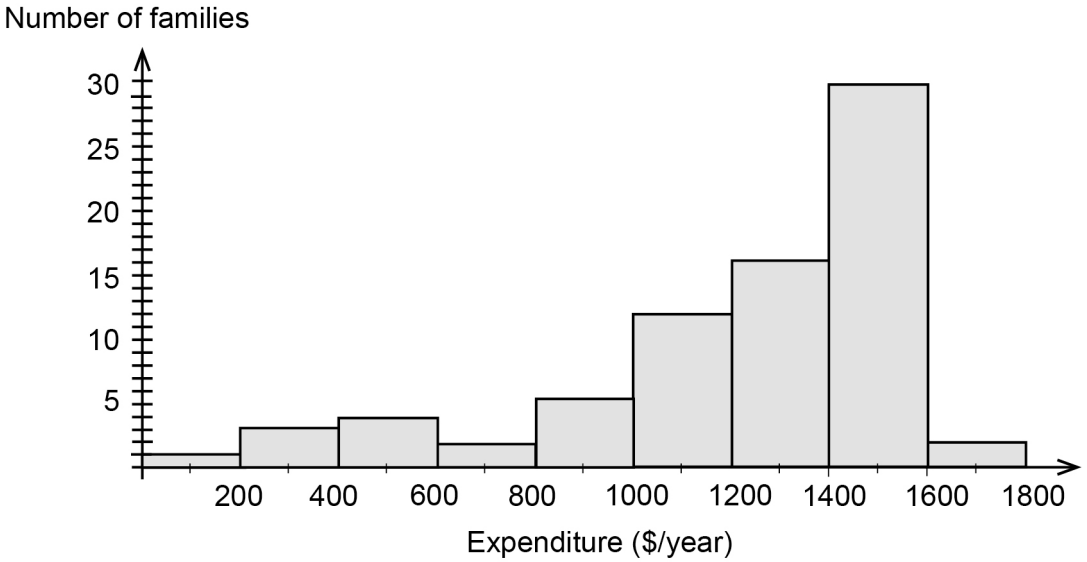
(d) On the axes below draw a histogram to represent these data. (3 marks)

| **Solution** |
|---|
|  |
| **Specific Behaviours** |
| ✓ plots at least five frequencies correctly<br>✓ identifies continuous scale for expenditure<br>✓ forms a histogram correctly |

(e) Give one advantage of displaying the data as a graph instead of a table. (1 mark)

| **Solution** |
|---|
| Easy to see the shape of the distribution |
| **Specific Behaviours** |
| ✓ correctly gives an appropriate reason |

The same data are collected for children who are aged between 10 and 13 years. The data are presented in the graph below.

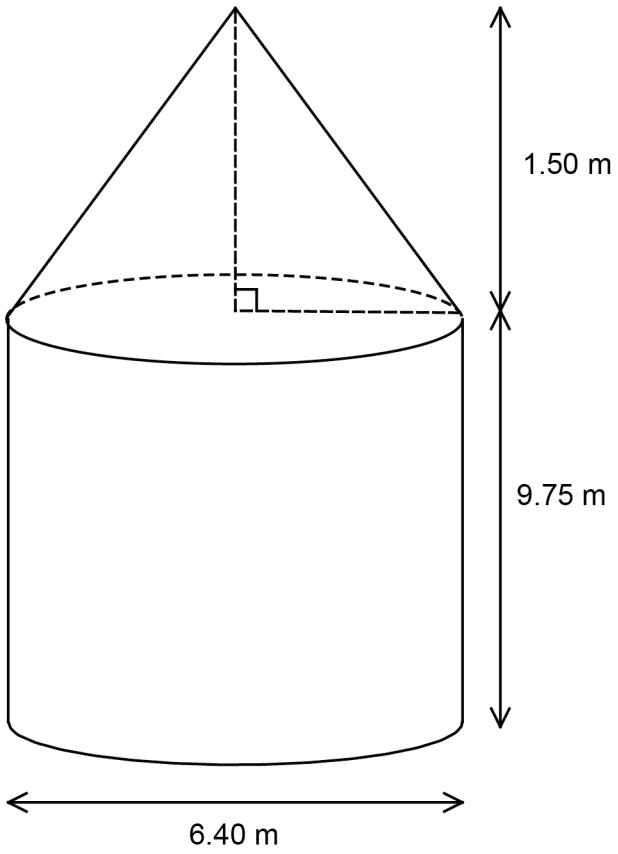


(f) Describe two ways in which the data sets differ: that is, compare the expenditure on extra-curricular activities for children aged 6 to 9 years with the expenditure on extra-curricular activities for children aged 10 to 13 years. (3 marks)

| **Solution** |
|---|
| The graph of money spent on 6 – 9 year olds is more dense at the lower end indicating less money tends to be spent on them. The distribution is more even than that of the 10 – 13 year old graph which is heavily clustered to the right indicating the money spent on them tends to be larger.<br>The modal class (1400 – 1600) for 10 – 13 year olds is higher than that of the 6 – 9 year olds (400 – 600).<br>The mean for the 6 – 9 year olds is more heavily clustered between 200 and 800 indicating a lower mean than that of the 10 – 13 year olds, which is more heavily clustered between 1200 and1600. |
| **Specific Behaviours** |
| ✓✓ compares data sets in two different ways<br>✓ uses mathematical language such as cluster, density, gaps, frequency, mean, spread, and so on when comparing data sets |

**Question 13** **(7 marks)**

A hollow wheat silo is to be constructed from metal. It has a circular base which is 6.40 m in diameter. On top of the base is a cylinder with a cone on top, as shown below.
(Note: this diagram is not to scale.)




(a) Determine the maximum volume of wheat that this silo could hold if it was filled from the top of the cone. (3 marks)

| **Solution** |
|---|
| Radius $= 3.20$ m<br>Volume cylinder $= \pi r^2 h$<br>$= \pi(3.2)^2 \times 9.75$<br>$= 313.66$ m$^3$<br>Volume cone $= \frac{1}{3}\pi r^2 h$<br>$= \frac{1}{3}\pi(3.2)^2 \times 1.5$<br>$= 16.08\ m^3$<br>Total volume $= 329.74$ m$^3$ |
| **Specific Behaviours** |
| ✓ uses the radius as 3.20 m<br>✓ substitutes into the formulas for the volumes of the cylinder and the cone correctly<br>✓ calculates the total volume correctly |

(b) Before the surface area can be determined, the slant height of the cone top needs to be calculated. Show that the slant height is 3.5 m, to **one (1)** decimal place. (1 mark)

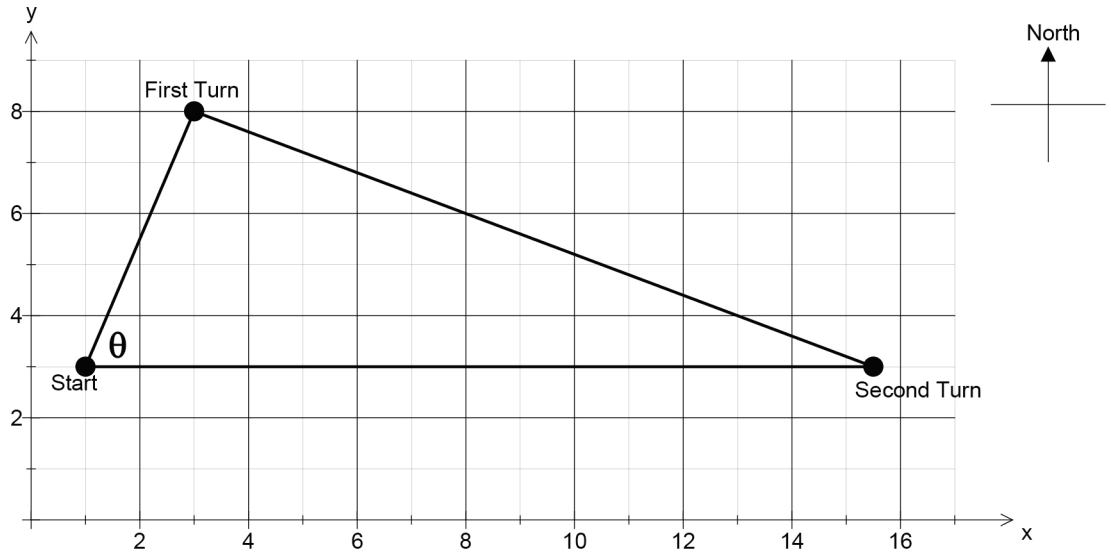
| **Solution** |
|---|
| $d = \sqrt{1.5^2 + 3.2^2}$<br>$= 3.53$<br>$\approx 3.5$ m |
| **Specific Behaviours** |
| ✓ calculates the length correctly showing use of Pythagoras' theorem |

(c) Given that the slant height of the cone top is 3.5 m, determine the amount of metal (in square metres) required to build the silo. (3 marks)

| **Solution** |
|---|
| Area circle base $= \pi \times 3.2^2$<br>$= 32.17$ m$^2$<br><br>Surface area open cone $= \pi \times (3.2) \times 3.5$<br>$= 35.19$ m$^2$<br><br>Surface area open cylinder $= 2\pi \times (3.2) \times 9.75$<br>$= 196.04$ m$^2$<br><br>Total amount of metal required $= 263.40$ m$^2$<br><br>Or<br>Surface area of a cone = $= \pi \times (3.2) \times 3.5 + \pi(3.2)^2$ = 67.36 m$^2$<br><br>Surface area of a cylinder = $= 2\pi \times (3.2) \times 9.75 + 2\pi(3.2)^2$ = 260.38 m$^2$<br><br>Less the area of two circles = $2\pi$ (3.2)$^2$ = 64.34 m$^2$<br><br>Therefore total surface area = 327.74 m$^2$ – 64.34 = 263.40 m$^2$ |
| **Specific Behaviours** |
| ✓ correctly calculates surface area of cone<br>✓ correctly calculates surface area of cylinder<br>✓ correctly calculates total amount of metal required |

**Question 14** **(4 marks)**

A yachting regatta is being held off the coast of Fremantle. The course is shown below with a grid and axes overlaying the course. One unit on the map represents 1 km on the ocean.




(a) Calculate the distance from the Start to the First Turn. (2 marks)

| **Solution** |
|---|
| $d = \sqrt{2^2 + 5^2}$<br>$= \sqrt{29}$<br>$\approx 5.4$ km |
| **Specific Behaviours** |
| ✓ correctly identifies coordinates or horizontal and vertical distances<br>✓ correctly calculates the distance |

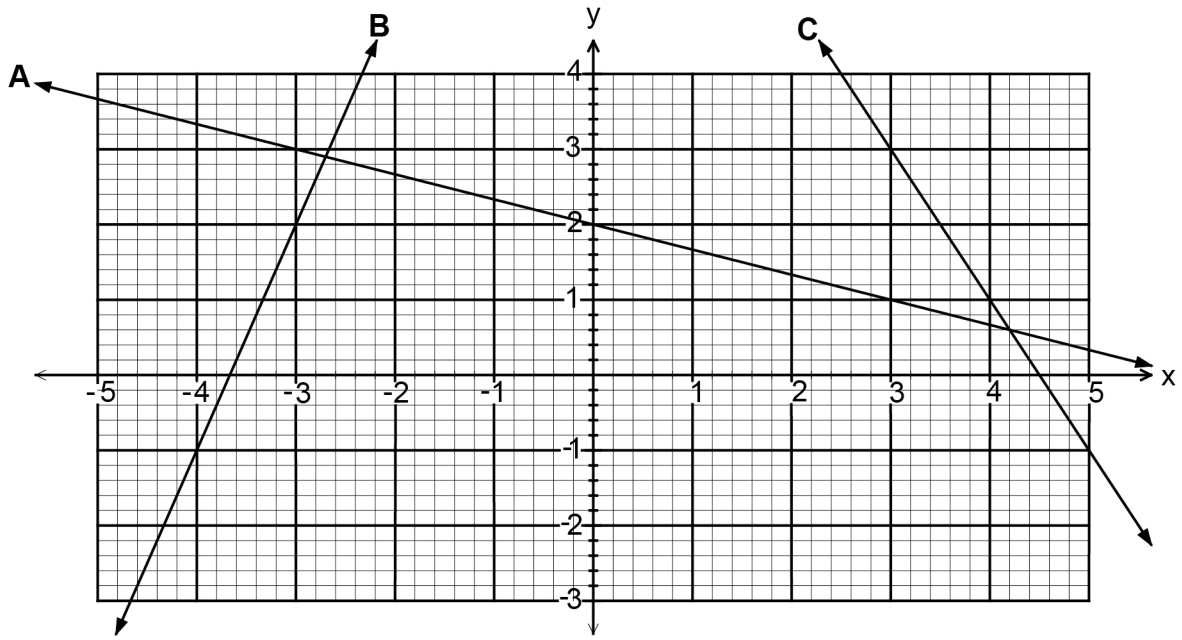
(b) Use trigonometry to calculate the size of the angle marked $\theta$. (2 marks)

| **Solution** |
|---|
| $\tan(\theta) = \frac{5}{2}$<br>$\theta = 68^\circ$ |
| **Specific Behaviours** |
| ✓ correctly writes the ratio<br>✓ correctly calculates the angle |

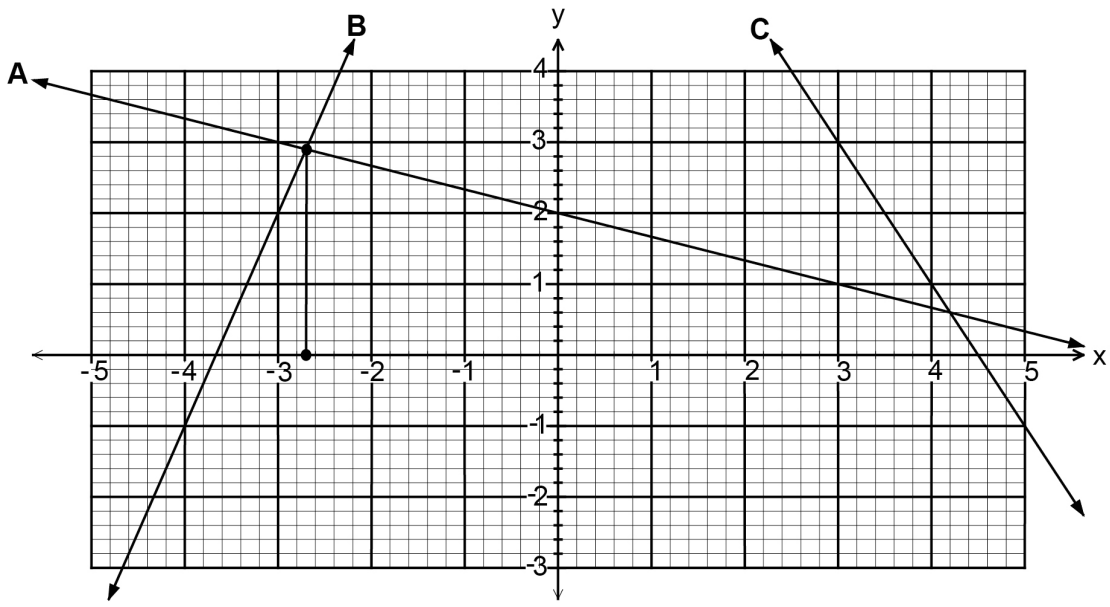
**Question 15** **(4 marks)**

Three lines, A, B and C, have been graphed on the axes below. Their equations are:

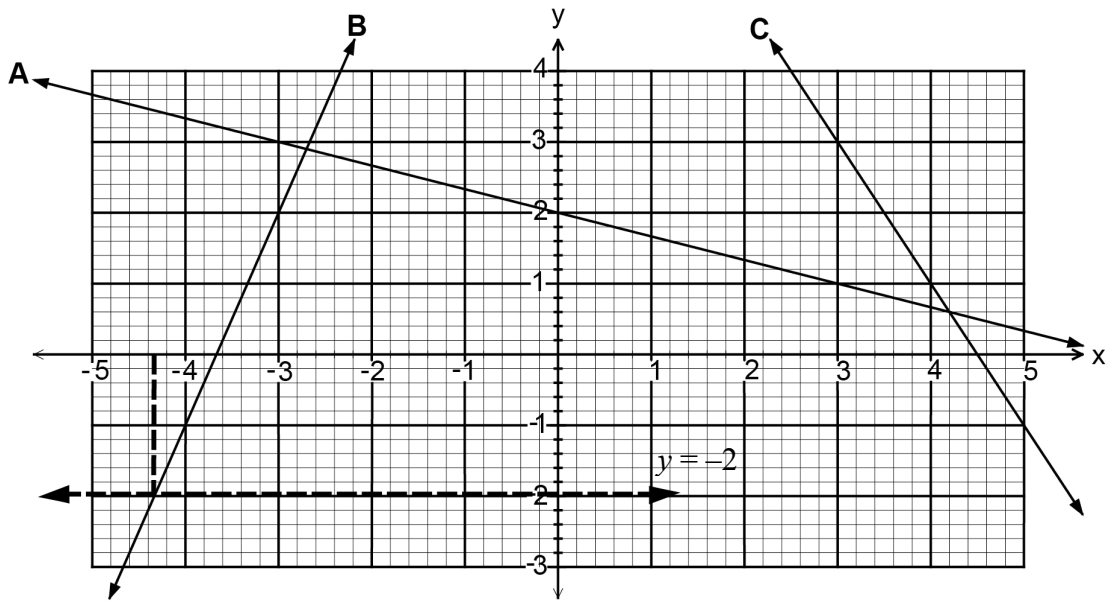
**A**: $y = -\frac{1}{3}x + 2$ **B**: $y = 3x + 11$ **C**: $2x + y = 9$




(a) Show how to use the graph, to estimate to **one (1)** decimal place, the solution to the equation: $-\frac{1}{3}x + 2 = 3x + 11$. State your solution. (1 mark)

| **Solution** |
|---|
|  |
| **Specific Behaviours** |
| ✓ shows the dotted line on graph and states solution as $x$ = –2.7 |

(b) Show how to use the graph, to estimate to one decimal place, the solution to the equation: $3x + 11 = -2$. State your solution. (1 mark)

| **Solution** |
|---|
|   |
| **Specific Behaviours** |
| ✓ shows the dotted lines on graph and states solution as $x \sim -4{\cdot}3$ (accept $-4{\cdot}4$) |

(c) Determine the point of intersection of lines B and C. (2 marks)

| **Solution** |
|---|
| (–0.4, 9.8) |
| **Specific Behaviours** |
| ✓ correctly gives $x$ value<br>✓ correctly gives $y$ value<br>Or<br>one mark in total for obtaining a reasonable approximation to this point using an alternative method, e.g. extension of the lines to find the intersection |

**Question 16** **(6 marks)**

CensusAtSchool Australia is a nationwide annual project that collects data about students. It provides a snapshot of the characteristics, attitudes and opinions of those students who have completed questionnaires. The tables below present information from the 2010 survey.

**Table 1: Number and percentage of students by year level and sex who participated in the 2010 survey**

| Number of students | | | | |
|---|---|---|---|---|
| **Year level** | **Female** | **Male** | **Total** | **% of total** |
| **Yr 4 or below** | 203 | 213 | 416 | 1.9 |
| **Yr 5** | 1346 | 1262 | 2608 | 11.7 |
| **Yr 6** | 2097 | 2092 | 4189 | 18.8 |
| **Yr 7** | 1466 | 1464 | 2930 | 13.1 |
| **Yr 8** | 2059 | 1649 | 3708 | 16.6 |
| **Yr 9** | 2014 | 1741 | 3755 | 16.8 |
| **Yr 10** | 1461 | 1197 | 2658 | 11.9 |
| **Yr 11** | 793 | 706 | 1499 | 6.7 |
| **Yr 12** | 259 | 230 | 489 | 2.2 |
| **Other** | 32 | 35 | 67 | 0.3 |
| **Total** | 11 730 | 10 589 | 22 319 | 100.0 |

* The total column percentages may not equal 100, due to rounding.

**Table 2: Favourite takeaway foods by year level**

| Takeaway food | Yr 4 or below | Yr 5 | Yr 6 | Yr 7 | Yr 8 | Yr 9 | Yr 10 | Yr 11 | Yr 12 | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| **None** | 2.4 | 1.4 | 1.2 | 1.2 | 1.3 | 1.8 | 1.4 | 1.1 | 1.2 | 1.5 |
| **Chicken** | 6.7 | 6.8 | 7.3 | 6.3 | 7.3 | 8.4 | 9.4 | 10.1 | 9.4 | 14.9 |
| **Chips/fries** | 16.8 | 16.4 | 18.0 | 16.2 | 17.8 | 17.4 | 15.2 | 13.0 | 13.5 | 9.0 |
| **Fish** | 7.2 | 9.5 | 8.6 | 8.1 | 6.7 | 6.8 | 6.3 | 5.4 | 5.7 | 7.5 |
| **Fruit/fruit salad** | 4.3 | 2.6 | 2.4 | 2.4 | 2.1 | 2.0 | 1.8 | 1.9 | 2.0 | 4.5 |
| **Hamburgers** | 12.0 | 11.8 | 11.4 | 11.2 | 11.0 | 11.9 | 10.4 | 11.3 | 14.3 | 6.0 |
| **Kebabs/wraps** | 6.3 | 6.3 | 7.5 | 8.9 | 9.7 | 9.9 | 11.2 | 13.7 | 11.5 | 9.0 |
| **Noodle dishes** | 3.1 | 3.5 | 3.2 | 4.0 | 4.0 | 4.4 | 4.1 | 5.5 | 4.9 | 10.5 |
| **Pies/pasties** | 3.6 | 3.9 | 3.3 | 3.9 | 3.1 | 2.6 | 2.3 | 2.1 | 1.8 | 0.0 |
| **Pizza/pasta** | 22.1 | 21.6 | 22.4 | 22.7 | 21.9 | 21.2 | 23.1 | 21.4 | 21.5 | 11.9 |
| **Rice dishes** | 2.6 | 3.7 | 3.6 | 4.4 | 5.2 | 5.1 | 4.4 | 6.5 | 6.5 | 9.0 |
| **Rolls/sandwiches** | 1.9 | 1.4 | 1.5 | 1.9 | 1.9 | 2.2 | 3.6 | 2.6 | 2.5 | 0.0 |
| **Salads** | 1.2 | 2.8 | 2.0 | 1.7 | 1.6 | 1.4 | 1.8 | 0.9 | 1.8 | 4.5 |
| **Other** | 9.6 | 8.5 | 7.5 | 7.0 | 6.5 | 4.9 | 5.0 | 4.6 | 3.3 | 11.9 |

* The figures represent the percentages of the total number of students at each year level who participated in the 2010 survey.

By referring to the two tables, answer the following parts of this question.

(a) Which year group contributed the most opinions to the survey? (1 mark)

| **Solution** |
|---|
| Year 6 |
| **Specific Behaviours** |
| ✓ states answer correctly |

(b) What percentage of students who participated in the survey were female? (2 marks)

| **Solution** |
|---|
| $\frac{11730}{22319} \times 100\% = 52.6\%$ |
| **Specific Behaviours** |
| ✓ identifies the number of females from the table correctly<br>✓ calculates the percentage of females correctly |

(c) Which was the least favourite takeaway food for Year 11 students? (1 mark)

| **Solution** |
|---|
| Salads |
| **Specific Behaviours** |
| ✓ states salads |

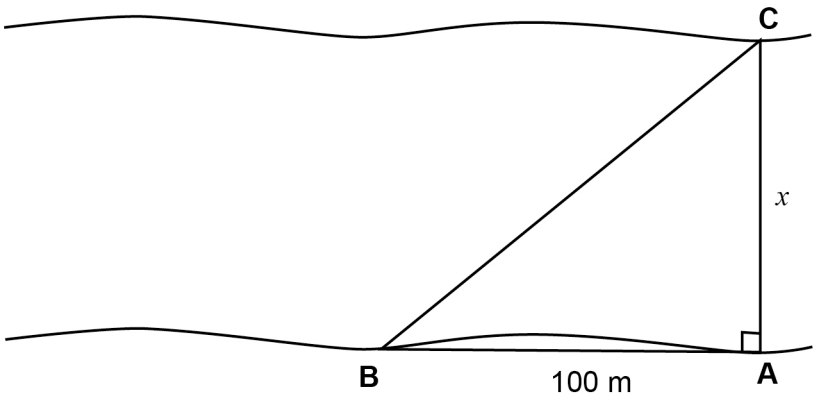
(d) For how many Year 12 students was Pizza/pasta their favourite takeaway food? (2 marks)

| **Solution** |
|---|
| $21.5\% \times 489 = 105$ |
| **Specific Behaviours** |
| ✓ identifies the percentage of Year 12s who prefer pizza/pasta correctly<br>✓ calculates the number of Year 12s correctly |

**Question 17** **(6 marks)**

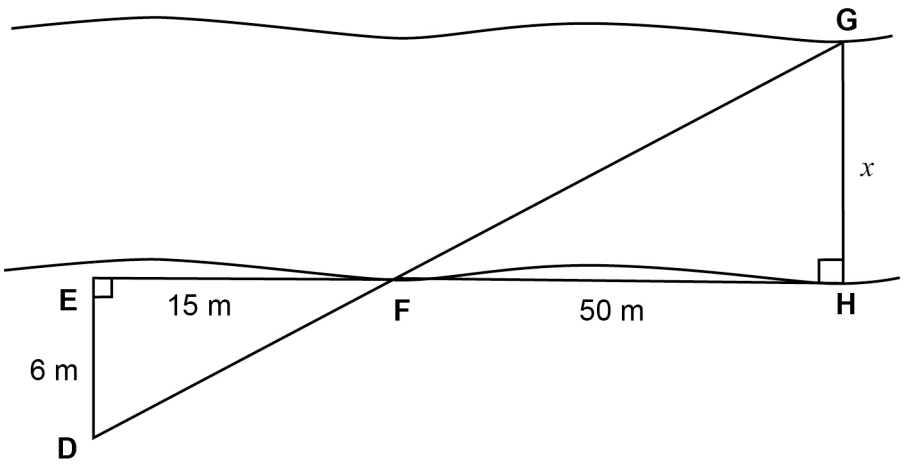
For a classroom project, students are required to determine the width of a river.

(a) Jerome places a marker at point A, directly opposite a tree at point C. He walks 100 m and places another marker at point B. He then determines the size of angle ABC as 12º. Use trigonometry to determine the width, $x$, of the river according to Jerome. Give your answer to **one (1)** decimal place. (3 marks)




| **Solution** |
|---|
| $\tan 12° = \frac{x}{100}$<br>$x = 21.256$<br>$= 21.3$ m to one decimal place |
| **Specific Behaviours** |
| ✓ identifies the use of the tan ratio<br>✓ uses the tangent ratio to determine the correct length<br>✓ rounds correctly to one decimal place |

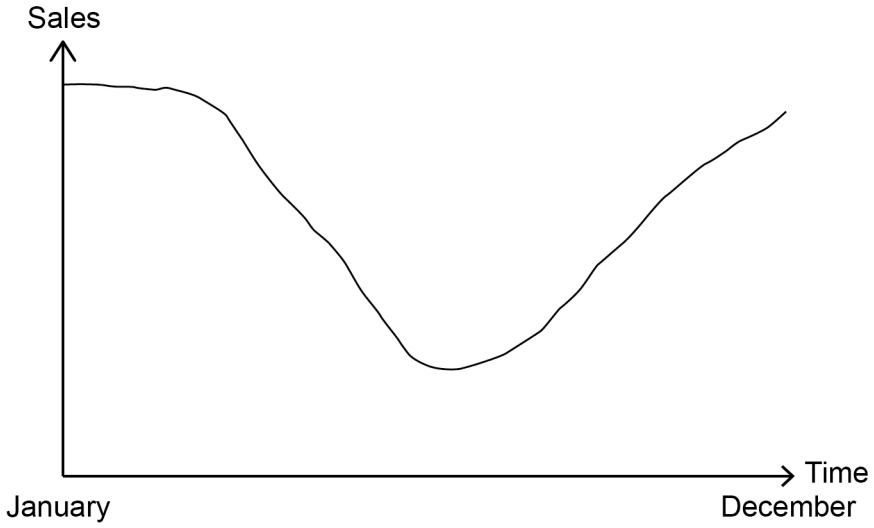
(b) Mary takes measurements on one bank, as shown below. Use these measurements to determine the width, $x$, of the river according to Mary. (3 marks)




| **Solution** |
|---|
| $\frac{x}{6} = \frac{50}{15}$<br>$x = 20$ m<br><br>Or<br>$\tan\theta = \frac{6}{15}$<br>$\theta = 21.8^\circ$<br>$\tan 21.8^\circ = \frac{x}{50}$<br>$x = 20$ m |
| **Specific Behaviours** |
| ✓ identifies the proportion in the length of the sides OR calculates the size of angle F correctly<br>✓ writes an equation to solve for the unknown length<br>✓ calculates the length correctly |

**Question 18** **(5 marks)**

(a) Amalia, the manager of a café at a Perth beach, wants to estimate her ice-cream sales for the coming year. Sketch a predicted Sales versus Time graph over a year on the axes below. (2 marks)

| **Solution** |
|---|
|  |
| **Specific Behaviours** |
| ✓ identifies sales will not be constant<br>✓ sketch includes peaking in summer months |

(b) Brad wanted to find an answer to the question:

'Do people in Western Australia tend to marry someone of about the same age?'

Brad planned to survey ten Year 12 students in his class.

(i) Write one question that he could ask the students so that he could gather data to answer his question. (1 mark)

| **Solution** |
|---|
| Any reasonable question, such as "At what age did your parents marry?" |
| **Specific Behaviours** |
| ✓ asks a question which would allow the appropriate data to be collected |

(ii) State one way in which he could improve his data collection (1 mark)

| **Solution** |
|---|
| Ask a bigger variety of people from many suburbs and towns |
| **Specific Behaviours** |
| ✓ suggests a larger more diverse sample |

(iii) In an earlier survey at the school, the ages at which the male staff had married were recorded:

27, 32, 58, 32, 29, 28, 26, 24

Is the median or the mean a better indication of the 'average' age at which male staff at Brad's school marry? Explain. (1 mark)

| **Solution** |
|---|
| Mean will be skewed by the outlier 58. Median will be less affected and so give a good indication of the typical marrying age of the male staff at Brad's school. |
| **Specific Behaviours** |
| ✓indicates that the mean is affected by outliers whereas the median is not |

**Question 19** **(7 marks)**

A Magic Square is a puzzle made up of different numbers such that the sum of the numbers is the same for any row, column or long diagonal. This sum is called the Magic Constant.

For example, a 3 by 3 Magic Square has the Magic Constant of 15. An example of a possible solution is below:

Figure 1

| | | |
|---|---|---|
| 2 | 7 | 6 |
| 9 | 5 | 1 |
| 4 | 3 | 8 |

(a) A 4 by 4 Magic Square has a Magic Constant of 34. Complete the Magic Square below. (1 mark)

| **Solution** |
|---|
| |
| **Specific Behaviours** |
| ✓ completes all the table correctly |

| | | | |
|---|---|---|---|
| 1 | 15 | 14 | 4 |
| 12 | 6 | 7 | 9 |
| 8 | 10 | 11 | 5 |
| 13 | 3 | 2 | 16 |

The Magic Constant ($M$) for an $n$ by $n$ Magic Square ( $n \geq 3$ ) is given by the rule:

$$M = \frac{n\,(n^2 + 1)}{2}$$

(b) Is this rule linear, exponential or neither of these? (1 mark)

| **Solution** |
|---|
| neither |
| **Specific Behaviours** |
| ✓ identifies rule as neither linear nor exponential |

(c) Use this rule to find the Magic Constant for a 6 by 6 Magic Square. (2 marks)

| **Solution** |
|---|
| $M = \frac{n\,(n^2 + 1)}{2}$<br>$= \frac{6\,(6^2 + 1)}{2}$<br>$= 111$ |
| **Specific Behaviours** |
| ✓ substitutes values correctly |
| ✓ calculates the value correctly |

The order of a Magic Square is given by the dimensions of the square. For example, a 3 by 3 Magic Square has order 3. A Magic Square of an odd order (3 by 3, 5 by 5, 7 by 7, etc) is easily solvable if the middle number is set. For example, the middle number for a 3 by 3 Magic Square is 5 (confirm this by looking back at Figure 1). The middle number of an odd ordered Magic Square follows a pattern. The table used to determine this pattern is shown below.

| Order | Middle Number | Magic Constant |
|---|---|---|
| 3 | 5 | 15 |
| 5 | 13 | 65 |
| 7 | 25 | 175 |
| 9 | 41 | 369 |
| 11 | 61 | 671 |

(d) Lien conjectures that: Magic Constant = Order × Middle Number.

Show by an example that Lien's conjecture appears to be true. (1 mark)

| **Solution** |
|---|
| shows one example eg $3 \times 5 = 15$ |
| **Specific Behaviours** |
| ✓ shows one example correctly |

(e) What would be the middle number of a 19 by 19 Magic Square? (2 marks)

| **Solution** |
|---|
| Follows pattern in second column to find the middle number is 181<br><br>or calculates it as below<br><br>$M = \frac{n\,(n^2 + 1)}{2}$<br><br>$= \frac{19\,(19^2 + 1)}{2}$<br><br>$= 3439$<br><br>$3439 = 19 \times$ Middle Number<br><br>Middle Number $= \frac{3439}{19} = 181$ |
| **Specific Behaviours** |
| ✓ follows pattern or substitutes 19 into formula<br>✓ states the value required correctly |

## ACKNOWLEDGEMENTS

**Section Two:**

**Question 7** Data source: Australian Bureau of Statistics. (2011). 6202.0-*Labour force, Australia, Mar 2011*. Retrieved April 9, 2011, from www.abs.gov.au/ausstats/abs@.nsf/mf/6202.0.

**Question 16** Australian Bureau of Statistics. (n.d.) *CensusAtSchool Australia* [Tables]. Retrieved April 19, 2011, from www.abs.gov.au/websitedbs/CaSHome.nsf/Home/2010+CensusAtSchool+Summary+Data#.