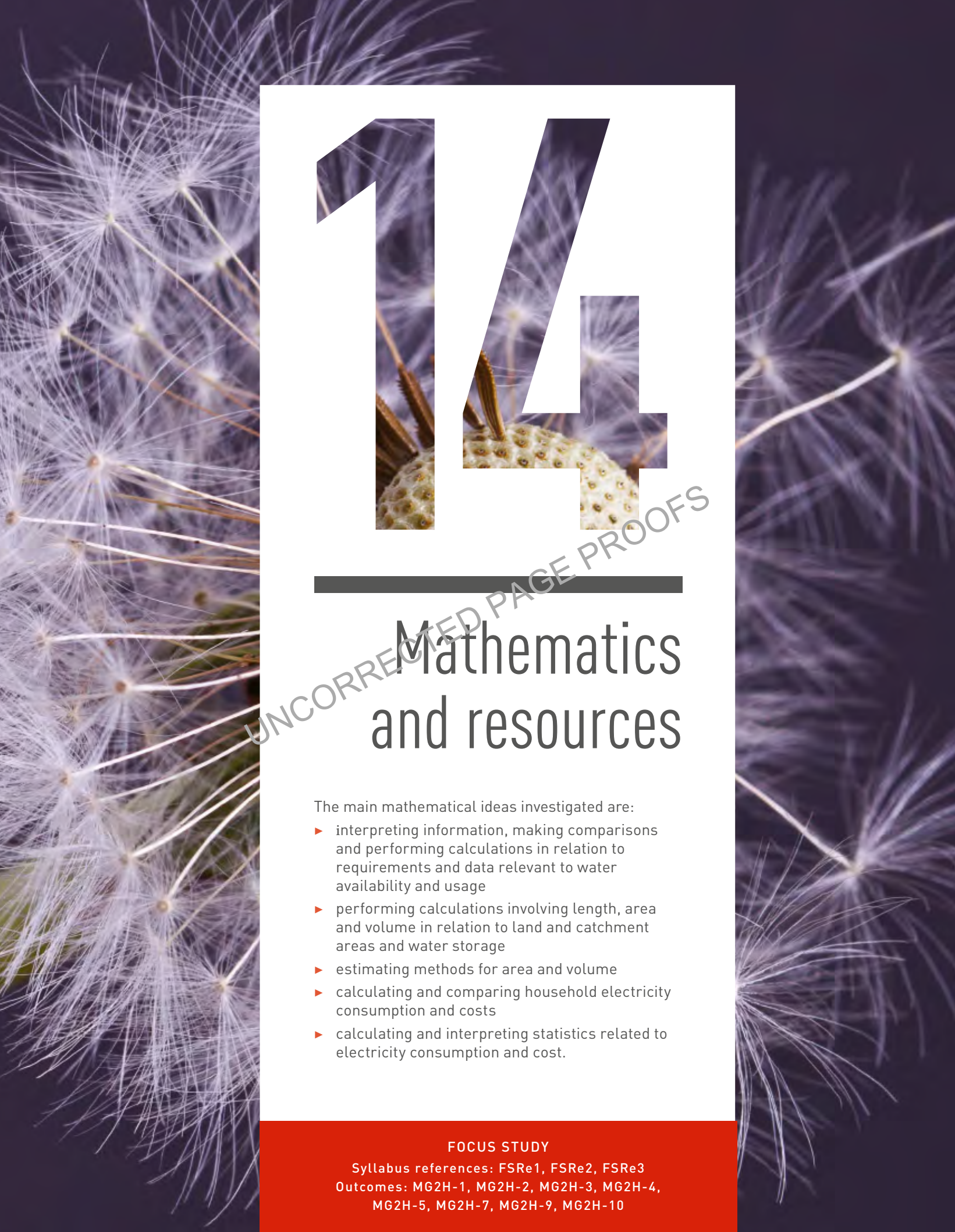


14

Mathematics and resources

The main mathematical ideas investigated are:

- interpreting information, making comparisons and performing calculations in relation to requirements and data relevant to water availability and usage
- performing calculations involving length, area and volume in relation to land and catchment areas and water storage
- estimating methods for area and volume
- calculating and comparing household electricity consumption and costs
- calculating and interpreting statistics related to electricity consumption and cost.

FOCUS STUDY

Syllabus references: FSRe1, FSRe2, FSRe3
Outcomes: MG2H-1, MG2H-2, MG2H-3, MG2H-4, MG2H-5, MG2H-7, MG2H-9, MG2H-10

14A Water availability and usage

EXERCISE 14A

1 **a** Use the information in the sample water bill on the opposite page to answer the following questions.
- **i** What is the supply period for this bill?
- **ii** How many days is this?

b The fixed charges are those payable for having water and sewerage available to your property. What is the total of the fixed charges for this account?

c **i** How much water did this household use for the period shown?
- **ii** Using the answer to part **a ii**, calculate the average daily water usage.

d The usage charge is what you pay for the amount of water that you use.
- **i** What is the cost per kilolitre of water?
- **ii** What is the total cost (fixed and usage) for this period?
- **iii** Using the answer to part **a ii**, calculate the average daily cost.

e Assuming the same fixed and usage charges, was this bill smaller or larger than:
- **i** the last bill?
- **ii** the bill for the same period last year?

f Assume the same fixed and usage charges.
- **i** Calculate the water usage charge for the last bill.
- **ii** Calculate the total charges for the last bill.

g The water usage charge last year was \$2.13 per kL. What is the difference between the water usage charge for this bill and that for the bill for the same period last year?

h How did the average daily water consumption for this bill compare with the local area average?

i The table 'Targets for water-efficient households' shown on the bill allows you to compare a household's water usage with the supplier's targets for ideal water-efficient households. This bill is for a medium-sized property with five occupants.
- **i** Is this household's usage smaller or larger than the ideal efficient usage shown in the table?
- **ii** By how much would this household have to change its daily usage to reach the ideal?
- **iii** If a bucket can hold 12 L of water, how many buckets is this equivalent to?

2 Use the water-efficient targets table to determine the ideal daily water consumption for these households.

a a large property with four people

b a small property with two people

c a 600 m^2 property with three people

d an 18 m by 40 m property with six people

3 In 2013, residential properties in the region managed by Hunter Water were charged a water availability fee of \$18.92 p.a. and a water usage rate of \$2.08/kL. Calculate the total annual cost for a property that uses 190 kL of water.

4 **a** In 2013, residential properties managed by Shoalhaven Water were charged \$1.55/kL for water usage up to 450 kL and \$1.75/kL for usage over 450 kL. The water availability charge was \$81. What is the annual cost of water for a household that uses:
- **i** 270 kL?
- **ii** 480 kL?

FOCUS STUDY

MONT BAY WATER

Mr S Ample
12 Water Street
NORTH WATERVILLE

Customer Number	**22988701**
Due Date	**23 April 2013**
Amount	**$348.99**

ACCOUNT DETAILS

Account for residential property

Usage Charges (GST does not apply)
For period 01/01/2013 to 31/03/2013 (90 days)

Water Usage	
68 kL @ $2.17 per kL =	$147.56
Total Usage Charges	**$147.56**

Service Charge Details (GST does not apply)

Water Service Charge	$47.68
Sewerage Service Charge	$153.75
Total Service Charges	**$201.43**
Total Current Charges	**$348.99**

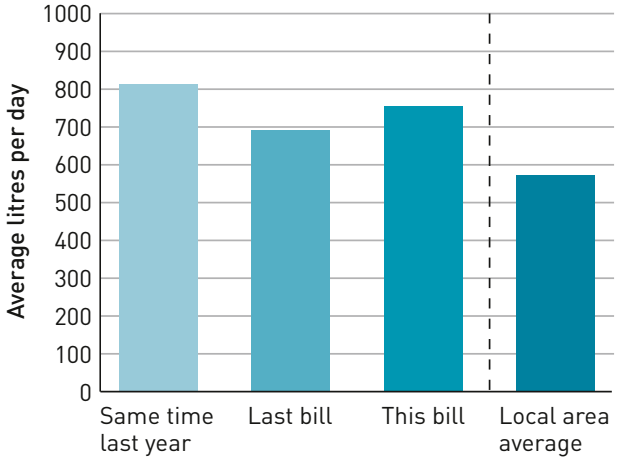
YOUR CHARGES EXPLAINED

Water Usage
Recorded by your water meter, this charge covers the amount of water used at your property. This charge is billed per kilolitre (kL) of water you use.

Service Charges
Your water and sewerage service charges are fixed charges for access to our water supply and sewerage systems. They also help us maintain, renew and expand these systems so we can continue to provide you with high quality drinking water and safe sewerage removal now and into the future.

NOTICEBOARD

Your average daily water usage comparison



Targets for water-efficient households

People per household	Property size		
	Small	Medium	Large
1 person	247 L/day	249 L/day	267 L/day
2 people	367 L/day	375 L/day	396 L/day
3 people	463 L/day	477 L/day	498 L/day
4 people	546 L/day	565 L/day	587 L/day
5 people	621 L/day	645 L/day	666 L/day
6 people	689 L/day	718 L/day	739 L/day

***Note*:**
A small property has an area of <500 m^2.
A medium property has an area between 501 m^2 and 700 m^2.
A large property has an area between 701 m^2 and 900 m^2.

FOCUS STUDY

b For non-residential properties, the water usage charge is $1.55/kL. The water access charge is based on the size (diameter) of the water meter service connection(s), as shown. If you have more than one connection you must pay for each one.
What would be the water availability charge for a non-residential property that is supplied by:
- **i** one 32 mm connection?
- **ii** one 25 mm and one 40 mm connection?
- **iii** one 50 mm connection?
- **iv** two 25 mm connections?

Meter connection	Charge ($)
20 mm	81
25 mm	127
32 mm	207
40 mm	324
50 mm	506
100 mm	2025

c Explain why the answers to parts **b iii** and **iv** are not the same. (Consider the cross-sectional areas of the pipes supplying the water.)

d A non-residential property has one 20 mm, one 32 mm and one 40 mm connection. If the amount of water used is 560 kL, calculate the total annual cost.

5 The charges by Kempsey Shire Council for water access in 2012 are given in the table. The water supply usage charges are listed below.
Residential usage
For 0–250 kL: charge is $1.67/kL
Each kL >250 kL: charge is $2.35/kL
Non-residential usage
All consumption: charge is $1.67/kL

Meter connection	Charge ($)
20 mm	235
25 mm	367
32 mm	602
40 mm	940
50 mm	1469
100 mm	5875

a Calculate the total annual cost of water for a residential property with a 20 mm connection that uses:
i 210 kL **ii** 330 kL

b Calculate the total annual cost of water for a non-residential property that uses 480 kL of water and has one 20 mm and one 50 mm connection.

6 The average rate of flow of a bathroom shower with a normal shower rose is 18 L/min.

a Jenny has two 8 minute showers each day. Calculate the annual cost of Jenny's showers if the water usage charge is $2.17/kL. (Use 1 year = 365 days.)

b Jenny's brother Sam has one 20 minute shower each day. What is the annual cost of Sam's showers?

c How much could Jenny and Sam save each year by using a water-efficient shower rose that only uses 8.5 L/min?

7 A 7.0 kg top-loading washing machine, which costs $556, uses 170 L of water per wash. A 7.0 kg front-loading machine by the same manufacturer costs $660 and uses 80 L per wash. A large family who use their washing machine 4 times per week is considering whether to buy a top-loading or front-loading machine.

a Calculate the annual water usage charges for each machine if water costs $2.25/kL. (Use 1 year = 52 weeks.)

b What are the annual savings in water usage costs if they purchase the front loader?

c **i** What is the difference in the purchase prices of the machines?

ii If they purchase the front loader, how long will it take to break-even on total costs (purchase price and water usage)?

8 **a** There are 4 people in the Lee family. How many litres of water per year would they save by replacing their full-flush toilet with a 3-star rated dual-flush toilet, if the full-flush toilet uses 54 L per person per day and the 3-star rated dual-flush toilet uses 18 L per person per day?

b What would be the cost savings if the water usage charge is $2.75/kL?

FOCUS STUDY

INVESTIGATION 14.1

9 A rectangular backyard swimming pool is 10.3 m by 3.9 m and has an average depth of 1.4 m.

a How much water does it hold?

b What is the cost of filling the pool if the water usage charge is $1.98/kL?

10 The table below shows water usage data for the states and territories of Australia in 2010/11.

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Total water consumption (GL)	5041	2359	2964	1023	1369	371	167	43	13 337
Average price of water for households ($/kL)	2.53	2.34	2.95	3.09	1.75	1.75	1.51	2.52	2.31
Household consumption (GL)	527	311	311	115	310	69	31	25	1699
Household use per capita (kL)	72	55	68	70	132	135	136	69	92
Re-use water consumed (GL)	161	78	56	25	18	7	1	4	351

a For which state or territory is the total water consumption:

i highest? **ii** lowest?

b What percentage of the total Australian consumption was the NSW consumption?

c Which state or territory paid more than the Australian average price for water?

d For which state or territory was the price of water:

i highest? **ii** lowest?

e What percentage was Victoria's household consumption of its total water consumption?

f **i** Which state or territory was the highest consumer of re-use water?

ii What percentage was this state's consumption of the total Australian consumption, for re-use water?

g For which state or territory was the household use per capita:

i highest? **ii** lowest?

h Calculate the total revenue from the sale of water for household consumption in Queensland.

i For which state or territory was household use per capita above the Australian average?

11 **a** Refer to the table, which shows water consumption by industry sector in Australia (GL) over different periods. For which industry sector was the water consumption:

i highest? **ii** lowest?

Industry sector	2000–01	2004–05	2008–09
Agriculture	14 989	12 191	6 996
Electricity and gas	255	271	328
Manufacturing	549	589	677
Forestry and fishing	40	47	101
Household	2 278	2 108	1 768
Mining	321	413	508
Water supply	2 165	2 083	2 396
Other industries	1 106	1 063	1 327
Total	21 703	18 767	14 101

b In which sectors was there a decrease in consumption from 2000–01 to 2008–09?

c What was the percentage increase in consumption for the sector 'Electricity and gas' from:

i 2000–01 to 2004–05? **ii** 2004–05 to 2008–09?

d What percentage of Australia's total water consumption in 2008–09 was in

i agriculture? **ii** mining? **iii** manufacturing? **iv** household?

FOCUS STUDY

12 Using the data for water prices in the table, calculate the percentage increase in the price from 2009/10 to 2010/11 for:

a household usage

b agricultural usage

c total usage.

	2009/10	2010/11
Household price ($/kL)	2.10	2.44
Agricultural price ($/kL)	0.11	0.14
Total price ($/kL)	0.82	1.03

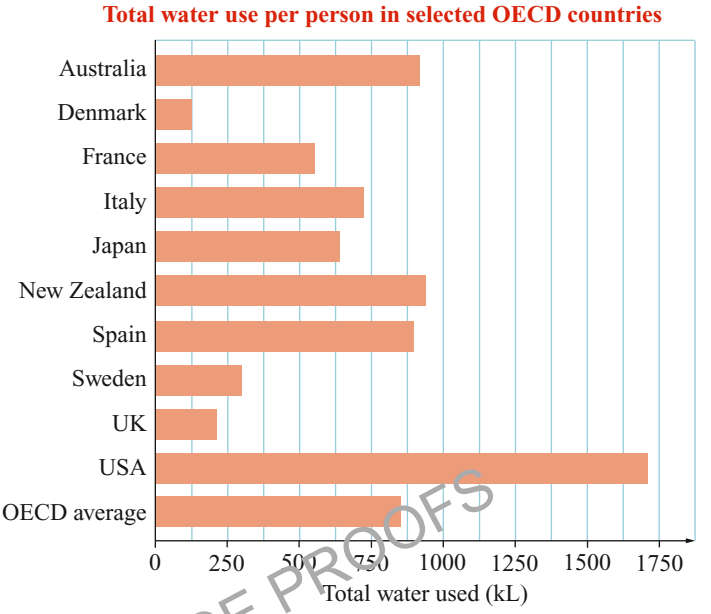
13 The graph shows the total water use per person per year across 10 OECD countries. (Total water use includes use for households, agriculture, industry, etc.)

a What is the OECD average?

b For which country was the average

i highest? **ii** lowest?

c Which countries had water use above the OECD average?



INVESTIGATION 14.2

14 The table below is a global comparison of water resources and use in 2000/01.

Region	Available water per area (ML/ha)	Population density (People/km²)	Available water per capita (ML/person/year)	Water consumed (1000 GL/year)
Australia	0.5	2.5	21.3	25
North America	2.8	20.7	13.4	603
Central America	11.2	115.7	9.6	23
Southern America	6.9	21.5	32.2	165
Western and Central Europe	4.3	107.1	4.0	265
Eastern Europe	2.5	11.5	21.4	110
Africa	1.3	32.7	4.0	215
Middle East	0.8	47.1	1.6	271
Central Asia	0.6	18.5	3.0	163
Southern and Eastern Asia	5.5	174.4	3.2	1991
Oceania and Pacific	1.1	3.3	33.0	26
World	3.2	50.4	6.4	3837

a **i** Which region of the world has the most available water per area?

ii Does this region consume the most water per year?

b **i** Which region of the world has the least available water per area?

ii Does this region consume the least water per year?

FOCUS STUDY

c Consider the data for 'Available water per capita'.

i Draw a box-and-whisker plot for this data.

ii What is the range of the data?

iii What is the interquartile range?

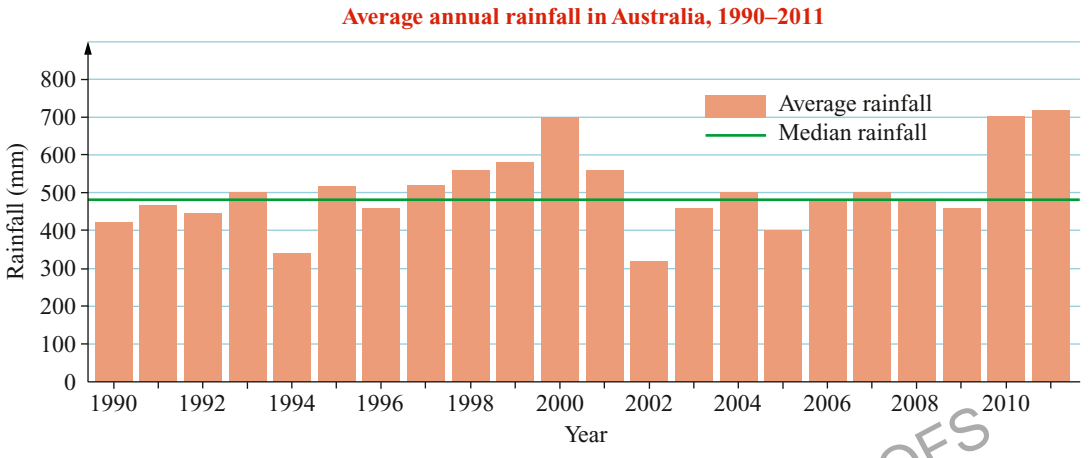
iv Comment on the spread of the scores.

d Consider the data for 'Population density'.

i Calculate the mean and standard deviation for this data.

ii Which region(s) have a population density that is more than one standard deviation above the mean?

15 The graph shows the average annual rainfall for Australia from 1990 to 2011.



a In which years, in this period, did the highest and lowest rainfalls occur?

b **i** In how many years in the decade 2000–2009 was the average rainfall below the median?

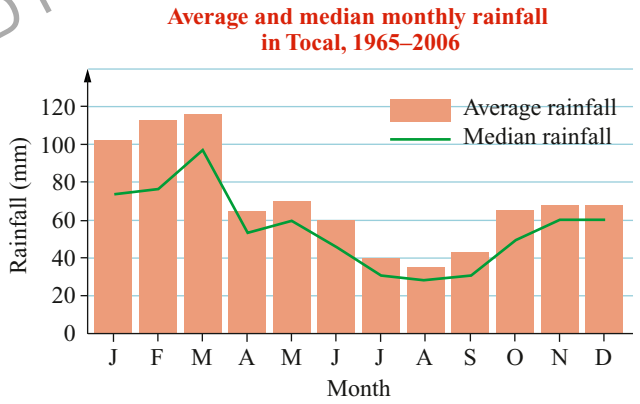
ii Comment on the weather for this decade.

16 The graph shows the mean and median monthly rainfall in Tocal from 1965 to 2006.

a For which season of the year was the rainfall:

i greatest? **ii** least?

b For each month the mean is greater than the median. Explain what weather conditions might have caused this to be so.



17 The table below shows the rainfall in mm over the summer months for Sydney for the decade 1990–1999. Summer in 1990 is December 1989 to February 1990.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Dec	161	44	190	202	36	81	102	40	29	55
Jan	84	120	66	61	52	95	150	186	99	178
Feb	631	63	409	100	99	51	55	137	31	143
Total										

a Complete the row for the total rainfall for each summer of this decade.

b Draw a column graph for the total rainfall data for part **a**.

FOCUS STUDY

c Calculate the mean and standard deviation of the total rainfall for each summer.

d Draw a box-and-whisker plot for the summer totals.

The table below shows the rainfall in mm over the summer months for Sydney for the decade 2000–2009.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Dec	82	46	40	75	60	76	25	74	123	54
Jan	56	186	98	14	51	68	121	45	57	25
Feb	19	109	348	59	129	125	51	108	258	128
Total										

e Complete the row for the total rainfall for each summer of this decade.

f Draw a column graph for the data of part **e**.

g Calculate the mean and standard deviation of the total rainfall for each summer.

h Draw a box-and-whisker plot for the summer totals.

i Using the information above, compare the summer rainfall for these two decades in Sydney. Write a short report and discuss your findings with the class.

18 The tables below show the summer rainfall in mm in Melbourne and Brisbane for the decade 2000–2009.

a

Summer in Melbourne (2000–2009)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Dec	94	35	49	12	71	59	82	18	71	77
Jan	38	12	38	11	63	24	54	33	33	1
Feb	33	12	68	20	13	167	72	13	25	3
Total										

b

Summer in Brisbane (2000–2009)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Dec	190	52	78	143	147	233	70	59	106	88
Jan	74	25	57	6	263	108	173	66	216	84
Feb	67	256	37	274	137	29	63	98	188	156
Total										

i Complete the row for total rainfall in each city.

ii Draw a column graph for the data of part **i**.

iii Calculate the mean and standard deviation of the total summer rainfall for each city.

iv Draw a box-and-whisker plot for the summer totals for each city.

c Compare the summer rainfall in each of these cities with the summer rainfall in Sydney for the decade 2000–2009.

19 The table shows the mean monthly rainfall in mm for Cairns and Alice Springs.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cairns	419	422	460	264	111	73	39	42	44	50	98	203
Alice Springs	43	41	33	16	16	15	14	10	9	20	25	36

a Draw a box-and-whisker plot for each city.

b Compare the weather in these two cities. Write a short report and discuss it with the class.

FOCUS STUDY

20 **a** This table gives the mean number of days of rain for each month for all years of record for Sydney.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Number rainy days	12.2	12.5	13.6	12.8	13.1	12.5	11.2	10.4	10.6	11.7	11.7	11.5

i What is the mean number of days of rain for August?

ii Using this data, find the probability that it will rain on any particular day in August.

ii What is the probability that it will rain on two consecutive days?

b This table gives the mean number of days of rain for each month for the years 1981–2010 for Sydney.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Number rainy days	12.3	12.9	13.3	11.1	12.2	10.5	10.2	8.4	8.8	11.1	12.7	11.2

i Use this data to find the mean number of days of rain for August.

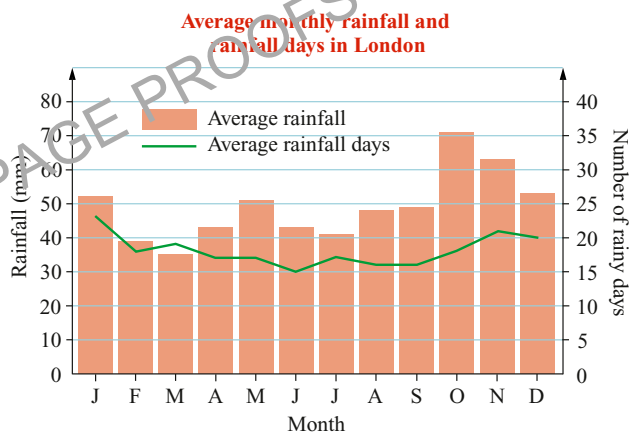
ii What is the probability that it will rain on any particular day in August?

iii What is the probability that it will rain on two consecutive days?

c Which set of data do you think would be the most accurate in predicting the probability that it will rain on any particular day in August next year? Discuss this with your class.

21 Go to the Bureau of Meteorology's website *www.bom.gov.au/nsw* and find the past weather data for your town. Use this data to calculate the probability that it will rain on your birthday next year.

22 The graph shows the average rainfall for each month in London, UK, and the average number of days of rain for each month.



a Does London have more rain in summer or winter?

b Which month is the:

i wettest? **ii** driest?

c Find the mean and standard deviation of the:

i average monthly rainfall

ii average number of rainy days per month.

d Comment on the pattern of rainfall in London.

e Find the probability that it will rain next year on:

i 5 August **ii** 5 January.

23 The table shows the average rainfall and the average number of rainy days for each month in Tokyo, Japan.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average rainfall (mm)	62	61	125	139	151	169	183	186	215	235	108	45
Average rainy days	11	10	16	17	18	19	18	16	18	17	12	9

a Draw a column graph for average rainfall each month.
b On the column graph draw a line graph for the number of rainy days.
c Does Tokyo have more rain in summer or winter?
d Which month is the:
  i wettest? **ii** driest?
e Calculate the mean and standard deviation of the:
  i average monthly rainfall **ii** average number of rainy days each month.
f Comment on the pattern of rainfall in Tokyo.
g Compare the rainfall in London with that in Tokyo.
h Find the probability that it will rain in Tokyo next year on:
  i 5 August **ii** 5 January.

INVESTIGATION 14.3

14B Volume and collection of water

WORKED EXAMPLE 1

The surface area of a lake is 460 000 m^2. If an average of 6 mm of rain falls on the lake, what will be the increase in the volume of water in the lake? Ignore any run-off from the surrounding area.

Solve	Think	Apply
$V = 460\,000 \times 0.006$ $= 2760$ m^3 $= 2\,760\,000$ L or 2.76 ML	6 mm = 0.006 m 1 m^3 holds 1000 L. 1 ML = 1 000 000 L	Use $V = A \times h$.

EXERCISE 14B

1 The surface area of a lake is 785 000 m^2. If an average of 4 mm of rain falls on the lake, what will be the increase in the volume of water in the lake? Ignore any runoff from the surrounding area.

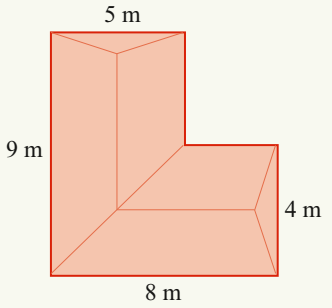
2 The rainfall over a rectangular paddock that measures 280 m by 196 m is 8 mm.
a If all the rain flows into a dam on the property, what will be the increase in the volume of water in the dam?
b If 20% of the rain soaks into the ground before flowing into the dam, what will be the increase in the volume of the dam?

3 Lake Burragorang is formed by Warragamba dam, which supplies most of Sydney's population with water.
a The area of Lake Burragorang is 75 km^2. If an average of 3 mm of rain falls over the lake, what will be the increase in the volume of water in the lake?
b The total catchment area for Lake Burragorang is 9051 km^2. If an average of 1 mm of rain falls over the catchment and 85% of this runs into the lake, what will be the increase in the volume of water in the dam?

FOCUS STUDY

WORKED EXAMPLE 2

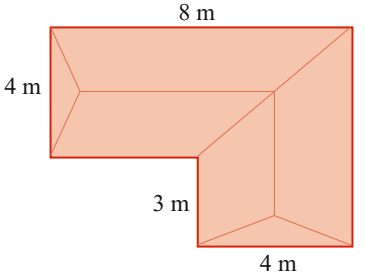
a Calculate the plan-view area of the roof of the house shown.
b How much water could be collected from this roof if 6 mm of rain fell on it, allowing 10% for wastage?



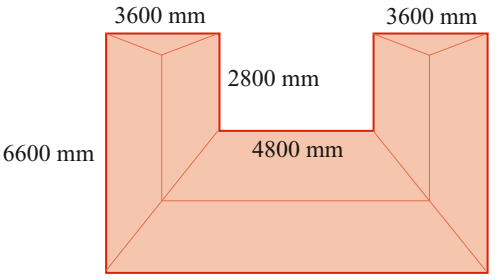
	Solve	Think	Apply
a	Area of roof $= 5 \times 9 + 4 \times 3$ $= 57\ m^2$	Divide the plan-view area into rectangles.	Find the plan-view area of the roof by dividing the shape of the roof into rectangles.
b	Volume of water collected $= 0.9 \times 57 \times 0.006\ m^3$ $= 0.3078\ m^3$ $= 307.8\ L$ $= 308\ L$ (to nearest L)	If all the rain is collected then $V = 57 \times 0.006\ m^3$. However it is usual to allow 10% for wastage. So $V =$ 90% of 57×0.006 (90% is known as the water runoff coefficient).	Volume of rain collected $V\ (m^3) = C \times A \times R$ where $C =$ the water runoff coefficient, as a decimal $A =$ roof area (m^2) $R =$ amount of rainfall (m)

Note: The **plan-view area** of the roof includes the width of the eaves and so, in general, is not the same as the floor area. The plan-view area is sometimes referred to as the 'footprint' of the 'drip line' of the house.

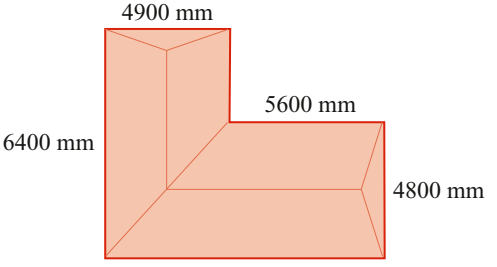
4 a i Calculate the plan-view area of the roof of the house shown.
ii How much water could be collected from this roof if 4 mm of rain fell on it, allowing 10% for wastage?



b i Calculate the plan-view area of the roof of the house shown.
ii This house is situated in Newcastle. The average rainfall for Newcastle in January is 91.4 mm. How much water could be expected to be collected from this roof in January next year, allowing 10% for wastage?



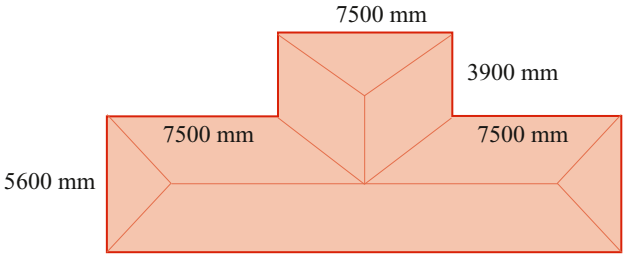
c i Calculate the plan-view area of the roof of the house shown.
ii This house is situated in Wollongong. The average rainfall for Wollongong in spring is 206.7 mm. How much water could be expected to be collected from this roof in spring next year, allowing 15% for wastage?



FOCUS STUDY

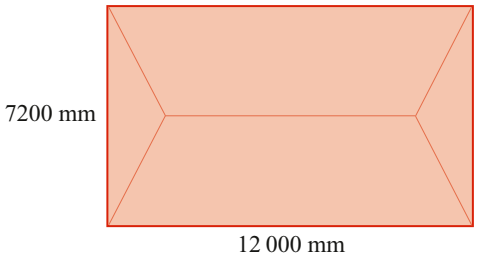
d **i** Calculate the plan-view area of the roof of the house shown.

ii This house is situated in Canberra. The average annual rainfall for Canberra is 633.1 mm. How much water could be expected to be collected from this roof next year, allowing 15% for wastage?



e **i** Calculate the plan-view area of the roof of the house shown.

ii This house is situated in Bourke. The average annual rainfall for Bourke is 354.7 mm. How much water could be expected to be collected from this roof next year?



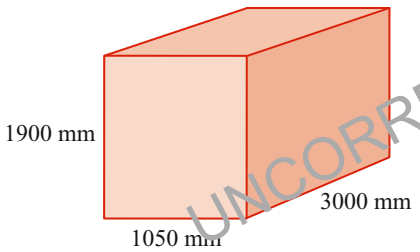
iii Because of pollution it is necessary to discard the first 40 L each time there is a rain event (that is it rains). Water tanks often have a flushing device fitted to discard the first water collected. The mean annual number of rainy days in Bourke is 47. Treating each rainy day as a separate rain event, how much water will be discarded each year.

v Calculate the amount of water that, on average, could actually be collected each year.

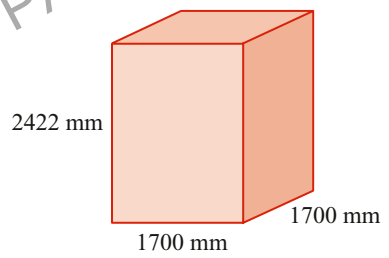
vi The cost of town water in Bourke is $1.86/kL. If all the water collected in the tank is used for household consumption, how much could this household save each year?

5 Calculate the capacity of the following water tanks to the nearest kL.

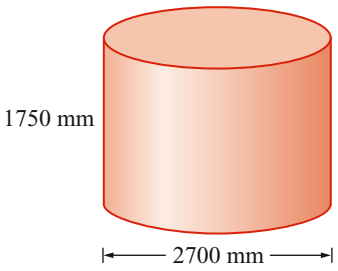
a



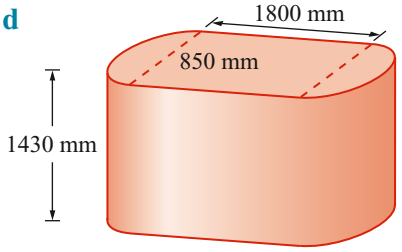
b



c



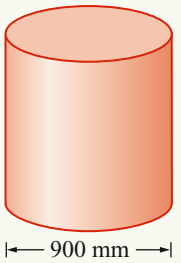
d



FOCUS STUDY

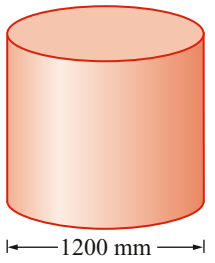
WORKED EXAMPLE 3

If 308 L of rain is collected in the tank shown, what will be the rise in the height of the water?

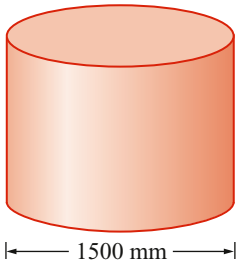


Solve	Think	Apply
Cross-sectional area of tank $= \pi \times 0.45^2$ m^2 $= 0.636$ m^2 Volume of water collected $= 0.308$ m^3 $0.308 = 0.636 \times h$ $h = \frac{0.308}{0.636}$ $= 0.484\,27\ldots$ m $= 484$ mm (to nearest mm) The water will rise by 484 mm.	Cross-sectional area of tank $= \pi \times r^2$, $r = 450$ mm $= 0.45$ m Volume of water collected $= \frac{308}{1000}$ m^3 (1 m^3 = 1000 L)	Calculate the horizontal cross-sectional area of the tank. Convert the volume of water to cubic metres. Use volume of water = cross-sectional area × height

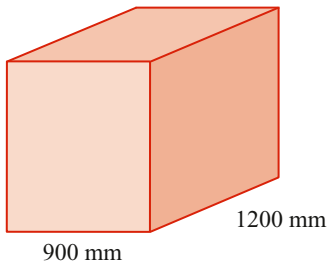
6 a If 295 L of rain is collected in the tank shown, what will be the rise in the height of the water?



b If 370 L of rain is collected in the tank shown, what will be the rise in the height of the water?



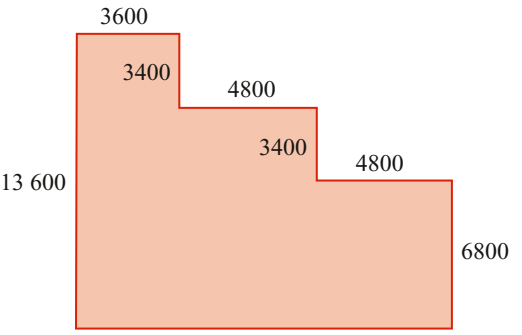
c If 300 L of rain is collected in the tank shown, what will be the rise in the height of the water?



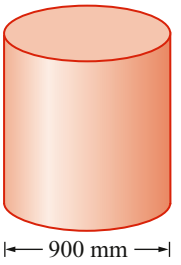
FOCUS STUDY

7 **a** Calculate the plan-view area of the roof of the house shown. (All measurements are in mm.)

b How much water could be collected from this roof if 4 mm of rain fell on it, allowing 10% for wastage?



c If the water from the roof is collected in the water tank shown, what will be the rise in the height of water in the tank?

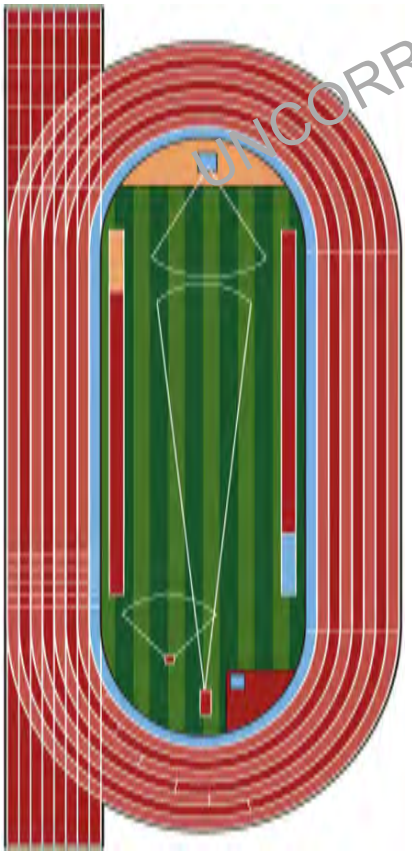


14C Scale

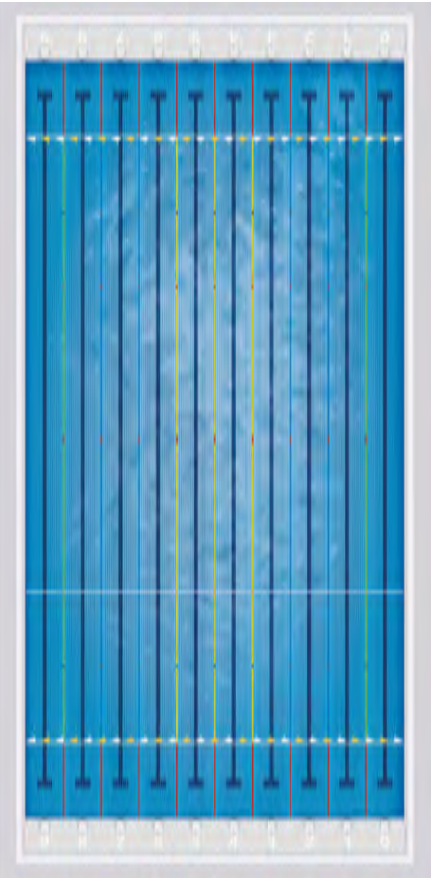
EXERCISE 14C

1 Calculate the scale used in these diagrams.

a The straight track on the athletics field is 100 m.

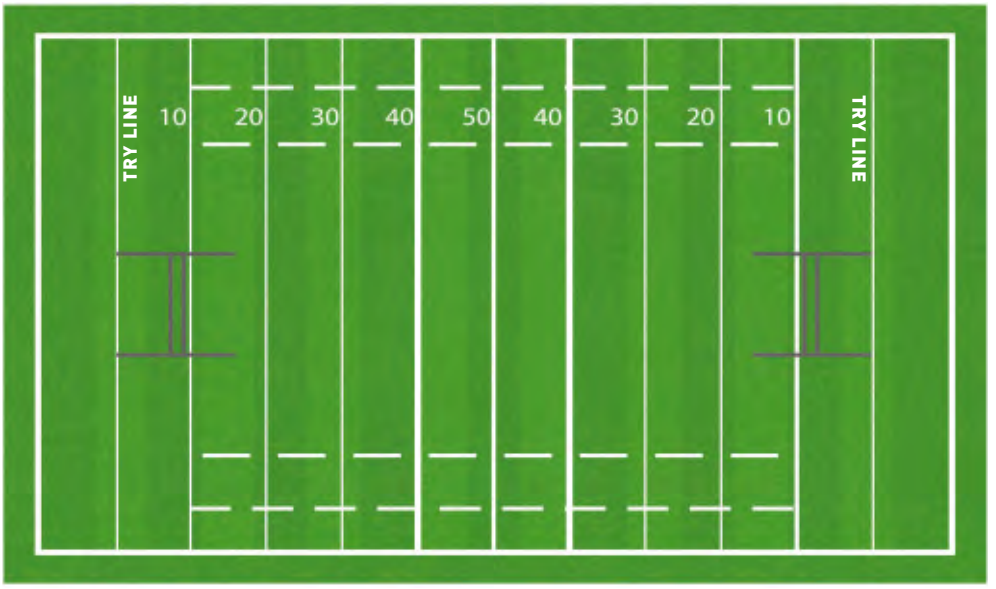


b The swimming pool is 50 m long.



FOCUS STUDY

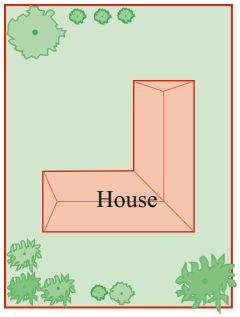
c The length of a rugby league field is 100 m, between the try lines.



2 Use measurement and the scale given for the following site plans to find the:

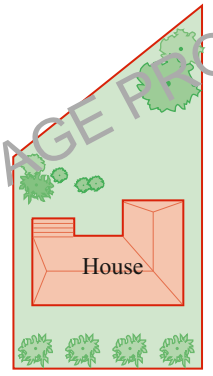
i perimeter of the land **ii** area of the land.

a



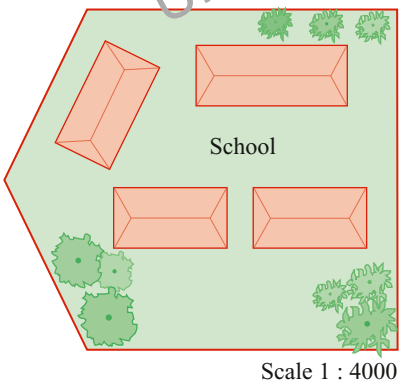
Scale 1 : 1000

b



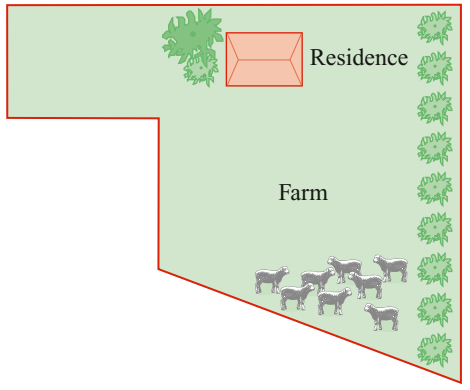
Scale 1 : 800

c



Scale 1 : 4000

d



Scale 1 : 24 000

3 Consider the site plan in given question **2** part **a**.

a Measure the length and breadth to the nearest millimetre.

b What is the greatest possible error for each of these measurements?

c Find the lower and upper limits of these measurements.

d Apply the scale factor to find the lower and upper limits of the actual length and breadth.

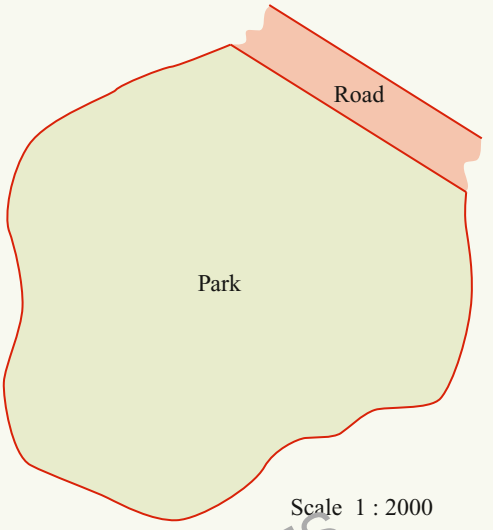
e Hence determine the lower and upper limits of the actual area.

INVESTIGATION 14.4

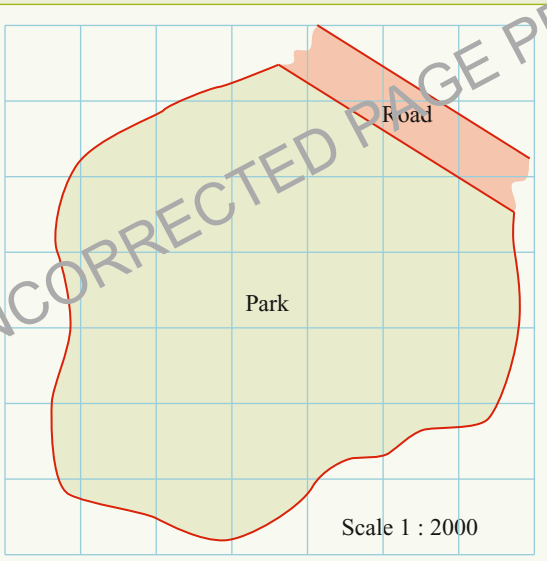
14D Estimating area using grid squares

WORKED EXAMPLE 1

Use the grid-square method to estimate the area of the park shown.



Solve/Think	Apply
Place or draw a 1 cm by 1 cm grid over the area. *Step 1:* The number of whole grid squares within the park's boundary = 19. *Step 2:* The number of squares around the edge that are partially inside boundary = 23. Approximate number of *whole* grid squares partially within the boundary = $23 \times 0.5 = 11.5$ *Step 3:* Total number of whole grid squares $\approx 19 + 11.5 = 30.5$ *Step 4:* The scale is 2000 : 1, so the area of each grid square on the park is 1×2000 cm by 1×2000 cm or 20 m by 20 m = 400 m^2. *Step 5:* Area of park $\approx 30.5 \times 400$ m^2 $\approx 12\,200$ m^2	*Step 1:* Count the number of whole grid squares within the boundary. *Step 2:* Count the grid squares around the edge that are partially inside the boundary. Approximate to the number of whole squares partially inside the boundary by multiplying by 0.5. *Step 3:* Add to find the total number of whole grid squares. *Step 4:* Use the scale to calculate the area of each grid square in the park. *Step 5:* Area = total number of grid squares × area of each grid square.



Note: In step 2 various methods can be used to estimate the number of whole grid squares covered by the squares partially inside the boundary. For example, if more than half of any grid square lies within the area, count it as a whole square, and if less than half of a grid square is within the area, ignore it.

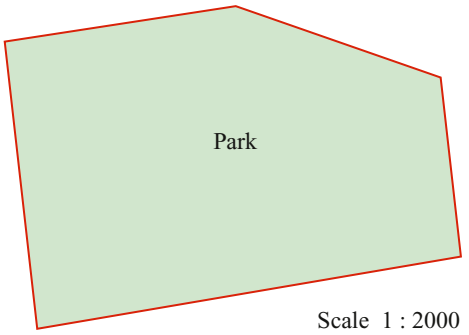
Other grid sizes may be used, such as 5 mm by 5 mm or 2 mm by 2 mm. The smaller the grid squares, the more accurate the estimate. To check your answer, lay the grid at a different angle over the area and count squares again.

FOCUS STUDY

EXERCISE 14D

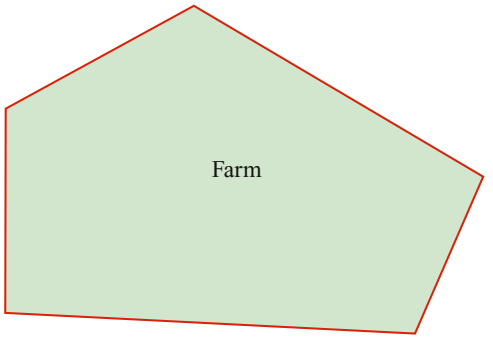
1 Use the grid-square method to estimate the following areas.

a



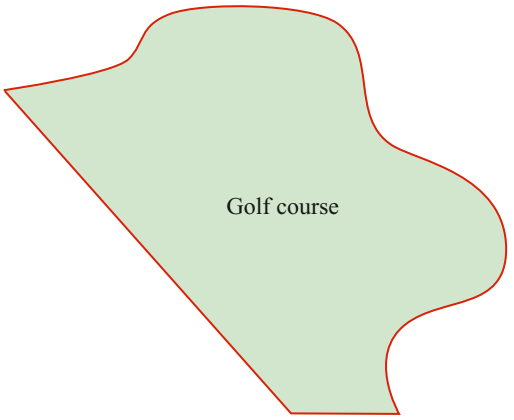
Scale 1 : 2000

b



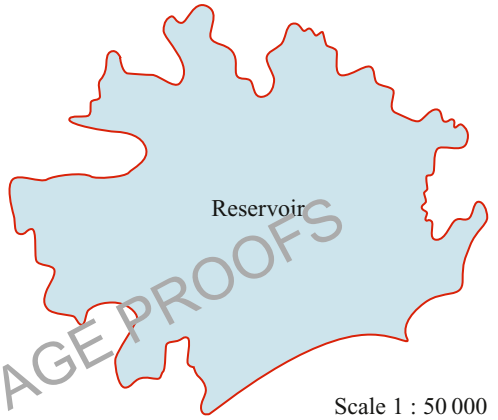
Scale 1 : 40 000

c



Scale 1 : 30 000

d



Scale 1 : 50 000

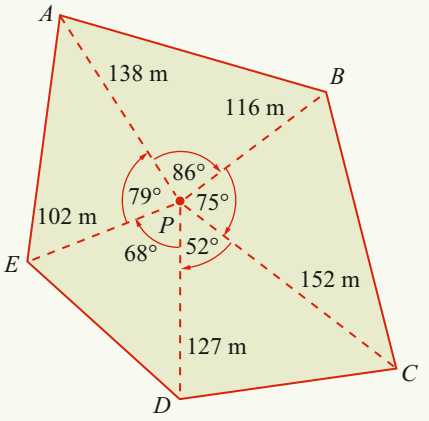
14E The polygon method

The **polygon method** involves breaking up a polygon into simple plane shapes in order to find its area. This can be done using the measurements obtained from:

- a radial survey
- an offset (or traverse) survey.

WORKED EXAMPLE 1

Find the area of the land in the diagram, using the measurements obtained from a radial survey.



FOCUS STUDY

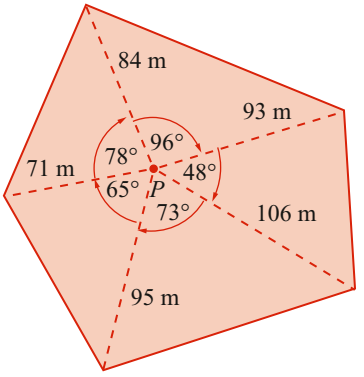
WORKED EXAMPLE 1 CONTINUED

Solve/Think	Apply
Area $\triangle PAB = \frac{1}{2} \times 138 \times 116 \times \sin 86° = 7984.5 \text{ m}^2$ Area $\triangle PBC = \frac{1}{2} \times 116 \times 152 \times \sin 75° = 8515.6 \text{ m}^2$ Area $\triangle PCD = \frac{1}{2} \times 152 \times 127 \times \sin 52° = 7605.9 \text{ m}^2$ Area $\triangle PDE = \frac{1}{2} \times 127 \times 102 \times \sin 68° = 6005.4 \text{ m}^2$ Area $\triangle PEA = \frac{1}{2} \times 102 \times 138 \times \sin 79° = 6908.7 \text{ m}^2$ Total area $= 37\,020 \text{ m}^2$	Find the area of each triangle using $A = \frac{1}{2}ab \sin C$ and sum these to find the total area.

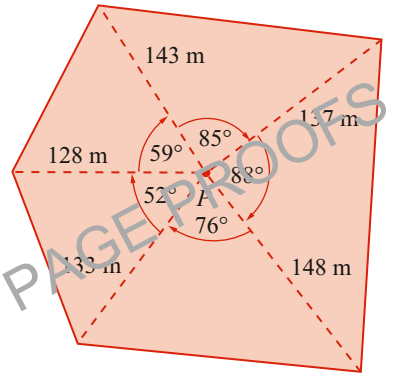
EXERCISE 14E

1 Find the area of the land in each diagram, using the measurements obtained from a radial survey.

a

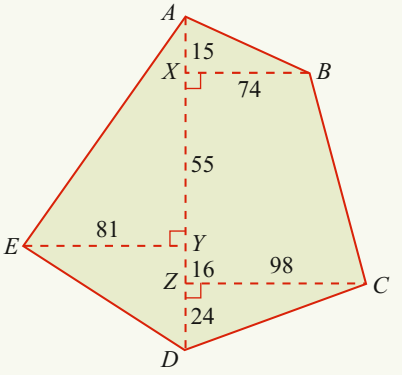


b



WORKED EXAMPLE 2

Find the area of the land in the diagram, using the measurements obtained from a traverse survey. (Lengths shown are in metres.)

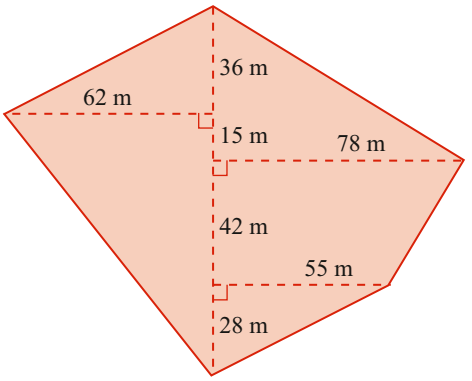


Solve	Think	Apply
Area $\triangle ABX = \frac{1}{2} \times 15 \times 74 = 555 \text{ m}^2$ Area $XBCZ = \frac{1}{2} \times (74 + 98) \times 71 = 6106 \text{ m}^2$ Area $\triangle ZCD = \frac{1}{2} \times 24 \times 98 = 1176 \text{ m}^2$ Area $\triangle ADE = \frac{1}{2} \times 110 \times 81 = 4455 \text{ m}^2$ Total area $= 12\,292 \text{ m}^2$	Area of a triangle $= \frac{1}{2}bh$ Area of a trapezium $= \frac{1}{2}(a + b)h$ In trapezium $XBCZ$, $XZ = 55 + 16 = 71$ m. In $\triangle ADE$, $AD = 15 + 55 + 16 + 24 = 110$ m.	Find the area of each plane shape and sum these to find the total area.

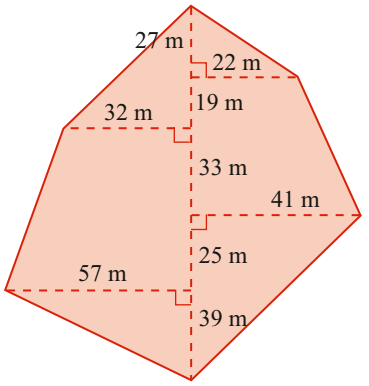
FOCUS STUDY

2 Find the area of the land in these diagrams, using the measurements obtained from a traverse survey. (Lengths shown are in metres.)

a

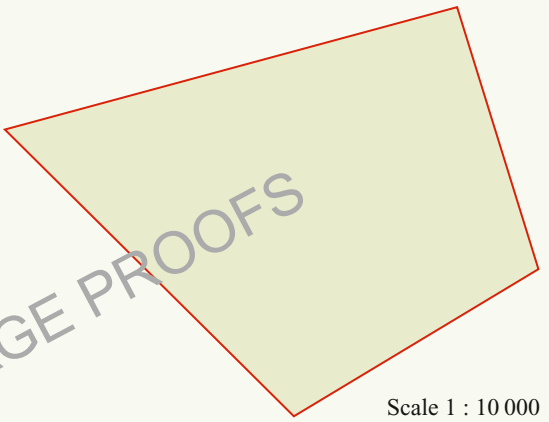


b



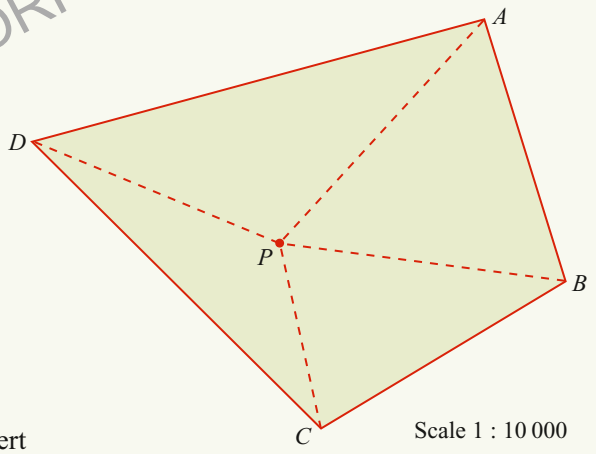
WORKED EXAMPLE 3

Find the area of the land shown in the scaled diagram, using a radial survey.



Scale 1 : 10 000

Solve/Think	Apply
Step 1: Choose a point, P, inside the shape and label the vertices of the polygon. *Step 2:* Draw and measure the radial arms on the diagram. $PA = 40$ mm $PB = 38$ mm $PC = 25$ mm $PD = 35$ mm Use the scale to convert these to the actual lengths. $PA = 40 \times 10\,000$ mm $= 400\,000$ mm or 400 m $PB = 38 \times 10\,000$ mm $= 380\,000$ mm or 380 m $PC = 25 \times 10\,000$ mm $= 250\,000$ mm or 250 m $PD = 35 \times 10\,000$ mm $= 350\,000$ mm or 350 m *Step 3:* Measure the angles between the radial arms. $\angle APB = 55°$, $\angle BPC = 70°$ $\angle CPD = 125°$, $\angle DPA = 110°$	Choose a point, P, inside the shape. Draw and measure the radial arms on the diagram. Use the scale to convert these to the actual lengths. Measure the angles between the radial arms.



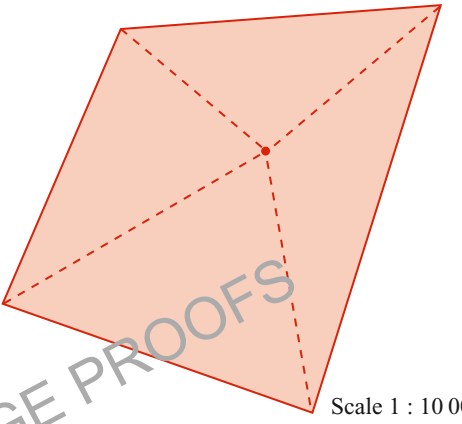
Scale 1 : 10 000

FOCUS STUDY

WORKED EXAMPLE 3 CONTINUED

Solve/Think	Apply
Step 4: Calculate the area of each triangle and sum them to find the total area. Area $\triangle APB = \frac{1}{2} \times 400 \times 380 \times \sin 55° = 62\,255.6\ \text{m}^2$ Area $\triangle BPC = \frac{1}{2} \times 380 \times 250 \times \sin 70° = 44\,635.4\ \text{m}^2$ Area $\triangle CPD = \frac{1}{2} \times 250 \times 350 \times \sin 125° = 35\,837.9\ \text{m}^2$ Area $\triangle DPA = \frac{1}{2} \times 350 \times 400 \times \sin 110° = 65\,778.5\ \text{m}^2$ Total area $= 208\,507\ \text{m}^2$	Calculate the area of each triangle using $A = \frac{1}{2}ab \sin C$ and sum them to find the total area.

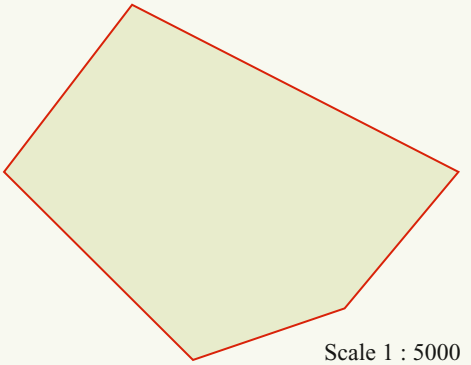
3 Find the area of the land shown in the scaled diagram using a radial survey.



Scale 1 : 10 000

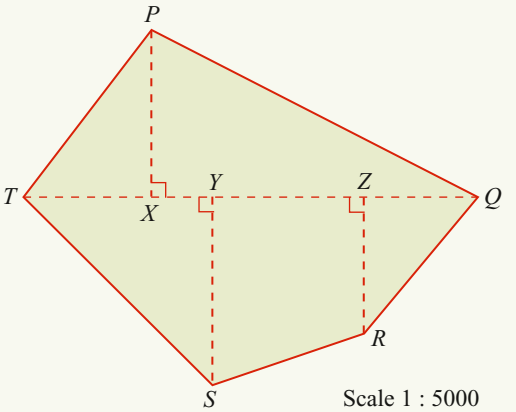
WORKED EXAMPLE 4

Find the area of the land shown in the scaled diagram, using an offset survey.



Scale 1 : 5000

Solve/Think	Apply
Step 1: Label the vertices of the polygon and choose a suitable diagonal. *Step 2:* Draw and measure the lengths of the perpendicular offsets from each vertex to the diagonal. $PX = 22$ mm $SY = 25$ mm $RZ = 18$ mm	Label the vertices of the polygon and choose a suitable diagonal. Draw and measure the lengths of the perpendicular offsets from each vertex to the diagonal.



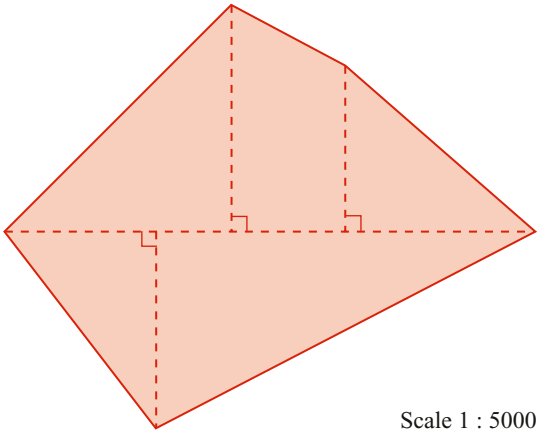
Scale 1 : 5000

FOCUS STUDY

WORKED EXAMPLE 4 CONTINUED

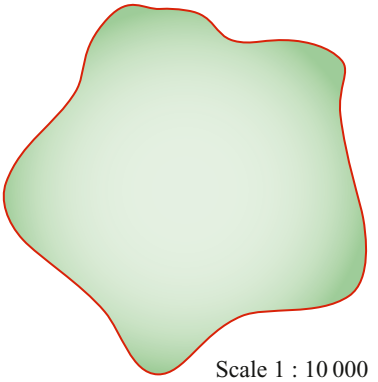
Solve/Think	Apply
Step 3: Start at T, say, and measure the distances between the bases of each offset. $TX = 17$ mm, $XY = 8$ mm, $YZ = 20$ mm, $ZQ = 15$ mm *Step 4:* Use the scale to convert all measurements to actual lengths. $PX = 22 \times 5000 = 110\,000$ mm $= 110$ m $SY = 25 \times 5000 = 125\,000$ mm $= 125$ m $RZ = 18 \times 5000 = 90\,000$ mm $= 90$ m $TX = 17 \times 5000 = 85\,000$ mm $= 85$ m $XY = 8 \times 5000 = 40\,000$ mm $= 40$ m $YZ = 20 \times 5000 = 100\,000$ mm $= 100$ m $ZQ = 15 \times 5000 = 75\,000$ mm $= 75$ m Hence $TQ = 300$ m *Step 5:* Calculate the areas of the triangles and trapezium and sum them to find the total area. Area triangle $TPQ = \frac{1}{2} \times 300 \times 110 = 16\,500$ m^2 Area triangle $TYS = \frac{1}{2} \times 125 \times 125 = 7812.5$ m^2 Area trapezium $SYZR = \frac{1}{2} \times (125 + 90) \times 100 = 10\,750$ m^2 Area triangle $RZQ = \frac{1}{2} \times 75 \times 90 = 3375$ m^2 Total area $= 38\,437.5$ m^2	Start at one end of the diagonal and measure the distances between the bases of each offset. Use the scale to convert all measurements to actual lengths. Calculate the areas of the triangles and trapezium and sum them to find the total area.

4 Find the area of the land shown in the scaled diagram, using an offset survey.



Scale 1 : 5000

5 Complete the following steps to estimate the area of this irregular shape using a radial survey and a traverse survey.



Scale 1 : 10 000

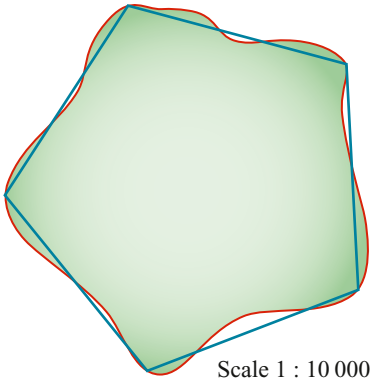
FOCUS STUDY

Mark and label five points on the boundary. Join these points to form a polygon.

i Choose a point P inside the polygon and use a radial survey to find its area.

ii Draw a suitable diagonal and use a traverse survey to find the area of the polygon.

Note: Choose five or six suitable points on the boundary of the shape and determine the area of the polygon formed by joining these points using a radial survey or a traverse survey. The area of the polygon is then an approximation for the area of the irregular shape. The more vertices you choose the better the approximation.



Scale 1 : 10 000

6 Find estimates for the areas in Exercise 14D using a radial survey and a traverse survey. Compare methods and discuss your answers.

14F Simpson's rule for area

Another method of finding the area of shapes with curved boundaries is **Simpson's rule**, which was discussed in Chapter 2. This rule gives an estimate of the area.

Simpson's rule for area is:

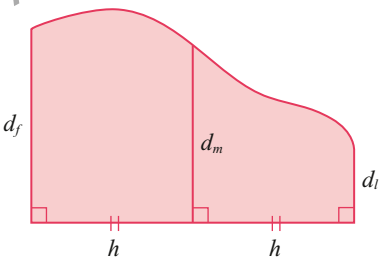
$$A \approx \frac{h}{3}(d_f + 4d_m + d_l)$$

where h = the equal distance between offsets

d_f = the first offset

d_m = the middle offset

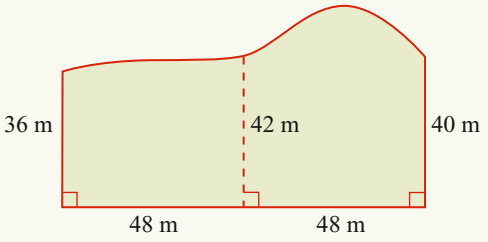
d_l = the last offset



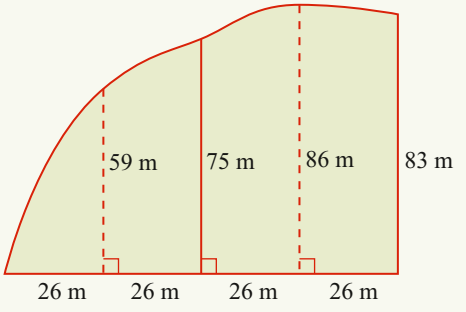
WORKED EXAMPLE 1

Use Simpson's rule to approximate the areas shown below.

a Use one application.



b Use two applications.



FOCUS STUDY

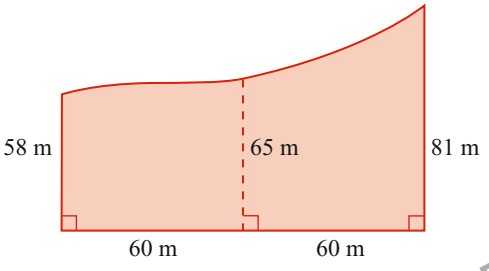
WORKED EXAMPLE 1 CONTINUED

	Solve	Think	Apply
a	$A \approx \frac{48}{3}(36 + 4 \times 42 + 40)$ $= 3904 \text{ m}^2$	$h = 48$ m, $d_f = 36$ m, $d_m = 42$ m, $d_l = 40$ m	Substitute the appropriate values into Simpson's rule.
b	$A \approx \frac{26}{3}(0 + 4 \times 59 + 75)$ $+ \frac{26}{3}(75 + 4 \times 86 + 83)$ $= 7046 \text{ m}^2$	$h = 26$ m For the first strip, $d_f = 0$ m, $d_m = 59$ m, $d_l = 75$ m For the second strip, $d_f = 75$ m, $d_m = 86$ m, $d_l = 83$ m	

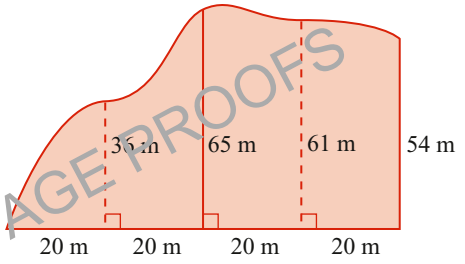
EXERCISE 14F

1 Use Simpson's rule to approximate the areas shown below.

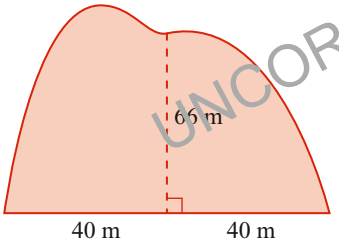
a Use one application.



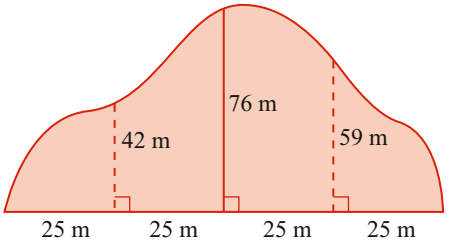
b Use two applications.



c Use one application.

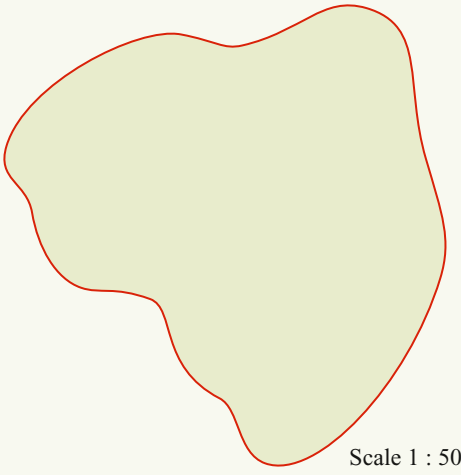


d Use two applications.



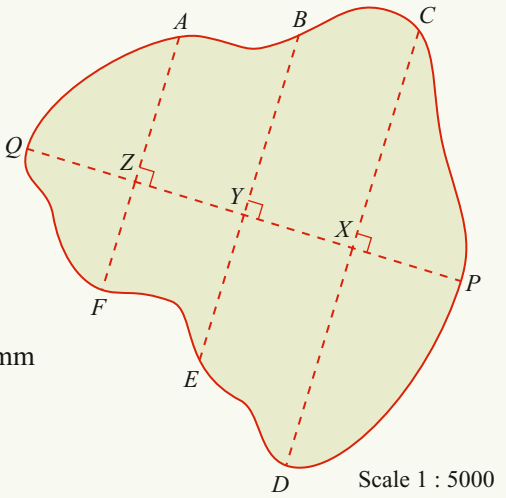
WORKED EXAMPLE 2

Use two applications of Simpson's rule to approximate the area shown.



FOCUS STUDY

WORKED EXAMPLE 2 CONTINUED

Solve/Think	Apply
Step 1: Draw a suitable baseline PQ across the shape. Divide this line, at X, Y and Z into four equal subintervals: make $PX = XY = YZ = ZQ$. Draw and measure the perpendicular offsets at X, Y and Z. $PX = XY = YZ = ZQ = 15$ mm $XC = 30$ mm, $YB = 25$ mm, $ZA = 20$ mm, $XD = 30$ mm, $YE = 20$ mm, $ZF = 15$ mm  Scale 1 : 5000 *Step 2:* Use the scale to convert all measurements to actual lengths. $PX = XY = YZ = ZQ = 15 \times 5000 = 75\,000$ mm or 75 m $XC = 30 \times 5000 = 150\,000$ mm or 150 m $YB = 25 \times 5000 = 125\,000$ mm or 125 m $ZA = 20 \times 5000 = 100\,000$ mm or 100 m $XD = 30 \times 5000 = 150\,000$ mm or 150 m $YE = 20 \times 5000 = 100\,000$ mm or 100 m $ZF = 15 \times 5000 = 75\,000$ mm or 75 m *Step 3:* Use Simpson's rule to approximate the areas $PCBAQ$ and $PDEFQ$. Area $PCBAQ \approx \frac{75}{3}(0 + 4 \times 100 + 125) + \frac{75}{3}(125 + 4 \times 150 + 0)$ $= 31\,250$ m^2 Area $PDEFQ \approx \frac{75}{3}(0 + 4 \times 75 + 100) + \frac{75}{3}(100 + 4 \times 150 + 0)$ $= 27\,500$ m^2 Total area $\approx 58\,750$ m^2	Draw a suitable base line across the shape. Divide this line into two (for one application) or four (for two applications) equal subintervals. Draw and measure the perpendicular offsets. Use Simpson's rule to approximate the area.

2 Complete the following to estimate the area in the scaled diagram using one application of Simpson's rule.

By measurement: $PX = XQ =$ ___ mm, $PB =$ ___ mm, $XA =$ ___ mm, $PC =$ ___ mm, $XD =$ ___ mm

The actual lengths are then:

$PX = XQ =$ ___ $\times$ 10 000 = ___ mm or ___ m

$PB =$ ___ $\times$ 10 000 = ___ mm or ___ m,

$XA =$ ___ $\times$ 10 000 = ___mm or ___ m,

$PC =$ ___ $\times$ 10 000 = ___ mm or ___ m,

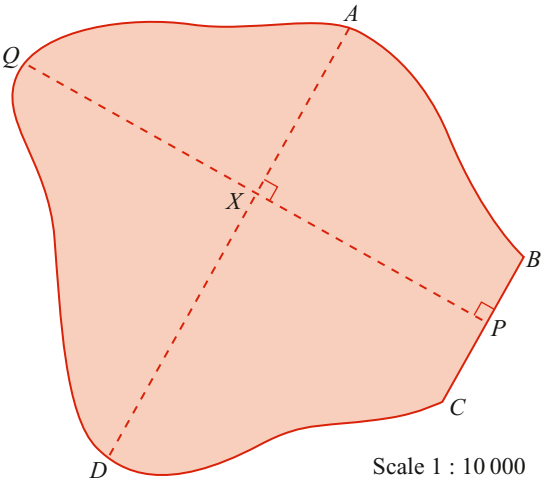
$XD =$ ___ $\times$ 10 000 = ___mm or ___ m

Using Simpson's rule:

Area $PBAQ \approx \frac{\square}{3}($ ___ $+ 4 \times$ ___ $+$ ___ $) =$ ___

Area $PCDQ \approx \frac{\square}{3}($ ___ $+ 4 \times$ ___ $+$ ___ $) =$ ___

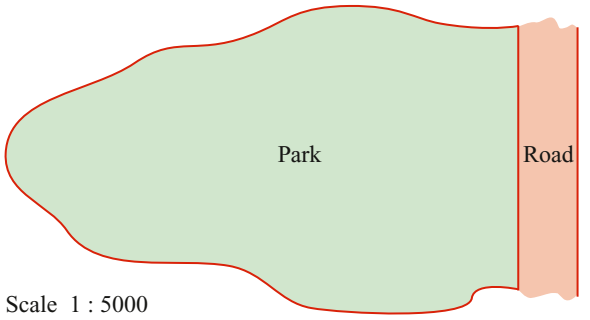
Total area $\approx$ ____



Scale 1 : 10 000

FOCUS STUDY

3 Use two applications of Simpson' rule to estimate the area shown in the scaled diagram.



14G Volume using Simpson's rule

Simpson's rule was used in the Preliminary Mathematics General course to approximate areas. It can also be used to estimate volumes, given the cross-sectional area at three equal intervals. The formula becomes:

Simpson's rule for volume is:

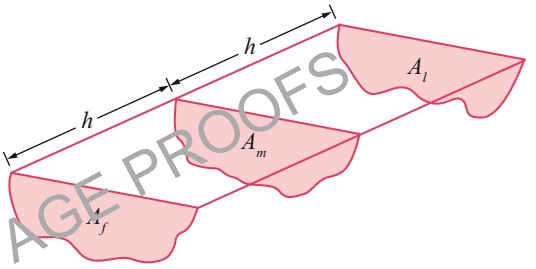
$V \approx \frac{h}{3}(A_f + 4A_m + A_l)$ where

h = the equal distance between the cross-sections

A_f = area of first cross-section

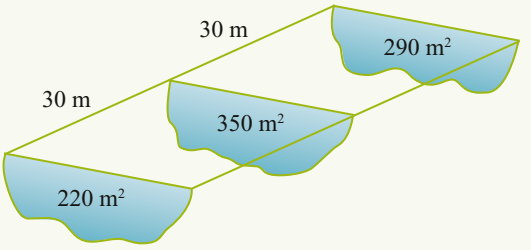
A_m = area of middle cross-section

A_l = area of last cross-section



WORKED EXAMPLE 6

Find the approximate volume of the reservoir shown in the diagram.



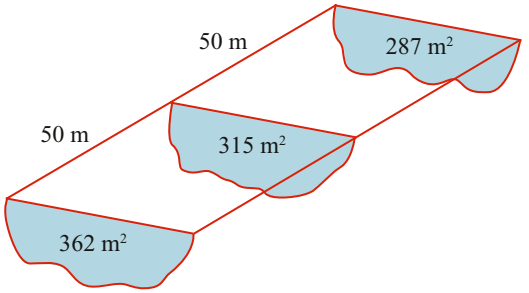
Solve	Think	Apply
$V \approx \frac{h}{3}(A_f + 4 \times A_m + A_l)$ $= \frac{30}{3}(220 + 4 \times 350 + 290)$ $= 19\,100\ \text{m}^3$ $= 19\,100\,000\ \text{L}$ $= 19.1\ \text{ML}$	$h = 30, A_f = 220, A_m = 350, A_l = 290$ $1\ \text{m}^3 = 1000\ \text{L}, 1\ \text{ML} = 1\,000\,000\ \text{L}$	Substitute the appropriate values into the formula.

FOCUS STUDY

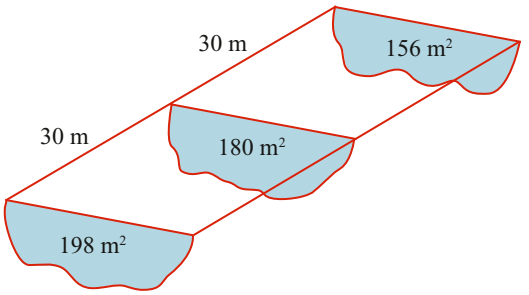
EXERCISE 14G

1 Use Simpson's rule to find the approximate volume of the following.

a

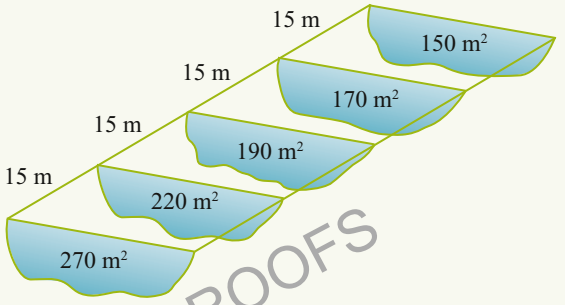


b



WORKED EXAMPLE 2

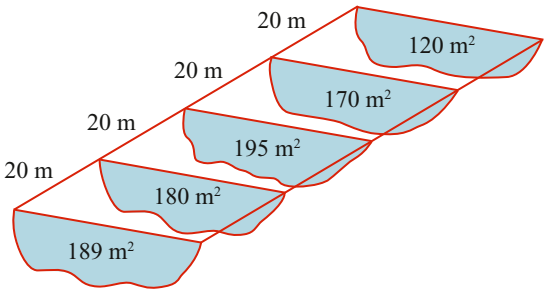
Apply Simpson's rule twice to find the approximate volume of the dam shown.



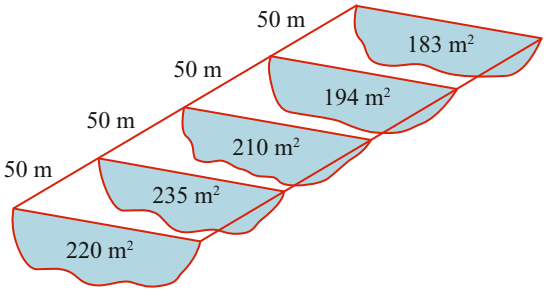
Solve	Think	Apply
$V \approx \frac{15}{3}(270 + 4 \times 220 + 190)$ $+ \frac{15}{3}(190 + 4 \times 170 + 150)$ $= 11\,800\ \text{m}^3$ $= 11\,800\,000\ \text{L}$ $= 11.8\ \text{ML}$	$V = V_1 + V_2$ $V_1 \approx \frac{15}{3}(270 + 4 \times 220 + 190)$ $V_2 \approx \frac{15}{3}(190 + 4 \times 170 + 150)$	Divide the volume into two equal sub-volumes and use Simpson's rule to approximate each one. Sum the two sub-volumes.

2 Use two applications of Simpson's rule to find each volume.

a



b



FOCUS STUDY

WORKED EXAMPLE 3

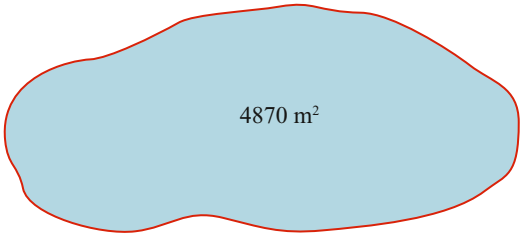
The approximate volume of a dam can also be found if its surface area and average depth are known. Determine the approximate volume of the reservoir, given that its average depth is 4.2 m.

Average depth = 4.2 m

Solve/Think	Apply
$V \approx 3690 \times 4.2$ m^3 $= 15\,498$ m^3 $= 15\,498\,000$ L $= 15.498$ ML	Use $V = A \times h$

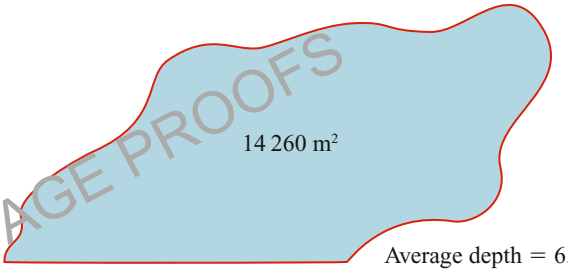
3 Approximate the volumes of these lakes.

a



Average depth = 3.9 m

b



Average depth = 6.5 m

14H Cost of electrical energy

EXERCISE 14H

1 Use the sample electricity account on the following page to answer these questions.

a **i** What is the supply period for this bill?

ii How many days is this?

b The electricity service availability charge is a charge for having electricity available to your property (the cost of supplying and maintaining the poles and wires).

i What is the daily charge?

ii Calculate the total charge for this account.

c The usage charge is what you pay for the amount of electricity that you use.

i What was the total amount of electricity used by this household, for the billing period?

ii What is the average daily usage?

d The cost of usage is broken down into peak energy rate, shoulder energy charge and off-peak energy charge. What percentage of usage occurred in the:

i shoulder period?

ii off-peak period?

FOCUS STUDY

FIRST COMBINATION *energy*

Mr P Smith
71 Winter Grove
SUMMERTON

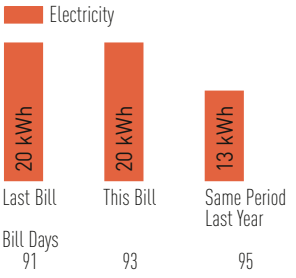
Customer Number	0123456
Due Date	18 March 2013
Amount Payable	$621.41

Quarterly Electricity Account

LOCATION: 71 Winter Grove, SUMMERTON

Previous Amount Payable		**529.44**
Payment Received — Thank You		–529.44 Cr
Electricity (22/11/2012 to 22.02/2013)	594.65	
Electricity Discount 5% (22/11/2012 to 22/02/2013)	–29.73 Cr	
Subtotal of Charges before GST	564.92	
Total GST Payable 10%	56.49	
Total Charges including GST		621.41
Total Amount Payable		**$621.41**

AVERAGE DAILY USAGE



Consider reducing your environmental impact. Greenhouse gas released to produce your electricity this period = 1973.1 kg of CO_2

Energy Used & Costs

METER ID	THIS READING	– LAST READING	= ENERGY USED	x RATE	= COST
Peak Energy Rate — Contract (22/11/12 — 22/02/13)					
EDX009745/001	649.9	0.0	649.9 kWh	47.7700c	$310.44
Shoulder Energy Charge — Contract (22/11/12 — 22/02/13)					
EDX009745/002	940.8	0.0	940.8 kWh	19.4000c	$182.52
Off-Peak (Night Rate) Energy Rate — Contract (22/11/12 — 22/02/13)					
EDX009745/003	270.7	0.0	270.7 kWh	11.9000c	$32.22
Electricity Service Availability Charge		93 days		74.7000c/Day	$69.47
Total Electricity Before GST			**1861.4 kWh**		**$594.65**

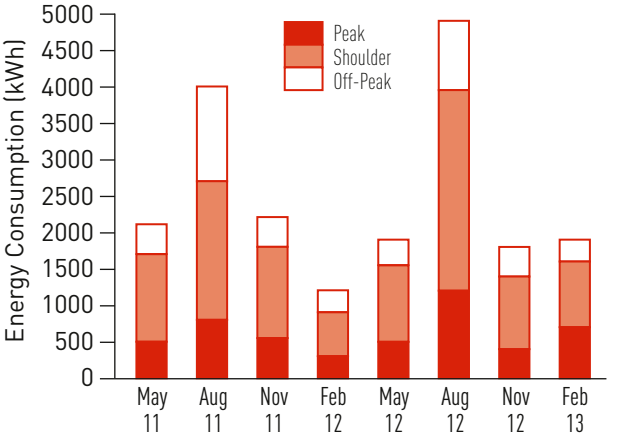
PowerSmart Home Electricity Usage Summary

Supply Period:
22 November 2012 to 22 February 2013 — 93 days

USAGE BREAKDOWN

Peak	650 kWh	34.91%
Shoulder	941 kWh	50.54%
Off-Peak	271 kWh	14.54%
TOTAL ENERGY	**1,861 kWh**	

ELECTRICITY USAGE COMPARISON



FOCUS STUDY

e **i** What is the peak energy rate per kilowatt-hour?
ii What is the difference between the peak and off-peak rates per kilowatt-hour?
f **i** What is the total energy usage charge for this quarter?
ii What is the total cost (availability and usage) for this quarter, after GST?
iii What is the average daily cost?
g Assuming the same fixed and usage charges, was this bill smaller or larger than:
i the last bill?
ii the bill for the same period last year?

Consider the bill for the same period last year.

h **i** What was the average daily usage?
ii Calculate the total amount of electricity used for this period.
i If the total electricity usage (calculated in part **h ii**) is broken down in the same proportion as the current bill, what would have been the amount of electricity used in these periods?
i peak **ii** shoulder **iii** off-peak
j Using your answer for part **i**, calculate:
i the energy usage charge for the period (assume the same rates as the current bill)
ii the service availability charge (assume the same daily rate as this bill)
iii the total of the usage and availability charges for this period
iv the total charges after the discount is applied and the GST added.
k Consider the electricity usage comparison. In which month was the:
i most energy consumed?
ii least shoulder rate energy used?
iii most off-peak rate energy used?

INVESTIGATION 14.5

WORKED EXAMPLE 1

An alternative unit for energy is the watt-hour. One watt-hour is the amount of energy used by a 1 watt load for 1 hour. A more satisfactory unit to measure the amount of energy a household uses is the **kilowatt-hour** (kWh or kW·h).

1 kWh is the energy used by a 1 kW appliance operating for 1 hour.

Hence: Energy (kWh) = power (kW) × time (h)

Calculate the cost of running a 300 W television set for 6 hours if the domestic rate is 47.77 cents/kWh.

Solve	Think	Apply
Energy used $= 0.3 \times 6$ $= 1.8$ kWh Cost $= 1.8 \times 0.4777$ $= \$0.86$	300 W = 0.3 kW 47.77 cents = \$0.4777	Use Energy (kWh) = Power (kW) × time (h) and Cost = energy used (kWh) × rate (\$/kWh)

2 Calculate the cost of running each of the following appliances.
a An 8000 watt electric oven is used for 3 hours. The domestic rate is 47.77c /kWh.
b A 1500 watt hair dryer is used for 10 minutes every day for 30 days. The rate is 19.4 cents/kWh.
c A 1200 watt iron is used for 2 hours per day for 5 days. The rate is 12.6 cents/kWh.
d A 100 watt light bulb is left on for 5 hours per day for a year. The rate is 36.58 c/kWh.

3 **a** Calculate the cost of running a 1400 watt pool filter for 2 hours per day for a year if the peak rate is 47.77 c/kWh.

b How much could be saved by programming the filter to come on in the off-peak period of the day when the cost is 19.4 c/kWh?

INVESTIGATION 14.6

4 What is the difference in the annual running costs for each of these two models of dishwasher, given that the energy rate is 39.65 c/kWh.

a Gold DL10: energy consumption of 230 kWh/year
Gold DL20: energy consumption of 275 kWh/year

b Speedy G123: energy consumption of 231 kWh/year
Speedy G456: energy consumption of 324 kWh/year

5 What is the difference in the annual running costs for the following models of television sets, given that the energy rate is 42.84 c/kWh.

a Sonic LED 138.8 cm screen: energy consumption of 261 kWh/year
Sonic LED 98 cm screen: energy consumption of 141 kWh/year

b Yanso LCD 66 cm screen: energy consumption of 241 kWh/year
Yanso LCD 100 cm screen: energy consumption of 561 kWh/year

6 Many appliances consume electricity even when they are not operating. This is generally referred to as stand-by power consumption. The table shows the average stand-by power consumption for some common household appliances.

i Calculate the annual energy consumption for each appliance in kilowatt-hours if they are left on stand-by for 24 hours a day for a year.

ii Hence determine the annual cost of stand-by energy used for each, if the cost of electricity is 26 c/kWh.

	Appliance	Stand-by power (W)
a	Cordless phone	3
b	Television	10
c	Computer monitor	5
d	Clock radio	4
e	Personal computer	2

Use this table of units to answer questions **7** to **10**.

Metric units

Multiple	Name	Symbol
10^{-3}	milliwatt	mW
10^{0}	watt	W
10^{3}	kilowatt	kW
10^{6}	megawatt	MW
10^{9}	gigawatt	GW

7 A new mobile phone charger has stand-by power of 96 mW.

a Express this in kilowatts, using scientific notation.

b What is the energy consumption in kilowatt-hours if the charger is left on stand-by for a week?

8 NSW has an electricity generation capacity of approximately 18 000 MW of power. Convert this to:

a kW **b** GW

INVESTIGATION 14.7

FOCUS STUDY

9 The Capital Wind farm at Tarago, NSW, has an electricity generation capacity of 1.41×10^8 W. Convert this to:

a GW **b** MW **c** kW **d** mW

10 The Murray Power Station in the Snowy Mountains has a generation capacity of 1500 MW of hydroelectricity. Convert this to:

a W **b** kW **c** GW

11 Use the graph of household electricity prices in Australia and projections compared to other major economies at average 2011 exchange rates to answer these questions.

a In 2011/12 for which country was the average price:

i highest? **ii** lowest?

b What is the projected percentage increase in price for Australia from 2011/12 to 2013/14?

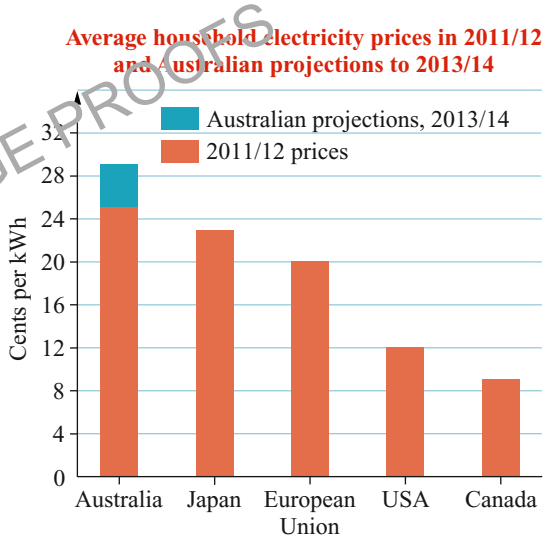
c Complete the following statements:

i The price in Australia is ___ % higher than in Japan.

ii The price in Australia is ___ % higher than in the European Union countries.

iii The price in Australia is ___ % higher than in the USA.

iv The price in Australia is ___ % higher than in Canada.



12 Use the graph of the household electricity price index for 2002 to 2011 to answer the following questions.

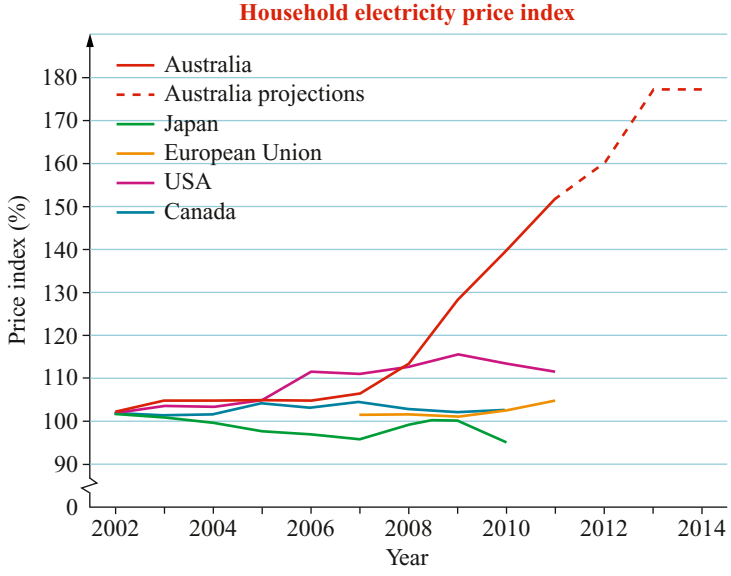
a In which countries has the price of household electricity been relatively stable over this time period?

b Describe the trend in prices in Australia.

c **i** What was the percentage increase in Australian household electricity prices from 2007 to 2011?

ii What is the projected increase in price from 2011 to 2014?

d In which countries was there a decrease in price over the period shown?



FOCUS STUDY

13 The table shows the approximate electricity consumption for the top 15 users in the world in 2012. The population of each of these countries is also shown.

Country	Electricity consumption (kWh $\times 10^9$)	Population $\times 10^6$	Electricity consumption per capita (kWh/person, to nearest 100)
Australia	225	22	
Brazil	456	193	
Canada	550	34	
China	4690	1340	
France	461	65	
Germany	545	82	
India	601	1185	
Italy	310	60	
Japan	860	127	
Korea, South	455	50	
Russia	858	142	
Spain	268	47	
Taiwan	221	23	
United Kingdom	345	62	
USA	3741	310	

a In which of these countries was the electricity consumption the:

i greatest **ii** least?

FOCUS STUDY

b What is Australia's rank compared with the rest of the world?

c Complete the following statements:

- **i** China's consumption is ___ kWh more than Australia's consumption.
- **ii** China's consumption is ___ times more than Australia's consumption.
- **iii** The total consumption of China and the USA is ___ (< or >) the total consumption of the next 13 biggest users.

d **i** Complete the column for Energy consumption per capita in the table above.

- **ii** Which of these countries has the highest electricity use per person?
- **iii** Which of these countries has the lowest electricity use per person?
- **iv** What is Australia's rank in consumption per person?

e **i** Does the country with the highest consumption per person have the highest population?

- **ii** Does the country with the lowest population have the lowest consumption per person?

14I The BASIX Certificate

The aim of the Building and Sustainability Index (BASIX) Certificate is to ensure the effective use of water and energy in homes across NSW by including reduction targets in these areas for all development plans.

EXERCISE 14I

Imagine that you are about to build the house with the plans shown on the next page. Carry out the following calculations and investigations in preparation for the completion of a BASIX certificate for this development proposal. Then follow the instructions below.

1 Calculate the:

a site area **b** roof area **c** floor area

d ratio of floor area for which air-conditioning applies to floor area for which air-conditioning does not apply. (You will need to decide which rooms you will have air-conditioned.)

2 Make a landscape design for the property and calculate the garden and lawn areas.

3 Assume that you will be installing a water tank and a swimming pool.

a Decide on the size of the tank and where it will be situated.

b Calculate the volume of the swimming pool you select. (Keep the design simple.)

4 What is the thickness of the internal and external walls of the house?

5 What is the width of the eaves on each side of the house?

6 Investigate and calculate the amount of roof insulation required for this house.

7 Determine the orientation of the windows.

8 Determine the breeze path and indicate it on the plan.

Instructions

Now go to the NSW Government BASIX website, *www.basix.nsw.gov.au*. Use the plans given and your answers to the questions above to complete each section of the BASIX Certificate. You will need to modify your plans along the way until you have passed.

FOCUS STUDY

Step 1: On the home page go to the login box and click on 'Register' and then 'next'. Select 'Education' as your user type and click on 'next'.

Step 2: Make up a username and password.

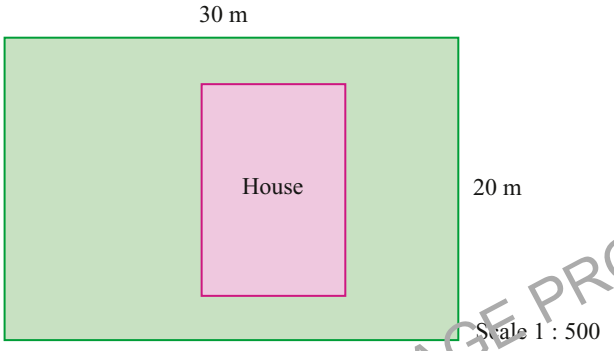
Step 3: Enter your name, school (institution) and email address. Click on 'next'. An email is then sent to you with your verification code.

Step 4: Return to the home page. In the login box enter your username and password. Tick '… terms and conditions' and enter the verification code sent to you by email. Submit.

Step 5: Select 'New Dwellings' and enter.

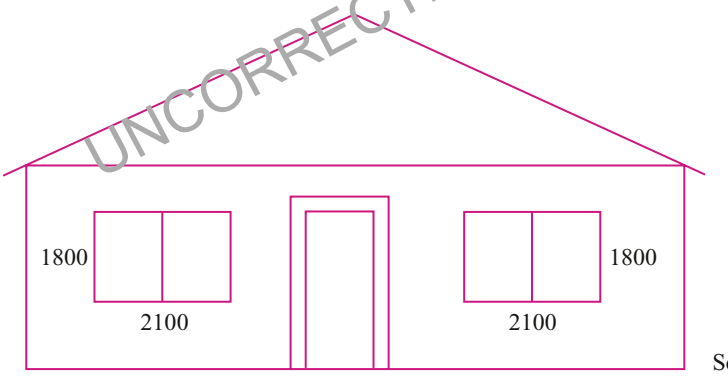
Step 6: Click on 'Start a new project'.

Sample house plans



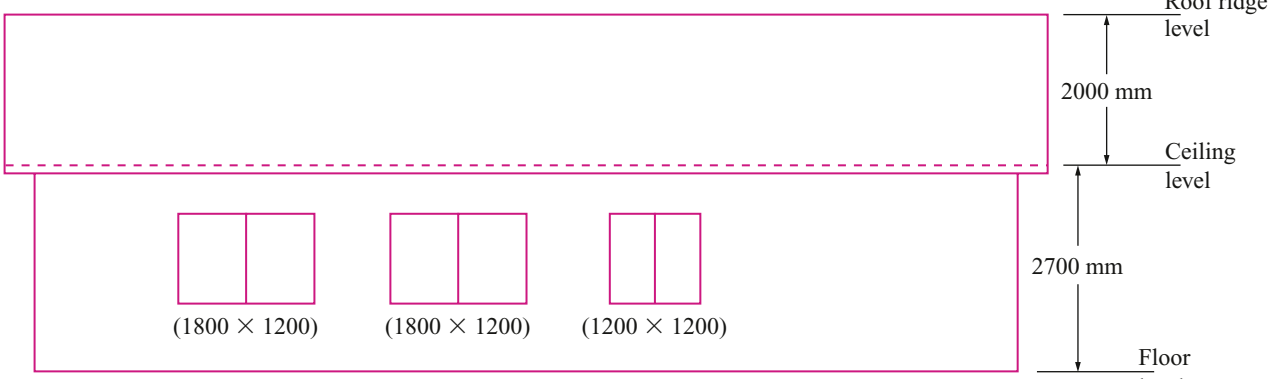
Site plan

East elevation



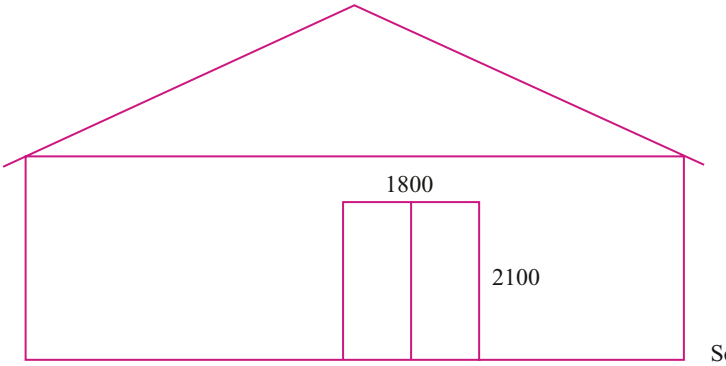
Scale 1 : 100

South elevation



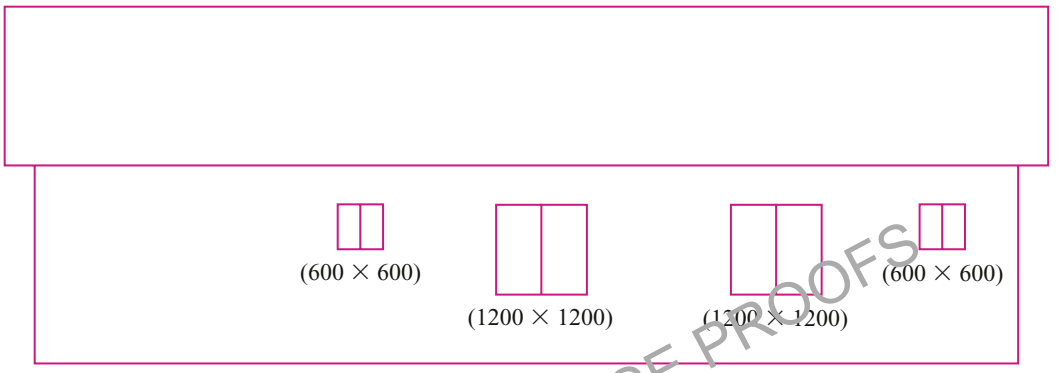
FOCUS STUDY

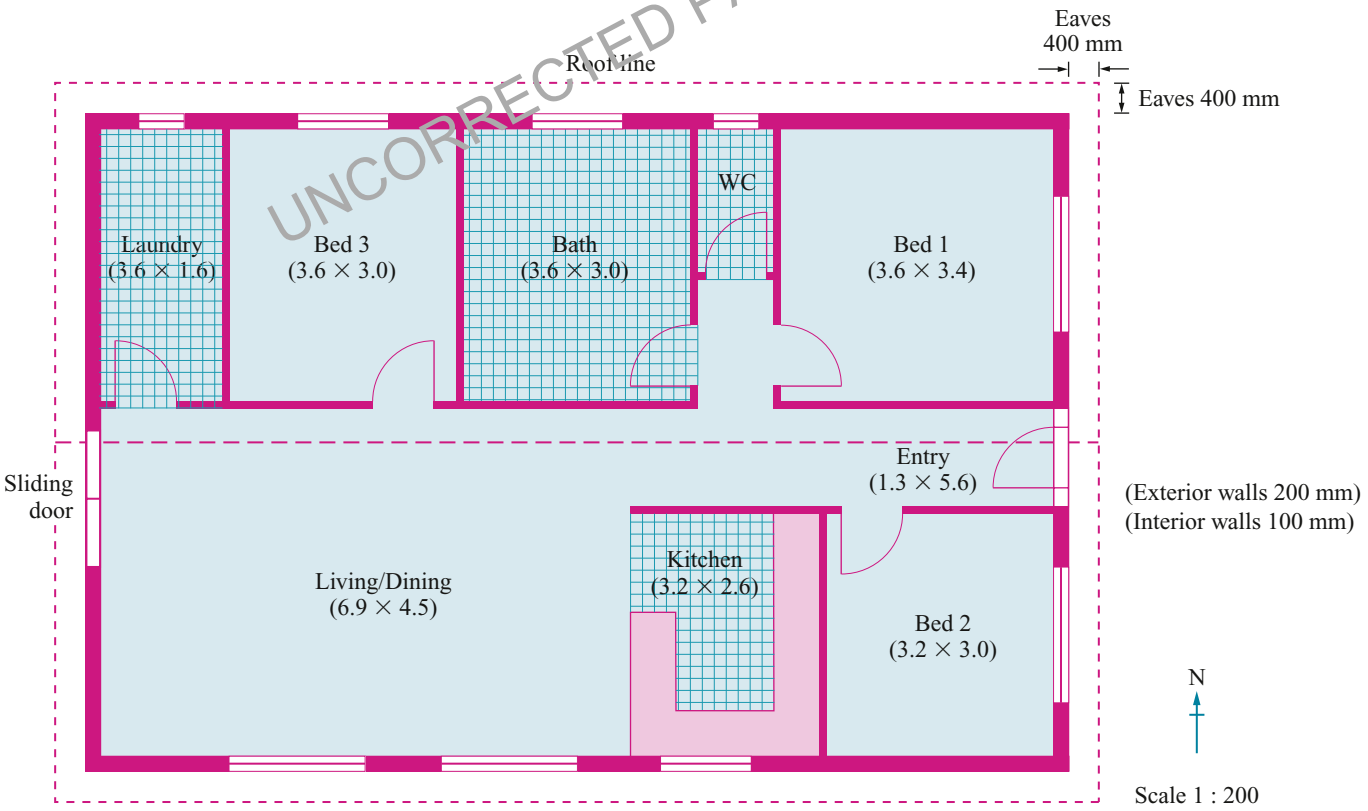
West elevation



Scale 1 : 100

North elevation





Scale 1 : 200

FOCUS STUDY

INVESTIGATION **14.1**

Water usage chart

1 Use the information in the water usage chart to complete this investigation of the amount of water used by your household over a week. (Show any calculations that you make.)

Number of people living in the house _____

In the bathroom

Shower

Average time for shower ___

Number of showers/day ___

Amount of water/day _____

Bath

Number of baths/day ___

Amount of water/day _____

Toilet

Amount of water/day _____

Hand basin (running tap for washing, shaving, brushing teeth)

Average time/day/person ___

Amount of water/day _____

In the kitchen

Dishwashing by hand

Number of times/day ___

Amount of water/day _____

Dishwashing machine

Number of times/week ___

Amount of water/week _____

In the laundry

Washing machine

Number of washes/week ___

Amount of water/week _____

Hand washing

Number of times/week ___

Amount of water/week _____

Outdoors

Using a sprinkler/hose

Number of hours/week ___

Amount of water/week _____

Washing cars

Number of washes/week ___

Amount of water/week _____

Leaks (estimate if relevant)

Amount of water/week _____

Usage	Litres used
Shower	
Regular type	18 L/min
3-star rated shower head	9 L/min
Bath	
Average bath	58 L
Toilet	
11 L full flush	54 L /person/day
3-star rated dual flush	18 L/person/day
Hand basin	
Running tap	up to 18 L/min
Dishwashing	
Washing by hand	18 L
3-star rated machine	18 L/cycle
Clothes washing	
Average washing machine	99 L/load
$4\frac{1}{2}$-star rated washing machine	41 L/load
Hand washing	20 L/wash
Garden	
Filling swimming pool	up to 54 000 L
Sprinkler or hand-held hose	15 L/min
Car washing	
Hose washing	180 L/wash
Bucket washing	100 L/wash
Leaks (taps and pipes)	
Dripping taps	30–200 L/day
Leaking pipe (1.5 mm hole)	99 L/day
Leaks (from toilet cisterns)	
Slow, barely visible	9 L/day
Visible, just audible	144 L/day
Constant refilling hiss	261 L/day

Total amount of water used by your household in a year is _____.

(Use 1 year = 365 days = 52.14 weeks.)

FOCUS STUDY

2 **a** Find the water usage cost for your locality and calculate the total cost of water usage for a year.
b Calculate the average usage per person per year.
c Calculate the average cost per person per year.

3 Compare and discuss your household's water usage with that of others in your class by listing the data on the board.
a Calculate the median usage for the class.
b Is your household's usage higher or lower than the median for the class?

4 **a** How could you reduce the amount of water used in your household?
b How much per year could you save?

INVESTIGATION 14.2

The water footprint concept

Write a short report, using tables and graphs where relevant, to answer the following questions. Discuss your report with the class. The UNSW website: *National water footprints* may be helpful.

- Explain what is meant by the terms *water footprint* and *virtual water content*.
- How is the water footprint calculated?
- What are the major factors that contribute to the global water footprint?
- List examples of the virtual water content of some common items (for example a slice of bread, a cotton T-shirt, a hamburger, etc.)
- Which countries have the largest water footprint:
  a per year? **b** per person per year?
- How does Australia's water footprint compare with that of other countries?
- How can a country reduce its water footprint?

INVESTIGATION 14.3

International weather

Go to *www.worldweatheronline.com* to find weather summaries for other cities of the world.
Investigate and compare Australia's weather with weather in other parts of the world.

INVESTIGATION 14.4

Distance and area

To calculate the distance between two points on a section of land using online tools, go to *www.freemaptools.com*.

1 Use the 'Measure Distance' tool to find the distance between:
- Sydney and London
- Sydney(CBD) and Penrith
- Sydney and Canberra
- the ends of the street/road in which you live.

Try some of your own examples.

2 Use the 'Area Calculator' to estimate the area of:
- NSW
- your school grounds.

Try some of your own examples.

Or you could use the appropriate tools in Google Earth to determine selected distances.

INVESTIGATION 14.5

Power rating

Power is the rate at which energy is used; that is, power $= \frac{\text{energy}}{\text{time}}$.

The SI unit for power is the watt (W), which is defined as follows:

1 watt = 1 joule/second where the amount of energy is measured in joules (J)

Thus 1 kilowatt (kW) = 1000 W = 1000 J/s

Rank the rate of energy consumption (power rating) of the following common appliances and physical activities:

- an electric kettle
- an incandescent light bulb
- an electric room heater
- a car engine
- fast running
- playing tennis
- doing aerobics
- swimming or cycling

Hint: The power ratings of electrical appliances can be found directly from the appliance or from tables. For the physical activities, convert the rate of energy use to joules/second (watts).

INVESTIGATION 14.6

Energy rating labels

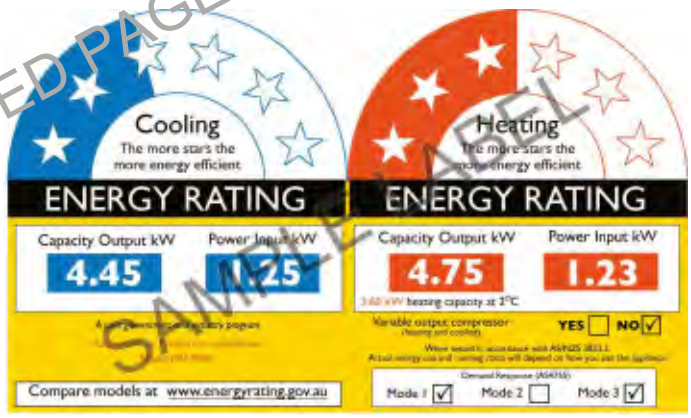
Go to the government website *www.energyrating.gov.au* to find the answers to these questions.

1 What are the two main features of the energy rating label?

2 How is the star rating determined?

3 What is the approximate difference in energy consumption between 2-star and 3-star rated appliances?

4 What other factors should be considered when buying an appliance?



INVESTIGATION 14.7

The price of household electricity in Australia

1 Investigate the price of electricity in the various states and territories of Australia.
   a Compare the cheapest and most expensive plans.
   b What proportion of people switch plans each year?
   c How much has the price increased over the last 1, 2 and 5 years?

2 Write a short report and discuss it with your class.

FOCUS STUDY

REVIEW 14 MATHEMATICS AND RESOURCES

Language and terminology

Here is a list of terms used in this chapter. Explain each term in a sentence.

catchment area, energy, fixed charges, grid-square method, joule, kilowatt, kilowatt-hour, off-peak rate, peak rate, plan-view area, polygon method, power, radial survey, stand-by power, traverse survey, usage charges, water-efficient targets, water footprint, watt

Having completed this chapter you should be able to:

- interpret information about a household water bill
- interpret data on household and personal water usage
- construct and interpret rainfall graphs
- calculate the probability of rainfall in a locality
- interpret data and calculate statistics on water availability and usage
- calculate the volume of water held by tanks of various shapes and sizes
- calculate the volume of water that can be collected from a roof
- calculate the scale used on a photograph, given that it contains a feature with a known dimension
- calculate the perimeter and area of a section of land using a scale diagram
- use online tools to calculate the distance between two points on a section of land
- estimate the area of land using the grid-square method or the polygon method
- calculate the volume of rainfall using $V = Ah$
- estimate volumes using Simpson's rule
- interpret information about a household electricity bill
- rank common appliances and physical activities in terms of their energy consumption
- calculate the cost of operating household appliances
- calculate and interpret statistics for electricity costs, production and consumption
- identify the issues and make calculations for the issues addressed in the BASIX.

14 REVIEW TEST

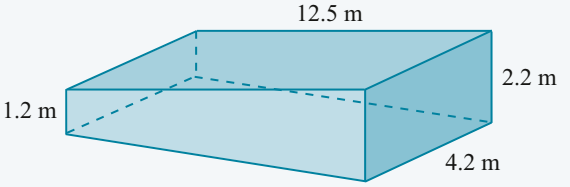
1 In Bangarra shire, the water usage charge for non-residential properties is \$1.76/kL for the first 250 kL and \$2.02/kL for any consumption over 250 kL. The water connection fees are \$89 for a 20 mm meter connection and \$138 for a 25 mm connection. A non-residential property has one 20 mm and one 25 mm meter connection. If the amount of water consumed is 490 kL, the total annual cost is:

A \$924.80 **B** \$1089.40 **C** \$1151.80 **D** \$1216.80

2 A front-loading washing machine uses 90 L per wash. A family uses the washing machine 5 times a week. Given that water costs \$2.26/kL, the annual water usage charge for this machine is (use 1 year = 52 weeks):

A \$1.02 **B** \$10.58 **C** \$52.88 **D** \$528.84

Use this diagram to answer questions **3** and **4**.



3 The volume of the swimming pool shown in the diagram is:

A 69.3 m^3 **B** 89.25 m^3

C 115.5 m^3 **D** 178.5 m^3

4 If the water usage charge is \$2.34/kL, the cost to fill this pool is:

A 162.16 **B** \$208.85 **C** \$270.27 **D** \$417.69

5 The table gives the mean number of days of rain for each month of the year for Sydney (for all years of record).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Number rainy days	12.2	12.5	13.6	12.8	13.1	12.5	11.2	10.4	10.6	11.7	11.7	11.5

Using this data, the probability that it will rain on the 19 June and 20 June next year is:

A $\frac{2}{25}$ **B** $\frac{4}{625}$ **C** $\frac{5}{12}$ **D** $\frac{25}{144}$

6 The Hunter River catchment area is approximately 21 500 km^2. If an average of 6 mm of rain falls over this area and 85% runs into its dams, the increase in the volume of these dams will be:

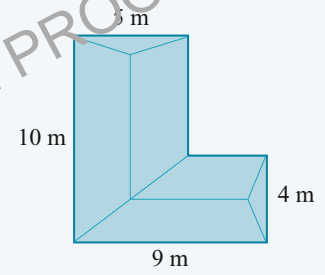
A 1.0965×10^8 m^3 **B** 1.0965×10^2 m^3

C 1.0965×10^7 m^3 **D** 1.935×10^7 m^3

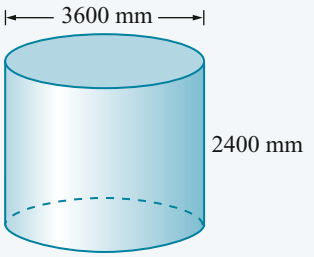
7 The amount of water that could be collected from this roof when 7 mm of rain falls on it, allowing 10% for wastage, is:

A 0.4158 L **B** 415.8 L

C 0.462 L **D** 462 L



Use this diagram to answer questions **8** and **9**.



8 The capacity of the tank is:

A 12200 L **B** 24400 L

C 44000 L **D** 97700 L

9 If 760 L of rain water is collected in this tank, the rise in the water level will be approximately:

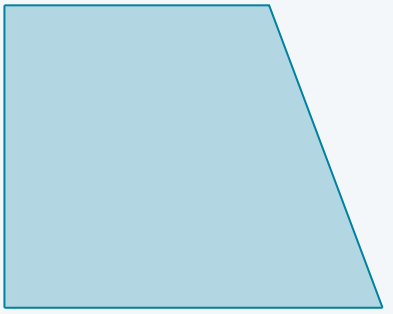
A 235 mm **B** 134 mm

C 75 mm **D** 42 mm

10 Using measurement and the scale given, the perimeter of this site plan is approximately:

A 134.4 m **B** 168 m

C 1344 m **D** 1360 m



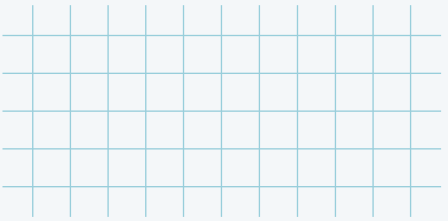
Scale 1 : 800

FOCUS STUDY

11 The diagram shows part of a 5 mm by 5 mm grid. The real area of each grid square is:

A 25 m^2 **B** 36 m^2

C 60 m^2 **D** 3600 m^2



Scale 1 : 12 000

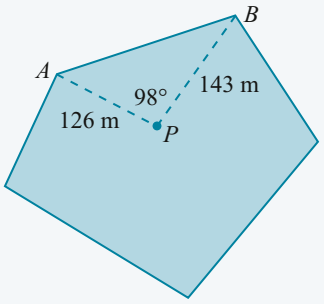
12 The area of triangle *PAB* in the diagram is:

A $\frac{1}{2} \times 126 \times 143$

B $\frac{1}{2} \times 126 \times 143 \times \cos 98°$

C $\frac{1}{2} \times 126 \times 143 \times \sin 98°$

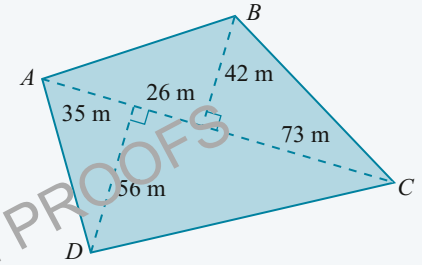
D $\frac{1}{2} \times 126 \times 143 \times \tan 98°$



13 The area of *ABCD* is:

A 4053 m^2 **B** 13132 m^2

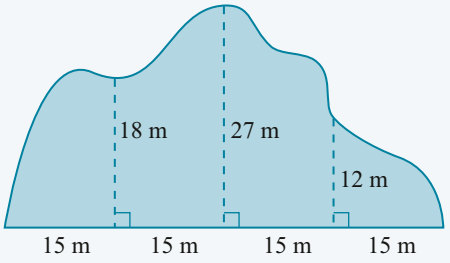
C 6566 m^2 **D** 4305 m^2



14 Using two applications of Simpson's rule, the area in the diagram is approximately:

A 420 m^2 **B** 540 m^2

C 870 m^2 **D** 1080 m^2



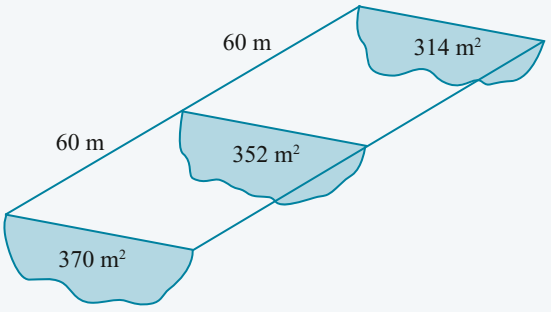
15 Using Simpson's rule, the volume of this reservoir is approximately:

A $\frac{120}{3}(370 + 352 + 314)$

B $\frac{60}{3}(370 + 352 + 314)$

C $\frac{60}{3}(370 + 4 \times 352 + 314)$

D $\frac{60}{2}(370 + 4 \times 352 + 314)$



16 Given that the cost of electricity is 52.68 c/kWh, the cost of running a 2200 W electric heater for 5 hours a day for 70 days is:

A \$81.13 **B** \$579.49 **C** \$162.26 **D** \$405.64

17 A wind farm generates 2400 megawatts of power. This is equivalent to:

A 2.4 gigawatts **B** 2.4 kilowatts

C 240 gigawatts **D** 240 kilowatts

If you have any difficulty with these questions, refer to the examples and questions in the sections listed in the table.

Question	1–5	6–9	10	11	12, 13	14	15	16, 17
Section	A	B	C	D	E	F	G	H

14A REVIEW SET

1 The charges for water access and supply of water by Kempsey Shire Council in 2012 are given below. Calculate the annual cost of water to a residential property that has a 25 mm connection and uses 315 kL of water.

Meter connection

For 20 mm: charge is $235

For 25 mm: charge is $367

Water supply usage charges

For 0–250 kL: charge is $1.67/kL

Each kL > 250 kL: charge is $2.35/kL

2 **a** A 2-star washing machine uses 99 L of water per load. Calculate the cost of using the machine three times a week for a year (52 weeks) if the cost of water is $2.08/kL.

b A 3-star washing machine is 20% more efficient. Calculate the savings each year if the 2-star machine is replaced by the 3-star machine.

3 The table shows the average monthly rainfall (mm) for Wagga Wagga and Grafton, in NSW.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wagga Wagga	42	39	41	46	55	49	60	54	54	61	43	41
Grafton	138	134	121	81	71	73	53	39	44	63	80	101

a Draw a side-by-side column graph to display this information.

b Draw a box-and-whisker plot for each city on the one set of axes.

c Compare the rainfall in each city. Write a short report.

4 The table shows the mean number of rainy days each month for a year in Wagga Wagga.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Number rainy days	5	5	5	6	9	10	11	12	10	9	7	6

a What is the probability that next year in Wagga Wagga it will rain on:

i 1 April? **ii** 1 April and 2 April?

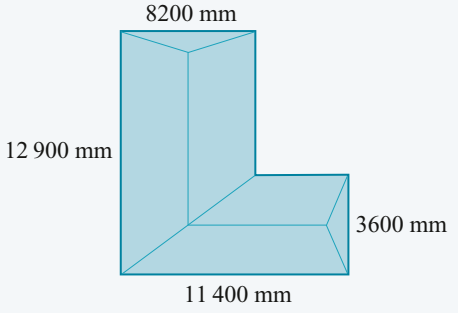
b For which season of the year was the number of rainy days:

i the most? **ii** the least?

5 **a** Calculate the plan-view area of the roof of this house.

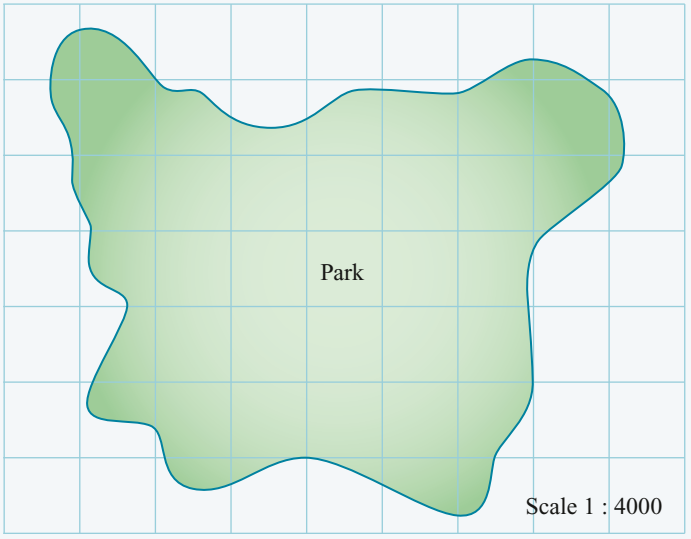
b How much water could be collected from this roof when 5 mm of rain falls on it, allowing 10% for wastage?

c The water is collected in a round tank of diameter 1300 mm. By how much would the water level in the tank rise?



FOCUS STUDY

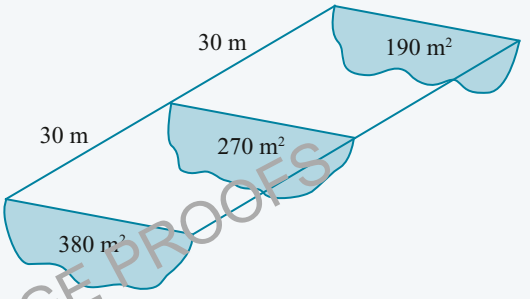
Use this diagram of a park to answer questions **6** and **7**.



6 Use the grid-square method, with 1 cm by 1 cm squares, to estimate the area of the park.

7 Estimate the area of the park using a radial survey.

8 Use Simpson's rule to estimate the volume of the reservoir shown.



9 Calculate the cost of running a 350 watt television set for 8 hours when the cost of electricity is 47.77 c/kWh.

10 Convert 3.2 MW into kW.

14B REVIEW SET

1 For non-residential properties in Shoalhaven, the water usage charge is \$1.55 per kL. The water availability charge is based on the size (diameter) of the water meter service connection(s), as shown below. If you have more than one connection you must pay for each one.

Meter connection

For 20 mm: charge is \$81

For 40 mm: charge is \$324

a What would be the water availability charge for a non-residential property that is supplied by:

i one 40 mm connection? **ii** two 20 mm connections?

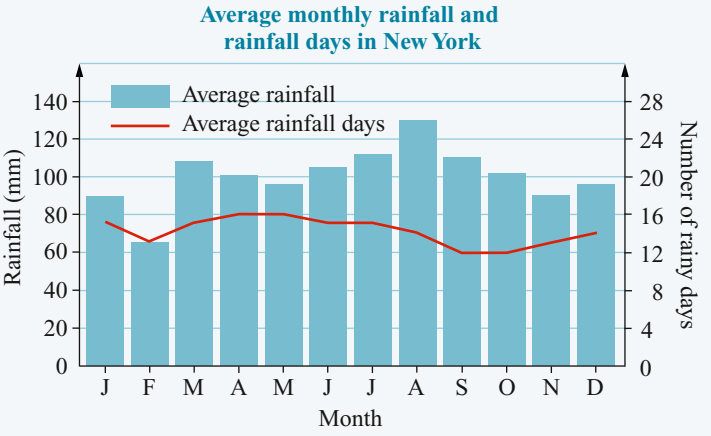
b Explain why the answers to part **a i** and **ii** are not the same.

2 Bill washes his car every fortnight. Washing by hose uses 180 L/wash and washing by bucket uses 100 L/wash.

a How much does it cost each year if he uses a hose and water costs \$2.18/kL?

b How much would he save each year if he used a bucket instead of a hose?

3 The graph shows the average rainfall for each month in New York (mm) and the average number of days of rain for each month.



a Does New York have more rain in summer or winter?

b Which month is the:

i wettest? **ii** driest?

c Find the mean and standard deviation of the:

i average monthly rainfalls

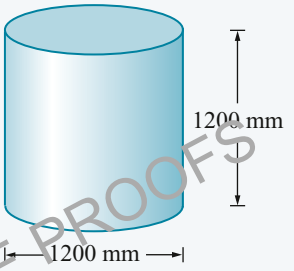
ii average number of rainy days each month.

d Comment on the pattern of rainfall in New York.

e Find the probability that it will rain next year on:

i 5 August **ii** 5 January.

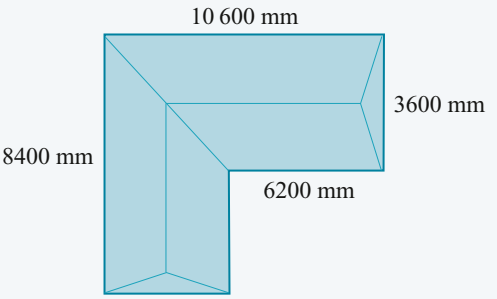
4 Calculate the capacity of the water tank on the right.



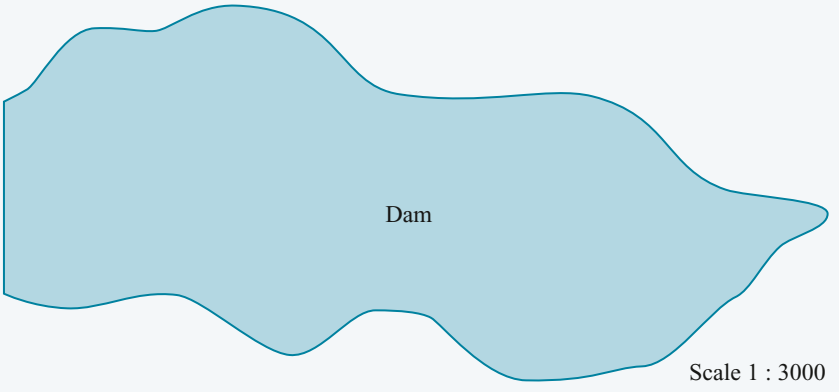
5 **a** Calculate the plan-view area of the roof of this house.

b How much water could be collected from this roof if 3 mm of rain were to fall on it, allowing 15% for wastage?

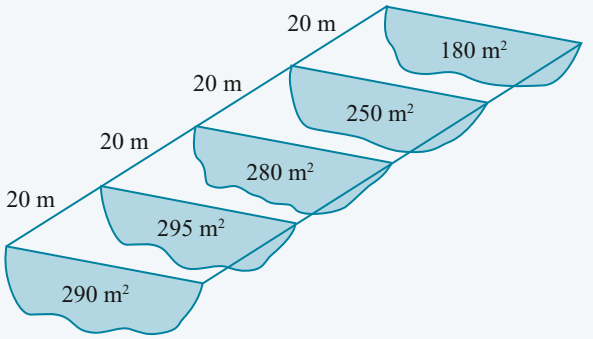
c The water is collected in a round tank of diameter 900 mm. By how much would the water level in the tank rise?



6 Use the polygon method (offset survey) to estimate the surface area of the dam shown.



7 Use two applications of Simpson' rule to estimate the volume of the dam shown.



8 Calculate the cost of running a 175 watt ceiling fan for 4 hours a day for 60 days when the cost of electricity is 54.6c/kWh.

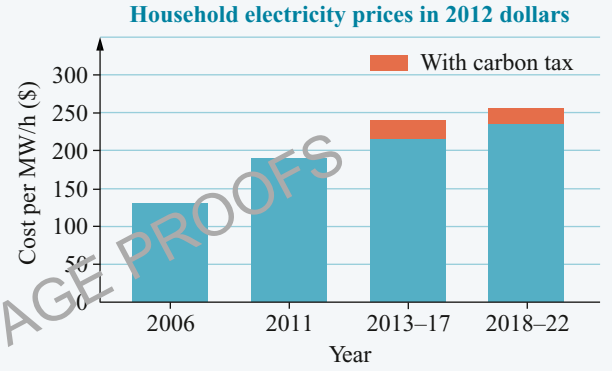
9 Convert 6.1 GW into:

a kW **ii** MW

10 The graph shows predicted household electricity prices.

a What was the percentage increase in price from 2006 to 2011?

b What percentage does the carbon tax contribute to the price of electricity in 2013?



14C REVIEW SET

1 Use the water bill on page 431 in Section 14A to answer the following questions.

a By how much did the daily consumption for this bill exceed the local area average?

b **i** How many days were in the billing period?

ii By how much did the total consumption on this bill exceed the local area average?

c Given that water costs $2.31/kL, how much more than the local average did this consumer pay?

2 The table shows mean rainfall data for Moree, NSW.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	77	69	47	37	46	27	46	37	32	45	57	64
Number rainy days	8	6	5	5	6	6	7	6	6	7	7	8

a Construct a rainfall graph.

b Draw a box-and-whisker plot for the rainfall data.

c Calculate the mean and standard deviation for the number of rainy days.

d Comment on the yearly weather pattern in Moree.

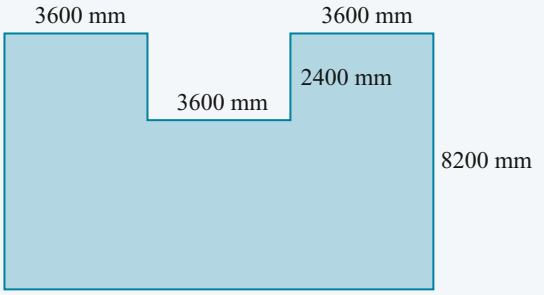
e What is the probability that it will rain on 5 September next year?

f What is the probability that it will rain on two consecutive days in September?

3 **a** Calculate the plan-view area of the roof of this house.

b How much water could be collected from this roof if 6 mm of rain were to fall on it, allowing 15% for wastage?

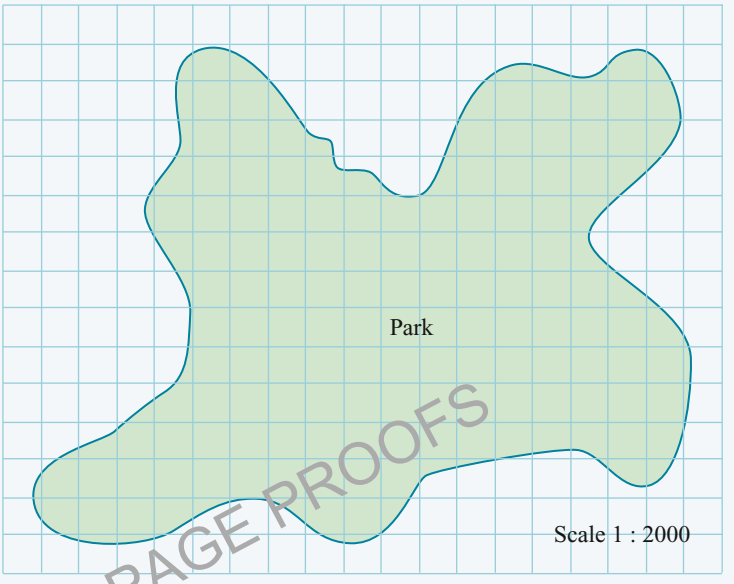
c The water is collected in a round tank of diameter 1100 mm. By how much would the water level in the tank rise?



Use this diagram to answer questions **4** and **5**.

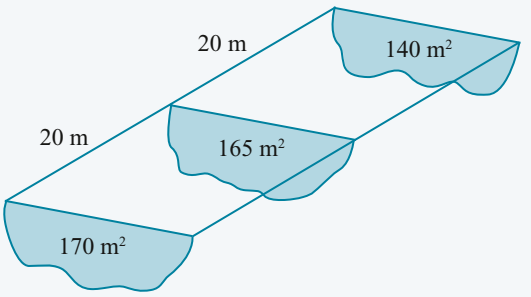
4 Use the grid-square method, with 5 mm by 5 mm squares, to estimate the area of land shown.

5 Estimate the area using the polygon method (radial survey).



6 A small farm dam has a surface area of approximately 290 m^2. If the average depth of the dam is 2.2 m, calculate the volume of water in the dam.

7 Use Simpson's rule to estimate the volume of this reservoir.



8 **a** Complete the table to find the total usage charges for this electricity bill.

	Energy used (kWh)	Rate ($/kWh)	Cost ($)
Peak	583.6	0.5144	
Flexi	892.8	0.2136	
Off-peak	291.7	0.139	
		Total	

b The service availability charge is 78.67 c/day. If the billing period was 91 days, calculate the total availability charge for this bill.

c Find the total amount payable for this bill if a 5.5% discount is applied and then GST added.

d Would it make any difference to the amount paid if the discount is applied after the GST is added?

FOCUS STUDY

9 **a** A computer monitor has a stand-by power usage of 4 watts. Calculate the annual energy consumption in kilowatt-hours if it is left on stand-by for 20 hours a day for a year.

b Hence determine the cost of stand-by energy used, when the cost of electricity is 26.9 c/kWh.

10 A wind farm has an electricity generation capacity of 1.28×10^8 watts. Convert this to:

a gigawatts **b** megawatts **c** kilowatts **d** milliwatts.

14D REVIEW SET

1 The average rate of flow of a bathroom shower with a normal shower rose is 18 L/minute.

a Nora has two 10 minute showers each day. Calculate the annual cost of Nora's showers given the water usage charge is \$2.17/kL. (Use 1 year = 365 days)

b How much could Nora save each year by using a water-efficient shower rose that only uses 8.5 L/minute?

2 Use the water-efficiency targets in the table below to find the ideal daily water consumption for these households.

a a large property with 6 people

b a small property with 4 people

c a 650 m^2 property with 3 people

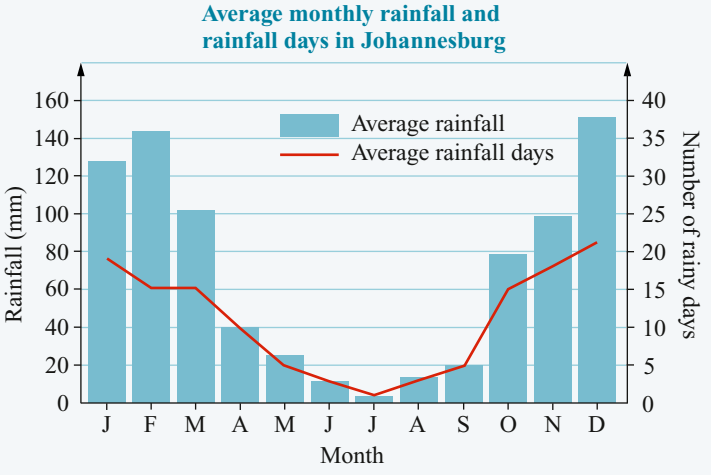
d a 19 m by 40 m property with 5 people

Targets for water-efficient households

People per household	Property size		
	Small	Medium	Large
1 person	247 L/day	249 L/day	267 L/day
2 people	367 L/day	375 L/day	396 L/day
3 people	463 L/day	477 L/day	498 L/day
4 people	546 L/day	565 L/day	587 L/day
5 people	621 L/day	645 L/day	666 L/day
6 people	689 L/day	718 L/day	739 L/day

Note:
A small property has an area of <500 m^2.
A medium property has an area between 501 m^2 and 700 m^2.
A large property has an area between 701 m^2 and 900 m^2.

3 The graph shows the average rainfall for each month in Johannesburg and the average number of days of rain for each month.



a Does Johannesburg have more rain in summer or winter?

b Which month is the:

i wettest? **ii** driest?

c Find the mean and standard deviation of the:

i average monthly rainfall

ii average number of rainy days each month.

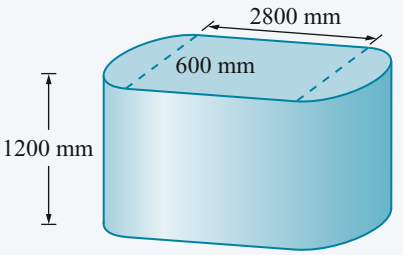
d Comment on the pattern of rainfall.

e Find the probability that it will rain next year on:

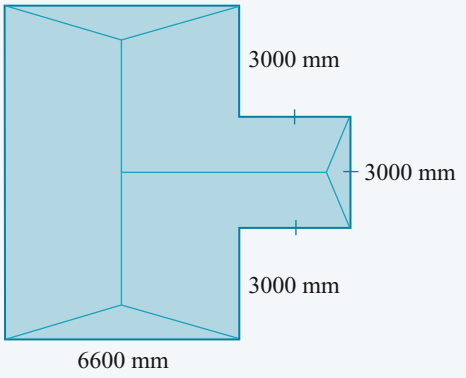
i 5 August **ii** 5 January.

f What is the probability that it will rain on two consecutive days in June next year?

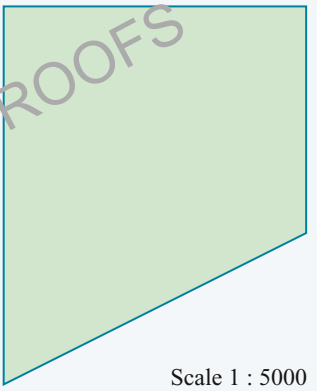
4 Calculate the capacity of the water tank shown.



5 **a** Calculate the plan-view area of the roof of this house.
b How much water could be collected from this roof if 4 mm of rain were to fall on it, allowing 12% for wastage?
c The water is collected in a round tank of diameter 1500 mm. By how much would the water level in the tank rise?



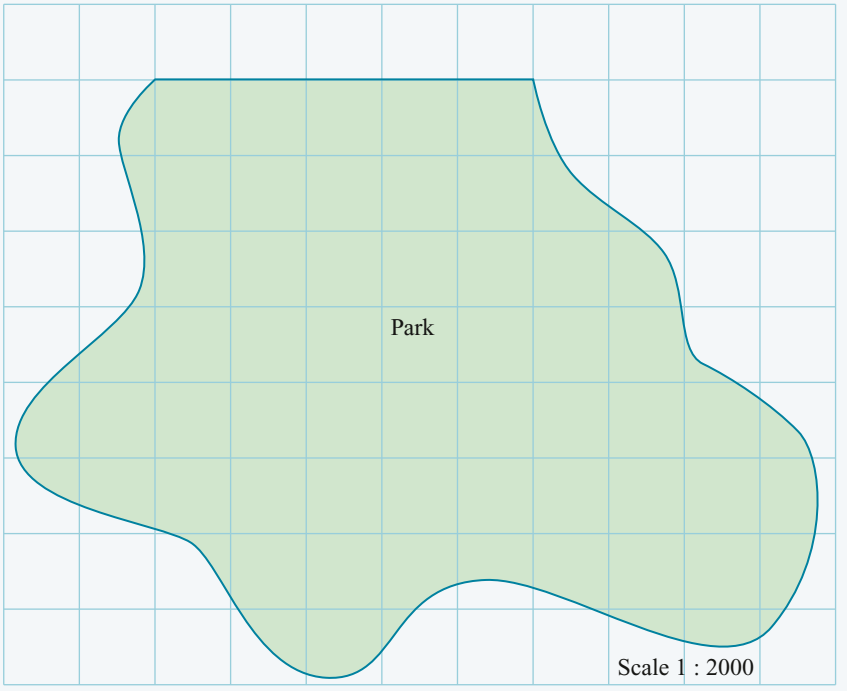
6 **a** Find the actual perimeter and area of the section of farmland shown in the scale diagram.
b If 2 mm of rain falls on this land and 85% of it flows into a dam, by how much will the capacity of the dam be increased?



Use this diagram to answer questions **7** and **8**.

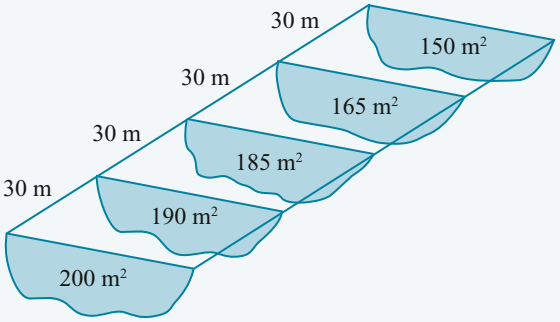
7 Use the grid-square method, with 1 cm by 1 cm squares, to estimate the area of the park shown.

8 Estimate the area of the park in question **7** using the polygon method (traverse survey).



FOCUS STUDY

9 Use two applications of Simpson's rule to estimate the volume of the reservoir shown.



10 Calculate the annual cost of running the average Sydney home, which uses 21 kWh of energy each day, given that the cost of electricity is 47.77 c/kWh.

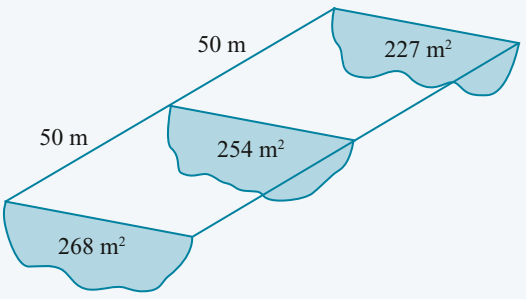
14 EXAMINATION QUESTION (15 MARKS)

a The charges for water access and supply by a shire council in 2013 are given in the table below.

Meter connection	Charge ($)
20 mm	235
25 mm	367
32 mm	602
40 mm	940
50 mm	1469
100 mm	5875

The water supply usage charges are:
Residential usage
For 0–250 kL: charge is $1.72/kL
Each kL >250 kL: charge is $2.55/kL
Non-residential usage
All consumption: charge is $1.67/kL
Calculate the total annual cost of water for a residential property that has a 40 mm connection and uses 296 kL. (2 marks)

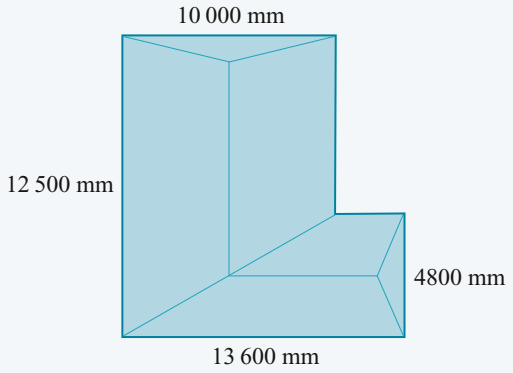
b



i Use Simpson's rule to estimate the volume of the dam shown above.
ii Express the answer in megalitres. (2 marks)

FOCUS STUDY

c **i** Calculate the plan-view area of the roof of the house shown.



ii This house is situated in Broken Hill. The average annual rainfall for Broken Hill in January is 28.6 mm. How much water could be expected to be collected from this roof next January, allowing 10% for wastage?

iii If the water is collected in a round tank of diameter 2400 mm, what would be the rise in the height of the water in the tank? (3 marks)

d **i** Calculate the amount of energy needed to run a 2200 watt heater for 4 hours a day for 90 days.

ii How much could be saved in a year by only putting the heater on for 3 hours a day, given the price of electricity is 33.6 c/kWh? (2 marks)

e The table shows the mean number of rainy days each month of the year in Taree, NSW.

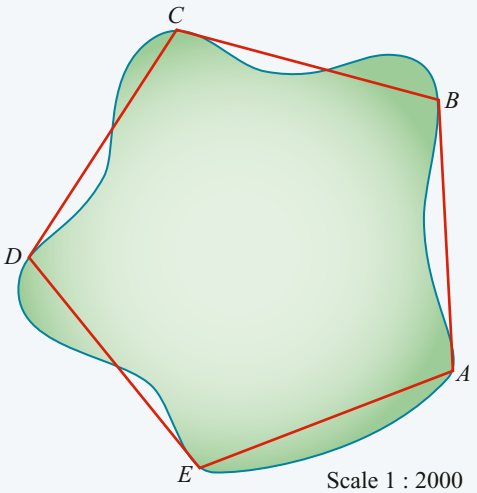
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Number rainy days	11	11	12	11	9	9	7	8	8	9	10	11

What is the probability that it will rain in Taree on:

i 1 April next year?

ii 1 April and 2 April next year? (2 marks)

f **i** Using *EB* as the baseline, estimate the area of the bushland reserve shown below using a traverse survey.



Scale 1 : 2000

ii Use one application of Simpson's rule to estimate this area. (4 marks)