6.

MANAGING A HOME

Many management and financial skills are required to run a household successfully. This chapter ties together the financial, measurement and statistical knowledge necessary to manage the utilities of water and electricity in the 21st century home. The science of nutrition and energy in food is also covered.

CHAPTER OUTLINE

IN THIS CHAPTER YOU WILL:

- interpret household water bills and calculate water usage costs
- calculate areas and volumes of water tanks and dams
- convert between watts, kilowatts, megawatts and gigawatts
- interpret household electricity bills and calculate electricity usage costs
- compare the energy consumption and running costs of household appliances
- convert between units of energy
- relate units of energy to food and nutrition
- prepare a personal budget

TERMINOLOGY

budget

discretionary spending

fixed spending

joule

kilowatt-hour (kWh)

sewerage

calorie

Energy Rating Label (ERL)

halogen light

kilojoule (kJ)

megajoule (MJ)

watt (W)

capacity

expense

incandescent light globe

kilowatt (kW)

megawatt (MW)

SkillCheck

1 a During exercise, Grace has a heart rate of 135 beats per minute. Convert this rate to beats/second.

   b How many times would Grace's heart beat in half an hour?

2 The cost of 55 L of petrol is $78.65. Express this cost as a rate in cents per litre.

3 Convert:

   a 8.4 cm to mm   **b** 9600 mm to m   **c** 36 000 mL to L

   d 2610 L to kL   **e** 5.2 m^3 to L   **f** 660 s to min.

4 The quarterly electricity bill was $423.85 before GST. Calculate the electricity bill after 10% GST is added, correct to the nearest cent.

5 How many days from 05/05/19 to 03/08/19?

6 The electricity account for the period 05/08/20 to 09/11/20 was $468.24. What was the average daily cost for the electricity usage?

7 A phone call costs 74 cents per minute.

   a Find the cost of a 7-minute call.

   b If Jessie's call cost $9.62, how long was the call?

6.01 Water usage in the home

Your home has a **water meter** that measures the amount of water used in your home. A water bill is sent to your home every quarter listing the cost of the water service and **sewerage** (which are fixed), and the cost of the water used in your home (which is variable).

EXAMPLE 1

Yitong's water bill shows the following charges:

Water service	$ 41.39
Wastewater (sewerage)	$162.88
Water usage 33.5 kL @ $2.115 per kL	A
Amount due	B

Calculate Yitong's total water usage (A) and the total amount due (B).

Solution

Total water usage $= 33.5 \times \$2.115$

$= \$70.8525$

$\approx \$70.85$

Total amount due $= \$41.39 + \$162.88 + \$70.85$

$= \$275.12$

Exercise 6.01 Water usage in the home

Example
1

1 Anil's water bill shows the following charges:

Water service	$ 41.39
Wastewater (sewerage)	$162.88
Water usage 52.1 kL @ $2.115 per kL	A
Amount due	B

a Calculate Anil's total water usage (**A**).

b Find the total amount due (**B**).

2 For the month of June, a household used 425 L of water per day. How much water did they use for the entire month? Answer in kilolitres. Select **A**, **B**, **C** or **D**.

A 11.9 kL   **B** 12.75 kL   **C** 13.175 kL   **D** 17 kL

3 Below is a water bill from Riverstone Water.

Riverstone **WATER**			General Enquiries	13 20 92
			Telephone Payments	1300 12 34 58

Last bill	Credits	Balance	This bill	Total amount due
$225.30	$225.30	$0.00	$261.45	**$261.45**

Date of issue 12 May 2018

Please pay by

02/06/18

Account number

4402 4244 418

MR WALTER TANK
3/47 LAKESIDE DRIVE
RIVERSTONE NSW 2765

Account for strata unit	**3/47 Lakeside Drive, Riverstone**

Charges	1 April 2018–30 June 2018	$
Water service		24.00
Sewerage service		118.75

Usage charge	10 Feb 2018–8 May 2018	38.07
Water	18 kilolitres at $2.115 per kilolitre	

Your average daily usage	**Total amount due**	**$180.82**

Litres (graph):
- This bill: 205
- Last bill: 386
- Same time last year: 222

1000 litres = 1 kilolitre

Water Meter Details

	Date read	Reading
This reading	8 May 2018	699 kilolitres
Last reading	10 Feb 2018	681 kilolitres

Total water used in 88 days was 18 kilolitres

a How many days are there from the bill's day of issue to the payment's due date?

b Is this bill paid monthly, two-monthly or **quarterly**?

c What are the fixed charges for, and how much are they in total?

d How many kilolitres of water were used in the period covered by this bill?

e Was more water used each day for this bill compared to the last bill? Give a possible reason for this.

f Why is it more useful to compare average daily usage with that of the same time last year?

g Verify the average daily usage of 205 L by dividing the volume of water used by the number of days covered by this bill.

h What is the cost per kilolitre for water usage?

i Verify the water usage charge of $38.07 using this rate.

j A backyard swimming pool contains 40 kL of water. Calculate the cost of filling this pool with water.

4 For the final quarter of the year (October to December), the Brentnall family used 66.24 kL of water. On average, how many litres of water did they use each day? Select **A**, **B**, **C** or **D**.

A 585   **B** 690   **C** 720   **D** 736

5 Hannah's water bill shows that water usage is charged at $2.115/kL.

   a If Hannah used 24 kL of water, how much will she need to pay?

   b Hannah paid $32.57 in water usage charges on her latest bill. Correct to one decimal place, how many kilolitres of water did she use?

   c Hannah was also charged $41.39 for the water service and $232.88 for the wastewater (sewerage) service. What was the total of Hannah's bill?

6 The Carrozza family has two adults and two teenagers. In one year, their water usage for each quarter was as shown below:

Quarter	Date	Water usage (kL)
1	1 Jan–31 Mar	51.0
2	1 Apr–30 Jun	47.3
3	1 July–30 Sept	46.5
4	1 Oct–31 Dec	54.8

   a What was the Carrozza family's total water usage for the year?

   b On average, how much did they use per quarter?

   c Calculate the average daily water use for 1 January to 31 March.

   d The Carrozza family use their dishwasher twice a day, requiring 21 L of water each time it is used. How much water did their dishwasher use over the 3rd quarter?

   e Calculate what percentage of the 3rd quarter water usage was for the dishwasher. Answer correct to one decimal place.

7 The Harris family are calculating their water usage for the quarter. This reading is 8764 kL and the previous reading was 8112 kL. What was their water usage for the quarter? Water usage is charged at $2.115/kL. Select **A**, **B**, **C** or **D**.

A $652   **B** $985   **C** $1378.98   **D** $3569.57

8 Jeremy and Annie pay a recycled water charge of $9.37 per quarter. If they also use 12 kL of recycled water at $1.93/kL and 20.2 kL of drinking water at $2.115 kL, calculate their charges for water usage for the quarter.

9 The Green family pay a recycled water charge of $11.58 per bill. On their latest bill they used 39 kL of recycled water at $1.93/kL. How much did they pay in total for recycled water charges? Select **A**, **B**, **C** or **D**.

A $66.30   **B** $77.88   **C** $86.85   **D** $385.32

10 The average daily water usage for two families, for the quarter 1 January–31 March, is:

- The Baskaran family (4 people), 560 L/day
- The Zhong family (6 people), 710 L/day

For each family, calculate:

a the water usage costs for the quarter if water costs $2.115 per kL and state which family pays more

b the average daily water use per person and state which family uses more.

DID YOU KNOW?

Water usage in the home

• Washing your hands/face	5 L
• Brushing your teeth (tap running)	5 L
• Brushing your teeth (tap not running)	1 L
• Cooking and making coffee/tea	8 L per day
• Flushing the toilet	9 L to 13 L
• Flushing the toilet (half flush)	4.5 L to 6 L
• Household tap	18 L per minute
• Washing the dishes (by hand)	18 L
• Washing the dishes (dishwasher)	25 L per cycle
• Bath use	85 L to 150 L
• Shower (8 minutes)	80 L to 120 L
• Washing machine (front loading)	120 L per cycle
• Washing machine (top loading)	180 L per cycle
• Washing the car (with hose)	100 L to 300 L
• Garden sprinkler	1 kL to 1.5 kL per hour
• Garden hose	1.8 kL per hour
• Swimming pool (backyard)	20 kL to 55 kL

On average, a four-person Sydney house (with garden) uses 936 litres of water per day. Outside taps and toilet flushing account for half of this usage.

How much water does your household use each day? Find out by investigating your water bill.

WATER USAGE IN YOUR HOME

Visit the Sydney Water and Water rating websites to find out more about water bills and the costs of water usage, including recycled water and wastewater. Also investigate water efficiency in the home.

Over a one-week period, investigate the amount and cost of water used in your home, including showering and bathing, washing clothes, watering the garden, washing a car and using the toilet.

Put a bucket in your shower to measure how much water is used per minute, and time your showers. Find the amount of water that your kitchen sink, washing machine and toilet use each time, and keep a tally of their weekly usage.

1 Draw a graph comparing the amount of water used in different areas of your home.

2 Investigate the Water Efficient Targets on the Sydney Water website and compare your household use with the daily water consumption targets. Give an explanation of your findings.

3 Find a recent water bill for your home and interpret the different costs. Can you recommend any changes to your family's usage to help save water in your home?

6.02 Water tanks and dams

Australia is the world's driest inhabited continent, with water availability affected by drought, making it a valuable resource. Rainwater is collected in water tanks and dams. The amount of rain falling in a location is measured in millimetres. For example, a rainfall of 5 mm means that the amount of water falling would fill a container to a height of 5 mm.
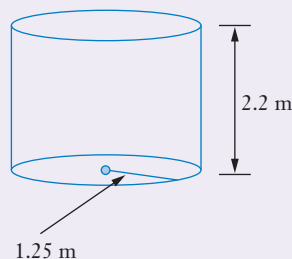
Water tanks

EXAMPLE 2

Calculate the volume of this cylindrical rainwater tank in kilolitres, correct to two decimal places.

Solution

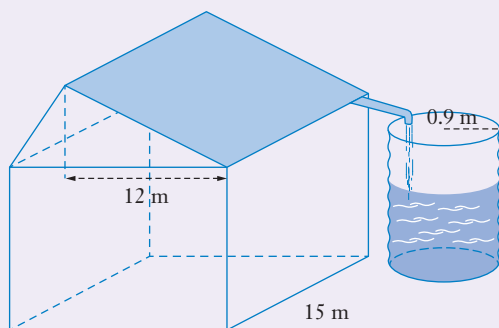radius $r = 1.25$ m, height $h = 2.2$ m

$V = \pi r^2 h$

$\quad = \pi \times 1.25^2 \times 2.2$

$\quad = 10.7992...\, m^3$

$\quad = 10.7992...\, kL$

$\quad = 10.80\, kL$

2.2 m

1.25 m

EXAMPLE 3

Rainwater falling onto the right face of the roof of a building is collected into an empty cylindrical water tank.

The top view of the right face shows the aerial dimensions of the catchment area.

a After 20 mm of rainfall, how many litres of water are drained into the tank?

b If the radius of the water tank is 0.9 m, what was the water level in the tank after 20 mm of rainfall, correct to the nearest 0.1 m?
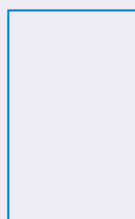
> This is the right face's 'horizontal' area as seen from above, not its actual sloped surface area.

15 m

12 m

Top view of right face

Solution

a Area of a rectangle $= 12 \times 15$

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

Volume of rainfall $= 180 \text{ m}^2 \times 20 \text{ mm}$ 　　Change 20 mm to m

$$= 180 \text{ m}^2 \times 0.02 \text{ m}$$

$$= 3.6 \text{ m}^3$$

$$= 3.6 \times 1000 \text{ L}$$ 　　$1 \text{ m}^3 = 1000 \text{ L}$

$$= 3600 \text{ L}$$

b 　Volume of a cylinder $= \pi r^2 h$

$V = 3.6 \text{ m}^3$ from part **a** and $r = 90 \text{ cm} = 0.9 \text{ m}$

$$3.6 = \pi \times 0.9^2 \times h$$

$$3.6 = 2.5446\ldots \times h$$

$$h = \frac{3.6}{2.5446\ldots}$$

$$= 1.4147\ldots$$

$$= 1.4 \text{ m}$$

The height of the water in the tank was 1.4 m.

Trapezoidal rule for estimating area

$$A \approx \frac{h}{2}(d_f + d_l)$$

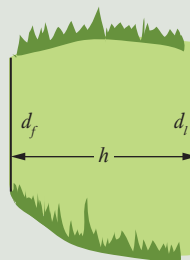where A = area

   h = distance between successive measurements

   d_f = first measurement

   d_l = last measurement

or in words:

$$\text{Area} \approx \frac{\text{width of strip}}{2}(\text{first measurement + last measurement})$$

EXAMPLE 4

The width of a dam is measured at 10-metre intervals.

a Use two applications of the trapezoidal rule to estimate the area of the dam.

b Calculate the volume of water in the dam in kilolitres if it is 1.9 metres deep.

2.3 m

4.5 m   10.6 m
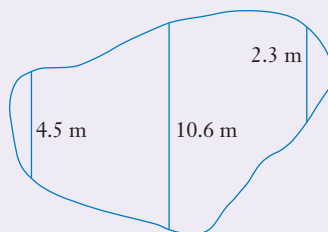
Solution

a Using the first two measurements:

$d_f = 4.5, d_l = 10.6$

$A \approx \dfrac{10}{2}(4.5 + 10.6)$

$\quad = 75.5$

Using the last two measurements:

$d_f = 10.6, d_l = 2.3$

$A \approx \dfrac{10}{2}(10.6 + 2.3)$

$\quad = 64.5$

Total area = 75.5 + 64.5

$\qquad\quad = 140 \text{ m}^2$

b $V = Ah$

$\qquad = 140 \times 1.9$

$\qquad = 266 \text{ m}^3$

$\qquad = 266 \text{ kL}$ $\qquad\qquad\qquad\qquad\qquad$ $1 \text{ m}^3 = 1 \text{ kL}$

The volume of water in the dam is 266 kL.

Exercise 6.02 Water tanks and dams

Example 2

1 Calculate the **capacity** (volume) of each tank or pool in kilolitres, correct to two decimal places.

    a   a cylindrical rainwater tank with diameter 9.36 m and height 2.18 m

    b   a rectangular swimming pool with dimensions 2.4 by 4.8 m filled to a depth of 1.2 m

    c   a semicircular pond with a radius of 1.2 m and a depth of 0.4 m

2 Bella has installed two water bladders (water storage bags) under her new house to collect rain. They are both in the shape of the rectangular prism shown.
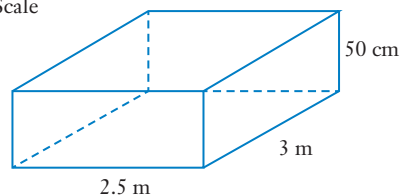
    a   Calculate the combined capacity of the water bladders, in litres.

    b   In April, Bella's family uses an average of 570 L/day. If the water bladders are full, how long will it take to use all the water in the bladders (assuming no rainfall). Answer to the nearest day.

Not to Scale

50 cm

3 m

2.5 m

Example 3

3 Rainwater falls onto the rectangular roof of a shed so that it drains into an empty cylindrical water tank of radius 60 cm and height 2.4 m.

    a   After 50 mm of rainfall, how many litres of water are drained into the tank?

    b   What is the water level after 50 mm of rainfall?

    c   How many millimetres of rain needs to fall onto the roof to completely fill the tank?

7.5 m   4.8 m
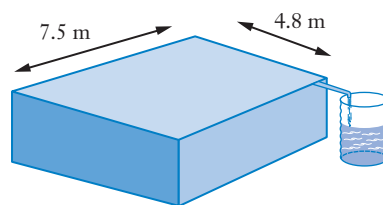
Example 4

4 The diagram shows the outline of a lake in a botanical garden.

    a   Use two applications of the trapezoidal rule to find the approximate surface area of the lake.

    b   The average water depth in the lake is 1.6 metres. How many whole litres of water can the lake hold when full?

12.3 m   10.5 m

7 m

9 m
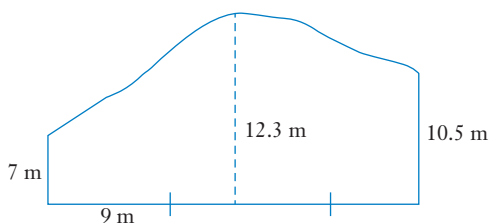
5 This table shows the monthly storage levels of Warragamba Dam in Sydney in 2016, listing the percentage of dam's capacity and the available storage in megalitres.

	Available storage (%)	Available storage (ML)
Jan 2016	94.4	1 914 444
Feb 2016	93.3	1 891 728
March 2016	90.9	1 842 528
April 2016	89.0	1 803 930
May 2016	87.2	1 768 468
June 2016	99.1	2 008 362
July 2016	100.0	2 027 000
August 2016	96.5	**A**
September 2016	97.2	1 969 816
October 2016	**B**	1 943 221
November 2016	94.6	1 918 134
December 2016	92.4	1 873 640

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a In which month was Warragamba Dam at full available storage?

b What was the level below capacity (in ML) in January 2016?

c What was the available storage (in ML) in August 2016 (**A**)?

d Calculate the available storage percentage (**B**) of Warragamba Dam in October 2016.

e How much did the storage level rise at Warragamba between May and June 2016?

f Calculate the percentage decrease in water available in Warragamba Dam from November to December 2016.

g In which month was the dam at its lowest level?

h Construct a graph of the available storage of the dam over the 12 months.

i Describe the change in the available storage over the 12 months.

6 This graph shows the available water storage for NSW from 1998 to 2016.

© State of New South Wales through WaterNSW
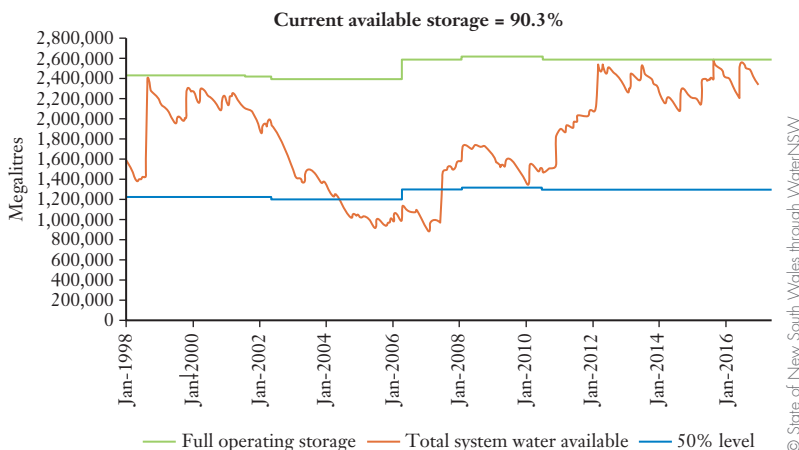
a Estimate the available water storage in January 2016.

b Write another year when the available water storage was at the same level as January 2016.

c When was the available water storage at its lowest and what was this amount?

d Why do you think the water storage was so low at this time?

e How many megalitres was 'full operating storage' in January 2016?

f How many megalitres of water was considered to be 'half full' in January 2016?

g In which years was the available water storage at 2 000 000 ML?

7 This graph shows the percentages of Australian bathrooms using water-efficient shower heads and dual-flush toilets from 2001 to 2013.

Households with water-saving products

Source: Australian Bureau of Statistics (ABS), ENVIRONMENTAL ISSUES: WATER USE AND CONSERVATION, 2014
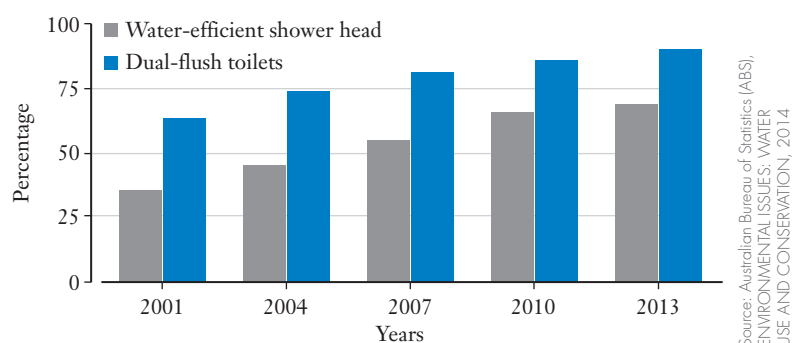
a Which is the more popular water-saving product?

b What percentage of Australian households had water-efficient shower heads in 2010?

c In which year did 74% of households have dual-flush toilets?

d What was the percentage increase in households with water-efficient shower heads installed between 2007 and 2010?

e In which year did the smallest increase occur for water-efficient shower heads?

f Calculate the overall percentage increase in dual-flush toilets installed from 2001 to 2013.

g Briefly explain why there was a significant increase in households installing water-saving products between 2001 and 2013.

6.03 Electricity usage in the home

EXAMPLE 5

This sector graph shows how electricity is used in in an average Australian home.

Cooking 5%　Standby power 3%
Lighting 7%
Refrigerator/freezer 8%
Other appliances 14%
Heating and cooling 40%
Water heating 23%
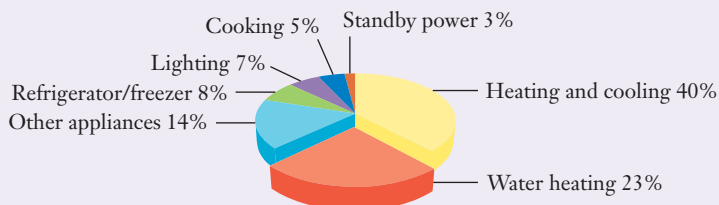
a Calculate, to the nearest degree, the angle size of the 'Cooking' sector.

b What area consumed the most electricity in the home?

c If the cost of a household electricity bill was $978.58 for the Nov–Feb quarter, how much was spent on heating and cooling?

d What could be included in 'Other appliances'?

e If the cost of 'Other appliances' for one bill was $58.50, what was the total electricity bill?

Solution

a Angle size of 'Cooking' sector = 5% × 360°

$$= 18°$$

b Heating and cooling　　　　　　　　　　　　40% is the highest percentage

c Cost of heating and cooling = 40% × $978.58

$$= \$391.432$$

$$\approx \$391.43$$

d 'Other appliances' may include dishwasher, washing machine, iron, kettle, clothes dryer, TV, phones, computers, tablets and other entertainment devices.

e Other appliances (14%) = $58.50　　　　Using the unitary method

$$1\% = \$58.50 \div 14$$

$$= \$4.17857 \ldots$$

Total electricity bill (100%) = $4.17857 … × 100

$$= \$417.857\ldots$$

$$\approx \$417.86$$

Units of power

The **watt** (abbreviation W) is a unit of **power** and is equal to one joule of energy per second.

Unit	Relationships
microwatt (μW)	$1 \, \mu W = \dfrac{1}{1\,000\,000} W = 10^{-6} \, W$
milliwatt (mW)	$1 \, mW = \dfrac{1}{1000} W = 10^{-3} \, W$
watt (W)	$1 \, W = 1000 \, mW = 1\,000\,000 \, \mu W$
kilowatt (kW)	$1 \, kW = 1000 \, W$
megawatt (MW)	$1 \, MW = 1000 \, kW = 1\,000\,000 \, W$ or $10^6 \, W$
gigawatt (GW)	$1 \, GW = 1000 \, MW = 1\,000\,000\,000 \, W$ or $10^9 \, W$

Units of energy usage

Units of energy usage

Electrical energy usage is measured in **watt-hours (Wh)**, which is the amount of electrical energy used by a one-watt load (such as a light globe) drawing power for one hour.

The electricity usage for households is measured in **kilowatt-hours (kWh)**, which is 1000 watt-hours. The **cost** of electricity usage is given in **cents/kilowatt-hour** (c/kWh).

EXAMPLE 6

Convert:

a 8350 W to kW **b** 35 000 MW to W **c** 152 600 GW to kW.

Give answers in scientific notation where necessary.

Solution

a $8350 \, W = 8350 \div 1000 \, kW$ $\qquad\qquad$ $1 \, kW = 1000 \, W$
$\qquad = 8.35 \, kW$

b $35\,000 \, MW = 35\,000 \times 1\,000\,000 \, W$ $\qquad$ $1 \, MW = 1\,000\,000 \, W$
$\qquad\qquad = 35\,000\,000\,000 \, W$
$\qquad\qquad = 3.5 \times 10^{10} \, W$

c $152\,600 \, GW = 152\,600 \times 1\,000 \, MW$ $\qquad$ $1 \, GW = 1000 \, MW$
$\qquad\qquad = 152\,600 \times 1000 \times 1000 \, kW$ $\qquad$ $1 \, MW = 1000 \, kW$
$\qquad\qquad = 152\,600\,000\,000 \, kW$
$\qquad\qquad = 1.526 \times 10^{11} \, kW$

Domestic and off-peak electricity

Domestic rate electricity refers to electricity that is used during the day.

Off-peak rate electricity refers to electricity that is used during the late evening and early morning, such as between 11 p.m. and 7 a.m., when the demand from households and businesses is much lower. Off-peak rate electricity is charged at a cheaper rate than domestic rate electricity, and is often used to heat water in homes.

EXAMPLE 7

Calculate the cost of electricity usage for a household where domestic usage is 954 kWh at \$0.284500/kWh and off-peak usage is 748 kWh at \$0.120379/kWh.

Solution

Cost of domestic usage $= 954 \times \$0.284500$

$= \$271.413$

Cost of off-peak usage $= 748 \times \$0.120379$

$= \$90.043$

Total cost $= \$271.413 + \$90.043$

$= \$361.456$

$\approx \$361.46$

Exercise 6.03 Electricity usage in the home

1 The sector graph shows the energy use for an average household in NSW.

Washing machine, clothes dryer, dishwasher 10.1%
Other 1.3%
Cooking 6%
TV, computer 5%
Lighting 4.7%
Refrigerator 15.2%
Hot water 31.3%
Heating and cooling 26.4%
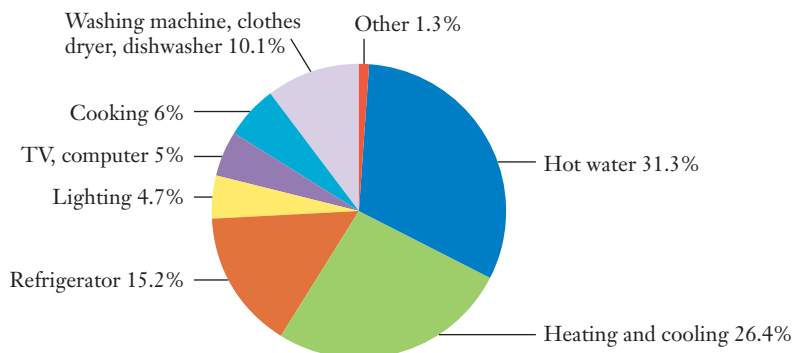
a What fraction of energy use is for cooking?
b What could be included in the 'Other' sector?
c If the household bill for 90 days is \$562.37, how much did 'TV, computers' cost?

d If lighting costs $0.67 per day, what would be the total electricity bill be for 90 days?

e Calculate, to the nearest degree, the angle size of the 'Hot water' sector.

2 The divided bar graph below shows the electricity use for an average Tasmanian household.

a What fraction of electricity is used for heating?

b What percentage of electricity is used for hot water?

c If the average Tasmanian household uses 10 000 kWh of electricity per year, how much electricity is for lighting?

3 Express each measurement of power in scientific notation.

a 5 700 000 MW   **b** 3 000 000 kW   **c** 4 845 000 000 GW

4 Which of the following is 6 840 000 MW expressed in scientific notation, correct to two significant figures? Select **A**, **B**, **C** or **D**.

A 6 800 000 MW   **B** 6.9×10^6 MW

C 6.84×10^6 MW   **D** 6.8×10^6 MW

5 Convert:

a 5600 W to kW   **b** 27 500 000 kW to MW

c 3 495 000 mW to kW.

6 How many kW in 8 450 000 W? Select **A**, **B**, **C** or **D**.

A 845 kW   **B** 8.45 kW   **C** 8450 kW   **D** 84 500 kW

7 Convert 2.35 GW to:

a megawatts   **b** kilowatts   **c** watts.

8 An electricity bill from Lightning Energy is shown on the next page.

a Is this bill paid monthly, two-monthly or quarterly?

b What was the average daily electricity usage over this period?

c From the graph, find the time of the year when the electricity usage was greatest. Why do you think this is so?

d How much electricity was used in the period covered by this bill?

e How many days of usage were covered by this bill?

f When was the electricity meter read? What was the reading?

g Has the electricity bill increased or decreased since the last bill? By how much?

Lightning Energy

Ms B. SPARKS
13 AMPERE CRESCENT
LIGHTNING RIDGE, NSW 2834

ELECTRICITY ACCOUNT

Account Summary

Description	Amount
Previous Balance	$415.69
Less payment(s) received to 05/09/18	$415.69 CR
Subtotal	$0.00
Bill period: 16 Aug 2018 to Nov 2018 (91 days)	$385.44
Total Amount Due (Incl. GST)	**$385.44**

How much energy are you using?

Average daily cost and usage.
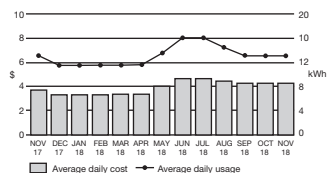
Never use more than one adaptor on the one power outlet. Better still use a power board to plug in additional low current applications as they have their own safety overload cut out switch.

Compare with other homes in your area.

2 people — 955kWh
Your home — 1,191kWh
3 people — 1,219kWh

Snapshot.

Average daily cost:
$4.24

Average daily usage:
13.09kWh

Same time last year:
14.38kWh
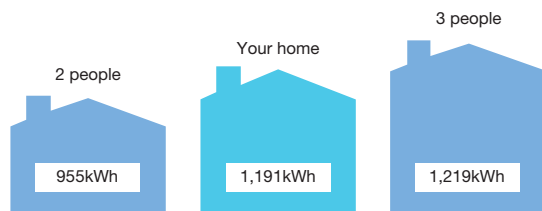
Average usage data supplied by Australian Energy Regulator based on homes with gas and no pool during spring.
Visit energymadeeasy.gov.au for more information.

Your electricity supply details.

Meter No.	Read Date	Days	Start Read	End Read	kWh
0874221	14 Nov 2018	91	57144	58335	1191

Your next meter read is between **13 Feb 2019** and **17 Feb 2019**. Please ensure easy access to your meter on to your meter on these days.

New charges and credits.

Usage and supply charges	Units	Price	Amount
peak	997 kWh	$0.2511	$250.35
Off Peak	194 kWh	$0.2438	$47.30
Supply charge	91 days	$0.7857	$71.50
Other Charges			
Payment processing fee			$2.08
Total charges			$371.23
Credits			
7% Pay On Time Discount			$20.84 CR
TOTAL NEW CHARGES AND CREDITS			$350.39
Total GST			$35.05
TOTAL AMOUNT PAYABLE (incl. GST)			$385.44

Consider the picture graphs of houses on the bill, under the heading 'Compare with other homes in your area'.

h This bill is for a household of 2 adults and 2 children. Do you think this house is running efficiently? Justify your answer.

i Name two given features of this house which possibly explain the energy efficiency.

j Explain the two different cost rates of electricity usage.

9 This graph shows the domestic and off-peak electricity usage for a Campbelltown household over a 96-day period.

Off-peak 47%   Domestic 53%
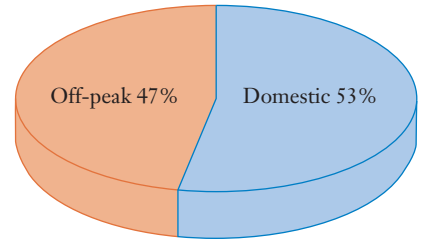
a If the total usage was 3022 kWh, how many kilowatt hours was off-peak usage?

b Calculate the cost of:
  i off-peak usage at $0.092800/kWh
  ii domestic usage at $0.265800/kWh.

c What was the average daily cost for domestic usage?

10 The following questions refer to the electricity bill shown on the next page.

a What was the average daily electricity usage over the period of this bill? Answer separately for peak and off peak.

b From the graph, find the time of the year when electricity usage was the greatest. Why do you think this is so?

c An extra fee is charged in addition to off-peak and peak usage. What is this extra fee for and at what rate is it charged?

d Explain the difference in the two off-peak domestic usage rates in this bill.

e At what time of day are domestic peak rates charged?

f Did this household use more peak or off-peak power?

g By how much has electricity usage increased or decreased when compared to the same period the previous year? Answer separately for peak and off peak.

11 The pricing information for a electricity supplier is given below.

Tariff Type	Cost
Off Peak (cents/kWh)	12.03719
Supply charge (cents/day)	95.6494
Domestic First 1750 kWh/qtr (cents/kWh)	27.027
Remaining Usage kWh/qtr (cents/kWh)	20.46

Calculate the electricity bill for a Penrith household with off-peak usage of 984 kWh and domestic usage of 1985 kWh for a 90-day period.

NCM Energy

FOR ACCOUNT ENQUIRIES: PHONE 131 002
FOR 24HR EMERGENCY ASSISSTANCE: PHONE 131 002

ELECTRICITY ACCOUNT

Issue Date: 03/08/2018

MR B POWER
125 FARADAY DR
PICTON   2571

Summary of Your Account

Description	Amount
Balance of last account	$342.15
<u>Less payments and rounding</u>	<u>$342.15 CR</u>
Subtotal	$0.00

Account Summary – 05/05/18 to 03/08/18

Electricity charges (see next page for details)*	$532.17	
Plus GST payable	$53.22	
Total amount of this account (including GST)		$585.39
Total Amount Due (including GST)		**$585.39**

*GST applies to this item

Your Electricity Usage

PEAK USAGE — kW/h per day: FEB 4.8, MAY 5.6, AUG 8.5, NOV 5.9, FEB 4.8, MAY 5.2, AUG 7.9 (Period ending)

OFF PEAK USAGE — kW/h per day: FEB 3.1, MAY 3.6, AUG 4.6, NOV 4.1, FEB 3.6, MAY 4.0, AUG 4.9 (Period ending)
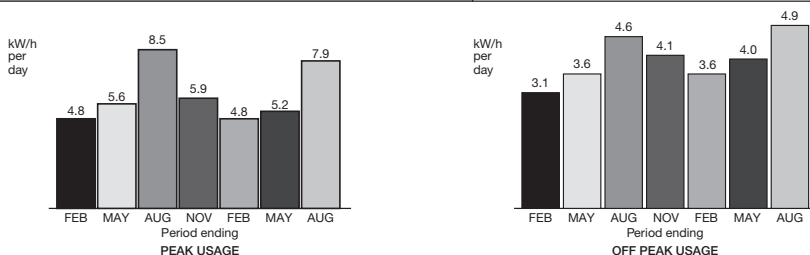
Itemised Details

Meter information for Period 05/05/18 to 03/08/18 – 90 days

Meter No.	Const		Days	Usage (kWh)
1234530	1		90	437
OFF PEAK – Total Usage				437
1234532	1		90	718
DOMESTIC – Total Usage				718

Your Account Calculations

Pricing Option	GST	Usage Applies	Rate	Amount
DOMESTIC OFF PEAK(10 pm – 7 am Mon – Fri)				
OFF PEAK Off Peak 1	Yes	369.000	$0.11913	$43.96
DOMESTIC OFF PEAK (SHOULDER USAGE 7 am – 2 pm, 8 pm – 10 pm)				
Off Peak 2	Yes	68.000	$0.21186	$14.41
DOMESTIC PEAK(2 pm – 8 pm Mon – Fri)				
DOMESTIC Domestic	Yes	718.00	$0.54164	$388.90
Daily Supply Chg $0.94336	Yes	90 days		$84.90
Electricity subject to GST				**$532.17**

BUILDING AN ENERGY-EFFICIENT HOME

When building a new home, there are many things that can be done to reduce the amount of electricity used. For example, up to 35% of heat gain and loss from a house can be through a ceiling that is not insulated. Insulating the roof, walls and suspended floors will reduce energy use and cut electricity costs.

1 Investigate the following websites to find different ways a house can be made to be more energy efficient:

Environment NSW

Energy Australia and select 'Energy saving and safety'

Your Home (government site)

2 What are 'ideal' settings for heating and for cooling?

3 How can landscaping help reduce your energy bill?

4 What type of lighting should be used in outdoor areas?

DID YOU KNOW?

Watts it all about?

- **Microwatts** are used to measure power from solar cells used in calculators and watches.
- A person's hearing aid uses less than one **milliwatt** while a laser pointer outputs about 5 milliwatts of light power.
- A wind turbine has a power capacity of 1 to 3 **megawatts**, while a lightning strike may contain tens of **gigawatts.**
- The total power of sunlight striking Earth's atmosphere is 170 to 180 **petawatts**.

How much power is generated by a person climbing a flight of stairs? A highly-trained athlete sprinting 100 metres? A car engine while cruising?

6.04 Energy consumption and the costs of appliances

Heating and cooling make up almost a quarter of a home's energy use. The biggest users of energy in Australian homes are hot water systems. To reduce costs and improve efficiency you need to know how and where energy is used in the home.

EXAMPLE 8

How much energy is used (in kWh) when a 100 W light globe is on for 5 hours?

Solution

Energy used in 5 h = 100 W × 5 h

$\qquad$ = 500 Wh

$\qquad$ = 500 ÷ 1000 kWh   1 kWh = 1000 Wh

$\qquad$ = 0.5 kWh

Running costs of electrical appliances

You can calculate the **running cost** of an electrical appliance by multiplying the power used (in kWh) by the cost of electricity.

Running costs

$$\text{Running cost} = \text{power used (kWh)} \times \text{electricity cost (\$/kWh)}$$

EXAMPLE 9

Tamin takes about $1\frac{1}{2}$ hours per week to iron his clothes. If he uses a 2200 W iron and the cost of electricity is \$0.267257/kWh, calculate the cost of using the iron in one year.

Solution

Power used in one year = 2200 W × 1.5 × 52

$\qquad$ = 171600 Wh

$\qquad$ = 171.6 kWh

Annual cost = 171.6 × \$0.267257

$\qquad$ = \$45.86130

$\qquad$ ≈ \$45.86

Energy ratings

Many household appliances display an **Energy Rating Label (ERL)** to help people choose energy-efficient appliances. These include TVs, washing machines, clothes dryers, refrigerators, freezers, dishwashers, air conditioners and heaters. These labels contain a star rating to show how efficient the appliance is – the more stars, the more efficient the energy use. A standard label has 6 stars but for more efficient appliances there is a label that goes up to 10 stars. The label also lists an estimate of the energy (in kWh) the appliance will use over a year.

Hot water systems

Water heating can account for up to 30% of the energy used in a home. The types of hot water systems (storage and instantaneous) available are solar, heat pumps, natural gas and off-peak electric. Around half of Australian homes use electric water heaters, but they contribute 80% of hot water greenhouse emissions. By installing an appropriate and efficient water heater for the household size, considering water use patterns and climate, it is possible to save money and reduce greenhouse emissions.

Lighting

About 5% of the electricity used in NSW homes is for lighting. The main types of light globes used in homes are **compact fluorescent lamps** (CFL), **halogen** (used in downlights) and LED lights. In 2009, the traditional **incandescent light globes** started being phased out in favour of more energy-efficient light sources with longer lamp lives. It is estimated that by phasing out incandescent light globes, the average household could save 300 kWh and $75 each year.

EXAMPLE 10

A traditional (obsolete) incandescent 75 W light globe and the equivalent modern compact fluorescent 10.5 W lamp are used for 5 hours a day. Compare the cost of using both globes over a year if electricity is charged at $0.258100/kWh.

Solution

Incandescent light globe:

Electricity used in one year $= 75 \times 5 \times 365$

$\qquad\qquad\qquad = 136\ 875$ Wh

$\qquad\qquad\qquad = 136.875$ kWh

Cost of electricity used $= 136.875 \times$ $0.258100

$\qquad\qquad\quad = \$35.3274375$

$\qquad\qquad\quad \approx \$35.33$

Compact fluorescent lamp:

Electricity used in one year $= 10.5 \times 5 \times 365$

$\qquad\qquad\qquad = 19\ 162.5$ Wh

$\qquad\qquad\qquad = 19.1625$ kWh

Cost of electricity used $= 19.1625$ $\times \$0.258100$

$\qquad\qquad\quad = \$4.94584125$

$\qquad\qquad\quad = \$4.95$

Over a year, the cost of using the compact fluorescent lamp is approximately one-seventh of the cost of the incandescent light globe.

Appliances

Washing machines, clothes dryers, fridges and freezers, televisions, dishwashers and other appliances can account for 25% of a household's electricity bill. Choosing energy-efficient products can reduce power use and running costs.

EXAMPLE 11

Calculate the lifetime running cost of the following televisions. Use 30.0 cents/kWh as an estimate for the cost of electricity and assume that the average lifetime of major appliances is 10 years.

a A 138 cm, UHD Smart LED TV with a 4.5-star label, energy consumption 380 kWh/year

b A 140 cm, SUHD Smart LED television with a 5-star label, energy consumption 310 kWh/year.

Solution

a Lifetime running cost $= 380 \times \$0.30 \times 10$

$\qquad\qquad\qquad\qquad = \$1140$

b Lifetime running cost $= 310 \times \$0.30 \times 10$

$\qquad\qquad\qquad\qquad = \$930$

Standby power

Many appliances such as sound systems, computers and cordless phones have a **standby mode** so that they can be turned on quickly. **Standby power** is the electricity used by appliances with an electronic clock, when they are turned off or waiting to be turned on by a remote control. Standby power accounts for about 5.9% of total household electricity usage and many household appliances use some standby power.

In Australia, the average daily standby power consumption is 39.4 W per household or 129.4 kWh per year, with an annual cost of $860 million. To save energy costs, you should aim to switch appliances completely off when not in use if possible, either by using the OFF switch or at the power point.

EXAMPLE 12

The power consumption of a cordless phone in standby mode is about 3 W. What is the cost of the standby mode for the phone over a year if electricity is charged at the rate of 25.81 cents/kWh?

Solution

Power consumption $= 3 \times 24 \times 365$ Wh

$\qquad\qquad\qquad = 26\ 280$ Wh

$\qquad\qquad\qquad = 26.28$ kWh

Annual cost $= 26.28 \times \$0.2581$

$\qquad\qquad = \$6.782868$

$\qquad\qquad = \$6.78$

Exercise 6.04 Energy consumption and the costs of appliances

Example 8

1 Calculate how much energy (in kWh) is used when each light globe is used for 8 hours.
   a a 100 W (old style) incandescent light globe
   b a 20 W compact fluorescent lamp
   c a 12 W LED light globe
   d a 50 W halogen light globe

2 How much energy is used if it takes 2 min 36 seconds to boil 1 litre of water in a 2200 W kettle? Select **A**, **B**, **C** or **D**.
   A   5.192 kWh   **B**   0.5192 kWh   **C**   0.09533 kWh   **D**   0.9533 kWh

3 How much energy is used over 5 hours by an air conditioner if the power input is 0.78 kW?

4 The Energy Rating label on page 262 shows the average energy consumption of a washing machine that is used 250 times a year. If it consumes 45 kWh of electricity per year for cold washes and 547 kWh per year for warm washes, calculate how much power is used for:

    a   a cold wash   **b**   a warm wash.

5 Simon uses a 1500 W steam mop for 30 minutes a week to clean the tiled floors of his house.

Example **9**

    a   How many kWh of energy does the mop use over a year?

    b   If electricity is charged at the rate of 26.8400 c/kWh, calculate the cost of using the steam mop over a year.

6 The power input of a bar heater is 2400 W and is used on average for 5 hours a day during the winter quarter (92 days). Calculate the cost of using the heater during if power is charged at the rate of $0.288200/kWh.

7 The power input of the wash cycle of a front loader washing machine is 2100 W. The machine is used five times a week and it takes 38 minutes to complete a cold water wash cycle. Electricity is charged at the rate of 29.8210 cents/kWh. What is the total cost of using this washing machine in one year?

8 A reverse cycle air conditioner is on for 260 hours a year for heating and 240 hours a year for cooling. Calculate the cost of running each brand of air conditioner for a year if the cost of electricity is 24.7793 c/kWh.

    a   an Iamtubizi Electric – 4.5-star energy rating for cooling with power output 2.5 kW, 4.5-star energy rating for heating with power output 3.2 kW.

    b   a NBG – 5-star energy rating for cooling with power input 2.3 kW, 5-star energy rating for heating with power input 3.0 kW.

    c   a Tishu – 2.5-star energy rating for cooling with power input 7.1 kW, 3-star energy rating for heating with power input 8.0 kW.

9 A house has 18 lights which are used for an average of 4 hours per day. Electricity is charged at the rate of 24.45 cents/kWh. Calculate the cost of lighting for a year if:

Example **10**

    a   75 W 'vintage style' light globes are used

    b   15 W compact fluorescent lamps are used

    c   12 W LED lights are used

    d   50 W halogen (with a 10 W transformer) lights are used.

10 The energy consumption for a 2-star top-loader washing machine is 123 kWh/year for a cold wash and 636 kWh per year for a warm wash. If electricity is charged at a rate of 29.82 cents/kWh, calculate the difference in cost between cold and warm washing for a year.

Example **11**

11 The energy rating label on a small bar refrigerator showed 1.5 stars. The energy consumption was 259 kWh per year. Find the cost of running the bar fridge for one year if electricity costs 29.8210 cents/kWh.

12 a A 3-bedroom house has 18 lights. Compact fluorescent lights of 20 W are used and the lights are on for 6 hours per day. The cost of electricity is 30 cents/kWh. What is the cost of lighting for one year?

b If 12 W LED lights are used instead of CFLs, what is the cost of lighting for one year and how much will be saved?

13 a For each appliance in the table, calculate the cost of using it over a quarter (91 days), using 30 cents/kWh for the cost of electricity.

Appliance	Average quarterly energy use
Refrigerator	130 kWh
Freezer	70 kWh
Washing machine	10 kWh (based on 4 cold washes/week)
Dishwasher	92 kWh (for hot water wash, 7 times/week)
Clothes dryer	110 kWh (based on 1 cycle/week)
Television	171 kWh (based on television being on 10 h/day)
Computer	216 kWh (based on computer being on 8 h/day)

b What is the total cost?

14 Assuming that the average lifetime of a major appliances is 10 years, calculate the lifetime running cost of each appliance. Use 30 cents/kWh as an estimate for the cost of electricity.

a a dishwasher with a $2\frac{1}{2}$-star energy rating label and energy consumption of 336 kWh per year for a hot water cycle

b a refrigerator with a 1-star energy rating label and energy consumption of 685 kWh per year

c a reverse cycle air conditioner with a 4-star energy rating label for cooling with power input of 3.5 kW and a 4-star energy label for heating with power input 3.7 kW. The air conditioner is cooling for 250 hours per year and heating for 280 hours per year.

Example **12**

15 A games console in standby mode uses 5.4 W. Find the cost of standby for the games console for one year if electricity is charged at the rate of 28.0500 cents/kWh.

16 This table shows the standby power consumption per hour for some common household appliances. If electricity is charged at the rate of 26.675 cents/kWh, calculate the:

a standby power cost per year for each appliance

b total standby power cost for the seven appliances.

Appliance	Standby power consumption (per hour)
Television (LCD)	3.5 W
Computer notebook	8.9 W
Inkjet printer	1.3 W
Microwave oven	3.1 W
Dishwasher	2.7 W
Set-top box (Pay TV)	15.8 W
Mobile phone charger	0.3 W

Source: © Government of South Australia

TECHNOLOGY

Energy calculators

The cost of appliances, heating and cooling a home, and lighting can be calculated using online energy calculators which can be found on the Internet. Search for an energy calculator such as **Energy Use Calculator.**

1 Use the energy calculator to find the yearly cost of running appliances such as washing machines, LCD/LED display or TV screen, laptops and notebooks, refrigerators, freezers, dishwashers, recharging mobile (cell) phones and so on, as well as calculating the cost of lighting, heating and cooling a home.

2 Prepare a report, putting your information in a table so that the total energy use of your home can be calculated over a year.

3 Appliances can be compared in terms of their running costs for different numbers of years. Visit the **Energy Rating** government website and select 'Compare Products', choose an appliance and compare the cost of 2 or 3 different brands, comparing the cost over 1 year and 10 years. Record or print your results.

4 Repeat this process for at least three other appliances that are used in the home.

ENERGY CONSUMPTION IN YOUR HOME

1 Visit the government website **Energy made easy** and select 'Understand and compare your electricity usage' to calculate the average household electricity usage per day, per season and per year for:

a   North Ryde   **b**   Bathurst

c   Bondi Beach   **d**   where you live.

2 Reducing electricity consumption can be achieved by understanding the running costs of your appliances. Fact sheets on saving energy can be found at the **Origin Energy** website by searching for 'State fact sheets'.

a Use this site to obtain fact sheets for NSW, Victoria, Queensland and South Australia.

b Draw a clustered column graph from information on the fact sheets that can be used to compare electricity consumption between the states.

c What advice do the fact sheets give for reducing electricity consumption?

Another useful site is the **Your Energy Savings** government website.

6.05 Food and energy consumption

Nutrition in food provides a source of energy to maintain life and also for growth. The right balance of nutrients help the body to function and fight illness and disease. The more active a person is, the more energy they need.

Energy intake is measured in **joules** (J) or **calories** (Cal). Calories are an older unit of energy. Sometimes in food packaging, you will see the word **kilocalories**. When describing energy in food and nutrition, kilocalories (kcal) and calories are the same thing.

> **Converting units of energy**
>
> 1 kilojoule (kJ) = 1000 joules (J)
>
> 1 megajoule (MJ) = 1 000 000 joules (J) = 1000 kJ
>
> 1 calorie (Cal) = 4.184 kJ

EXAMPLE 13

Convert each unit of energy.

a 300 J to kJ
b 14 MJ to kJ
c 82 Cal to kJ
d 1600 kJ to Cal
e 0.17 MJ to Cal

Solution

a $300 \text{ J} = 300 \div 1000$

$\qquad = 0.3 \text{ kJ}$

b $14 \text{ MJ} = 14 \times 1000$

$\qquad = 14\ 000 \text{ kJ}$

c $82 \text{ Cal} = 82 \times 4.184$

$\qquad = 343.088 \text{ kJ}$

d $1600 \text{ kJ} = 1600 \div 4.184$

$\qquad = 382.4091778$

$\qquad \approx 382.4 \text{ Cal}$

e $0.17 \text{ MJ} = 0.17 \times 1000$ $1 \text{ MJ} = 1000 \text{ kJ}$

$\qquad = 170 \text{ kJ}$

$\qquad = 170 \div 4.184$ $1 \text{ Cal} = 4.184 \text{ kJ}$

$\qquad = 40.6309\ldots$

$\qquad \approx 40.6 \text{ Cal}$

Exercise 6.05 Food and energy consumption

1 Convert each unit of energy.

    a 2350 kJ to J
    b 54 MJ to kJ
    c 760 Cal to kJ
    d 1475 kJ to MJ
    e 250 kJ to Cal
    f 0.9 MJ to Cal

Example
13

2 One glass of orange juice contains 400 kJ of energy. How many calories is this?

3 A box of 6 fruit and nut snack packs contains a total of 14.6 grams of fat.

    a If 1 gram of fat = 37 kJ, calculate the total number of kilojoules of fat in the box.
    b How many kilojoules of fat are in one of the snack packs?
    c How many calories of fat are in one snack pack?

4 Anthea bought a 1 kg box of rolled oats cereal. The front of the box contained this dietary intake information per 50 g serve.

Calculate the total amount of energy in this box of oats in:

a megajoules (MJ)

b (kilo) calories.

Alamy/Clare Gainey

5 This nutrition information panel shows the percentage of the recommended daily intake (DI) of energy provided by 2 slices of organic bread.

Energy	Protein	Fat	Saturated Fat	Carbs	Sugars	Sodium	Fibre
751 kJ	11.2 g	4.8 g	0.7 g	19.9 g	2.4 g	361 mg	5.6 g
9% DI	22% DI	6% DI	3% DI	6% DI	3% DI	16% DI	20% DI

The recommended daily energy intake for an adult is 8700 kJ. Calculate:

a the number of kilojoules represented by protein

b the number of calories in a loaf of this bread containing 14 slices.

6 Anneliese bought her lunch which consisted of the following items:

Item	Energy (kJ)
One-quarter BBQ chicken	2120
Small fruit salad	744
Iced chocolate milk	1620

a Calculate the total energy intake for Anneliese's lunch.

b What percentage (correct to one decimal place) of the recommended daily intake (of 8700 kJ), does her lunch represent?

7 Olivia is making a hamburger and milkshake at home. She knows the energy content of her ingredients as shown in the table.

Food	Energy content (kJ)
1 hamburger slice	1280
1 hamburger bun	650
1 egg	300
Potatoes (1 cup)	680
1 teaspoon of oil	185
Milk (1 glass)	645
1 scoop of ice cream	268
1 teaspoon of sugar	80
1 slice of cheese	429
1 serve of tomato sauce	64

a Calculate the total amount of energy, in kilojoules (kJ), contained in Olivia's meal if she consumes the following:

Hamburger	Milkshake
1 hamburger bun	1 glass of milk
1 hamburger slice	2 scoops of ice cream
1 egg	Chocolate syrup (contains 3 teaspoons of sugar)
1 slice of cheese	
1 serve of tomato sauce	

b If Olivia is 25 years old, use this table to determine what percentage of her daily energy intake her meal represents.

Estimated daily energy requirement (kilojoules) for a sedentary person (e.g. office work or study, no strenuous physical activity)		
Age	**Male**	**Female**
12–15 years	8200–9900	7400–8200
16–18 years	10300–10900	8400–8500
19–30 years	10300*	8400*
31–50 years	9900*	8000^
51–70 years	9100*	7600^
Adults over 70 years	8300*	7200^

*estimated energy intake for male 180 cm tall, 71.3 kg
^estimated energy intake for female 170 cm tall, 63.6 kg

Source: National Health and Medical Research Council.

8 The nutrition information panel for a tub of yoghurt is shown below.

Servings per package: 3 Serving size: 150 g	Quantity per serving	Quantity per 100 g
Energy	608 kJ	405 kJ
Protein	4.2 g	2.8 g
Fat – total	7.4 g	4.9 g
– saturated	4.5 g	3.0 g
Carbohydrate – total	18.6 g	12.4 g
– sugars	18.6 g	12.4 g
Sodium	90 mg	60 mg

   a   **i** How many suggested servings are there in the tub of yoghurt?
        ii Calculate the total weight of the tub of yoghurt.

   b Convert the energy content per 100 g into calories.

   c   **i** Given that 1 g of carbohydrates has 17 kJ, calculate the number of kilojoules of
         carbohydrates per serving.
        ii What percentage of the energy content per serving does this represent?

9 The table below shows the energy used by Michael, an 18-year-old male weighing 75 kg and
with a height of 170 cm, in a number of physical activities with a duration of 30 minutes.

Activity	Energy used (kJ)
Weightlifting	465
Lawn bowling	512
Golf	667
Skateboarding	775
Cycling (gentle)	930
Bushwalking	930
Skiing	1085
Soccer	1085
Swimming	1085
Touch football	1240
Running	1240

a Name at least two activities that would best help Michael use this energy in physical activity and state how long he would need to exercise if he:

   i consumes a bacon and egg roll with an energy content of 2194 kJ

   ii has a chicken teriyaki salad with an energy content of 1015 kJ.

b Selena is an 18-year-old female, 170 cm tall and weighing 62 kg. Calculate how long it will take Michael and Selena to use the energy given in each actvity below, with the given energy content.

   i running/jogging, 1049 kJ

  ii swimming, 918 kJ

 iii bushwalking, 787 kJ

INVESTIGATION

COMPARING ENERGY CONTENT OF FOODS AND PHYSICAL ACTIVITY

Visit the **Calorie King** website and search for its food database.

Select a food item listed below and compare the energy rates of at least two types of activity from the table below to use the energy contained in the food. Calculate the amount of time needed for you to use the energy in each activity you choose.

a hamburger   **b** muffin   **c** frozen yoghurt

d noodles   **e** soft drink

Activity	Energy rate (kJ/kg/h)
Sitting quietly	1.7
Writing	1.7
Standing relaxed	2.1
Driving a car	3.8
Vacuuming	11.3
Walking rapidly	14.2
Running	29.3
Swimming (4 km/h)	33
Rowing in a race	67

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DID YOU KNOW?

The five food groups

To meet the nutritional requirements for good health, a variety of foods from each of the five food groups is recommended. It is not essential to eat from each food group at every single meal because some foods in the food groups are recommended to only be consumed a few times a week.

The five food groups are:

- vegetables and legumes/beans
- fruit
- grain (cereal) foods mostly whole grain and/or high cereal fibre varieties
- lean meats and poultry, fish, eggs, tofu, nuts and seeds
- milk, yoghurt, cheese and/or alternatives, mostly reduced fat.

Fruit

Bread

Vegetables

Milk

Meat
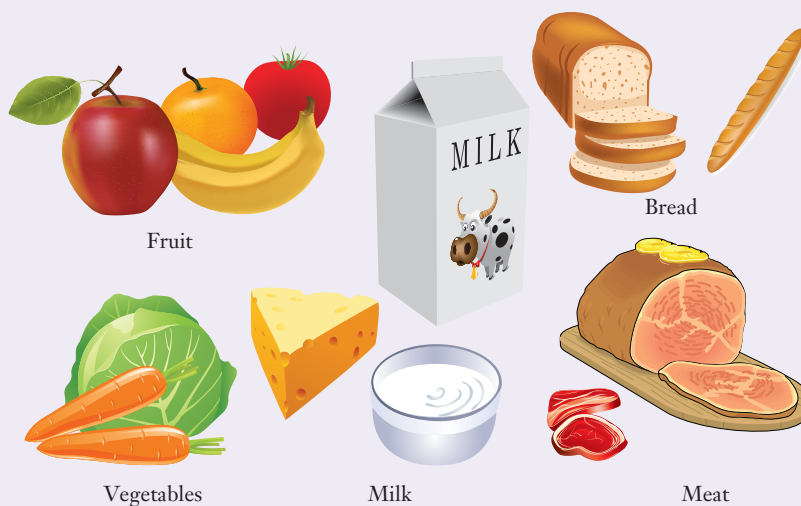
Visit the Eat for health website and select:

- **'How much do we need each day' to find out how many serves of each food group we should aim to eat and how often they should be consumed**
- **'Serve sizes' to find out the mass of serving sizes for different food groups and their average energy content in kilojoules (kJ).**

6.06 Household budgeting

A **budget** is an estimate of income and spending for a certain period of time. It is a plan to help manage your income wisely. Whether you are running a household or a business or just managing your pocket money, it is essential that you do not spend more than you earn. A budget is divided into **income** and **expenses** and a balanced budget is one in which the total expenses equal the total income.

When preparing a budget it is also important to identify items that qualify as **fixed spending** and **discretionary spending**. **Fixed spending** is money spent on necessities such as food, clothes, fuel and household bills. **Discretionary spending** is money spent by consumers on items other than necessities. These purchases could involve technology or entertainment items, movie tickets or upgrading furniture or appliances. Overspending on discretionary items could lead to debt if expenses are more than income.

EXAMPLE 14

Lucy was saving for an overseas trip and accepted some extra casual work. She set up a weekly budget, as shown in the table, and aimed to save $170 per week.

Income		Expenses	
Wages	$1120	Rent	$425
Casual wage	_____	Groceries	$163
		Fares	$103
		Car loan	$188
		Petrol/car maintenance	$93
		Entertainment	$185
		Savings	_____
Total:	$1305	Total:	$_____

a How much did Lucy earn from her casual job?

b What should be Lucy's total expenses?

c To balance her budget, how much can Lucy save per week?

d Name an expense that represents discretionary spending.

e Suggest a way Lucy could increase her savings to $170 per week.

Solution

a   Casual wage = $1305 – $1120

   = $185

b   Total expenses = $1305   Equal to total income

c   Savings = $1305 – ($425 + $163 + $103 + $188 + $93 + $185)

   = $148

d   Entertainment or possibly the car loan (in addition to fares listed). Perhaps they live near public transport and don't need the car as well.

e   Suggestions: cut down on entertainment, rent with a friend, sell the car, or look for weekly grocery specials.

Exercise 6.06 Household budgeting

1   Categorise each item as either income or expense.

   a   a car insurance payment
   b   an inheritance from your grandmother
   c   a birthday present for a friend
   d   the cost of a plane ticket to London
   e   a second prize win in the lottery
   f   the monthly rental of a computer
   g   a rent payment to a real estate agent
   h   the admission price to the cinema
   i   the rent from an investment unit
   j   pay to an electrician for installing new power points
   k   your weekly wage
   l   the cost of a gym class
   m   pocket money
   n   a Christmas present from your aunt
   o   the cost of a Friday night pizza

2   For each expense item from Question **1**, identify it as either fixed spending or discretionary spending.

3 Mariella's budget allowed her to save $60 each week. Her budget is shown below.

Income		Expenses	
Youth allowance	$239.50	Rent	$160
Casual job	_____	Fares	$56
		Groceries	$124
		Clothes	$75
		Entertainment	_____
		Bills	$68
		Savings	$60
Total:	**$621.00**	**Total:**	**$**

a How much did Mariella earn for her casual job?

b Is entertainment a fixed or discretionary item? What amount did Mariella spend on entertainment?

c Suggest two ways that Mariella could increase her weekly savings to $80.

4 Jess wants to save $2200 for an end of year trip. She earns $615.40 net a week and has the following weekly expenses: meals $40, rent $138, groceries $52, fares $36, tennis $20, entertainment $60, car loan $85, bills $65 and magazines $8.

a Calculate the amount Jess has left for savings each week.

b Will Jess have enough saved to pay for her trip in one year?

c If the trip price increases by 20%, would Jess have enough saved in one year to pay the new price?

5 The Rogers family has the following net weekly incomes: wages $1901.77, part-time job wages $289.53 and parenting allowance $197.20. The family also has the following weekly expenses: bills $105.30, school fees $85.80, entertainment costs $295, health fund payment $53.40, clothes $132, home maintenance $184, groceries $210.50, petrol $85.40, Friday night takeaway $46, newspapers and magazines $26, home loan repayments $545.60, and car loan repayment $184.22.

a Use a table or spreadsheet to display this data as a budget, adding an entry for savings.

b What amount does the Rogers family save per week?

6 Zac shares a flat and pays $110 a week towards the rent. He spends $64 on food and $46 on public transport. His shares of the quarterly electricity bill and two-monthly phone bill are $45.10 and $12.80 respectively. He earns $551.40 net per week, spends about $45 per week on entertainment and visits a chiropractor once a month at a cost of $42 a visit. Convert Zac's expenses to weekly amounts and draw up a weekly budget, including an amount for savings.

a What is Zac's weekly income?

b What is the total of Zac's weekly expenses?

c How much can Zac save per week?

PREPARING A BUDGET

Imagine that you are 25 years old with a net monthly income of $3340.

	Amount	Per	Weekly amount
Income			
	$3340.00	month	
Expenses			
Rent	$185.00	week	
Mobile phone		month	
Gym membership	$484.00	year	
Internet	$49.95	month	
Water	$114.80	quarter	
Electricity	$122.50	quarter	
Health fund	$26.40	week	
Groceries		week	
Petrol/car maintenance		week	
Fares		week	
Clothes		week	
Entertainment		week	
Sport		week	
Gifts/donations		week	
Savings		week	
Other		week	

a Use a calculator or spreadsheet to copy this weekly budget and complete it after converting the fixed expenses to weekly amounts.

b Choose the amount you wish to spend per week on each variable expense and enter these amounts.

c Suggest three ways that you could save more per week.

The Luk family has three 1.5 kW solar panels installed on the roof of their house.

a Calculate how much electricity will be generated in one year if the average daily production of each solar panel is 2.09 kWh. Assume it is a normal year.

b The Luk family's average annual household electricity consumption is 8764 kWh. What percentage of the household consumption is generated by the solar panels? Answer correct to two decimal places.

c **i** How much of their annual electricity consumption is *not* generated by the solar panels?

   ii If their electricity provider charges $0.258100/kWh, what is the Luk family's expected annual cost for electricity?
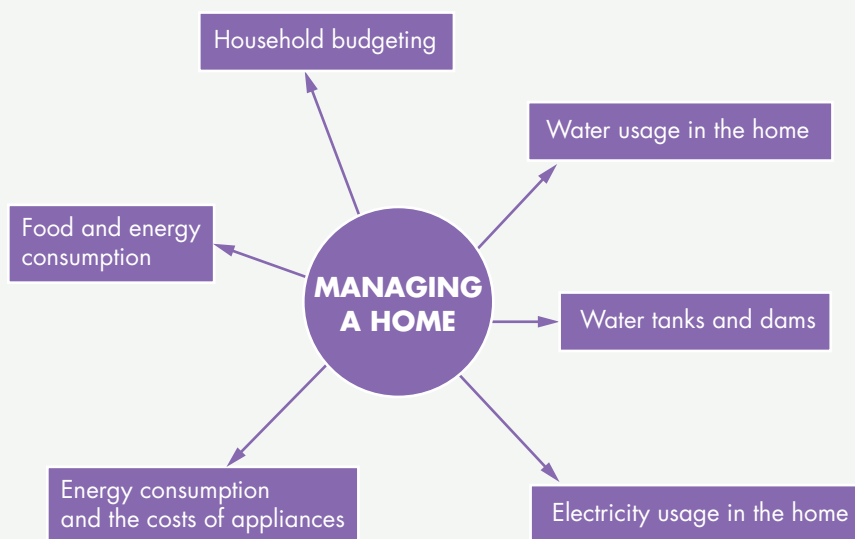
Study tip

Organising your notes

- One feature of effective study is an organised collection of class notes. This allows you to quickly and easily locate your work on any topic. The key to maintaining a neat set of notes is to label everything: the names of the topics, the theory, the class examples, the exercises, your folders.

- Your maths class follows a program of topics, which may correspond roughly to the chapters of this textbook. Ask your teacher for a copy of the program or syllabus and organise your folder according to these topics. Use coloured dividers or title pages to mark the start of each new topic.

- Start each maths lesson with the title of the lesson and the date. Pay attention to your teacher's explanations and copy the class examples into your book. Make sure you write the question as well as each step in the solution. You can add any personal notes, comments or reminders to help you later, when revising the work. If you don't understand something you should ask your teacher to explain again.

- When using a loose-leaf folder, make sure your notes are filed in the correct order. Number the pages of each topic so that you can refile if they get out of order. If your folder becomes too bulky to manage, you should start a new one or remove some of the older topics and file them at home. Realise that you do not need to bring to school all your notes for the entire maths course, just what you are currently working on in class.

6. CHAPTER SUMMARY

This chapter, Managing a home, examined the financial mathematics, measurement and statistics behind water and electricity use in the home. The science of nutrition and energy in food was also covered. Make sure that you develop a deep understanding of the terminology, calculations and metric units involved in the usage and costs of household water and electricity. Revise volumes and capacities of water tanks and dams, and how to apply the trapezoidal rule to irregular areas and volumes.

Make a summary of this topic. Use the outline at the start of this chapter as a guide. An incomplete mind map is shown below. Use your own words, symbols, diagrams, boxes and reminders. Gain a 'whole picture' view of the topic and identify any weak areas.

```
                    Household budgeting
                                              Water usage in the home

Food and energy
consumption            MANAGING
                        A HOME           Water tanks and dams

       Energy consumption
       and the costs of appliances
                                    Electricity usage in the home
```

1 Jed's water bill shows that water usage is charged at $2.115/kL.

   a If Jed used 21.6 kL, how much will he need to pay?

   b Jed was also charged $41.39 for the water service and $162.88 for the wastewater (sewerage) service. What was the total of Jed's bill?

2 The Hamper family is calculating their water costs for the quarter. This reading is 8342 kL and the previous reading was 8145 kL. What was their water bill if usage is charged at $2.115/kL? Select **A**, **B**, **C** or **D**.

   A $197   **B** $416.66   **C** $2374.58   **D** $3487.00

3 The width of a lake is measured at 10-metre intervals.

   a Use two applications of the trapezoidal rule to estimate the area of the lake.

   b Calculate the volume of water in the lake if it is 3.1 metres deep.

5.2 m   11.3 m   7.8 m
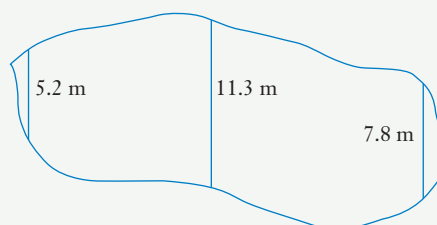
4 Convert:

   a 16 400 kW to MW   **b** 7.15 GW to kW   **c** 26 000 000 mW to kW.

5 The pricing information for an electricity supplier is given below. Calculate the quarterly (92 days) electricity bill for a household with off-peak usage of 1087 kWh and domestic usage of 2107 kWh.

Tariff type	Cost
Off Peak (cents/kWh)	12.03719
Domestic (cents/kWh)	29.5443
Supply charge (cents/day)	95.6494

6 In a household of four people, containing two adults and two teenagers, each person uses on average, 8 minutes of hot water per shower. This house contains a 3.6 kW hot water unit and each person showers twice per day.

If electricity is charged at 27.5 c/kWh when the hot water unit is being used, what is the electricity cost for the hot water used by this household in one week? Select **A**, **B**, **C** or **D**.

   A $221.52   **B** $61.60   **C** $7.39   **D** $3.70

7 A 2400 W kettle is used on average 15 minutes per day. If the cost of electricity is 24.25 cents/kWh, how much will it cost to use the kettle over one year?

8 The energy consumption for a 4-star 8 kg top-loader washing machine is 85 kWh/year for a cold wash and 360 kWh per year for a warm wash. If electricity costs 28.34 cents/kWh, calculate how much cheaper it is to wash in cold water than in warm.

9 Convert:

   a 4.65 kJ to J   **b** 19 MJ to kJ

   c 7235 calories to kJ   **d** 108.5 kJ to MJ

   e 680 kJ to calories   **f** 0.4 MJ to calories.

10 Bella had a 150 g tub of yoghurt for a snack. The front of the box contained this dietary intake information per 60 g serve.

PER 60g SERVE

Australian Food and Grocery Council

Calculate the total amount of energy in this tub of yoghurt in:

   a kilojoules   **b** calories (to one decimal place).

11 Chloe earns $1654 per fortnight as a graphic designer as well as collecting $1270 monthly rent from an apartment she owns.

   a Calculate Chloe's total weekly income.

   b Prepare a balanced weekly budget for Chloe using the items and values below.

• Groceries	$142
• Home loan repayment	$235
• Health fund	$28.20
• Household bills	$43
• Newspapers and magazines	$18
• Take-away meals	$32
• Petrol	$70
• Fares	$56.70
• Entertainment	$?
• Clothes	$?
• Savings	$?

   c Name one way Chloe could reduce her discretionary spending and save $40 more per week.