ALGEBRA, STATISTICAL ANALYSIS

12.

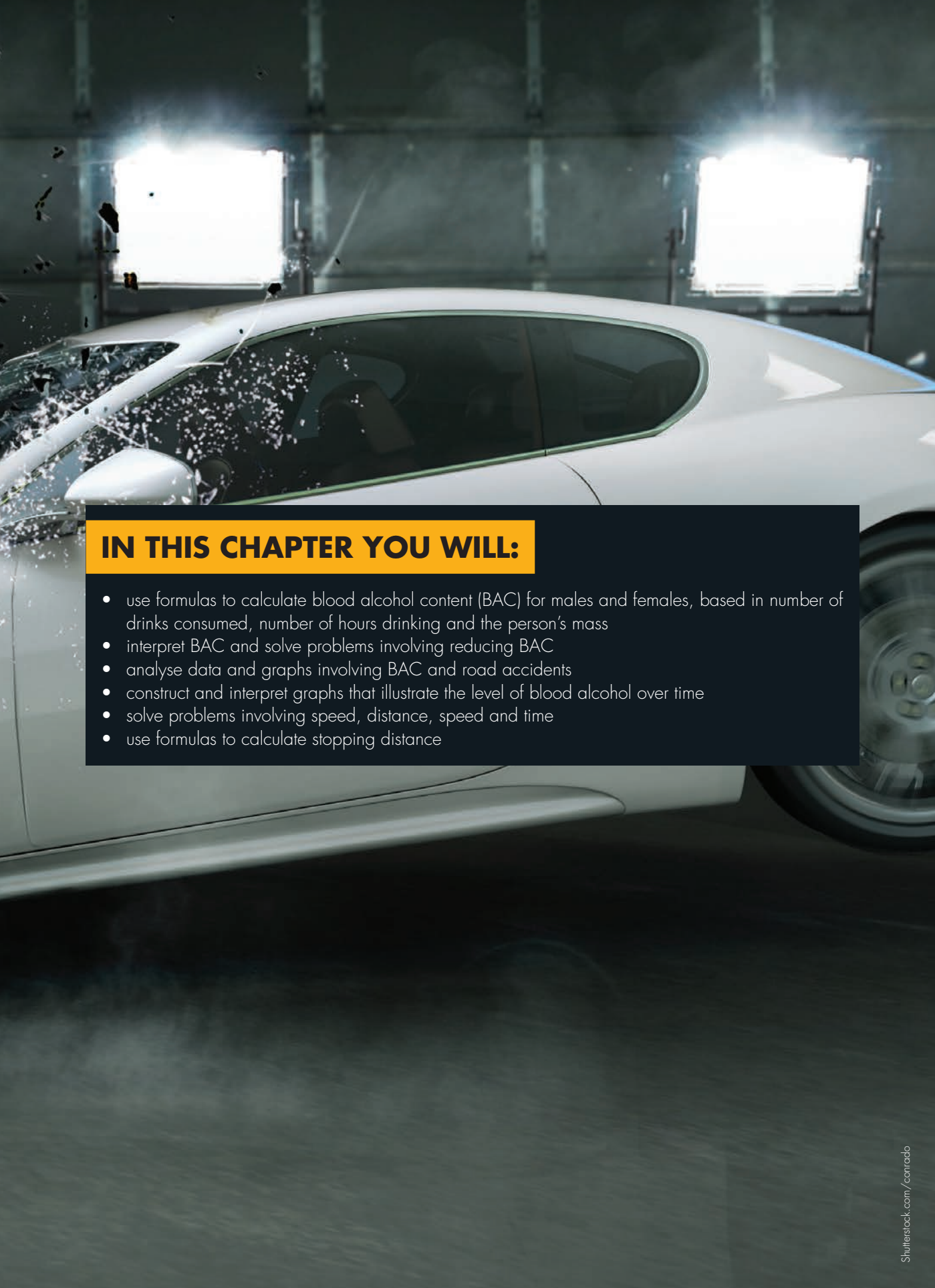
DRIVING SAFELY

ANCAP, the Australian New Car Assessment Program, crash-tests cars in five ways:

- front-on test where the car hits a barrier at 64 km/h
- side impact test where the car is hit on the driver's side by another car travelling at 50 km/h
- pedestrian test to assess head and leg injuries to pedestrians at 40 km/h
- pole test where the car moves sideways at 29 km/h and hits a pole lined up with driver's head
- whiplash test where the stationary car is 'rear-ended' by another car travelling at 32 km/h.

The 2016 Toyota Prius received a 5-star safety rating, scoring 36.22 out of 37.

CHAPTER OUTLINE



IN THIS CHAPTER YOU WILL:

- use formulas to calculate blood alcohol content (BAC) for males and females, based in number of drinks consumed, number of hours drinking and the person's mass
- interpret BAC and solve problems involving reducing BAC
- analyse data and graphs involving BAC and road accidents
- construct and interpret graphs that illustrate the level of blood alcohol over time
- solve problems involving speed, distance, speed and time
- use formulas to calculate stopping distance

TERMINOLOGY

blood alcohol content (BAC)
braking distance
fatality
reaction distance
reaction time
standard drink
stopping distance

SkillCheck

Assignment 12

1 Evaluate each expression, correct to two decimal places.

a $\dfrac{0.03}{0.015}$ **b** $\dfrac{0.04}{0.023}$ **c** $\dfrac{0.1}{0.034}$

d $\dfrac{26-15}{5.5\times45}$ **e** $\dfrac{10\times7-5\times7.5}{6.8\times64}$ **f** $\dfrac{2\times10-18}{5.5\times83}$

2 a Copy and complete this table for the linear function $y = 4 - 0.3x$.

x	0	1	2	3	4	5
y						

b If this function was graphed, what would be the gradient of the line?

3 For each set of data, find the:

i mean **ii** median **iii** mode
iv range **v** interquartile range.

Answer correct to one decimal place where necessary.

a 5 7 8 9 10 4 5 2 4 1
b 10 12 14 9 0 2 8 12 1

4 Evaluate the subject of each formula.

a $v = u + at$ when $u = 2.3, a = 8.7, t = 3$
b $s = kv(kv + b)$ when $k = 4.1, v = 42.3, b = 7.2$
c $S = \dfrac{D}{T}$ when $D = 128, T = 3.4$

5 Convert:

a 25 km to m **b** 2463 m to km
c 3 h 45 min to hours **d** 5.2 h to hours and minutes
e $7.\dot{3}$ h to hours and minutes **f** 20 km/h to m/s
g 110 km/h to m/s **h** 3.5 m/s to km/h.

ISBN 9780170413565

6 A plane moves at an average speed of 840 km/h for 1 day. How many km does it travel?

7 A car travels 245 km in 3 h 45 min. What is its average speed in km/h?

8 Find, correct to the nearest cent:

a 14 % of $35.80 **b** 9.5% of $26 580 **c** 12.5% of $298.60.

12.01 Blood alcohol content (BAC)

Your **blood alcohol content (BAC)** is the concentration of alcohol in your blood. A person with a BAC of 0.05 has 0.05 grams (or 50 mg) of alcohol per 100 mL of blood.

BAC formula practice

Graphing BAC

When alcohol is consumed, skills that safe driving requires become impaired and a driver will have difficulty concentrating on multiple tasks at a time. For example, a driver may be able to monitor their speed but be unable to stay within their lane.

Alcohol affects a driver's:

- **judgement** – ability to reason and respond appropriately
- **concentration** – ability to focus
- **comprehension** – ability to understand a situation quickly
- **reaction time** – ability to respond to a situation quickly.

Shutterstock.com/Ralf Kleemann

ISBN 9780170413565

Calculating BAC

A **standard drink**, for example a middy of beer or a small glass of wine, contains 10 grams of alcohol.

iStock.com/270770

iStock.com/yam

A person's BAC depends on four factors:

- the sex of the person
- number of alcoholic drinks consumed
- how quickly the drinks are consumed
- the mass of the person.

Calculating blood alcohol content

$$BAC_{male} = \frac{10N - 7.5H}{6.8M} \quad \text{and} \quad BAC_{female} = \frac{10N - 7.5H}{5.5M}$$

where N = number of standard drinks consumed
H = number of hours drinking
M = mass in kg

Blood accounts for about 7% of a person's mass so if we assume 1 kg ≈ 1 L then an 80 kg **male driver** will have 5.6 L of blood whereas a 60 kg **female driver** has only 4.2 L of blood. The male has a greater mass to 'soak up' the alcohol and will not get drunk as quickly.

ISBN 9780170413565

EXAMPLE 1

Justin and Britney were at a party for 5 hours. Justin, who weighs 75 kg, had 6 standard drinks and Britney, who weighs 58 kg, had 5 standard drinks.

a Who had the lower blood alcohol content (BAC)?

b If 7% of Justin's mass is blood, what is his blood volume, correct to one decimal place?

Solution

a For Justin: $N = 6,\ H = 5,\ M = 75$

$$BAC_{male} = \frac{10N - 7.5H}{6.8M}$$
$$= \frac{10 \times 6 - 7.5 \times 5}{6.8 \times 75}$$
$$= 0.0441...$$
$$\approx 0.044$$

For Britney: $N = 5,\ H = 5,\ M = 58$

$$BAC_{female} = \frac{10N - 7.5H}{5.5M}$$
$$= \frac{10 \times 5 - 7.5 \times 5}{5.5 \times 58}$$
$$= 0.0391...$$
$$\approx 0.039$$

Britney had the lower BAC.

b Justin's blood volume = $7\% \times 75 = 5.25$ L.

Limitations of the formulas

The BAC formulas only give an *approximate* BAC because many other factors affect BAC, such as:

- your health
- the time taken for your liver to process alcohol
- the size and type of drink
- how fast you drink (the faster you drink, the higher your BAC)
- alcohol is absorbed more slowly into the bloodstream if food is in your stomach
- the type of mixer used (water and juice slow absorption while carbonated mixers speed it up)
- the temperature of the drink (warm alcohol is absorbed quicker).

ISBN 9780170413565

Getting back to a BAC of zero

A healthy liver can only break down about one standard drink (10 g alcohol) per hour. Not even black coffee or cold showers will speed up the rate at which your body gets rid of alcohol. Once a person stops consuming alcohol and is at a certain BAC level, a normal body can only reduce the BAC by between 0.015 and 0.02 per hour.

Returning to zero BAC

For a body that reduces BAC by 0.015 per hour, the number of hours before zero BAC is reached is:

$$\text{Number of hours} = \frac{BAC}{0.015}$$

For a body that reduces BAC by 0.02 per hour, the number of hours before zero BAC is reached is:

$$\text{Number of hours} = \frac{BAC}{0.02}$$

EXAMPLE 2

Justin and Britney from Example **1** are both on provisional licences (P plates). They stopped drinking at 11 p.m. and waited until one of them had a BAC of zero and could legally drive home. Who drove home and at what time? Assume BAC is reduced by 0.015 per hour.

Solution

For Justin: $BAC = 0.044$

$$\text{No. hours} = \frac{BAC}{0.015}$$
$$= \frac{0.044}{0.015}$$
$$= 2.9333\ldots \text{ h}$$
$$= 2 \text{ h } 56 \text{ min}$$

For Britney: $BAC = 0.039$

$$\text{No. hours} = \frac{BAC}{0.015}$$
$$= \frac{0.039}{0.015}$$
$$= 2.6 \text{ h}$$
$$= 2 \text{ h } 36 \text{ min}$$

Press SHIFT o’ ” to change decimal hours to hours and minutes.

Britney drove home 2 h 36 min after 11 p.m., that is, at 1.36 a.m.

ISBN 9780170413565

Graphing BAC

EXAMPLE 3

After drinking 5 standard drinks, Ben's BAC was 0.09. His BAC decreases over time according to the linear function $B = 0.09 - 0.014H$.

a Use the formula to complete this table of values, correct to three decimal places.

Time after drinking, H hours	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Blood alcohol content, B	0.09		0.08					0.04			

b Graph the linear function on a number plane.

c What is the gradient of the line and what does it represent?

d Use your graph to find:

i Ben's BAC after 3 h 15 min **ii** when his BAC reaches 0.05.

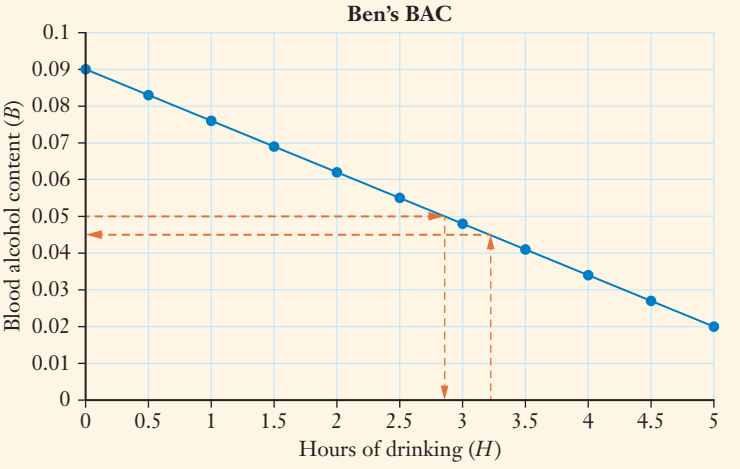
e Use the formula to find when Ben's BAC reaches zero.

Solution

a

Time after drinking, H hours	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Blood alcohol content, B	0.09	0.083	0.076	0.069	0.062	0.055	0.048	0.041	0.034	0.027	0.02

b



ISBN 9780170413565

c Choosing two points on the line or from the table, (0, 0.09) and (5, 0.02):

$$\text{Gradient} = \frac{0.02 - 0.09}{5 - 0} = -0.014.$$

The gradient is the rate at which Ben's BAC is decreasing per hour.

d **i** BAC after 3.25 h ≈ 0.045 From graph

ii BAC reaches 0.05 after about 2.9 h (or 2 h 50 min)

e When $B = 0$:

$$0 = 0.09 - 0.014H$$

$$0.014H = 0.09$$

$$H = \frac{0.09}{0.014}$$

$$= 6.428...$$

$$\approx 6\,\text{h}\ 26\,\text{min}$$

Ben's BAC reaches zero after 6 h 26 min.

DID YOU KNOW?

Princess Diana's tragedy

In 1997, Princess Diana, the mother of Princes William and Harry, died in a car accident in a road tunnel in Paris, France. Hotel security manager Henri Paul was the driver of the Mercedes Benz that crashed into a pillar, killing himself, the princess and her partner Dodi Fayed. He had a BAC of 0.187, was driving at 105 km/h, and none of them were wearing seat belts. His BAC was over 3 times the legal limit of 0.05, equivalent to drinking nine shots of whisky together quickly.

If Henri Paul's BAC had dropped by 0.017 per hour, how long would it have taken his BAC to return to zero?

Exercise 12.01 Blood alcohol content (BAC)

1 What is the main factor affecting your blood alcohol content? Select **A**, **B**, **C** or **D**.

A age

B number of drinks consumed

C time of day

D heart function

ISBN 9780170413565

2 Christine weighs 61 kg, Carla weighs 52 kg and Connie weighs 55 kg. If each drink 8 standard drinks over 6 hours, who has the highest BAC? Select **A**, **B**, **C** or **D**.

A Christine

B Carla

C Connie

D BAC is the same as they are all female

3 Mabel and Madge drank wine at an 80th birthday party over 4 hours. Mabel, who weighs 94 kg, had 4 standard drinks and Madge, who weighed 87 kg, had 3 standard drinks.

Example 1

a Who had the higher blood alcohol content, correct to two decimal places?

b If 7% of Mabel's weight was blood, how much blood did she have?

4 Who has the lowest blood alcohol content (BAC), correct to two decimal places? Select **A**, **B**, **C** or **D**.

A a 72 kg male who drank 8 drinks over 4 hours

B a 65 kg female who drank 9 drinks over 5 hours

C an 82 kg female who drank 7 drinks over 6 hours

D a 93 kg male who drank 10 drinks over 7 hours

5 This table shows the BAC (to two decimal places) for various body masses and number of drinks.

	Number of drinks									
Body mass (kg)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
50	0.03	0.07	0.10	0.14	0.17	0.20	0.24	0.27	0.31	0.34
55	0.03	0.06	0.09	0.13	0.16	0.19	0.22	0.25	0.28	0.31
73	0.02	0.05	0.07	0.09	0.12	0.14	0.16	0.19	0.21	0.23
82	0.02	0.04	0.06	0.08	0.10	0.13	0.15	0.17	0.19	0.21
95	0.02	0.04	0.05	0.07	0.09	0.11	0.13	0.14	0.16	0.18
100	0.02	0.03	0.05	0.07	0.09	0.10	0.12	0.14	0.15	0.17

a How many drinks does a 73 kg person need to drink to reach the legal limit of 0.05?

b How many drinks does a 100 kg person need to drink to reach the legal limit of 0.05?

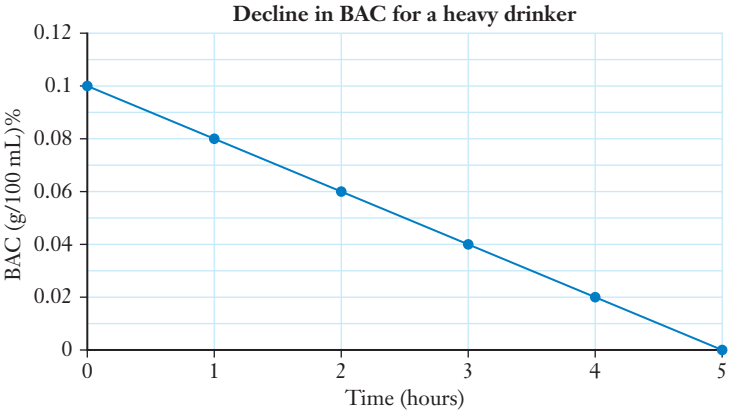
c What is the mass of a person who has a BAC of 0.16 after 7 drinks?

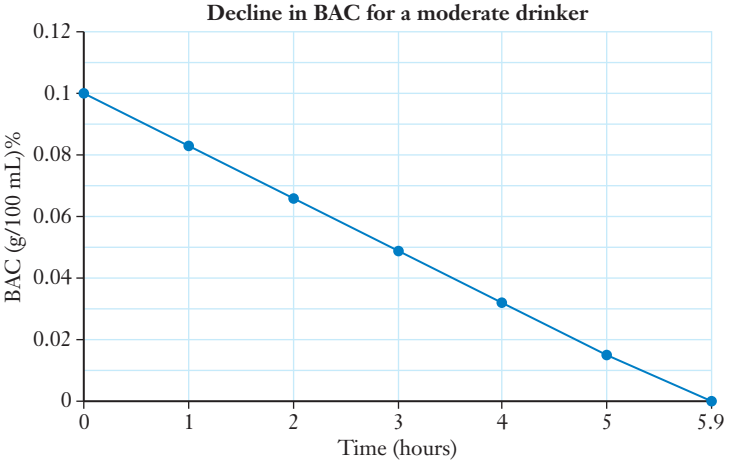
d What is the BAC of a 55 kg person after 8 drinks?

e Draw a line graph showing the BAC of a 50 kg person for 1 to 10 drinks.

ISBN 9780170413565

6 A heavy drinker consumes a large quantity of alcohol most days of the week whereas a moderate drinker consumes less alcohol less frequently. The two graphs show the difference in the decline of the BAC for a heavy drinker and a moderate drinker over time.





a Which drinker's BAC returns to zero quicker?

b What is the rate of decline of BAC for a:

i heavy drinker? **ii** moderate drinker?

c What is the BAC of a heavy drinker after 1 h 30 min?

d What is the BAC of a moderate drinker after 4 h 15min?

e What is the difference in the BAC for a heavy and a moderate drinker after 3 hours?

f Write a sentence or two describing the difference in the rate of BAC decrease for each type of drinker and possible reasons for the difference.

ISBN 9780170413565

7 Mark is 19, weighs 72 kg and holds a provisional licence with a zero alcohol limit. He started drinking at 6 p.m. and had 10 schooners of full strength beer (15 standard drinks) over 6 hours. He stopped drinking at midnight.

a What was his BAC, to two decimal places, at midnight?

b How long did it take before his BAC was back to zero if his BAC reduced by 0.02 per hour?

c At what time could he legally drive his car?

8 Maria is 17, weighs 61 kg and holds a provisional licence with a zero alcohol limit. She started drinking at 10 p.m. and had 6 mixer (9 standard) drinks over 4 hours.

Example 2

a What was her BAC, to two decimal places, at 2 a.m. when she stopped drinking?

b How long did it take before her BAC was back to zero if her BAC reduced by 0.015 per hour?

c At what time could she legally drive her car?

9 Hugh had a BAC of 0.06 when he stopped drinking and it took 5 hours for his BAC to return to zero. At what percentage rate per hour was his BAC reducing?

10 Chloe has a BAC of 0.08 and burns off alcohol at the rate of 0.016 per hour.

Example 3

a Copy and complete this table of values showing the decline in her BAC over 5 hours.

Time (hours)	BAC
0	0.08
0.5	0.072
1	
1.5	
2	
2.5	
3	
3.5	
4	
4.5	
5	

b Use the table of values to draw a line graph representing this information.

c If Chloe stopped drinking at midnight, then estimate to the nearest 15 minutes, when Chloe's BAC is equal to:

i 0.05 **ii** 0.

d What is the gradient of the line and what does it represent?

ISBN 9780170413565

INVESTIGATION

BAC feelings and effects

BAC	Person's feelings	Actual effects
0.03–0.05	relaxed talkative	worse concentration and coordination less able to make a judgement
0.05–0.1	blunted feelings lack of self-control	bad reflexes unable to perceive depth decreased reasoning skills
0.1–0.2	need to be over-expressive or act in a loud and disruptive manner	decrease in reaction time loss of physical control slurred speech
0.2–0.3	can't remember simple things in a daze	loss of understanding loss of sensations possible loss of consciousness
Over 0.3	depressed think they can do anything	can't read signs can't respond to traffic signals impaired breathing loss of bladder control unconsciousness or death

For example, a person in a nightclub with a BAC of 0.15 might talk loudly, disrupt other patrons and express themselves in a way that is not typical of their personality. Their speech may be slurred and they may not be able to walk or dance properly.

a How does a person feel with a BAC of 0.24?

b State three effects of drinking to a BAC of 0.06.

c What is the legal BAC for:

i a learner driver? **ii** a P-plate driver?

d Investigate the penalties for driving with a BAC of:

i 0.05 **ii** 0.1 **iii** 0.4

e Does a BAC below the legal limit mean that it is safe to drive? Explain.

ISBN 9780170413565

DID YOU KNOW?

BAC limits for drivers

The BAC limit in NSW (2017) for most drivers is 0.05, but lower if you are a less experienced driver or a driver of a heavy vehicle:

0 for all learner (L) and provisional (P) drivers

0.02 for drivers of buses, taxis, trucks over 13.9 tonnes or carrying dangerous goods

0.05 for all other drivers

Compared to a driver with a zero BAC, the risk of an accident with a BAC of 0.05 is double, 0.08 is 7 times and 0.15 is 20 times.

How many drinks can a provisional driver have if they plan to drive? Justify your answer.

12.02 Accident statistics

Alcohol, excessive speed, driver fatigue and distraction are the main causes of road accidents.

The risk of an accident resulting in death or serious injury is doubled for every 5 km/h you travel over 60 km/h. For example, a car travelling at 65 km/h is twice as likely to crash and a car travelling at 70 km/h is four times as likely to crash!

In a **fatal** accident, one or more persons die but there may be others who suffer serious injuries or permanent disability.

Fatal means 'resulting in death'.

Here are some statistics regarding fatal accidents in NSW.

- 65% occur in country areas.
- 13% involve alcohol.
- 30% affect motorcyclists.
- 88% of drink drivers involved in fatal accidents are male.

iStock.com/vasiliki

WS Investigating drivers in road fatalities

WS Investigating young drivers

ISBN 9780170413565

EXAMPLE 4

This table shows the involvement of alcohol in road accidents in 2015 in NSW.

Alcohol involved	Fatal crash	Serious injury	Non-serious injury	Total
Yes	43	386	382	811
No	283	5205	11 976	17 464
Total	**326**	**5591**	**12 358**	**18 275**

Source: Centre for Road Safety, Transport for NSW, State of NSW

a What percentage (correct to one decimal place) of fatal crashes involved alcohol?

b What percentage of the total road accidents had no alcohol involved?

c What percentage of the alcohol-involved road accidents involved a serious injury or fatality?

d If 14% of accidents involving alcohol were head-on crashes, how many was this?

Solution

a Percentage of fatal crashes involving alcohol $= \frac{43}{326} \times 100\%$

$= 13.1901 \ldots \%$

$\approx 13.2\%$

b Percentage of road accidents not involving alcohol $= \frac{17\,464}{18\,275} \times 100\%$

$= 95.5622 \ldots \%$

$\approx 95.6\%$

c Percentage of alcohol-related accidents involving serious injury or fatality $= \frac{43 + 386}{811} \times 100\%$

$= 52.8976 \ldots \%$

$\approx 52.9\%$

d Number of head-on crashes involving alcohol $= 14\% \times 811$

$= 113.54$

≈ 114

ISBN 9780170413565

EXAMPLE 5

This table gives the number of road fatalities in NSW from 2006 to 2015.

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Road fatalities	496	435	374	453	405	364	369	333	307	350

Source: Centre for Road Safety, Transport for NSW, NSW Government 'Road traffic casualty crashes in New South Wales: Statistical Statement for the year ended 31 December 2015' roadsafety.transport.nsw.gov.au

a For the 10-year period, find:

- **i** the mean number of fatalities per year
- **ii** the range
- **iii** the median
- **iv** the interquartile range.

b Draw a column graph representing the data.

c Write a sentence discussing the trend in fatalities from 2006 to 2015. Suggest reasons for these trends.

Solution

a **i** $$\text{Mean} = \frac{\text{sum of fatalities}}{\text{number of years}}$$
$$= \frac{3886}{10}$$
$$= 388.6$$

ii Put the values in ascending order:

307 333 350 369 364 374 405 435 453 496

lowest score; lower quartile; median; upper quartile; highest score

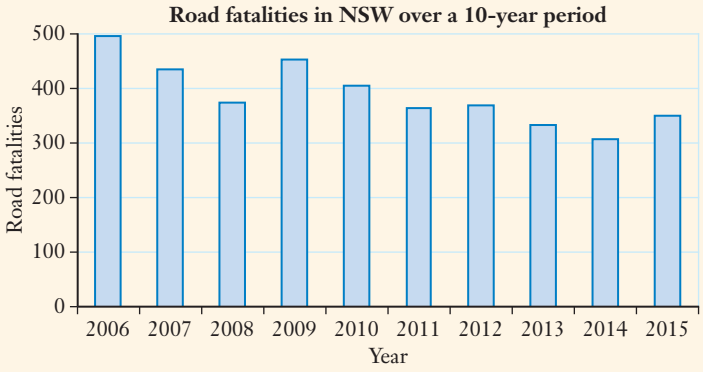
$$\text{Range} = \text{highest score} - \text{lowest score}$$
$$= 496 - 307$$
$$= 189$$

iii $$\text{Median} = \frac{364 + 374}{2} = 369$$

iv $$\text{Interquartile range} = \text{upper quartile} - \text{lower quartile}$$
$$= 435 - 350$$
$$= 85$$

ISBN 9780170413565

b



c The main trend is the decline in the number of road fatalities. This decline is possibly due to better road safety awareness programs, more police patrols and lower speed limits in school and roadworks zones.

Exercise 12.02 Accident statistics

1 In one year, 440 driver deaths on Australian roads were related to alcohol. Of these driver deaths, 224 had a BAC of over 0.05 and 273 were aged under 34.

a What fraction of drivers who died had a BAC over 0.05?

b What percentage (to the nearest whole number) of the drivers were aged under 34?

c What percentage of the drivers had a BAC of 0.05 or less?

Example 4

2 This table shows the number of Australian driver deaths by state and territory over two years.

Year	NSW	Vic	Qld	SA	WA	Tas	NT	ACT
2014	307	248	223	107	183	33	39	10
2015	350	252	243	102	160	34	49	15

Source: Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016, Road trauma Australia, 2015 statistical summary BITRE, Canberra ACT.

a How many driver deaths were there in Australia in:

i 2014? **ii** 2015?

b Find the average annual number of driver deaths in Australia over the two-year period.

c Which state or territory has the fewest driver deaths? Why do you think?

d Which state or territory had the smallest change between 2014 and 2015?

e Which states and territories had fewer driver deaths in 2015 than they did in 2014?

f Write a sentence describing the similarities and/or differences in the data for the years 2014 and 2015.

g Draw a divided bar graph representing the data for the year 2015.

ISBN 9780170413565

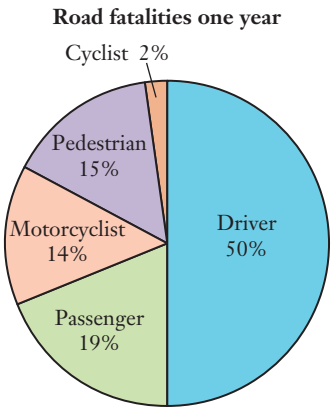
3 An accident survey reported that for fatigued drivers in 18 764 single-vehicle crashes, 70.2% were driving cars, 75.5% were male, 35% were aged under 24 years and 9.6% were aged over 60 years.

a How many drivers were aged 24 to 60?

b How many crashes did not involve cars?

c How many drivers were female?

4 This sector graph shows the category of person killed in road accidents.



a To the nearest degree, what is the sector angle in the graph for:

i Driver? **ii** Passenger? **iii** Cyclist?

b If there were 443 road fatalities last year, how many persons killed were:

i passengers? **ii** motorcyclists?

c If there were 68 pedestrians killed this year, how many drivers were killed?

5 This table shows the drivers under 40 years who died in road accidents over 4 years.

	Year			
Age of driver	**2012**	**2013**	**2014**	**2015**
under 17	70	66	65	65
17–25	284	230	234	226
26–39	300	243	252	272
All ages	1300	1187	1150	1205

Source: Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016, Road trauma Australia, 2015 statistical summary BITRE, Canberra ACT.

a Find the number of drivers aged 25 or less who were killed over the 4 years.

b Calculate (correct to one decimal place) the percentage of drivers killed in 2012 who were 17–25 years old.

c What was the percentage decrease (correct to one decimal place) of drivers killed aged 26–39 between 2014 and 2015?

d Which year had the fewest road fatalities overall?

e Which year had the fewest road fatalities for people aged 17–25?

ISBN 9780170413565

Example 5

6 This table shows the number of Australian road injuries involving different categories of people over six years.

Year	Drivers	Passengers	Pedestrians	Motorcyclists	Pedal cyclists	All road users
2008	3360	943	651	2341	1419	9315
2009	3420	1010	635	2576	1723	9854
2010	3421	988	726	2491	1780	9884
2011	3824	1047	632	2647	2017	10 667
2012	3713	995	643	2680	2157	10 671
2013	3773	1060	658	2881	2517	11 351

Source: Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016, Road trauma Australia, 2015 statistical summary BITRE, Canberra ACT.

a Which year and category had the highest number of road injuries?

b How many road injuries were there in Australia over the six years?

c What is the mean annual number of injuries involving motorcyclists (correct to one decimal place) over the 6 years?

d What is the range of passenger injuries over the 6 years?

e What is the median number of driver injuries over the 6 years?

f What is the interquartile range of pedal cyclist injuries over the 6 years?

g Represent the data for passengers and pedestrians on a line graph.

7 This table shows the number of Australian fatal crashes over 7 years categorised by number of vehicles and pedestrians involved.

Year	Single-vehicle crashes	Multiple-vehicle crashes	Pedestrian crashes	Total crashes
2009	649	509	189	1347
2010	544	520	169	1233
2011	504	463	184	1151
2012	520	503	167	1190
2013	515	430	156	1101
2014	463	438	149	1050
2015	491	447	163	1101

Source: Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016, Road trauma Australia, 2015 statistical summary BITRE, Canberra ACT.

a Calculate for single-vehicle crashes:

- **i** the mean number of crashes over the 7 years
- **ii** the median
- **iii** the range
- **iv** the interquartile range.

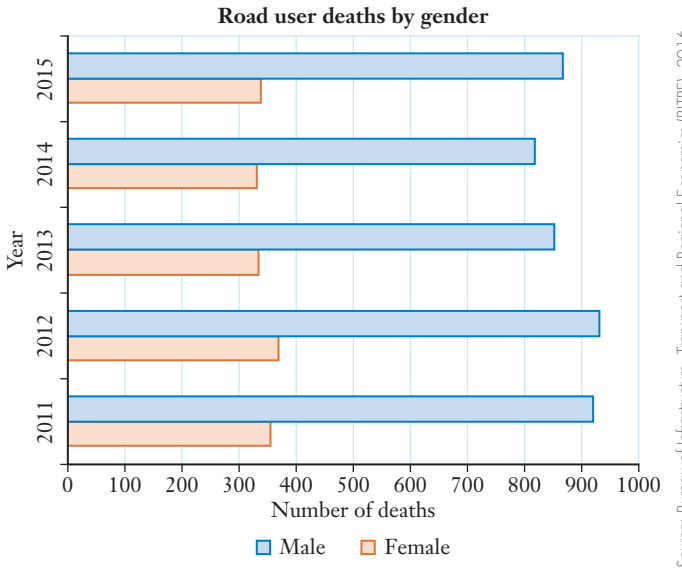
b Construct a column graph to represent the data for pedestrian crashes.

c Looking at the data for total crashes, describe any general trends over the 7 years and possible reasons for these.

d Why do you think there are more single-vehicle crashes than multiple-vehicle crashes?

ISBN 9780170413565

8 This clustered column graph compares male and female road fatalities over five years.



Source: Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016, Road trauma Australia, 2015 statistical summary BITRE, Canberra ACT.

a How many male deaths, to the nearest 50, occurred in 2013?

b How many female deaths, to the nearest 50, occurred in 2014?

c How many road user deaths, to the nearest 50, occurred in 2015?

d Describe any patterns in the data over the years and any differences between males and females, stating reasons for your comments.

9 This table shows the times of day NSW road casualties occurred in 2015.

Time of day	Road casualties
12 midnight–1:59 a.m.	447
2 a.m.–3:59 a.m.	270
4 a.m.– 5:59 a.m.	429
6 a.m.–7:59 a.m.	1404
8 a.m.–9:59 a.m.	2135
10 a.m.–11:59 a.m.	2080
12 midday–1:59 p.m.	2125
2 p.m.–3:59 p.m.	2608
4 p.m.–5:59 p.m.	2918
6 p.m.–7:59 p.m.	1985
8 p.m.–9:59 p.m.	1119
10 p.m.–11:59 p.m.	752

Source: Centre for Road Safety, Transport for NSW, State of NSW

ISBN 9780170413565

a Which time interval had the highest number of casualties? Give a reason why this may be so.

b Which time interval had the lowest number of casualties? Give a reason why this may be so.

c For this data set, find:

i the range **ii** the mean (correct to one decimal place)

iii the median.

d **i** Describe the pattern in the number of road casualties over the 24-hour period.

ii Do you think the pattern would still be the same for today? Give reasons.

10 This table shows the age and sex of speeding drivers involved in road accidents in NSW in 2015.

Age	Male drivers	Female drivers
17–20	357	150
21–25	319	125
26–29	195	71
30–39	374	145
40–49	286	104
All ages	2069	788

Source: Centre for Road Safety, Transport for NSW, State of NSW

a How many speeding drivers were aged 40–49?

b How many speeding female drivers were aged under 30?

c What percentage of speeding drivers aged 17–20 were male? Answer correct to three significant figures.

d What percentage (correct to two decimal places) of female speeding drivers were aged 17–20?

e What patterns do you notice between the numbers of male and female speeding drivers? Why do you think this is so?

f What patterns do you notice in the number of speeding drivers as age increases? Why do you think this is so?

ISBN 9780170413565

DID YOU KNOW?

Driver fatigue

Fatigue is mental or physical tiredness due to lack of sleep. In 2015, 16% of road fatalities in NSW involved driver fatigue. Most fatigue-related road fatalities occur between midday and 6 p.m., not at night. Fatigue is a factor in about 20% of head-on collisions where a vehicle crosses to the wrong side of the road due to a driver's slower reaction time or 'microsleeping'.

Here are some statistics on drivers in fatigue-related road accidents.

- 77% were driving cars.
- 72% were male.
- 26% were aged 17 to 25.
- 51% died or were seriously injured.

Shutterstock.com/Kathie Nichols

12.03 Speed, distance and time

Speed limits are imposed to ensure drivers travel at a safe speed for the road and surrounding environment. Some common speed limits in NSW are:

School zone	40 km/h
Residential area	50 km/h
City street	60 km/h
Highway	100 km/h
Motorway	110 km/h

WS Speed formula practice

WS Speed stories

WS Distance, speed and time

Average speed

$$\text{Average speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$S = \frac{D}{T}$$

This formula can also be written as $D = ST$ or $T = \frac{D}{S}$.

ISBN 9780170413565

EXAMPLE 6

Dean left home at 6 a.m. to travel from Sydney to Brisbane, a distance of 1027 km. He stopped for meal breaks and fuel and arrived in Brisbane at 8.30 p.m.

a What was his average speed for the trip, correct to the nearest km/h?

b How far, to nearest kilometre, could he travel at this speed in 50 minutes?

c How long, in hours and minutes, would it take him to drive 864 km at this speed?

Solution

a $D = 1027\,\text{km};\quad T = 14.5\,\text{h}$ ← 6 a.m to 8.30 p.m.

$$S = \frac{D}{T}$$
$$= \frac{1027}{14.5}$$
$$= 70.8275...$$
$$\approx 71\ \text{km/h}$$

Average speed was 71km/h.

b $S = 71\,\text{km/h};\quad D = ?;\quad T = 50\,\text{min} = \frac{50}{60}\,\text{h} = \frac{5}{6}\,\text{h}$

$$D = S \times T$$
$$= 71 \times \frac{5}{6}$$
$$= 59.166...$$
$$\approx 59\,\text{km}$$

He could travel 59 km.

c
$$T = \frac{D}{S}$$
$$= \frac{864}{71}$$
$$= 12.169...$$
$$\approx 12\,\text{h}\ 10\,\text{min}\ \ 8.45\,\text{s}$$

Press o’ ” to convert decimal hours to hours, minutes and seconds.

$$\approx 12\ \text{h}\ 10\ \text{min}$$

It would take him 12 h 10 min.

ISBN 9780170413565

Exercise 12.03 Speed, distance and time

1 Eva drove 93 km from Wollongong to Nowra in 1 hour 30 min. What was her average speed in km/h? Select **A**, **B**, **C** or **D**.

A 46.5 **B** 31 **C** 62 **D** 60

2 Stefan travelled 160 km at an average speed of 76 km/h. How long was his journey in hours and minutes? Select **A**, **B**, **C** or **D**.

A 2 h 10 min **B** 2 h 6 min **C** 2.2 h **D** 2.1 h

Example 6

3 Larni drove 742 km from home to her farm in 9 h 30 min.

a What was her average speed, correct to the nearest km/h?

b How long, in hours and minutes, would it take her to drive 1026 km at this rate?

c How far, to the nearest kilometre, could she travel at this rate in 3 h 10 min?

4 Cathy drove at an average speed of 57 km/h. At this rate, how long, in hours and minutes, will it take her to drive:

a 507 km? **b** 160 km? **c** 440 km?

5 Tan cycled 24 km to Scott's place at an average speed of 16 km/h. He cycled back at 12 km/h. Find:

a the total time for Tan's complete trip

b Tan's average speed, to the nearest km/h, for the trip.

6 Justine's car journey took 9 h 45 min at an average speed of 9.5 m/s. What is her:

a average speed in km/h?

b distance travelled, correct to the nearest metre?

7 How far, in metres to one decimal place, will a vehicle travel in 0.1 seconds when travelling at:

a 40 km/h? **b** 60 km/h? **c** 80 km/h? **d** 100 km/h?

8 Courtney drove a racecar for 402 m at 530 km/h.

a How long, to the nearest second, did it take?

b How far (correct to the nearest metre) could she travel in 10 seconds at this speed?

9 Luis rode his motorbike 460 m in 6.011 seconds.

a What was his speed in m/s, correct to one decimal place?

b How long, to the nearest 0.1 minute, would it take to go 58 km at this rate?

10 **a** Casey's average speed was calculated at 208.33 km/h for a 60.72 km motorbike race. How long, to the nearest 0.1 minute, did he take?

b If he took the same time to complete a 72.4 km race, what was his average speed in km/h for this race, correct to the nearest km/h?

ISBN 9780170413565

11 Shellie and Roxy set off for the beach 11.5 km away. Shellie rides her motor scooter at 32 km/h and Roxy cycles at 11 km/h. How many minutes head start should Shellie give Roxy so they arrive at the beach at the same time?

12 A car is travelling at 75 km/h. How far, to the nearest 0.1 m, will it travel in the 5 seconds it takes you to cross the road?

13 Police investigating a car crash determined that the car covered 20.7 m in 1.2 s. At what speed was the car travelling in km/h?

12.04 Stopping distance

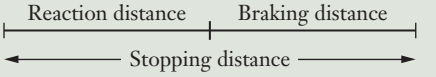
See, think, brake

Imagine you are driving and you see a child run out onto the road in front of you. You hit the brakes to avoid an accident. What is the time and distance from when you sense the danger to when you come to a full stop?

Shutterstock.com / Amy Johansson

Stopping distance

- **Reaction time** is the time between sensing a situation and applying the brakes.
- **Reaction distance** is the distance travelled during your reaction time.
- **Braking distance** is the distance travelled from when you apply the brakes until you stop.
- **Stopping distance** = Reaction distance + braking distance



ISBN 9780170413565

Braking distance

In dry conditions, a car travelling at 60 km/h can stop 20 m before one travelling at 80 km/h.

Drivers tend to underestimate stopping distance because the time taken to stop depends on many factors:

- your speed
- your reaction time
- the condition of your brakes and tyres
- the rate at which you decelerate
- the road surface and slope
- the wind speed and weather
- the weight of your vehicle
- driver visibility, whether it is night or day.

Braking distance formula

The approximate braking distance (d m) can be found using the formula:

$$d = kv^2$$

where v km/h is the initial speed of the car and
k is a **constant**.

EXAMPLE 7

Ben has a reaction time of 1.5 s. He was driving at 60 km/h when he saw a tree had fallen across the road. He applied his brakes and stopped 17.4 m later.

a What was his reaction distance, to the nearest metre?

b What was his stopping distance?

c Use the braking distance formula $d = kv^2$ and the given values to find:

- **i** the value of k (correct to two significant figures)
- **ii** the braking distance, to the nearest metre, when travelling at 84 km/h
- **iii** the stopping distance, to the nearest metre, when travelling at 84 km/h
- **iv** the speed, to the nearest km/h, of a vehicle with a braking distance of 100 m.

ISBN 9780170413565

Solution

a Reaction distance is the distance car travels in 1.5 s at 60 km/h.

Convert 60 km/h to m/s first.

$60 \text{ km/h} = 60\,000 \text{ m/h}$ Converting km to m

$= \frac{60000}{3600} \text{ m/s}$ Converting h to s

$= 16.666 \text{ m/s}$

$d = s \times t$

$= 25 \text{ m}$

Reaction distance is 25 m.

b Stopping distance = reaction distance + braking distance

$= 25 + 17.4$

$= 42.4 \text{ m}$

c **i** Given $d = 17.4$ m and $v = 60$ km/h,

$d = kv^2$

$17.4 = k \times 60^2$

$= 3600k$

$k = \frac{17.4}{3600}$

$= 0.004\,8333\ldots$

≈ 0.0048

ii Given $v = 84$ km/h and $k = 0.0048$,

$d = kv^2$

$= 0.0048 \times 84^2$

$= 33.8688$

≈ 34

Braking distance is 34 m.

iii Stopping distance = reaction time + braking distance

$= 25 + 34$

$= 59 \text{ m}$

Stopping distance is 59 m.

ISBN 9780170413565

iv Given $d = 100$ m and $k = 0.0048$,

$$d = kv^2$$

$$100 = 0.0048v^2$$

$$v^2 = \frac{100}{0.0048}$$

$$= 20833.333...$$

$$v = \sqrt{20833.333...}$$

$$= 144.3375\ldots$$

$$\approx 144$$

Speed is 144 km/h.

Speed and road conditions

It will take longer to stop on a wet road and even longer on an icy road. The braking distance changes with the condition of the road.

EXAMPLE 8

This table shows the different stopping distances at four different speeds and two different road conditions for a driver whose reaction time is 2 s.

Stopping distances for various speeds and road conditions						
Speed (km/h)	**Road**	**Reaction time (s)**	**Reaction distance (m)**	**Braking distance (m)**	**Stopping distance (m)**	**The equivalent of**
40	dry	2	22.2	7.9	30.1	
40	wet	2	22.2	12.6	34.8	
50	dry	2	27.8	12.3	40.1	8 car lengths
50	wet	2	27.8	19.7	47.5	4 bus lengths
60	dry	2	33.3	17.7	51.0	Olympic swimming pool
60	wet	2	33.3	28.3	61.6	3 cricket pitches
100	dry	2	55.6	49.2	104.8	length of a football field
100	wet	2	55.6	78.7	134.3	width of 10 houses

ISBN 9780170413565

a What do you notice about the reaction distances?

b Discuss the difference in braking distance for a car travelling at:

- **i** 40 km/h on a wet road and 50 km/h on a dry road
- **ii** 50 km/h on a wet road and 100 km/h on a wet road.

c Discuss the difference in stopping distance for a car travelling at:

- **i** 40 km/h on a dry road and 40 km/h on a wet road
- **ii** 60 km/h on a dry road and 100 km/h on a dry road.

d Why should you reduce speed when travelling on a wet road?

e Draw a clustered column graph to represent the data and say why this is a good representation of the data.

Solution

a The reaction distances increase with speed but do not depend on the road condition.

b **i** There is a 10 km/h difference in speed but the braking distances are about the same.

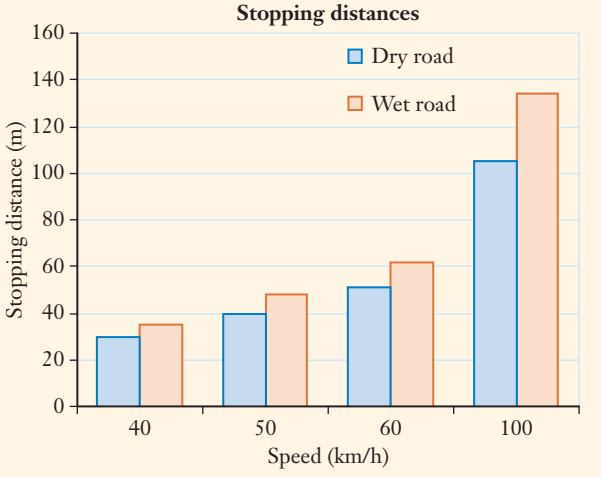
ii The speed is doubled but the braking distance is roughly 4 times greater.

c **i** At 40 km/h there is a 5 m difference in the stopping distance between a dry and wet road and this difference is significant.

ii There is a 40 km/h difference in speed but the stopping distance is doubled: 51.0 m and 104.8 m.

d You take longer to stop on a wet road so you should reduce your speed to avoid any incidents.

e The height of the columns shows clearly that as the speed increases, the difference between the stopping distances on dry and wet roads is greater.



ISBN 9780170413565

Exercise 12.04 Stopping distance

1 Darley saw a car stopped 80 m in front of him. He just stopped in time after travelling 51 m while braking. What was his reaction distance? Select **A**, **B**, **C** or **D**.

A 29 m **B** 80 m **C** 51 m **D** 30 m

2 A van moving at 110 km/h travelled a distance of 118.4 m on a wet road before its driver applied the brakes and finally stopped another 79.3 m later. What was the van's stopping distance?

Example 7

3 A motorcyclist with a quick reaction time stopped in 15.6 m after braking for a distance of 9.8 m. How far did he travel during the time it took to react to the danger?

4 This table shows the reaction, braking and stopping distances for a driver on a wet road with a reaction time of one second.

Speed (km/h)	Reaction time (s)	Reaction distance (m)	Braking distance (m)	Stopping distance (m)
40	1	11.1	B	23.7
50	1	A	19.7	33.6
60	1	16.7	C	45.0
100	1	27.8	78.7	D

a Find the values of A, B, C and D.

b When the speed is doubled from 50 km/h to 100 km/h, find to the nearest whole number the percentage increase in:
i braking distance **ii** stopping distance.

c If a driver with a reaction time of 1 s is travelling on a wet road at 100 km/h and sees an obstacle 110 m ahead, will he stop in time? Give reasons for your answer.

5 Two cars were moving side-by-side along a dry road in a 40 km/h school zone when their drivers each saw children crossing 50 m ahead. Fran applied her brakes within 1 second but Hanna took 2 seconds. Use the table of stopping distances from Example **8** on page 527 to find:

Example 8

a how far Hanna travelled under brakes

b how far Fran travelled before she applied her brakes

c if either would stop in time. Why?

6 Two truck drivers were travelling through a town on a dry road. Mark was doing 60 km/h and took 2 s to react to an accident up ahead while Sanjay was travelling at 40 km/h but took 4 s to react. Use the table of stopping distances from Example **8** on page 527 to find:

a how far Sanjay travelled before the brakes were applied

b how far Mark travelled under brakes

c which driver had the greater stopping distance.

ISBN 9780170413565

7 Fatima has a reaction time of 1.6 s. When travelling at 80 km/h, she applied his brakes and travelled 62 m before stopping. Use the braking distance formula $d = kv^2$ to find:

a the constant k, correct to four decimal places

b the braking distance, to the nearest 0.1 m, when travelling at 105 km/h

c the speed (to the nearest km/h) of Fatima if she travels 75 m under brakes before stopping

d the stopping distance (to the nearest 0.1 m) from a speed of:

i 80 km/h **ii** 105 km/h.

8 A car travelling at 115 km/h covered 89.6 m under brakes. Use the formula $d = kv^2$ to find:

a the constant k, correct to three significant figures

b the braking distance, correct to one decimal place, if the initial speed is 95 km/h

c the stopping distance for a driver with a reaction time of 2 s who is travelling at 115 km/h.

9 Use the formula $d = 0.02754v^2$ where v km/h is the speed of a car and d m the distance the car travels under brakes, to find (correct to three significant figures) the braking distance of a vehicle travelling at:

a 35 km/h **b** 61 km/h **c** 112 km/h **d** 93 km/h.

10 A car cruising at 80 km/h travelled 41.8 m on an icy road during the time it took for the driver to see a stop sign and start braking. It then travelled 57.2 m under brakes before it stopped.

a What was the driver's reaction time in seconds, to two decimal places?

b What was the stopping distance?

11 Use the formula $d = 0.00435v^2$, where d m is the distance travelled under brakes and v km/h the speed as brakes are applied, to find the speed of a racecar, correct to the nearest km/h, with a braking distance of:

a 142 m **b** 91.2 m **c** 101.4 m **d** 68.9 m.

12 A car travelled 84.3 m under brakes when initially travelling at 106.3 km/h. Use the braking formula $d = kv^2$ to find (correct to three significant figures):

a the constant k

b the braking distance for a car applying brakes from a speed of 110 km/h

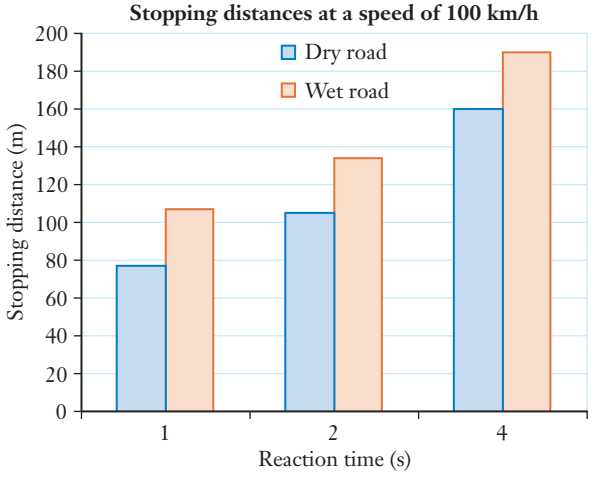
c the stopping distance of a car travelling at 110 km/h if the driver's reaction time is 2 s.

ISBN 9780170413565

13 The formula $d = \frac{1}{2}x^2 + 5x$, where x km/h is the speed of a vehicle and d m the distance travelled, is only used for very fast cars. How many metres can a racing car travel at a speed of:

a 100 km/h? **b** 250 km/h? **c** 300 km/h?

14 The graph shows the stopping distances on wet and dry roads with various reaction times.



a A driver on a dry road has a reaction time of 4 s. How far will he travel before he stops?

b How many metres does it take for a car to stop when travelling at 100 km/h on a wet road if the driver has a reaction time of:

i 1 s? **ii** 2 s? **iii** 4 s?

c Use the graph to copy and complete this table.

Road condition	Reaction time	Stopping distance

d Compare the benefits of showing data in a table with data represented on a graph.

ISBN 9780170413565

INVESTIGATION

STOPPING DISTANCES

1 a Use this table to describe the relationship between road conditions, speed and stopping distance, for a driver with a reaction time of 1.5 s. All values in the table are rounded to one decimal place.

Distances for a reaction time of 1.5 seconds				
Road condition	**Speed (km/h)**	**Reaction distance (m)**	**Braking distance (m)**	**Stopping distance (m)**
Dry	60	25.0	17.4	42.4
	100	41.7	48.2	89.9
Wet	60	25.0	27.8	52.8
	100	41.7	77.2	118.8
Icy	60	25.0	138.9	163.9
	100	41.7	358.8	427.5

This table of values, to one decimal place, was found using an online calculator.

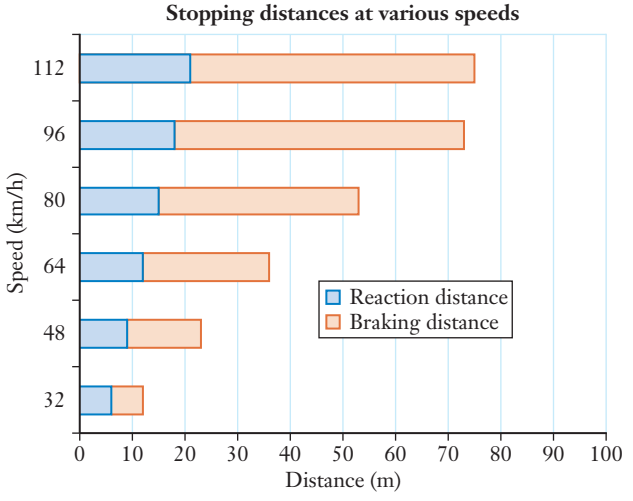
b Find an online calculator and use it to determine the stopping distance for:

i a car travelling at 60 km/h on an icy road if the driver has a reaction time of 1.6 s

ii the difference in stopping distances at 80 km/h for reaction times of 0.9 s and 1.4 s

iii a car travelling on a dry or wet road at 110 km/h, if reaction time is 1.5 s.

2 This graph shows the reaction and braking distances for cars travelling at various speeds. Use the graph to investigate the effect of speed on stopping distances.



Give one trend that you have discovered by looking at stopping distances with road conditions and speed.

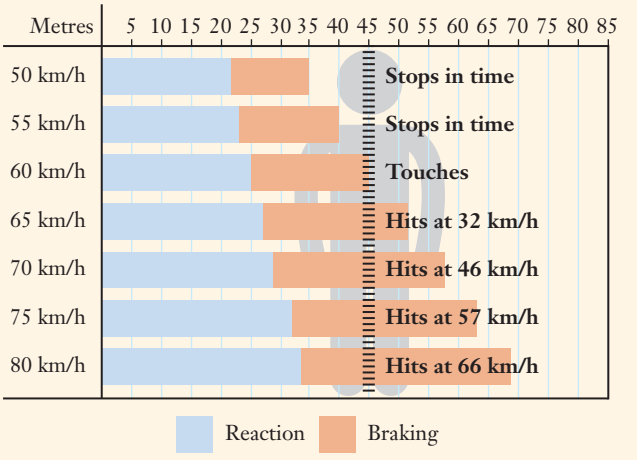
ISBN 9780170413565

DID YOU KNOW?

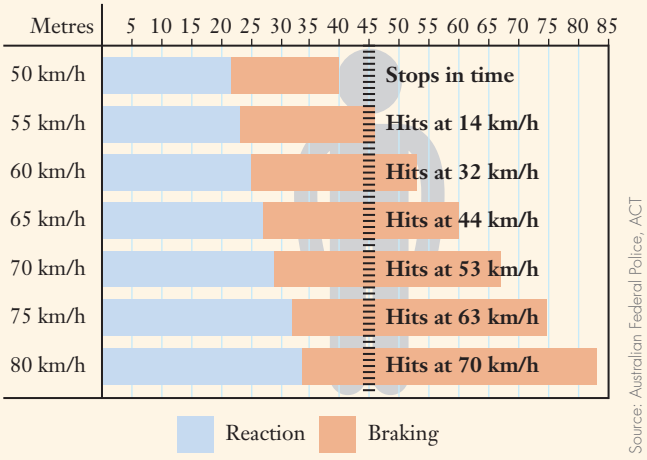
Will you stop in time?

These graphs were published by the Australian Federal Police to display stopping distances for different speeds and road conditions. If you are driving in a 60 km/h zone and a child runs onto the road 45 metres ahead and you brake hard, will you stop in time?

Dry conditions



Wet conditions



Source: Australian Federal Police, ACT

ISBN 9780170413565

INVESTIGATION

REACTION TIME TESTS

1 Use an Internet search engine to find a **Reaction Time Test** where the times you take to click the button when the light comes on are recorded and the average reaction time calculated. Work in groups of 4 or 5 and decide who has the best average reaction time.

2 Work in pairs to measure your 'reaction distance'.

- Your partner holds the top of a 30 cm ruler, at the 30 cm end.
- You sit on a chair with your thumb and forefinger around the bottom of the ruler, at the 0 cm end.
- Your partner drops the ruler at a random time.
- You catch the ruler and record the reaction distance.
- Repeat 5 times and find your average reaction distance.
- Swap places with your partner and repeat.

Which student in the class has the fastest reaction time (shortest reaction distance)? What is the class average?

3 Name three activities where a fast reaction time is an advantage.

Study tip

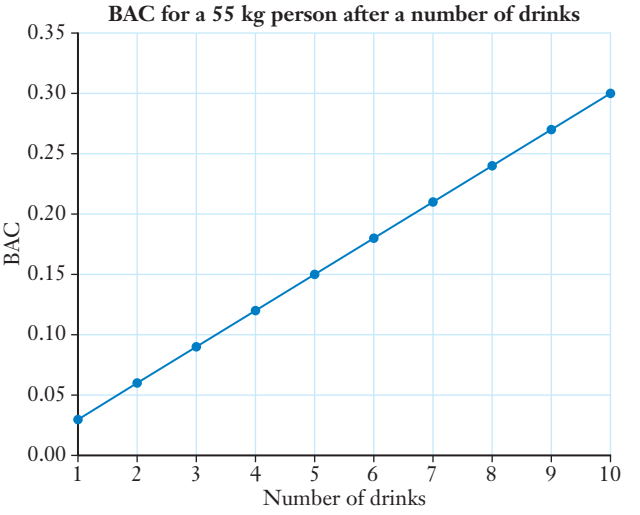
More exam tips

- Read all instructions carefully. Don't rush.
- Calculate the average time you should spend on each question.
- If one answer is taking too long, stop and ask yourself: 'Am I on the wrong track?' Don't get bogged down. You may need to retrace your steps, start again or come back later.
- When you have finished a question, make sure you have actually answered it. Do you need to write the answer in a sentence? Put a circle or box around the answer to highlight it.
- Make sure that your answer is reasonable, especially if it involves money or measurement. Did you round the answer correctly and include the correct units?
- If you have some time left at the end of the exam, double-check your answers, especially for the more difficult or uncertain questions.

ISBN 9780170413565

SAMPLE HSC PROBLEM

This graph shows the blood alcohol content (BAC) of a 55 kg woman according to the number of drinks she has had.



a Bianca is 55 kg. Estimate her BAC after 5 drinks.

b How many drinks will cause her to reach a BAC beyond 0.1?

c When BAC reaches 0.3, a person usually passes out. After how many drinks will this occur?

d What is the gradient of the line in the graph and what does it represent?

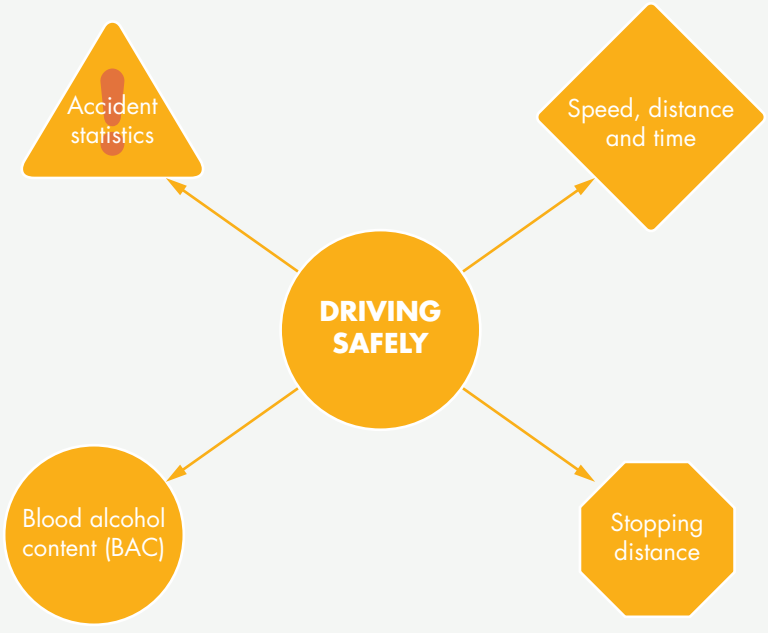
e If Bianca consumes 8 drinks, how many hours will it take her to return to a BAC of zero? (Use the formula: $h = \dfrac{BAC}{0.015}$)

ISBN 9780170413565

12. CHAPTER SUMMARY

This chapter, Driving safely, looked at the mathematics behind safe driving, covering the areas of measurement (blood alcohol, speed and stopping distance), algebra (formulas) and data analysis (road accident statistics). You should be familiar with the terminology, formulas, graphs and calculations involved with BAC, road accidents, speed and stopping distance.

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.



ISBN 9780170413565

12. TEST YOURSELF

1 Jennifer weighs 56 kg and drank 3 glasses of wine at a party over 3 hours. She thought she was safe to drive but when pulled over and tested, she was over the legal limit of 0.05. She later discovered that each wine glass contained $1\frac{1}{2}$ standard drinks. Use the formulas $BAC_{\text{female}} = \frac{10N - 7.5H}{5.5M}$; Number of hours $= \frac{BAC}{0.015}$ to answer the following questions.

Exercise 12.01

a What was her BAC, to three decimal places, when she was tested?

b How long, in hours and minutes, did it take before her BAC was back to zero?

c What would her BAC be, to three decimal places, after 3 standard drinks in 3 hours?

2 This table shows the BAC for women of different weights and number of drinks consumed in an hour.

Exercise 12.01

	Body weight (kg)						
Drinks per hour	**45**	**55**	**64**	**73**	**82**	**91**	**100**
1	0.05	0.04	0.03	0.03	0.03	0.02	0.02
2	0.09	0.08	0.07	0.06	0.05	0.05	0.04
3	0.14	0.11	0.10	0.09	0.08	0.07	0.06

Sheridan is 64 kg. At a party, she consumed 2 drinks in the first hour and 3 drinks in the second hour.

a Calculate Sheridan's BAC:

i at the start of the party

ii after the first hour

iii after the second hour.

b If Sheridan had no more drinks, how many hours until her BAC returns to zero? Assume that her body reduces her BAC at the rate of 0.018 per hour.

3 **a** Why is a heavier person less affected by alcohol?

Exercise 12.01

b Why are females more affected by alcohol?

ISBN 9780170413565

Exercise 12.02

4 This table shows the number of people killed in road crashes in an 8-year period in Australia.

Road fatalities in Australia for 2008–2015				
	Drivers		Passengers	
Year	Male	Female	Male	Female
2008	495	175	177	125
2009	521	186	182	148
2010	470	166	154	129
2011	422	146	158	126
2012	459	151	124	136
2013	393	164	101	102
2014	386	146	109	118
2015	424	131	117	132

Source: Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016, Road trauma Australia, 2015 statistical summary BITRE, Canberra ACT.

a What is the mean number of male drivers killed per year?

b What is the range of female passengers killed over the 8 years?

c In 2015, what percentage (correct to one decimal place) of drivers killed were male?

d In 2015, what percentage (correct to one decimal place) of females killed were drivers?

e What do you notice when you compare the numbers of drivers with the number passengers killed each year? Give a reason why this may be so.

f What is the median number of female drivers killed per year?

g Is the number of drivers killed each year generally increasing or decreasing? Give a reason why this may be so.

Exercise 12.02

5 This table shows the number of Australian fatal crashes over 7 years categorised by number of vehicles and pedestrians involved.

Year	Single-vehicle crashes	Multiple-vehicle crashes	Pedestrian crashes	Total crashes
2009	649	509	189	1347
2010	544	520	169	1233
2011	504	463	184	1151
2012	520	503	167	1190
2013	515	430	156	1101
2014	463	438	149	1050
2015	491	447	163	1101

Source: Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016, Road trauma Australia, 2015 statistical summary BITRE, Canberra ACT.

a Which category of crash shows a steady decline over the years until 2015?

b In 2015, what percentage (correct to one decimal place) of crashes involved pedestrians?

ISBN 9780170413565

c True or false? There are always more single-vehicle crashes than multiple-vehicle crashes.

d Which year had the highest number of:

i multiple-vehicle crashes? **ii** crashes overall?

e Calculate the percentage increase (to one decimal place) in single-vehicle crashes between 2014 and 2015.

f Draw a sector graph to display the data for 2015.

6 Scott took $2\frac{3}{4}$ h to drive from Canberra to Bodalla, 200 km away.

Exercise 12.03

a What was his average speed, correct to the nearest km/h?

b How long, in hours and minutes, would it take him to drive 430 km to Newcastle at this speed?

c How far, to the nearest km, could he travel at this speed in 5 hours?

7 A truck driver was travelling in the Northern Territory at 150 km/h on a road with no speed limits. He began braking 3 seconds after he saw a sign to a truck stop. If he travelled 810 m under brakes before coming to a stop, how far did he travel after seeing the sign?

Exercise 12.04

8 George is travelling on a dry road at 65 km/h and sees a cow in the middle of the road about 70 m ahead. He takes 1.2 s to apply the brakes, then travels 24 m under brakes before coming to a stop. Did he hit the cow? Give reasons for your answer.

Exercise 12.04

9 The following measurements were taken in a school zone.

Exercise 12.04

Stopping distances on a wet road in a school zone			
Reaction time (s)	**Reaction distance (m)**	**Braking distance (m)**	**Stopping distance (m)**
1	11.1	12.6	**A**
2	22.2	12.6	**B**
4	44.4	12.6	**C**

The speed limit in a school zone during school hours is 40 km/h.

a What do you notice about the braking distances?

b What do you notice about the reaction distances?

c Find the values of **A**, **B** and **C**.

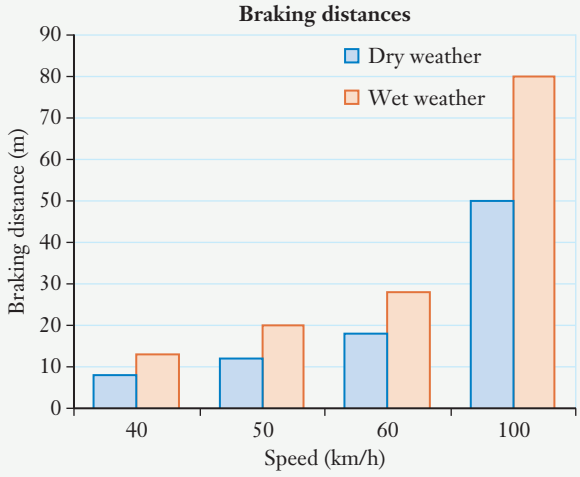
d If an 85-year-old driver in a school zone has a slow reaction time of 4 s, would he stop in time if he sees a child crossing the road 50 m ahead?

e Suggest two strategies for this driver that would help him avoid any accidents when driving.

ISBN 9780170413565

Exercise 12.04

10 This graph gives the braking distance for a car travelling on a dry or wet road at various speeds.



a What is the difference in braking distance on a dry road for two cars travelling at 50 km/h and 100 km/h respectively?

b How much further will a car travel under brakes on a wet road at 60 km/h than on a dry road at the same speed?

c If a car travels 50 m under brakes on a dry road, what is its approximate speed?

d What is the approximate speed of a car on a dry road that travels 12 m after the brakes are applied?

Chapter quiz

e Write a sentence noting any similarities or differences between braking distances on wet and dry roads, giving reasons for your answer.

ISBN 9780170413565