13

Mathematics and driving

This chapter deals with the application of knowledge and skills to practical driving contexts involving the purchase, running costs and safety of motor vehicles. The main mathematical ideas in this chapter are:

- interpreting tables and graphs to calculate motor vehicle purchase price and insurance costs
- calculating the cost of finance
- calculating fuel consumption
- calculating depreciation
- calculating the running costs of motor vehicles
- calculating speed and distance travelled
- solving problems relating to the safe operation of motor vehicles, including determining blood alcohol content and car stopping distances
- interpreting tables and graphs of road accident statistics.

FOCUS STUDY

Syllabus references: FSDr1, FSDr2, FSDr3
Outcomes: MGP–1, MGP-2, MGP-3, MGP-5, MGP-6, MGP-7, MGP-8, MGP-9, MGP-10

13A Cost of purchase

There are a number of costs additional to the retail price when purchasing a new car. Registration, stamp duty and compulsory third-party insurance are compulsory costs. There may also be a dealer delivery charge, other insurance costs and, if borrowing money to purchase the car, interest charges on the loan.

Registration

The fee to transfer the registration of a vehicle from one owner to another in 2012 was $29. The cost of registration of a new vehicle depends on the weight of the vehicle without a load (this is also referred to as the 'kerb weight' or tare) and whether the vehicle is being used mostly for private use or mostly for business use.
The table below shows some of these costs.

Table 1: Registration of motor vehicles in NSW

Size of vehicle	Tare weight	Private use ($)	Business use ($)
Cars, station wagons, trucks	up to 975 kg	243	358
	976 kg to 1154 kg	272	400
	1155 kg to 1504 kg	321	472
	1505 kg to 2504 kg	459	683
Motorcycles		112	112

Source: *www.rta.nsw.gov.au/*

WORKED EXAMPLE 1

Use Table 1 to determine how much extra it costs to register a new Toyota Corolla, which weighs 1250 kg, for business use compared with private use.

Solve	Think	Apply
Extra cost = $472 − $321 = $151	In Table 1, 1250 kg is in the range 1155 kg to 1504 kg. Cost for business use = $472 Cost for private use = $321	In the table, find the weight range in which the vehicle lies and read off the costs for business and private registration. Find the difference between these two costs.

Stamp duty

Stamp duty is a state tax that is based on the market value of the vehicle or the price paid, whichever is the greater. It is charged at the following rate:

3% of the market value up to $45 000 plus
5% of the value over $45 000.

(Go to the RTA website and click on the link to stamp duty for the costs for NSW.)

Insurance

Compulsory third-party (CTP) insurance, often referred to as a 'green slip', is necessary to register a vehicle in NSW. CTP is paid each time a vehicle is registered. It provides compensation to other people injured or killed when your vehicle is involved in an accident. (It does not cover damage to other vehicles, property, your vehicle or theft of your vehicle. Other types of insurance are available for these incidents.)

The cost of a green slip varies and depends on a number of factors including the type and age of the vehicle, where it is garaged, and the age and driving record of the drivers. You can get examples of cost of CTP (premiums) on the Motor Accidents Authority website at *www.maa.nsw.gov.au*.

There are other types of insurance available for motor vehicles, such as comprehensive insurance and third-party property insurance. These are not compulsory, but are advisable.

- Comprehensive insurance covers damage to, or theft of, your vehicle as well as damage to other vehicles and property.
- Third-party property damage vehicle insurance covers you for damage caused by your vehicle to someone else's vehicle or property. (It does not cover damage to, or theft of, your vehicle.)

Comprehensive insurance is more expensive than third-party property insurance because it covers more types of incidents. Both types of insurance vary in price according to factors such as the driver's age, driving experience, driving record, the type and age of the vehicle and where it is garaged. Many insurance companies will give an online quote for car insurance.

Dealer delivery

When purchasing a new car, the dealer will often charge a fee for 'dealer delivery'. This fee represents the cost to the dealer of preparing the car for delivery to the buyer. The fee varies from dealer to dealer and is sometimes waived or reduced in order to induce people to buy from them.

Trade-in

As part of the agreement, when you purchase a new car the dealer will usually buy your current car, if you have one, at an agreed price. When you sell your current car to the dealer in this way, it is called a trade-in.

EXERCISE 13A

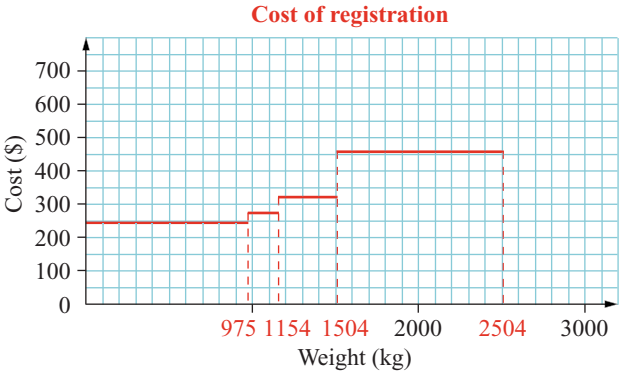
1 Complete the following to calculate the cost of registration, for private use, of a vehicle that weighs 1060 kg.
In the table, 1060 kg is in the range ____ kg to ____ kg.
∴ Cost to register for private use = ____.

2 Use Table 1 to calculate the cost of registration, for private use, of a vehicle that weighs:
a 1820 kg **b** 1150 kg.

3 How much more expensive is it to register a vehicle for business use than for private use, if the vehicle weighs:
a 2130 kg? **b** 975 kg?

1C 1E 10A 12E

4 The information in the table was used to draw the step graph of cost of registration versus weight for a vehicle for private use.



a Copy the graph and discuss its features.
b On the same axes, draw a graph of cost of registration versus weight for a vehicle for business use.
c Find the cost to register a vehicle that weighs:
i 1000 kg, for private use
ii 1450 kg, for business use.
d Find the difference between the cost of registration for private use and the cost for business use for a vehicle that weighs:
i 1750 kg **ii** 1200 kg.

FOCUS STUDY

WORKED EXAMPLE 2

Calculate the stamp duty to be paid on the purchase of a new Mazda RX8 that has a recommended retail price of $57 000.

Solve	Think	Apply
Stamp duty $= 0.03 \times 45\,000 + 0.05 \times (57\,000 - 45\,000)$ $= \$1950$	$3\% = 0.03$ 3% of $45 000 $= 0.03 \times \$45\,000$ The value over $45 000 $= \$57\,000 - \$45\,000$ $5\% = 0.05$ 5% of the value over $45 000 $= 0.05 \times (\$57\,000 - \$45\,000)$	If the price paid for the car is not more than $45 000, the stamp duty is 3% of its price. If the price is more than $45 000, the stamp duty is 3% of $45 000 ($1350) plus 5% of $(price − 45 000).

5 Complete the following to calculate the stamp duty.

a Market value = $17 900
Stamp duty = 3% of $_____
= 0.03 × $_____ = $_____

b Market value = $52 380
Stamp duty = ____% of $45 000 + ____% of ($_____ − $45 000)
= 0.____ × $45 000 + 0.____ × $_____ = $_____

6 Calculate the stamp duty that would be charged on a vehicle that has a market value of:

a $21 990 **b** $35 699 **c** $49 000 **d** $93 600

7 **a** Complete the following table.

Stamp duty on vehicle

Price ($'000)	3%	5%	Total
10	0.03 × $10 000 = $300		
20			
30			
40			
45	0.03 × $45 000 = $1350		
50	0.03 × $45 000 = $1350	0.05 × ($50 000 − $45 000) = $250	$1600
60	0.03 × $45 000 = $1350	0.05 × ($60 000 − $45 000) = $750	
70			
80			

b Use the information in the table to draw a graph with price, the independent variable, on the horizontal axis and stamp duty, the dependent variable, on the vertical axis. (This is a piecewise function: it is defined by more than one formula: in this case 3% of the market value up to $45 000, plus 5% of the value over $45 000.

c Use the graph to estimate the stamp duty on a vehicle purchased for:

i $35 000 **ii** $65 000 **iii** $78 000

WORKED EXAMPLE 3

a Calculate the total cost of purchasing a new Ford Falcon with a recommended retail price (RRP) of $37 000 and weight of 1704 kg. The CTP insurance for the car is $487 and the dealer delivery charge is $528. The car is for private use and the owner decides to take out comprehensive insurance that costs $960 for the first year.

b If the buyer receives a trade-in of $15 000 on their old vehicle, what is the changeover price for the new car?

	Solve	Think	Apply
a	RRP = $37 000 Registration = $459 Stamp duty = 0.03 × $37 000 = $1110 CTP insurance = $487 Dealer delivery = $528 Comprehensive insurance = $960 Total = $40 544	The weight of the car (1704 kg) is in the range 1505 kg to 2504 kg. From Table 1, the registration cost for private use is $459. The RRP of the car is less than $45 000; so stamp duty is 3% of its price ($37 000). Add all costs to the RRP of the car.	Use the weight of the vehicle to determine the registration cost from Table 1. Calculate the stamp duty. Add all the extra costs to the RRP of the car.
b	Changeover price = $40 544 − $15 000 = $25 544	Total cost = $40 544 Trade-in price = $15 000 Changeover price is the difference.	The changeover price is the total price of the vehicle less the trade-in.

8 Complete the following table to calculate the total cost to purchase each of the following new vehicles.

Costs	Holden Commodore	Mazda 6	Toyota Yaris	Toyota Prado	Yamaha motorcycle
RRP ($)	37 990	31 450	18 000	52 870	14 999
Weight (kg)	1 637	1 440	1 040	1 970	
Private or business	B	P	P	B	P
Registration ($)					
Stamp duty ($)					
CTP insurance($)	620	487	528	660	280
Dealer delivery ($)	790	585	499	887	389
Insurance ($)	1089	790	560	1185	299
Total					

WORKED EXAMPLE 4

Find the total cost of purchasing a 3-year-old Honda Civic that has an advertised price of $10 500. Third-party property damage insurance is $479.

Solve	Think	Apply
Dealer price = $10 500 Transfer of registration = $29 Stamp duty = 0.03 × $10 500 = $315 Insurance = $479 Total = $11 323	Transfer of registration fee is $29 for used vehicles. The price of the car is less than $45 000, therefore stamp duty is 3% of its price ($10 500).	The transfer of registration fee must be paid. Stamp duty is charged when there is a change of ownership of a vehicle. CTP insurance was paid when the car was last registered, so is not due until the next time it has to be registered.

9 Complete the following to find the total cost of buying a 4-year-old Nissan 350Z that is advertised for $43 900. Comprehensive insurance is $1560.

Dealer price = $43 900
Transfer of registration = $_____
Stamp duty = 0.03 × $_____ = $_____
Insurance = $_____
Total = $_____

10 Find the total cost of purchasing a 1-year-old Toyota Camry that has an advertised price of $23 900. Third party property insurance is $463.

11 Find the total cost of purchasing a 2-year-old Kawasaki 1400cc motorcycle that has an advertised price of $14 890. Comprehensive insurance is $678.

12 **a** Go to the Motor Accidents Authority website at *www.maa.nsw.gov.au* and use the following information to get a quote on a green slip for Richard.

Richard is buying a new car. There is no entitlement to GST input credit. The commencement date for the insurance will be the 1st/next month/this year. The vehicle is a new Mazda 6 Limited 2.5 L sedan that is normally garaged at Parramatta, postcode 2150. The car will be privately owned and registered for private use. It does not have a current CTP insurance policy because it is a new car. It will also be covered by comprehensive insurance with NRMA Insurance. Richard has continuously held comprehensive insurance with this company for 2 years. The policy does not have a no-claim discount. Richard, the sole owner/driver, is 20 years old. He has not had any accidents in the 3 years he has had his licence and has not lost any demerit points. Richard is not a member of NRMA roadside service.

b What is the cheapest quote?

c What would the cheapest quote be if Richard had had one at-fault accident and lost 4 demerit points.

13 **a** Search the internet for an insurance company (such as NRMA insurance at *www.nrma.com.au/*) and use the following information to get a quote for comprehensive insurance for this new car.

Vehicle details: Toyota Corolla Ascent Hatchback 1.8 that is usually garaged at Manly, postcode 2095. Insurance cover required $21 990. The car is for private use and the owner has no finance owing on the car. The driver is a 20-year-old male (enter a date of birth that makes the driver 20-years old) with 2 years driving experience and has had no accidents. He wants an excess of $600 on the policy and has no other relevant policies or memberships. As this is his first car there is no previous insurer.

b Vary the age of the driver (say 20, 25, 30, 35 years, etc.) and record and compare costs.

c Vary the gender of the driver for these same ages and compare costs.

d Using a map and list of postcodes, vary the locality where the vehicle is garaged and compare costs.

e Investigate the change in costs for a driver who has had an at-fault accident.

f Vary the type of vehicle and compare costs. For example, compare the costs for small versus large passenger vehicles, 4WDs, people movers, light commercial.

g Compare the costs from other insurers. (Try *www.thebuzzinsurance.com.au.*)

h Is there an age excess to be paid on top of the basic excess?

14 Investigate and compare the advantages and disadvantages of comprehensive and third-party property insurance for cars. In what circumstances might one form of insurance be more suitable than the other?

15 Investigate and compare the costs of third-party property insurance at *www.nrma.com.au/car-insurance/*. Use the example and investigations suggested in question **13**.

16 From the information gathered in the previous questions, make a list of the factors that affect insurance premiums (such as type of vehicle, driver experience, etc.)

13B Financing a purchase

Often people need to borrow money to buy a car. There are many financial institutions that will provide a car loan or personal loan for this purpose.

WORKED EXAMPLE 1

The following table gives the monthly repayments ($) for every $1000 borrowed on a declining-balance car loan.

Interest rate (% p.a.)	Term of loan (months)				
	12	24	36	48	60
8	86.99	45.23	31.34	24.41	20.28
9	87.45	45.68	31.80	24.89	20.76
10	87.92	46.14	32.27	25.36	21.25
11	88.38	46.61	32.74	25.85	21.74
12	88.85	47.07	33.21	26.33	22.24
13	89.32	47.54	33.69	26.83	22.75
14	89.79	48.01	34.18	27.33	23.27

a Calculate the monthly repayments on a loan of $23 600 at 9% p.a. reducible over 5 years.
b What is the total amount of interest paid on this loan?
c How much would be saved by repaying the loan over 4 years instead of 5 years?

	Solve	Think	Apply
a	Monthly repayment $= \$20.76 \times 23.6$ $\approx \$489.94$	5 years = 60 months From the table, monthly repayment on $1000 over 60 months at 9% p.a. is $20.76. The number of $1000s being borrowed $= \frac{23\,600}{1000} = 23.6$. Monthly repayment $= \$20.76 \times 23.6$	Convert the term of the loan to months. Find the monthly repayment on $1000 from the table for the interest and term. Divide the amount of the loan by 1000 to determine the number of thousands ($) borrowed. Multiply the monthly repayment for $1000 by the number of 1000s borrowed.
b	Total amount repaid $= \$489.94 \times 60 = \$29\,396.40$ Interest paid $= \$29\,396.40 - \$23\,600$ $= \$5796.40$	Total amount repaid $= \$489.94 \times 60.$ Amount borrowed was $23 600. Interest paid over 5 years $= \$489.94 \times 60 - \$23\,600.$	Total amount repaid is the monthly repayment by the number of months. The difference between this and the amount borrowed is the interest paid on the loan.
c	Monthly repayment over 4 years $= \$24.89 \times 23.6 \approx \$587.40$ Total amount repaid $= \$587.40 \times 48 = \$28\,195.20$ Amount saved $= \$29\,396.40 - \$28\,195.20$ $= \$1201.20$	Amount saved = amount repaid over 5 years − amount repaid over 4 years Amount saved is the difference between $29 396.40 and $28 195.20.	The amount saved is the difference between the total amount repaid over the longer term and the total amount repaid over the shorter term.

Note: Most financial institutions have an online calculator that can be used to calculate monthly repayments on a loan. Visit *www.aussie.com.au* or *www.savingsloans.com.au.*

EXERCISE 13B

Use the table in Worked Example 1 of this section, or an online calculator, to answer the following questions.

1 Complete the following to calculate the monthly repayments on a car loan of $22 700 at 12% p.a. reducible over 4 years.

4 years = ____ months

From the table, the monthly repayment on $1000 over ____ months at 12% p.a. = $_____.

Number of $1000s being borrowed $= \frac{22\ 700}{1000}$

$= $ ____

$\therefore$ Monthly repayment on $22 700 = $_____ $\times$ ____

= $_____

2 Calculate the monthly repayments on these car loans:

- **a** $25 000 at 11% p.a. reducible over 4 years
- **b** $13 600 at 9% p.a. reducible over 3 years
- **c** $38 900 at 14% p.a reducible over 5 years

3 For the following loans, calculate:

- **i** the monthly repayment
- **ii** the total amount of interest paid.

a $18 200 at 10% p.a. over 4 years

b $8700 at 8% p.a. over 2 years

c $34 800 at 12% p.a. over 5 years

4 Heidi wants to buy a motor bike. She is offered a loan of $14 100 at 9% p.a. over either 3 or 4 years. How much would she save if she chose the shorter term?

5 a Jack needs to borrow $19 600 to buy a car and can pay a maximum of $450 per month. He is offered a loan at 12% p.a. Can he afford the loan? Give details.

b Could he afford the loan if the interest rate was 14%? What advice would you give Jack?

6 a Jo's monthly repayment on a loan at 13% p.a. over 3 years is $808.56. How much did Jo borrow?

b Ben's monthly repayment on a loan at 10% p.a. over 4 years is $798.84. How much did Ben borrow?

FOCUS STUDY

INVESTIGATION 13.1

13C Fuel consumption

WORKED EXAMPLE 1

A car uses 50 L of petrol to travel 416 km. Calculate the fuel consumption of the car on this trip.

Solve	Think	Apply
Fuel consumption $= \frac{416 \text{ km}}{50 \text{ L}}$ $= 8.32$ km/L Car travels 8.32 km on 1 L of petrol. Fuel consumption $= \frac{50 \text{ L}}{416 \text{ km}}$ $= 0.12$ L/km Car uses 0.12 L of petrol for every 1 km travelled. 0.12 L/km = 12 L/100 km So the car consumes 12 L of petrol for every 100 km travelled.	Divide distance travelled (416 km) by amount of petrol used (50 L). Divide amount of petrol used (50 L) by the distance travelled (416 km). This is $0.12 \text{ L/km} = \frac{0.12 \times 100}{1 \times 100 \text{ km}}$ or 12 L/100 km, which is the most common way of expressing fuel consumption.	Fuel consumption is a comparison between two types of quantities, distance travelled and amount of fuel used: it is a rate. It can be determined by dividing the distance travelled by the amount of fuel used, giving the number of kilometres travelled on 1 L of petrol, or by dividing the amount of fuel used by the distance travelled, giving the amount of fuel consumed in travelling 1 km. For ease of comparison, this second rate is usually expressed as L/100 km.

EXERCISE 13C

2G 7I

1 If a car uses 35 L of petrol on a trip of 400 km, complete to calculate fuel consumption to 2 decimal places.

a Fuel consumption in km/L $= \frac{400 \text{ km}}{\square \text{ L}} =$ ____ km/L

b Fuel consumption in L/km $= \frac{35 \text{ L}}{\square \text{ km}} =$ ____ L/km

c Fuel consumption in L/100 km = ____ L/km × ____ km = ____ L/100 km

2 Calculate the fuel consumption for each trip in:

i km/L **ii** L/km **iii** L/100 km

a A car travels 260 km on 28 L of petrol.

b A car travels 220 km on 19 L of petrol.

c A car travels 420 km on 48 L of petrol.

WORKED EXAMPLE 2

How far can a Toyota Corolla travel on 48 L of petrol if its petrol consumption is 7.4 L/100 km?

Solve	Think	Apply
Distance $= \frac{48}{7.4} \times 100$ $= 649$ km	The number of 'lots of 7.4 L' used $= \frac{48}{7.4}$. The car travels 100 km for each 'lot of 7.4 L' used.	Distance travelled (km) $= \frac{\text{amount of fuel}}{\text{fuel consumption}} \times 100$ Fuel consumption is in L/100 km.

FOCUS STUDY

3 Complete this to calculate how far a vehicle can travel on 45 L of fuel if the fuel consumption is 6.4 L/100 km.

$$\text{Distance} = \frac{45}{\square} \times 100 = \_\_\_\_ \text{ km}$$

4 How far can a vehicle travel on:

a 35 L of fuel if fuel consumption is 8.4 L/100 km?

b 66 L of fuel if fuel consumption is 9.6 L/100 km?

c 94 L of fuel if fuel consumption is 12.2 L/100 km?

WORKED EXAMPLE 3

Calculate the amount of petrol used by a Holden Commodore on a trip of 640 km if its petrol consumption is 11 L/100 km.

Solve	Think	Apply
Petrol used $= \frac{640}{100} \times 11$ $= 70.4$ L	The number of 'lots of 100 km' travelled $= \frac{640}{100}$ (6.4). Each 'lot of 100' km uses 11 L of petrol.	Amount of fuel used (L) $= \frac{\text{distance travelled}}{100} \times$ fuel consumption Fuel consumption is in L/100 km.

5 Complete the following to calculate the amount of fuel used by a vehicle on a trip of 1160 km, if the fuel consumption is 10.6 L/100 km.

$$\text{Fuel used} = \frac{\square}{100} \times \square = \_\_\_\_ \approx \_\_\_\_ \text{ L}$$

6 Calculate the amount of fuel used by a vehicle on a trip of:

a 325 km, if the fuel consumption is 8.4 L/100 km

b 540 km, if the fuel consumption is 12.2 L/100 km

c 270 km, if the fuel consumption is 6.7 L/100 km.

7 A sales representative averages 3400 km of city driving each month in a Ford Falcon that has a fuel consumption of 11.4 L/100 km (city cycle). Calculate the cost of petrol used in a month in which the average price of unleaded petrol (ULP) is 149.9c/L.

8 In 2006 the average fuel consumption of Australian vehicles was 13.8 L/100 km and the average yearly distance travelled was 17 600 km. If the average price of fuel was 135.9c/L, what was the average yearly fuel cost?

9 A Citroën C4 uses 7.6 L/100 km of ULP and the diesel version of the same car uses 6 L/100 km of diesel fuel.

a Calculate the cost of driving the petrol version 780 km if ULP is 152.9c/L.

b Calculate the cost of driving the diesel version 780 km if diesel fuel is 162.2c/L.

c How much cheaper is the diesel option over this distance?

10 Harry owns a Holden Commodore that runs on ULP and has a fuel consumption of 10.6 L/100 km. When converted to run on liquid petroleum gas (LPG), its fuel consumption is 13.5 L/100 km. Harry averages 19 000 km per year.

a Calculate the annual cost for each type of fuel (assuming the car only runs on one type of fuel for a year) if the average price of ULP is 149.9c/L and LPG is 67.8c/L.

b How much a year would Harry save in fuel costs if he converted to the LPG model?

c What would be the savings per month?

d The cost of converting the car to LPG is $2600. How many months would Harry take to break even, if he converts the car to LPG?

e What distance would Harry travel before reaching the break-even point? (The break-even point is the point at which the cost of running on each type of fuel is the same.)

11 A car is available with a petrol motor or diesel motor. The petrol version uses 12.8 L/100 km and the diesel 7.8 L/100 km. Jenny averages 13 000 km per year.

- **a** **i** If Jenny bought the car with the petrol engine, what would be her annual fuel cost if ULP is 152.9c/L?
  - **ii** If Jenny bought the car with a diesel engine, what would be her annual fuel cost if diesel fuel is 169.9c/L?
  - **iii** How much per year would she save by buying the car with the diesel engine?
- **b** What is the average monthly saving?
- **c** The diesel car costs $1200 more to buy than the petrol car. How many months would it take to break even if Jenny buys the diesel car?
- **d** What distance would Jenny travel before reaching the break-even point?

12 **a** A large 4WD has a fuel consumption of 15 L/100 km when running on ULP. The cost of ULP is $1.50/L. Complete the table below to show the fuel cost of driving this car.

Distance travelled (km)	0	10 000	20 000	30 000	40 000	50 000
Fuel cost ($)	0	2250				

- **b** Use the information in the table to draw a graph of fuel cost versus distance travelled.
- **c** When converted to LPG the fuel consumption of this vehicle is 19.5 L/100 km. The cost of converting this vehicle to LPG is $3500 and the cost of LPG is 70c/L. Complete the following table to show the cost of driving this vehicle on LPG.

Distance travelled (km)	0	10 000	20 000	30 000	40 000	50 000
Fuel cost ($)	3500	4865				

- **d** On the same axes as in part **b**, draw a graph of fuel cost versus distance travelled for the LPG vehicle.
- **e** From the graph, estimate the distance travelled to reach the break-even point.

13 **a** A car running on ULP uses 12 L/100 km. The cost of ULP is $1.50/L. Complete the table below to show the cost of driving this car.

Distance travelled (km)	0	10 000	20 000	30 000	40 000	50 000
Fuel cost ($)	0	1800				

- **b** Use the information in the table to draw a graph of fuel cost versus distance travelled.
- **c** The diesel version of the same car costs $1400 more than the petrol version and uses 8 L/100 km. Diesel fuel costs $1.60/L. Complete the following table to show the cost of driving this car.

Distance travelled (km)	0	10 000	20 000	30 000	40 000	50 000
Fuel cost ($)	1400	2680				

- **d** On the same axes as in part **b**, draw a graph of fuel cost versus distance travelled for the diesel car.
- **e** From the graph, estimate the distance travelled to reach the break-even point.

INVESTIGATION 13.2

13D Depreciation

The **depreciation** of an item is its loss in value due to age and usage. The value of an item after depreciation is called its **salvage value**, or **book value**, or **written-down value**.

EXERCISE 13D

2I **1** The table gives the value of some new cars after 1 year.

Make	Value (RRP) when new ($)	Value after 1 year ($)	Decrease in value ($)	Decrease in value (%)
Ford Falcon	37 225	25 500	11 725	11 725 ÷ 37 225 × 100 = 31%
Holden Commodore	39 990	29 600		
Toyota Aurion	35 990	25 300		
Kia Rio	18 290	15 700		
Mazda 3	22 330	19 700		
Toyota Corolla	22 990	19 800		
Honda Accord Euro	40 140	36 500		
Mazda 6	33 450	29 500		
Land Rover Discovery	84 300	78 000		
Mitsubishi Pajero	63 190	57 000		
Toyota Prado	64 490	62 000		
Mercedes-Benz E220	83 300	71 400		
BMW 325	83 815	75 400		
Jaguar X-type	59 435	45 200		

a Complete the table by finding the decrease in value and the percentage decrease in value for each vehicle.
b Which vehicle depreciated the most?
c Do some categories (such as car make, large, small, luxury, 4WD, etc.) depreciate more than others?

WORKED EXAMPLE 1

Construct a table to calculate the value of a $20 000 car after 3 years if it depreciates $3400 each year.

Solve

Year	Value ($)	Depreciation ($)	Depreciated value ($)
1	20 000	3400	16 600
2	16 600	3400	13 200
3	13 200	3400	9 800

Think

Value end of year 1
= $20 000 − $3400
= $16 600
Value end of year 2
= $16 600 − $3400
= $13 200, etc.

Apply

Subtract the amount of depreciation from the value at the beginning of the year.
Note: Value at beginning of year = value at end of previous year.

FOCUS STUDY

Worked Example 1 is an illustration of the **straight-line method** of depreciation, which assumes that the item depreciates by a constant amount each year.

The formula for the straight-line method is $S = V_0 - Dn$
where S = salvage (current) value of the asset
V_0 = purchase price of the asset
D = amount of depreciation per time period
n = total number of time periods.

WORKED EXAMPLE 2

A car purchased for \$14 900 depreciates \$1660 per year. Calculate its book value after 5 years.

Solve	Think	Apply
$S = V_0 - Dn$ $= 14\,900 - 1660 \times 5 = \$6600$	Substitute $V_0 = 14\,900$, $D = 1660$, $n = 5$ into the formula.	Substitute the values of V_0, D and n into the formula $S = V_0 - Dn$.

2 A car purchased for \$26 990 depreciates \$3300 per year. Complete the following to calculate its book value:

a after 2 years

$S = V_0 - Dn$
$= \$26\,990 - \$\_\_\_\_ \times 2 = \$\_\_\_\_$

b after 4 years.

$S = V_0 - Dn$
$= \$\_\_\_\_ - \$\_\_\_\_ \times \_\_\_\_ = \$\_\_\_\_$

3 A car purchased for \$18 700 depreciates \$1980 per year. Calculate its book value after:

a 2 years **b** 5 years.

4 A car purchased for \$38 999 depreciates \$4200 per year. Calculate its book value after:

a 2 years **b** 5 years.

WORKED EXAMPLE 3

A car purchased for \$21 990 was worth \$11 990 after 4 years, using the straight-line method of depreciation. Calculate the annual amount of depreciation.

Solve	Think	Apply
$S = V_0 - Dn$ $\$11\,990 = \$21\,990 - D \times 4$ $4D + \$11\,990 = \$21\,990$ $4D = \$21\,990 - \$11\,990$ $= \$10\,000$ $\therefore D = \$2500$	Substitute $S = \$21\,990$, $V_0 = \$11\,990$, $n = 4$ into the formula. $\$11\,990 = \$21\,990 - D \times 4$ Add $4D$ to both sides. Subtract \$11 990 from both sides. Divide both sides by 4.	Substitute the given values into the formula $S = V_0 - Dn$ and solve the resulting equation.

5 A car purchased for \$26 900 was worth \$14 260 after 4 years, using the straight-line method of depreciation. Complete the following to calculate the annual amount of depreciation.

$S = V_0 - Dn$
$\_\_\_\_ = \_\_\_\_ - D \times 4$
$4D + \_\_\_\_ = \_\_\_\_$
$4D = \_\_\_\_ - \_\_\_\_ = \_\_\_\_$
$\therefore D = \_\_\_\_$

6 A car purchased for $45 900 was worth $35 150 after 5 years, using the straight-line method of depreciation. Calculate the annual amount of depreciation.

7 A car that was purchased for $36 760 was worth $14 460 after 5 years, using the straight-line method of depreciation. Calculate the annual amount of depreciation.

8 A car purchased for $15 570 depreciates $3120 each year. According to the straight-line formula, after how many years is the car worthless?

9 A car purchased for $22 880 depreciates $3200 each year. According to the straight-line formula, after how many years is the car worthless?

WORKED EXAMPLE 4

Construct a table to calculate the value of a $20 000 car after 3 years if its rate of depreciation is 20% p.a.

Solve

Year	Value ($)	Depreciation ($)	Depreciated value ($)
1	20 000	4000	16 000
2	16 000	3200	12 800
3	12 800	2560	10 240

Think

Using 20% = 0.2
Depreciation year 1
= 0.2 × $20 000 = $4000
Value end of year 1
= $20 000 − $4000
= $16 000
Depreciation year 2
= 0.2 × $16 000 = $3200
Value end of year 2
= $16 000 − $3200
= $12 800
Depreciation year 3
= 0.2 × $12 800 = $2560
Value end of year 3
= $12 800 − $2560
= $10 240

Apply

Amount of depreciation each year = rate of depreciation × the value of the car at the beginning of the year.
Subtract the amount of depreciation from the value at the beginning of the year.

10 Complete the table to calculate the value of a $24 900 car after 3 years if its rate of depreciation is 22% p.a.

Year	Value ($)	Depreciation ($)	Depreciated value ($)
1	24 900	0.22 × 24 900 = 5478	19 422
2	19 422	0.22 × _____ = ____	
3			

11 Complete the table to calculate the value of a $34 800 car after 4 years if its rate of depreciation is 18% p.a.

Year	Value ($)	Depreciation ($)	Depreciated value ($)
1	34 800	____ × 34 800 =	
2			
3			
4			

Worked Example 4 is an illustration of the declining-balance (or reducing-balance) method of depreciation, which assumes that the item depreciates at a constant percentage each year.

A formula that can be used for the declining-balance method is $S = V_0(1 - r)^n$
where S = salvage (current) value of asset
V_0 = the purchase price of asset
r = the percentage interest rate per time period, expressed as a decimal
n = the number of time periods.

WORKED EXAMPLE 5

A new car is purchased for $32 000. It depreciates in value at a rate of 22% per year.

a Calculate the book value of the car after 3 years.

b By what amount has the car depreciated in value after 3 years?

	Solve	Think	Apply
a	$S = V_0(1 - r)^n$ $= \$32\,000(1 - 0.22)^3$ $= \$15\,186$ (to nearest $)	Substitute $V_0 = 32\,000$, $r = 22\% = 0.22$ and $n = 5$ into the formula.	Substitute the values of V_0, r and n into the formula $S = V_0(1 - r)^n$.
b	Depreciation $= \$32\,000 - \$15\,186$ $= \$16\,814$	Subtract the book value ($15 186) from the original price ($32 000).	The amount of depreciation is the change in value of the car.

12 A new car is purchased for $35 000. It depreciates in value at a rate of 24% per year. Complete the following to find:

a the book value of the car after 3 years
$S = V_0(1 - r)^n$
$= \$\_\_\_\_ (1 - 0.24)^{\square}$
$= \$\_\_\_\_$ (to the nearest $)

b the amount the car has depreciated in value after 3 years.
Change in value $= \$35\,000 - \$\_\_\_\_$
$= \$\_\_\_\_$

13 A new car is purchased for $19 990. It depreciates in value at a rate of 28% per year.

a Calculate the book value of the car after 5 years.

b By what amount has the car depreciated in value after 5 years?

14 A new car is purchased for $56 000. It depreciates in value at a rate of 35% per year.

a Calculate the book value of the car after 4 years.

b By what amount has the car depreciated in value after 4 years?

WORKED EXAMPLE 6

A car depreciates in value from \$35 000 to \$22 000 in 2 years. Use the declining-balance formula to calculate the annual percentage rate of depreciation.

Solve	Think	Apply
$S = V_0(1 - r)^n$ $\$22\,000 = \$35\,000(1 - r)^2$ $\frac{22\,000}{35\,000} = (1 - r)^2$ $\sqrt{\frac{22\,000}{35\,000}} = 1 - r$ $0.7928 = 1 - r$ $r = 1 - 0.792\,8\ldots$ $= 0.207\,1\ldots \approx 0.21$ $\therefore$ Rate of depreciation $\approx 21\%$	Substitute $S = \$22\,000$, $V_0 = \$35\,000$ and $n = 2$ into the formula: $\$22\,000 = \$35\,000(1 - r)^2$ Divide both sides by \$35 000. Take the square root of both sides. Add r to both sides. Subtract 0.7928 from both sides.	Substitute the values of V_0, r and n into the formula $S = V_0(1 - r)^n$ and solve the resulting equation.

15 A car depreciates in value from \$29 000 to \$20 462 in 2 years. Complete the following to calculate the annual percentage rate of depreciation using the declining-balance formula: $S = V_0(1 - r)^n$.

$\$20\,462 = \_\_\_\,(1 - r)^2$

$\frac{\$20\,462}{\square} = (1 - r)^2$

$\sqrt{\frac{20\,462}{\square}} = 1 - r \quad \therefore \_\_\_\_ = 1 - r$

$r = 1 - \_\_\_\_ \approx \_\_\_\_$ $\quad \therefore$ Rate of depreciation $\approx$ ____%

16 A car depreciates in value from \$36 000 to \$19 000 in 2 years. Use the declining-balance formula to calculate the annual percentage rate of depreciation.

17 A car depreciates in value from \$44 900 to \$32 440 in 2 years. Use the declining-balance formula to calculate the annual percentage rate of depreciation.

18 A car depreciates in value from \$15 000 to \$4500 in 3 years. Use the declining-balance formula to calculate the annual percentage rate of depreciation.

19 A car depreciates in value from \$68 000 to \$31 000 in 3 years. Use the declining-balance formula to calculate the annual percentage rate of depreciation.

20 These graphs show the depreciation of a car using:

i the straight-line method

ii the declining-balance method.

a What was the purchase price?

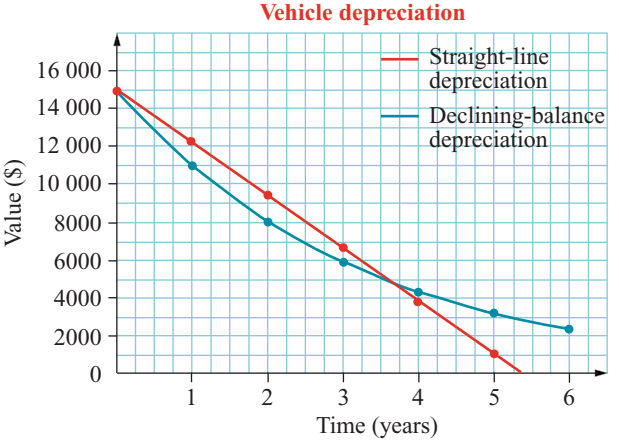
b What is the value of the car after 1 year using each method?

c When is the car worth \$8000, for each method?

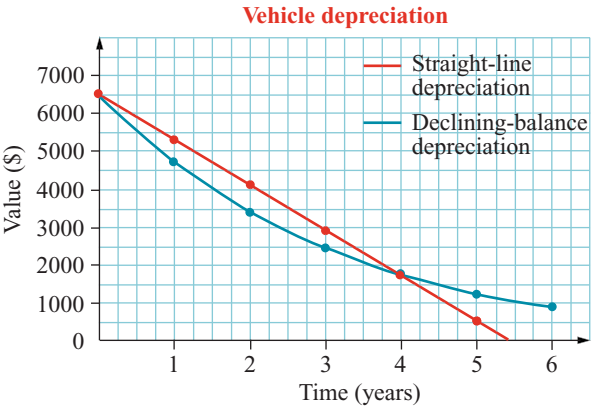
d When is the book value the same for each type of depreciation? What is it?

e When is the greatest difference in book values? How much is it?

f For the straight-line method, what is the annual amount of depreciation?



21 These graphs show the depreciation of a motorcycle using:



- **i** the straight-line method
- **ii** the declining-balance method.

a What was the purchase price?

b What is the value of the motorcycle after 2 years using each method?

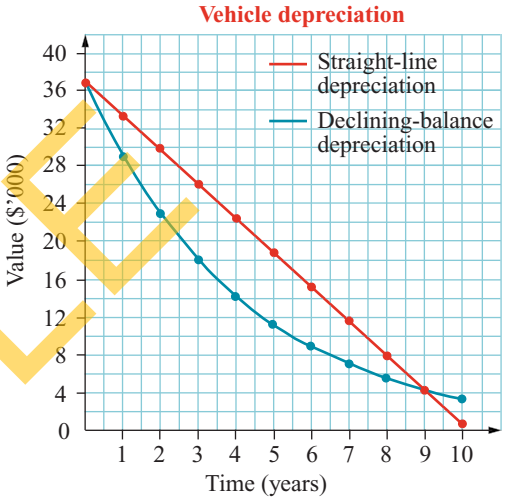
c When is it worth $4000 for each method?

d When is the book value the same for each type of depreciation? What is it?

e The motorcycle is scrapped after 5 years. What is its final written-down value for each method?

f For the straight-line method, what is the annual amount of depreciation?

22 These graphs show the depreciation of a car using:



- **i** the straight-line method
- **ii** the declining-balance method.

a What was the purchase price?

b What is the car's value after 2 years for each method?

c When is the car worth half its original value for each method?

d When is the book value the same for each type of depreciation? What is it?

e For the straight-line method, what is the annual depreciation?

f What is the annual rate of depreciation for the declining-balance method? (Use the method of Worked Example 6.)

WORKED EXAMPLE 7

A car is purchased for $19 800. The straight-line depreciation amount is $3800 and the declining-balance percentage rate is 40%.

a Complete a depreciation table.

b Draw a graph of the depreciation of the car for each method on the same set of axes.

c Find the value of the car after $3\frac{1}{2}$ years for each method.

d When is the car worth half its original value for each method?

e After what time is the depreciated value the same for each type of depreciation?

Solve	Think

a

Year	Straight-line value ($)	Declining-balance value ($)
0	19 800	19 800
1	16 000	11 880
2	12 200	7 128
3	8 400	4 277
4	4 600	2 566
5	800	1 540
6	0	924

Method 1

For the straight-line method:

Value end of year 1 = $19 800 − $3800 = $16 000

Value end of year 2 = $16 000 − $3800 = $12 200 …

For the declining-balance method:

Depreciation year 1 $= \frac{40}{100} \times \$19\,800 = \$7920$

Value end of year 1 = $19 800 − $7920 = $11 880

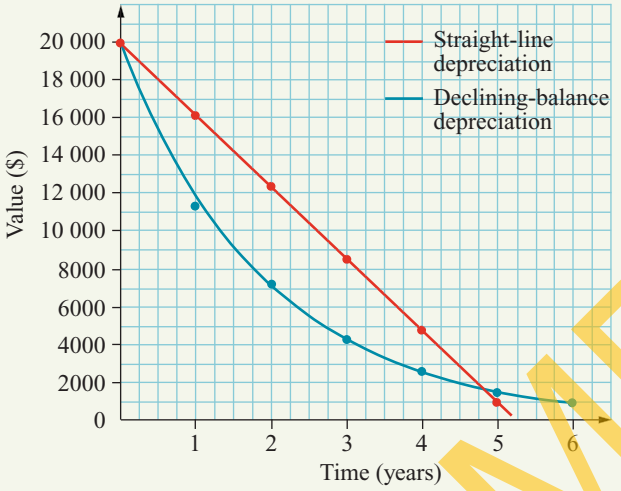
Depreciation year 2 $= \frac{40}{100} \times \$11\,880 = \$4752$

Value end of year 2 = $11 880 − $4752 = $7128 …

FOCUS STUDY

WORKED EXAMPLE 7 CONTINUED

	Think	Apply
a	*Method 2* For the straight-line method, use the formula $S = V_0 - Dn$. For the declining-balance method, use the formula $S = V_0(1 - r)^n$. *Method 3 for declining-balance method* The car value decreases by 40% each year, so at the end of the year it is worth 60% of its value at the beginning of the year. Using 60% = 0.6: Value at end of year 1 = 0.6 × \$19 800 = \$11 800 Value at end of year 2 = 0.6 × \$11 800 = \$7128, etc.	Complete the table using the depreciation formulas or step-by-step calculations.

	Solve	Think	Apply
b	**Vehicle depreciation**  	For the straight-line method, plot the points (0, 19 800), (1, 16 000), (2, 12 200), etc. and draw the straight line through them. For the declining-balance method, plot the points (0, 19 800), (1, 11 880), (2, 7128), etc. and draw a smooth curve through them.	Read the values from the table. Plot points and draw the graphs.
c	Value of the car after $3\frac{1}{2}$ years is approximately \$6500 and \$3300.	From the graphs, when $n = 3.5$, $S \approx 6500$ for the straight-line method and $S \approx 3300$ for the declining-balance method.	Read the values from the graph.
d	The car is worth half its original value approximately 2.6 years under the straight-line method and 1.4 years under the declining-balance method.	From the graphs, find when the value of the car is half its original value (\$9900).	
e	The depreciated values are the same after approximately 4.7 years or 4 years and 8 months.	The two lines intersect when $n \approx 4.7$ years.	Find the time when the lines intersect.

23 A car is purchased for \$19 900. The straight-line depreciation amount is \$3700 and the declining-balance percentage is 30%.

a Complete the depreciation table.

b Draw a graph of the depreciation of the car under for each method, on the same set of axes.

c From the table, when $n = 2$, $S =$ ____ for the straight-line method and $S =$ ____ for the declining-balance method.

Year	Straight-line value ($)	Declining-balance value ($)
0	19 900	19 900
1	16 200	13 930
2		
3		
4		
5		

d From the graphs, when $n = 3.5$, $S \approx$ ____ for the straight-line method and $S \approx$ ____ for the declining-balance method.

e From the graph, the straight line intersects the curve when $n \approx$ ____.
The values are the same after approximately ____ years, or ____ years and ____ months.

24 A motorcycle used for courier work is purchased for $11 350. The depreciation can be calculated as either $2100 per year using the straight-line method, or 32% per year using the declining-balance method.

a Complete a depreciation table showing the depreciated value each year for 5 years using each method.

b Draw a graph of the depreciation of the motorcycle under each method, on the same set of axes.

c Using the straight-line method, when is the salvage value less than that of the declining-balance method?

d What is the written-down value of the motorcycle after $3\frac{1}{2}$ years, using each method?

e When is the motorcycle worth half its original value, under each method?

13E Running costs

The total running cost of a vehicle is made up of **standing costs** (fixed) and **operating costs**.

Standing costs include the depreciation in value of the vehicle (the loss in value due to age and use), the interest charged on the loan used to purchase it, and on-road costs such as registration, CTP insurance and membership of a motoring organisation that provides roadside assistance (for example NRMA).

Operating costs are running costs that depend on how the vehicle is driven, such as the cost of fuel, tyres, servicing and repairs.

EXERCISE 13E

1 Calculate the missing values in the table below of average annual running costs for some vehicles. The calculations are based on buying a new vehicle for private use and operating it for 5 years. The interest charges are based on the total cost of the new vehicle being financed by a loan. It is assumed that the vehicle travels 15 000 km each year.

Average annual running costs	Ford Focus (small)	Toyota Corolla (small)	Ford Falcon (large)	Holden Commodore (large)	Honda CRV (compact SUV)	Toyota RAV4 (compact SUV)
Standing costs:						
Depreciation ($)	3120	3136	5980	5928	4628	4784
Interest ($)	1524	1560	2444	2444	2340	2288
On-road costs ($)	1248	957	1092	962	988	1061
Operating costs:						
Fuel ($)	1898	1872	2947	2626	2444	
Tyres ($)	146	146	132	146	177	208
Service and repairs ($)	671	848	614	634		952
Total ($)	**8607**		**13 209**	**12 740**	**11 445**	**11 633**
Average costs:						
Total cost/week ($/week)	165.52	163.83		245	220.10	223.71
Total cost/km (c/km)	57.4	56.8	88.1		76.3	77.6

2 For which vehicle is the fuel consumption:
- **a** best?
- **b** worst?

3 For which vehicle are the on-road costs:
- **a** highest?
- **b** lowest?

4 For which vehicle is the service cost:
- **a** highest?
- **b** lowest?

5 What percentage of the total running cost are fuel costs for the:
- **a** Toyota Corolla?
- **b** Toyota RAV4?

6 Calculate the fuel cost per kilometre to run the:
- **a** Ford Focus
- **b** Toyota RAV4.

7 What would be the fuel cost to drive a Ford Falcon from Sydney to Melbourne, a distance of 885 km?

8 If the cost of fuel increases by 10%, what would be the new running costs (per week and per kilometre) of the Honda CRV?

9 The interest charges are based on 100% of the cost of the new vehicle being financed by a loan.
- **a** What would be the savings over 5 years if cash has been paid for the Ford Falcon instead of borrowing the purchase price?
- **b** What would be the annual running costs for a new Honda CRV if cash has been paid instead of borrowing the purchase price?

10 What is the weekly cost of tyres for the:
- **a** Ford Falcon?
- **b** Honda CRV?

11 If the price of the Ford Focus is $22 500, what is the average yearly rate of depreciation?

12 The cost of the Honda CRV is $34 000.
- **a** What is the average yearly rate of depreciation?
- **b** What will be its depreciated value at the end of 5 years?

13 If the Holden Commodore cost $37 000 to buy, what is the average annual rate of interest charged on the loan?

14 Add another column to the table in question **1** and use the information given below to calculate the total cost/week and total cost/kilometre to run a Nissan Patrol (dealer price $61 440). Round to the nearest dollar.

Average depreciation each year is 13.7% of the dealer price.
Average annual rate of loan interest is 6.6% (assume total cost of vehicle is financed by the loan).
On-road costs are $24 per week.
Fuel consumption is 14 L/100 km and fuel costs 165.9c/L. Assume the vehicle travels 15 000 km each year.
Tyres cost $276 per year.
Services and repairs are $19.80 per week.

15 **a** Using the information in the table in question **1**, calculate the average operating costs per day for the Ford Falcon, the Holden Commodore, the Honda CRV and the Toyota RAV4 (use 1 year = 365 days).

b Four people, who live in the same general area and work in the same location, drive to work 5 days per week. Richard drives a Ford Falcon, Stephanie a Holden Commodore, Lilly a Honda CRV and Paul a Toyota RAV4.
- **i** Over a 4-week period, how much does it cost each person to drive to work, assuming the average daily operating cost is completely work related?
- **ii** They decide to form a car pool, so that each person drives everyone to work 1 week out of every 4 weeks. How much does each person save every 4 weeks by forming the car pool?

16 a Using the information in the table in question **1**, calculate the average operating costs per kilometre for the Ford Focus, the Toyota Corolla and the Toyota RAV4.

b Three people drive to work over an average distance of 64 km return, from each of their homes. They work a normal 5-day week. Helen owns a Ford Focus, Greg owns a Toyota Corolla and Peta owns a Toyota RAV4.

i Over a 3-week period, how much does it cost each person to drive to work?

ii They form a car pool and take turns driving each other to work on a weekly basis. How much does each person save every 3 weeks by sharing the driving?

INVESTIGATION 13.3

13F Blood alcohol content (BAC)

2G 3D 3F

Blood alcohol content is a measure of the concentration of alcohol in a person's blood. It is expressed as a percentage mass per unit of volume. For example, a person with a BAC of 0.02 (%) has $\frac{0.02}{100}$ g of alcohol in every millilitre of their blood. This is equivalent to 0.02 g/100 mL or 20 mg/100 mL.

BAC can be estimated from tables, formulas and on-line calculators; but it is very important to remember that these are only approximations because they are based on average values and do not apply equally to everyone.

BAC is affected by factors such as whether you are male or female, how much you drink, the length of time that you have been drinking, your weight, whether you are fit, the state of your liver, whether you are a regular drinker and your mood at the time.

The only way to measure your BAC accurately is with an approved breath analysing unit known as a 'breathalyser'.

An estimate of your BAC can be determined by counting the number of standard drinks you consume. A standard drink is any drink that contains 10 g of alcohol. A standard drink always contains the same amount of alcohol irrespective of the container size or type of drink (beer, wine or spirits).

The number of standard drinks in a container can be calculated using the formula:

$$N = 0.789 \times V \times A$$

where N = number of standard drinks

V = the volume of the container in litres

A = percentage of alcohol (% alc/vol) in the drink. (This is stated on the container.)

WORKED EXAMPLE 1

Calculate the number of standard drinks in a 150 mL glass of red wine, given that the alcohol content of the wine is 14.5% alc/vol.

Solve	Think	Apply
$N = 0.789 \times V \times A$ $= 0.789 \times 0.15 \times 14.5$ ≈ 1.7	The volume of the glass = 150 mL = 0.15 L. Hence $V = 0.15$. The alcohol content = 14.5% alc/vol. Hence $A = 14.5$.	Convert the volume of the container to litres and substitute the values of V and A into the formula $N = 0.789 \times V \times A$. (0.789 is the specific gravity of ethyl alcohol, the type of alcohol used in beverages.)

EXERCISE 13F

1 Complete the following to calculate the number of standard drinks in these beers:

a a 375 mL stubby of full-strength beer with an alcohol content of 4.8% alc/vol

$N = 0.789 \times V \times A$

$= 0.789 \times \_\_\_\_ \times 4.8 = \_\_\_\_$

b a 375 mL stubby of light beer with an alcohol content of 2.7% alc/vol

$N = 0.789 \times V \times A$

$= 0.789 \times 0.375 \times \_\_\_\_ = \_\_\_\_$

2 Calculate (to 1 decimal place) the number of standard drinks in:

a a 120 mL glass of wine with an alcohol content of 12% alc/vol

b a 90 mL glass of fortified wine with an alcohol content of 16.5% alc/vol

c a 375 mL can of bourbon and coke with an alcohol content of 6% alc/vol

d a 750 mL bottle of white wine with an alcohol content of 11.5% alc/vol

e a 275 mL bottle of vodka and orange with an alcohol content of 5% alc/vol

f a six-pack (6 × 330 mL) of full strength beer with an alcohol content of 4.9% alc/vol.

An estimate of your BAC can be found using these formulas:

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

where N = number of standard drinks consumed

H = number of hours drinking

M = person's mass in kg

Note:

One standard drink per hour will raise your BAC by between 0.01 and 0.03%. Your BAC will increase at a greater rate if you:

- are female
- have a low body weight
- have not eaten recently
- are drinking highly carbonated drinks
- are unfit
- have an unhealthy liver.

WORKED EXAMPLE 2

Calculate the BAC of:

a a 78 kg male who has consumed 5 standard drinks in 3 hours

b a 46 kg female who has consumed 4 standard drinks in 4 hours.

	Solve	Think	Apply
a	$BAC_{\text{male}} = \frac{10N - 7.5H}{6.8M}$ $= \frac{10 \times 5 - 7.5 \times 3}{6.8 \times 78}$ ≈ 0.05	Substitute $N = 5$, $H = 3$ and $M = 78$ into the formula $BAC_{\text{male}} = \frac{10N - 7.5H}{6.8M}$	Substitute the number of standard drinks consumed, the number of hours drinking and the mass of the person into the relevant formula.
b	$BAC_{\text{female}} = \frac{10N - 7.5H}{5.5M}$ $= \frac{10 \times 4 - 7.5 \times 4}{5.5 \times 46}$ ≈ 0.04	Substitute $N = 4$, $H = 4$ and $M = 46$ into the formula $BAC_{\text{female}} = \frac{10N - 7.5H}{5.5M}$	

3 Complete the following, using the formulas given above, to calculate the BAC of:

a a 83 kg male who has consumed 6 standard drinks in 3 hours

$$BAC_{\text{male}} = \frac{10N - 7.5H}{6.8M}$$
$$= \frac{10 \times \square - 7.5 \times \square}{6.8 \times \square} = \_\_\_\_$$

b a 58 kg female who has consumed 5 standard drinks in 4 hours

$$BAC_{\text{female}} = \frac{10N - 7.5H}{5.5M}$$
$$= \frac{10 \times \square - 7.5 \times \square}{5.5 \times \square} = \_\_\_\_$$

4 Using the formulas given, complete the following table.

	Gender	Mass (kg)	Number of standard drinks consumed	Number of hours drinking	BAC (%)
a	Male	70	3	2	
b	Female	50	4	2	
c	Male	95	6	3	
d	Female	57	2	2	

5 An 80 kg adult male wants to keep his $BAC \leqslant 0.05$. Complete the following to find how many drinks he can consume in 5 hours.

Let $BAC = 0.05$ then

$$0.05 = \frac{10N - 7.5 \times 5}{6.8 \times 80}$$
$$= \frac{10N - \square}{\square}$$
$$\_\_\_\_ = 10N - \_\_\_\_$$
$$\_\_\_\_ = 10N$$
$$\therefore N = \_\_\_\_$$

If he has ____ standard drinks, his $BAC = 0.05$. For his $BAC < 0.05$, he can have up to ____ standard drinks.

6 A 56 kg woman wants to keep her $BAC \leqslant 0.05$. How many drinks can she consume in 3 hours?

7 A rule of thumb can be used by a full licence holder to stay under the 0.05 legal limit in NSW:
For males: no more than two standard drinks in the first hour and one standard drink per hour after that.
For females: no more than one standard drink per hour.
Use this rule of thumb to calculate the maximum number of standard drinks that can be consumed by a person who wants to stay under 0.05 BAC if they are:

a a male and drinking for 4 hours
b a male and drinking for 6 hours
c a female and drinking for 4 hours
d a female and drinking for 6 hours

8 Use the rule of thumb above to calculate the answers to questions **5** and **6**.

Note: After drinking, the only thing that will reduce your BAC is the passing of time. Drinking coffee, exercising, taking a cold shower or making yourself vomit will not reduce your BAC. Alcohol is eliminated from the body by the liver at a rate between 4 g/h and 12 g/h, at an average of 7.5 g/h or 0.75 standard drinks per hour (since a standard drink contains 10 g of alcohol), and can vary considerably depending on your health. This means that it can take the liver more than an hour to eliminate one standard drink.

WORKED EXAMPLE 3

If a person's liver can break down alcohol at the rate of 6 g/h, how long will it take for this person's body to eliminate one standard drink?

Solve	Think	Apply
Time needed $= \frac{10}{6}$ h $= 1.666...$ h $= 1$ h 40 min	One standard drink contains 10 g of alcohol. If the liver can eliminate 6 g every hour, then the time needed is $10 \div 6$ hours. $1.666...$ h $(= 1\frac{2}{3}$ h$) = 1$ h 40 min, or use the appropriate function keys on your calculator.	If the rate at which the liver eliminates alcohol is given in g/h then: Time (h) needed to eliminate one standard drink $= \frac{10}{\text{rate of elimination}}$.

9 Complete the following to calculate the time it takes a person's body to eliminate one standard drink if their liver breaks down alcohol at the rate of 7 g/h.

Time needed $= \frac{10}{\square}$ h

$=$ ____ h

$=$ ____ h ____ min

10 Calculate the time it takes a person's body to eliminate one standard drink if their liver breaks down alcohol at these rates.

a 5 g/h **b** 10 g/h **c** 4 g/h **d** 12 g/h **e** 7.5 g/h

The liver breaks down alcohol at an average rate of 0.75 standard drinks per hour.
A formula that can be used to calculate the time it takes for your BAC to fall to zero is:

$$T = \frac{BAC}{0.015}$$

where $T =$ the number of hours you must wait.

WORKED EXAMPLE 4

Calculate how long you must wait for your BAC to drop to zero from 0.05%.

Solve	Think	Apply
$T = \frac{BAC}{0.015}$ $= \frac{0.05}{0.015}$ $= 3$ h 20 min	Substitute $BAC = 0.05$ into the formula. $\frac{0.05}{0.015} = 3.333...$ h $= 3$ h 20 min	Substitute the BAC into the formula $T = \frac{BAC}{0.015}$ Convert the time to hours and minutes.

11 Complete the following to calculate how long you must wait for your BAC to drop to zero from 0.04%.

$$T = \frac{\text{BAC}}{0.015} = \frac{\square}{0.015}$$

$= \_\_\_\_$ h $= \_\_\_\_$ h $\_\_\_\_$ min

12 Calculate how long you must wait for your BAC to drop to zero from these levels.

a 0.02% **b** 0.06% **c** 0.035%

13 **a** Calculate the BAC for an 80 kg male and a 52 kg female, both with provisional licences, who consume 4 standard drinks in 3 hours.

b A zero BAC is a requirement of NSW law for all learner and provisional drivers. How long would these two people have to wait before they could legally drive a motor vehicle?

14 Damien and Nicole go to a party and start drinking at 8 pm. Damien drinks 8 schooners of full strength beer (12 standard drinks) over the next 5 hours. Nicole has 6 mixer drinks (9 standard drinks) in the same time. Damian has a mass of 86.6 kg and Nicole's mass is 56.1 kg.

a Calculate the BAC of both Damien and Nicole at 1 am.

b At what time will they be able to legally drive if they both have provisional licences?

15 Ben goes to a party and consumes two stubbies (375 mL) of full strength beer (4.9% alc/vol) in the first hour and one stubby per hour for the next 3 hours.

a Calculate the number of standard drinks he has consumed.

b Use the formula to calculate his BAC if his mass is 72 kg.

c How long will it be before his BAC drops to zero?

SPREADSHEET APPLICATION 13.1

13G Speed, distance and time

2G The formula for the average speed of an object is given below.

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

This is usually written $S = \frac{D}{T}$

where S is the average speed, D is the distance travelled and T is the time taken

so it follows that $D = S \times T$ and $T = \frac{D}{S}$

This formula is used to calculate the average speed, distance and time travelled.

FOCUS STUDY

WORKED EXAMPLE 1

a A car travels 232 km in 4 hours and 17 minutes. Calculate its average speed.
b A train averages 83 km/h for 2 hours and 24 minutes. How far does it travel?
c If a motorcyclist can average 52 km/h, how long will it take her to travel 34 km?

	Solve	Think	Apply
a	$S = \frac{232}{4.28333...}$ $= 54.16...$ km/h $= 54$ km/h (to nearest whole number)	Change 17 minutes to hours. 17 min $= 17 \div 60$ h $= 0.283\,33...$ h 4 h 17 min $= 4.283\,33...$ hours Or use the degrees, minutes, seconds key on your calculator.	$S = \frac{D}{T}$
b	$D = 83 \times 2.4$ $= 199.2$ km	Change 24 minutes to hours. 24 min $= 24 \div 60 = 0.4$ h	$D = S \times T$
c	$T = \frac{34}{52}$ $= 0.6538...$ hours $= 39$ min (to nearest min)	$0.6538...$ hours $= 0.653\,8... \times 60$ min $= 39.23...$ min Or use the degrees, minutes, seconds key on your calculator.	$T = \frac{D}{S}$

EXERCISE 13G

1 Calculate the average speed for these distances and times.
a 185 km is travelled in 4 h
b 720 km is travelled in 9 h and 50 min
c 154 km is travelled in 3 h and 15 min
d 272 km is travelled in 4 h and 35 min

2 **a** Calculate the distance travelled in 3 h and 30 min at an average speed of 64 km/h.
b Calculate the distance travelled in 3 h and 20 min at an average speed of 56 km/h.
c Calculate the distance travelled in 5 h and 47 min at an average speed of 82 km/h.
d Calculate the distance travelled in 2 h and 13 min at an average speed of 75 km/h.

3 How long will it take to travel:
a 486 km at 60 km/h?
b 298 km at 74 km/h?
c 365 km at 82 km/h?
d 88 km at 95 km/h?

WORKED EXAMPLE 2

Convert 65 km/h to m/s.

Solve	Think	Apply
65 km/h $= \frac{65 \times 1000}{60 \times 60}$ m/s $= 18.1$ m/s (to 1 decimal place)	65 km $= 65 \times 1000$ m and 1 h $= 60 \times 60 = 3600$ s $\frac{65 \times 1000}{60 \times 60} = 18.055...$	Change kilometres to metres (by multiplying by 1000), change hours to seconds (by multiplying by 60×60) and divide.

4 Complete the following to convert to m/s.

$$70 \text{ km/h} = \frac{70 \times \square}{\square \times \square}$$
$$= \_\_\_\_ \text{ m/s (to 1 decimal place)}$$

5 Convert the following to m/s.

a 45 km/h **b** 76 km/h **c** 110 km/h

WORKED EXAMPLE 3

Convert 9.8 m/s to km/h.

Solve	Think	Apply
$9.8 \text{ m/s} = \frac{9.8 \times 60 \times 60}{1000} \text{ km/h}$ $= 35.28 \text{ km/h}$	9.8 m in 1 s = 9.8 × 60 m in 1 min = (9.8 × 60) × 60 m in 1 h Divide by 1000 to change metres into kilometres.	Change m/s to m/h by multiplying by 60 × 60. Change m to km by dividing by 1000.

6 Complete the following to convert to km/h.

$$8 \text{ m/s} = \frac{8 \times \square \times \square}{\square}$$
$$= \_\_\_\_ \text{ km/h}$$

7 Convert the following to km/h.

a 15 m/s **b** 12.5 m/s **c** 25 m/s

13H Car stopping distances

The distance a car travels in the time it takes to stop is:

Stopping distance = reaction-time distance + braking distance

2G 3D The reaction-time distance is the distance travelled in the time it takes the driver to react to a situation; that is, to realise there is a problem and move their foot to the brake. The usual reaction time, for drivers unaffected by alcohol, drugs or fatigue has been found to be about 2.5 s.

12A The braking distance is the distance the car travels after the brakes have been applied. This distance depends on (the square of) the speed of the car.

Note: Factors such as the condition of the road (wet or dry) and the car's brakes and tyres, as well as the state of the driver, all have an effect on the stopping distance.

WORKED EXAMPLE 1

Calculate the reaction-time distance for a car travelling at 60 km/h. Assume a reaction time of 2.5 s.

Solve	Think	Apply
Distance travelled $= \frac{60\,000}{60 \times 60} \times 2.5$ $\approx 41.7 \text{ m}$ (to 1 decimal place)	60 km/h $= \frac{60 \times 1000}{60 \times 60}$ m/s Assuming a reaction time of 2.5 s, the distance the car will travel before the driver applies the brakes in reaction to a situation is about 42 m.	Convert the speed to m/s and use $D = S \times T$ where $T = 2.5$ s, the time it takes the driver to react.

EXERCISE 13H

1 Complete the following to calculate the reaction-time distance travelled by a car travelling at 80 km/h. Assume a reaction time of 2.5 s.

$$\text{Distance travelled} = \frac{80 \times \square}{\square \times \square} \times 2.5$$
$$\approx \_\_\_\_ \text{ m (to 1 decimal place)}$$

2 Calculate the reaction-time distance for a car travelling at 100 km/h. Assume a reaction time of 2.5 s.

3 **a** Use the results of questions **1** and **2** to draw a (straight-line) graph of the relationship between reaction-time distance (m) and speed (km/h), given a reaction time of 2.5 s.

b Use the graph to estimate the reaction-time distance for a car travelling at these speeds.

i 120 km/h **ii** 45 km/h

c If the speed of a car increases by 10 km/h, what is the increase in the stopping distance?

4 **a** If a driver affected by fatigue has a reaction time of 3.5 s, what will be the reaction-time distance of a car travelling at 60 km/h?

b What is the difference for this driver between the stopping distance with a reaction time of 3.5 s and the stopping distance with the reaction time of 2.5 s?

5 If a driver affected by alcohol has a reaction time of 4.5 s, what difference will this make to the reaction-time distance of a car travelling at 100 km/h compared with the usual reaction time of 2.5 s?

6 The reaction-time distance, d m, for a car travelling at v km/h, assuming a reaction time of t s, can be approximated using the formula $d = 0.28vt$. Use this formula to check the answers to questions **4** and **5**.

The braking distance is a function of the square of the speed of the car. For a car with good brakes and tyres, travelling in dry conditions on a good road, the relationship can be approximated by the formula $d = 0.01v^2$, where d is the braking distance in metres and v is the speed of the car in km/h.
For the same car travelling on a slippery road, the formula for braking distance becomes $d = 0.014v^2$.

WORKED EXAMPLE 2

Calculate the braking distance for a car travelling in dry conditions at 60 km/h.

Solve	Think	Apply
Braking distance $= 0.01 \times 60^2$ $= 36$ m	Substitute $v = 60$ into the formula $d = 0.01v^2$.	Substitute the value of v into the dry conditions formula.

7 Complete the following to calculate the braking distance for a car travelling at 80 km/h in good conditions.

$$\text{Braking distance} = 0.01 \times \_\_\_\_^2$$
$$= \_\_\_\_ \text{ m}$$

8 **a** Calculate the braking distance for a car travelling at 100 km/h in good conditions.

b What is the braking distance of the car travelling at 100 km/h in wet conditions?

c What is the difference between the braking distances at 100 km/h in good conditions and wet conditions?

WORKED EXAMPLE 3

Find the total stopping distance to the nearest metre for a car travelling at 70 km/h in good conditions and assuming a reaction time of 2.5 s.

Solve	Think	Apply
Stopping distance $= \frac{70\,000}{60 \times 60} \times 2.5 + 0.01 \times 70^2$ $= 97.611 \ldots$ m $= 98$ m (to nearest m)	Reaction-time distance $= \frac{70 \times 1000}{60 \times 60} \times 2.5 = 48.611 \ldots$ m Braking distance $= 0.01 \times 70^2 = 49$ m $\therefore$ Total stopping distance $= 97.611 \ldots$ m	Add the reaction-time distance to the braking distance.

9 Complete the following to find the total stopping distance for a car travelling at 90 km/h in good conditions and assuming a reaction time of 2.5 s.

Stopping distance $= \frac{\square}{\square \times \square} \times 2.5 + 0.01 \times \_\_\_\_^2$

$= \_\_\_\_$ m (to nearest m)

10 Find the total stopping distance for a car travelling at 110 km/h in good conditions and assuming a reaction time of 2.5 s.

11 If the speed of a car increases from 50 km/h to 60 km/h, what is the increase in total stopping distance?

WORKED EXAMPLE 4

Find the total stopping distance for a car travelling at 70 km/h in good conditions, assuming a reaction time of 2.5 s, and using the formula $d = 0.7v + 0.01v^2$, where d is the stopping distance in metres and v is the speed in km/h.

Solve	Think	Apply
$d = 0.7 \times 70 + 0.01 \times 70^2$ $= 98$ m	Substitute $v = 70$ into the formula $d = 0.7v + 0.01v^2$.	Substitute the value of v into the formula.

12 a Use the formula in Worked Example 4 to complete the following table.

Speed (km/h)	0	20	40	60	80	100
Stopping distance (m)		$0.7 \times 20 + 0.01 \times 20^2 = 18$				

b Use the information in the table to graph the relationship between speed and stopping distance. (Join the points by a smooth curve.)

c From the graph, estimate the stopping distance for a car travelling at these speeds.

i 50 km/h **ii** 120 km/h

13 For a driver under the influence of alcohol and driving in poor road conditions, the formula for stopping distance becomes $d = 1.2v + 0.018v^2$.

a Prepare a table similar to the one in question **12**. Use the values to draw a graph of the relationship between speed and stopping distance for a driver under the influence of alcohol on the same set of axes as question **12**.

b From the graphs, what is the difference in stopping distances at:

i 50 km/h? **ii** 60 km/h? **iii** 110 km/h?

13I Road accident statistics

EXERCISE 13I

7E 7H 7I 8F 11A 11B 11C 11F 12D

1 Consider the following data on road fatalities in NSW from 1950 to 2010.

Year	1950	1955	1960	1965	1970	1975	1980
Number killed	634	820	978	1151	1309	1288	1303

Year	1985	1990	1995	2000	2005	2010
Number killed	1067	797	620	603	508	405

a Draw a line graph for the data in the table.

b Comment on any trends in these figures.

c In which 5-year period did:

i the largest increase in fatalities occur? **ii** the largest decrease in fatalities occur?

d Discuss why the number of fatalities has decreased since 1980 even though the number of registered vehicles has increased.

2 Consider the following data on road fatalities for the states and territories of Australia in 2010.

State or territory	Killed	Fatalities per 10 000 vehicles	Fatalities per 100 000 population
New South Wales	405	0.9	5.6
Victoria	288	0.7	5.2
Queensland	249	0.7	5.5
Western Australia	193	1.0	8.4
South Australia	118	1.0	7.2
Tasmania	31	0.8	6.1
Australian Capital territory	19	0.7	5.3
Northern Territory	49	3.6	21.4

a In which state or territory has the number of fatalities been the:

i highest? **ii** lowest?

b In which state or territory has the number of fatalities/10 000 vehicles been the:

i highest? **ii** lowest?

c In which state or territory has the number of fatalities/100 000 population been the:

i highest? **ii** lowest?

d For the number of fatalities per 10 000 vehicles, find the:

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

e Which state or territory has the safest roads? Discuss.

FOCUS STUDY

3 Consider the following data comparing Australia with other countries in 2010.

Country	Killed	Fatalities per 10 000 vehicles	Fatalities per 100 000 population
Australia	1352	0.8	6.1
Canada	2209	1.0	6.6
Denmark	265	0.9	4.8
France	3992	1.0	6.4
Germany	3651	0.7	4.5
Japan	5745	0.7	4.5
Netherlands	640	0.7	3.9
New Zealand	375	1.2	8.6
Norway	210	0.6	4.3
Sweden	287	0.5	3.1
United Kingdom	1905	0.6	3.1
United States of America	32 788	1.3	10.6

a In which countries are the fatalities/10 000 vehicles:
  i more than in Australia?
  ii less than in Australia?

b In which of these countries is driving the:
  i safest?
  ii least safe?

c Discuss your results.

4 Data for fatal car crashes by time period and day of week are given in the table below.

Time period	Day of week							
	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Total
00:00–01:59	5	3	2	2	0	4	7	23
02:00–03:59	6	2	1	0	1	1	1	12
04:00–05:59	6	1	3	7	3	1	7	28
06:00–07:59	2	3	4	5	5	4	6	29
08:00–09:59	3	3	2	5	5	4	2	26
10:00–11:59	5	3	7	0	4	4	5	28
12:00–13:59	5	5	4	5	5	5	8	37
14:00–15:59	5	6	11	3	5	13	9	52
16:00–17:59	7	4	3	8	7	8	5	42
18:00–19:59	3	3	3	6	5	6	6	32
20:00–21:59	3	4	1	4	6	8	2	28
22:00–midnight	4	3	0	2	1	9	9	28
Unknown	0	0	0	0	0	0	0	0
TOTAL crashes	54	42	41	47	47	67	67	365

a How many fatal crashes were there between 2 am and 4 am on a Saturday?
b Which day of the week had the greatest number of fatal crashes?
c What percentage of fatal crashes occur on the weekend?

d On which day of the week is it the safest to drive?

e Which time period had the greatest number of fatal crashes? Explain why this might occur.

f Which day had the greatest number of fatal crashes between midnight and 4 am? Discuss.

5 Data for fatal crashes involving alcohol, speeding and fatigue in NSW in 2010 are shown in the table below.

	Alcohol involved	Speeding involved	Fatigue involved
Yes	58	146	54
No or unknown	307	219	311
Total	365	365	365

a In how many fatal crashes was alcohol involved?

b In what percentage of all fatal crashes was:

i alcohol a factor? **ii** speed a factor? **iii** fatigue a factor?

6 Data for fatal crashes by car drivers in NSW in 2010, categorised by age and gender, are shown in the table.

	Age (years)										
Gender	**0–4**	**5–16**	**17–20**	**21–25**	**26–29**	**30–39**	**40–49**	**50–59**	**60–99**	**>70**	**Total**
Male	0	2	34	35	16	40	31	25	16	29	228
Female	0	0	12	11	3	13	14	20	7	11	91
Total	0	2	46	46	19	53	45	45	23	40	319

a Which age group of had the greatest number of fatal accidents for:

i males? **ii** females? **iii** all car drivers?

b Which age group over 16 years of age had the least number of fatalities for:

i males? **ii** females? **iii** all car drivers?

c What percentage of all car driver fatalities involved a male driver?

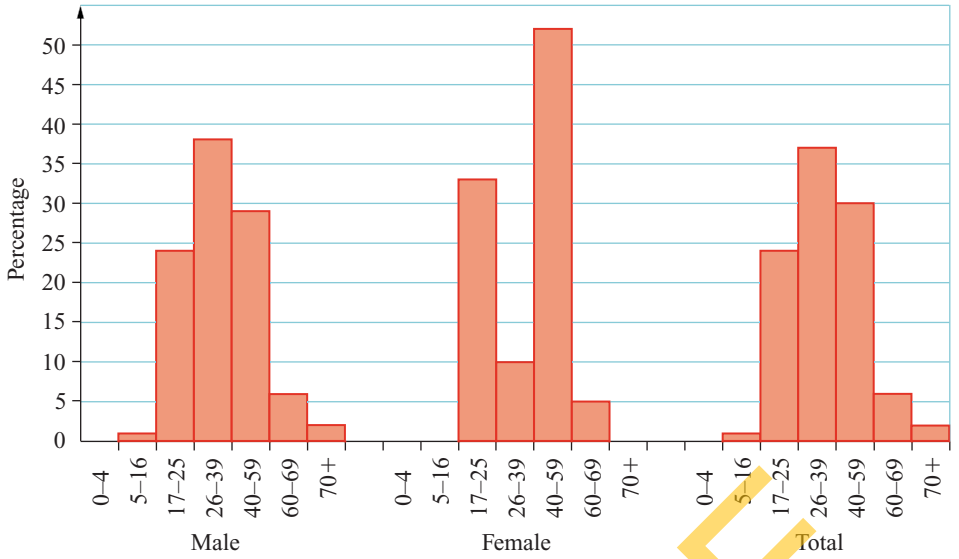
d What percentage of all car driver fatalities involved a person in the 17–20 age group?

7 The data for fatal crashes in NSW in 2010, grouped by the licence status of the car driver, are shown in the table. Draw a sector graph to show the number of learner, provisional, standard, unlicensed and unknown status car drivers who were involved in fatal crashes.

Licence status	Fatal crash
Learner	6
Provisional licence	60
Standard licence	221
Unlicensed	27
Unknown status	5
Total	**319**

7H **8** The graph below shows the percentage of riders and passengers killed in motorcycle accidents in 2008, categorised by gender and age. Use the graph to answer the following questions.

Motorcycle rider and passenger deaths by age groups and gender



a In 2008, approximately what percentage of all male riders or passengers killed in motorcycle accidents were:
- **i** 17–25 years old?
- **ii** 60–69 years old?

b Approximately what percentage of all female riders or passengers killed in motorcycle accidents were:
- **i** 17–25 years old?
- **ii** 60–69 years old?

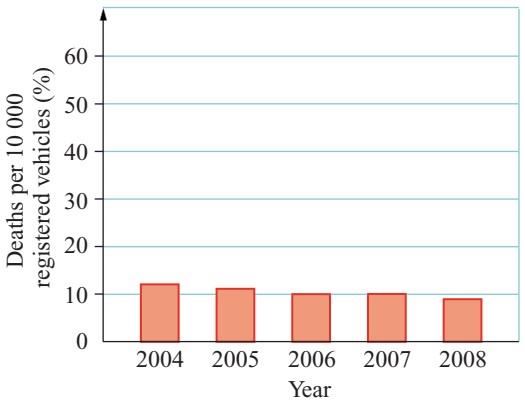
c Which age group of male motorcycle riders and passengers had the:
- **i** highest number of fatalities?
- **ii** lowest number of fatalities?

d Which age group of female motorcycle riders and passengers had the:
- **i** highest number of fatalities?
- **ii** lowest number of fatalities?

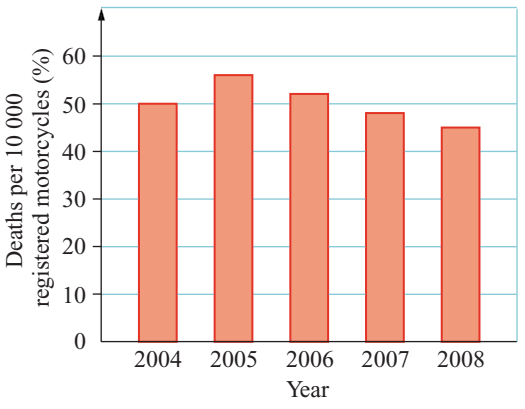
e Which age group of all motorcycle riders and passengers had the:
- **i** highest number of fatalities?
- **ii** lowest number of fatalities?

f The percentage of deaths per 10 000 vehicles, for all registered vehicles and motorcycles between 2004 and 2008, is shown on the graph. Approximately how many times more likely is a motorcyclist to be killed than a driver of any other type of vehicle?

Road deaths in vehicles

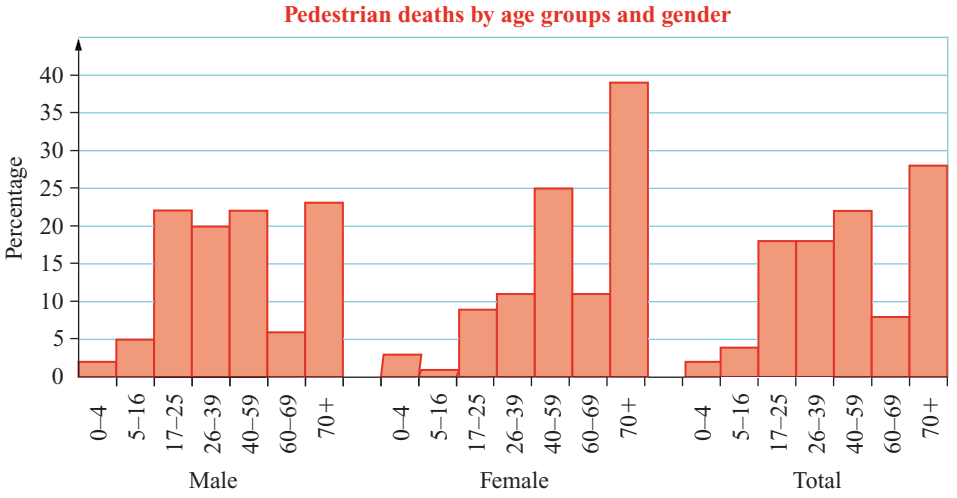


Road deaths on motorcycles



FOCUS STUDY

9 The graph below shows the percentage of pedestrian deaths in 2008, categorised by gender and age. Use the data to answer the questions.



a What is the probability that a male pedestrian killed in an accident will be in the 26–39 years age group?

b What is the probability that a female pedestrian killed in an accident will be in the 40–59 years age group?

c What is the probability that a pedestrian killed in an accident will be in the 60–69 years age group?

d Which age group of male pedestrians is:

i most likely to be killed?

ii least likely to be killed?

e Which age group of female pedestrians is:

i most likely to be killed?

ii least likely to be killed?

f Which age group of all pedestrians is:

i most likely to be killed?

ii least likely to be killed?

10 The table below gives the number of deaths per 100 000 of population of male and female drivers in the 17–25 years age group in Australia for the period 2002 to 2011.

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Male	27.4	25.9	25.1	25.6	25.8	22.5	20.8	18.6	17.3	14.0
Female	9.2	7.3	8.9	7.4	7.3	6.3	5.9	6.2	5.6	5.1

a Calculate the mean, median, mode and range of the number of deaths for each gender.

b Compare and discuss the main features of the data.

For more information on crash statistics visit: *www.rta.nsw.gov.au/roadsafety*
www.infrastructure.gov.au/roads/safety

INVESTIGATION 13.1

FOCUS STUDY

Investigate and write a report on the purchase of a motor vehicle. Include selecting the vehicle, making calculations for any funding needed, the type of lending institution and the lending rate, the amount payable in stamp duty, registration and insurance. New and used vehicle prices can be found in motoring magazines and on internet websites such as *www.redbook.com.au*.

INVESTIGATION 13.2

1 Search the internet for fuel watch websites to investigate trends in fuel prices for:

a different types of fuel

b different locations (for example, compare city and country prices).

Collect and present the data in tables and graphs.

2 Investigate cycles in the price of ULP. Describe a strategy that could be used to save money on fuel costs.

Some useful websites include: *www.mynrma.com.au* *www.motormouth.com.au*
www.fueltrac.com.au *www.icrc.act.gov.au/transport*

INVESTIGATION 13.3

Use an online motoring costs calculator to estimate the running costs for several different types of vehicles, including motorcycles. Visit *www.mynrma.com.au*

SPREADSHEET APPLICATION 13.1

The spreadsheet below shows the blood alcohol content for a 75 kg male and a 55 kg female, where *N* is the number of standard drinks consumed compared with the number of hours drinking. You can investigate what the BAC would be for a given number of standard drinks in a given time. Remember it is only an approximation!

	A	B	D	E	F	G	H	I	J
1	**Male**	Mass	75 kg						
2		**Hours of drinking**							
3	***N***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
4	1	0.005							
5	2	0.025	0.010						
6	3	0.044	0.029	0.015	0.000				
7	4	0.064	0.049	0.034	0.020	0.005			
8	5	0.083	0.069	0.054	0.039	0.025	0.010		
9	6	0.103	0.088	0.074	0.059	0.044	0.029	0.015	0.000
10	7	0.123	0.108	0.093	0.078	0.064	0.049	0.034	0.020
11	8	0.142	0.127	0.113	0.098	0.083	0.069	0.054	0.039
12									
13	**Female**	Mass	55 kg						
14		**Hours of drinking**							
15	***N***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
16	1	0.008							
17	2	0.041	0.017						
18	3	0.074	0.050	0.025	0.000				
19	4	0.107	0.083	0.058	0.033	0.008			
20	5	0.140	0.116	0.091	0.066	0.041	0.017		
21	6	0.174	0.149	0.124	0.099	0.074	0.050	0.025	0.000
22	7	0.207	0.182	0.157	0.132	0.107	0.083	0.058	0.033
23	8	0.240	0.215	0.190	0.165	0.140	0.116	0.091	0.066

REVIEW 13 MATHEMATICS AND DRIVING

Language and terminology

Cameras at intersections save lives, dollars

A landmark study has found that road safety cameras significantly reduce road accidents and so save the State of Victoria millions of dollars annually in associated crash costs. This is despite the public perception that road safety cameras are merely revenue-raising devices.

The Monash University Accident Research Centre (MUARC) study found that fixed digital speed and red light (FDSRL) cameras caused a decrease in casualty crashes of between 26 and 47 per cent, depending on vehicle approach, in the areas immediately surrounding their placement. This saves the community the costs associated with medical treatment, property damage and lost productivity caused by road accidents.

Dr Stuart Newstead and Mrs Laurie Budd of MUARC analysed 87 of Victoria's 175 FDSRL cameras at intersections located across the state last year, and compared crash rates before and after the installation of the cameras with those at comparable intersections without cameras.

'Across the areas we examined, the cameras led to 17 fewer crashes causing death or serious injury, and 39 fewer crashes causing minor injuries each year', Dr Newstead said. 'We estimate that this reduction represents at least $8 million in crash cost savings each year.'

1 What is FDSRL an abbreviation for in this report?

2 What do you think is meant by the term 'casualty crash'.

3 What was the percentage decrease in casualty crashes at intersections where a camera had been installed?

4 List the three major costs to the community associated with road accidents.

5 What percentage of Victoria's FDSRL cameras did the researchers analyse?

6 How many fewer crashes causing death or serious injury occurred in this survey?

7 What were the savings in costs to the community?

8 Discuss the use of fixed speed and red light cameras in your area. Do you think that they are merely revenue-raising devices?

Having completed this chapter

You should be able to:

- calculate the registration, stamp duty and insurance costs for new and used motor vehicles
- calculate the cost to finance the purchase of a motor vehicle
- solve problems related to the fuel consumption of a motor vehicle
- calculate the depreciation of the value of a motor vehicle using the straight-line method and the declining-balance method
- calculate the total running cost, including the standing costs and operating costs, of a motor vehicle
- calculate the number of standard drinks in a container, the BAC for males and females, and the time it takes for someone's BAC to fall to zero
- solve problems related to speed, distance and time
- calculate the distance a motor vehicle travels in the time it takes to bring it to a stop
- interpret tables and graphs related to motor vehicle accidents.

13 REVIEW TEST

1 The stamp duty charged when buying a car is 3% of the market value up to $45 000 plus 5% of the value over $45 000. The stamp duty to be paid on the purchase of a new car worth $56 000 is:
A $1680 **B** $2800 **C** $1900 **D** $550

2 The cost to register a new car that weighs 1504 kg and is used mostly for business is (use Table 1 in Section **13A**):
A $321 **B** $472 **C** $459 **D** $683

3 The monthly repayment on a loan of $12 000 over 5 years is $256.80. The total amount of interest paid on this loan would be:
A $15 408 **B** $3408 **C** $1284 **D** $13 284

4 A car travels 480 km on 60 L of petrol. Its fuel consumption is:
A 12.5 L/100 km **B** 0.125 L/100 km **C** 8 L/100 km **D** 28.8 L/100 km

5 How far can a motor vehicle travel on 45 L of petrol if its fuel consumption is 8.4 L/100 km?
A 5.36 km **B** 536 km **C** 18.7 km **D** 187 km

6 Using the straight-line method, the value after 4 years of a $25 000 car that depreciates $2650 per year is:
A $22 350 **B** $17 050 **C** $19 700 **D** $14 400

7 A car that was purchased for $29 900 was worth $14 300 after 5 years, using the straight-line method of depreciation. What was the annual amount of depreciation?
A $14 300 **B** $15 600 **C** $3120 **D** $11 180

8 A car is bought for $18 500. It depreciates in value by 22% per year. The book value of the car after 4 years is:
A $2220 **B** $4070 **C** $6848 **D** $9.53

9 A car depreciates in value from $36 800 to $23 550 in 2 years. Using the declining-balance method, the annual rate of depreciation is:
A 18% **B** 20% **C** 36% **D** 56%

10 The total running costs of a small car for the year were $8960. If the car travelled 14 800 km in the year, the average cost/kilometre was:
A $1.65/km **B** $16.50/km **C** $0.61/km **D** $6.10/km

11 If a car travels 280 km in 3 h and 25 min, its average speed is:
A 86 km/h **B** 82 km/h **C** 93 km/h **D** 42 km/h

12 70 km/h is equivalent to:
A 1.2 m/s **B** 0.02 m/s **C** 1167 m/s **D** 19.4 m/s

13 15 m/s is equivalent to:
A 250 km/h **B** 4.2 km/h **C** 54 km/h **D** 41.7 km/h

14 The distance a car travels in 2.8 s if its speed is 80 km/h is:
A 6.2 m **B** 7.9 m **C** 62.2 m **D** 373.3 m

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

Question	1, 2	3	4, 5	6–9	10	11–13	14
Section	A	B	C	D	E	G	H

13A REVIEW SET

1 How much more expensive is it to register a new Toyota Camry, which weighs 1460 kg, for business use than for private use?

2 Calculate the stamp duty to be paid on the purchase of a new BMW that has a recommended retail price of $76 000.

3 **a** Calculate the total cost of purchasing a new Holden Commodore that has a recommended retail price of $36 000, weighs 1637 kg, and CTP insurance is $477 and the dealer delivery charge is $630. The car is for private use and the owner decides to take out comprehensive insurance that costs $1150 for the first year.

b If the buyer receives $16 500 for the trade-in of her current vehicle, what is the changeover price to purchase the new Commodore?

4 Find the total cost of purchasing a 3-year-old Mazda that has an advertised price of $11 699, and for which third-party property damage insurance is $479.

5 **a** Complete the table below.

Price ($'000)	5	15	25	35	45	55	65	75	85
Stamp duty ($)									

b Use the information in the table to draw a graph with price, the independent variable, on the horizontal axis, and stamp duty, the dependent variable, on the vertical axis. (This is a piecewise function.)

c Use the graph to estimate the stamp duty on a vehicle purchased for:

i $33 000 **ii** $70 000

6 Use the loan repayment table in Worked Example 1 of Section **13B** to answer the following questions.

a Calculate the monthly repayments on a loan of $25 900 at 10% p.a. reducible over 5 years.

b What is the total amount of interest paid on this loan?

c How much would be saved by repaying the loan over 4 years instead of 5 years?

7 **a** Karen needs to borrow $17 000 to buy a car and can pay a maximum of $390 per month. She is offered a loan at 12% p.a. Can she afford to take out the loan? Give details.

b Could she afford the loan if the interest rate was 14% p.a.? What advice would you give Karen?

8 Jo's monthly repayment on a loan at 9% p.a. over 3 years is $381.60. How much did Jo borrow?

13B REVIEW SET

1 If a car uses 55 L of petrol on a trip of 560 km, calculate its fuel consumption in:

a km/L **b** L/km **c** L/100 km

2 How far can a vehicle travel on 38 L of fuel if its fuel consumption is 9.4 L/100 km?

3 Calculate the amount of fuel used by a vehicle on a trip of 315 km, if the fuel consumption is 10.2 L/100 km.

4 A salesman averages 5400 km of city driving each month in a Ford Falcon that uses 11.4 L/100 km (city cycle). Calculate the monthly cost of petrol used by the salesman if the average price of ULP is 139.9c/L.

5 A Citroën C4 uses 7.6 L/100 km of ULP. The diesel version of this car uses 6 L/100 km of diesel fuel. Which car would be cheaper to drive a distance of 680 km if the price of ULP is 142.9c/L and the price of diesel is 162.2c/L? How much cheaper is it?

6 Barry owns a Holden Commodore that runs on ULP and has a fuel consumption of 10.6 L/100 km. When converted to run on liquid petroleum gas (LPG), the car's fuel consumption will be 13.5 L/100 km. Barry drives an average of 18 000 km per year.

a Calculate the annual fuel cost of running a car on each type of fuel if the average price of ULP is 149.9 c/L and of LPG is 67.8c/L.

b How much per year would Barry save in fuel costs if he converted the car to LPG?

c What would be the saving per month?

d The cost of converting the car to LPG is $2500. How many months would it take to break even, if Barry converts the car to LPG?

e What distance would Barry need to travel before he broke even?

7 **a** A car running on ULP has a fuel consumption of 12 L/100 km. The cost of ULP is $1.35/L. Complete the table below to show the fuel cost of driving this car.

Distance travelled (km)	0	10 000	20 000	30 000	40 000	50 000
Fuel cost ($)	0	1620				

b Use the information in the table to draw a graph of fuel cost versus distance travelled.

c The diesel motor version of the car costs $1600 more than the petrol version and has a fuel consumption of 8 L/100 km. Diesel fuel costs $1.60/L. Complete the table to show the fuel cost of driving this car.

Distance travelled (km)	0	10 000	20 000	30 000	40 000	50 000
Fuel cost ($)	1600	2880				

d On the same axes as the graph in part **b**, draw a graph of fuel cost versus distance travelled, for the diesel car.

e From the graph, estimate the distance travelled to reach the break-even point.

8 A car purchased for $15 800 depreciates $1760 per year. Calculate its book value after 5 years.

9 A car that was purchased for $22 990 had a book value of $15 190 after 4 years, using the straight-line method of depreciation. Calculate the annual amount of depreciation.

10 A new car is purchased for $29 000. It depreciates in value at a rate of 21% per year.

a Calculate the book value of the car after 3 years.

b By what amount has the car depreciated in value over the 3 years?

11 A car depreciates in value from $33 000 to $19 000 in 2 years. Use the declining-balance formula to calculate the annual percentage rate of depreciation.

12 A car is purchased for $19 900. The straight-line depreciation amount is $3900 and the declining-balance percentage rate is 40%.

a Complete the following table to find the depreciated value using each method.

Year	Value straight-line value ($)	Declining-balance value ($)
0	19 900	19 900
1	16 000	11 940
2		
3		
4		
5		

b Draw a graph of the value of the car for each type of depreciation on the same set of axes.

c Find the value of the car after 2 years for each method.

d Find the value of the car after $3\frac{1}{2}$ years for each method.

e After what time is the depreciated value the same for the two methods?

13C REVIEW SET

1 The table below shows the average annual running costs for the vehicles listed. The calculations are based on the cost of buying a new vehicle for private use and operating it for 5 years. The interest charges are based on the total cost of the new vehicle being financed by a loan. It is assumed that the vehicle travels 15 000 km each year.

Average annual running costs	Ford Focus (small)	Holden Commodore (large)	Toyota RAV4 (compact SUV)
Standing costs:			
Depreciation ($)	3120	5928	
Interest ($)		2444	2288
On-road costs, road service membership ($)	1248	962	1061
Operating costs:			
Fuel ($)	1898	2626	2340
Tyres ($)	146	146	208
Service and repairs ($)	671	634	952
Total ($)	**8607**		
Average costs:			
Total cost/week ($/week)	165.52	245	223.71
Total cost/kilometre (c/km)	57.4		

a Calculate the missing values in the table.

b Add another column to the table and use the information below to calculate the cost per week and cost per kilometre to run a Nissan Pathfinder (dealer price $52 000):
Average depreciation each year is 13.6% of the dealer price.
Average annual rate of loan interest is 6.5% (assume the total cost of the vehicle is financed by the loan).
On-road costs are $23 per week.
Fuel consumption is 12 L/100 km and fuel price 145.9 c/L. Assume that vehicle travels 15 000 km each year.
Tyres cost $294 per year.
Services and repairs are $18.60 per week.

2 Three people, who live in the same general area and work at the same location, drive to work each day. Elizabeth owns a Ford Focus, Monique a Holden Commodore and Tanya a Toyota RAV4.

a Using the information in the table in question **1**, calculate the average operating costs per day for each car (use 1 year = 365 days).

b Over a 3-week period, how much does it cost each person to drive to work, assuming the average daily operating cost is completely work related?

c They decide to form a car pool, so that each person drives everyone to work 1 week out of every 3 weeks. How much does each person save every 3 weeks by forming the car pool?

3 Calculate the number of standard drinks in a 120 mL glass of red wine given that the alcohol content of the wine is 14.6% alc/vol.

4 **a** Calculate the BAC of a 76 kg male who has consumed 5 standard drinks in 3 hours.

b Calculate the BAC of a 52 kg female who has consumed 4 standard drinks in 4 hours.

5 Calculate how long you must wait for your BAC to drop to 0 from 0.06%.

6 **a** Calculate the BAC for a 75 kg male and 53 kg female, both with provisional licences, who consume 4 standard drinks in 3 hours.

b A zero BAC is a requirement of NSW law for all learner and provisional drivers. How long would the two people have to wait before they could legally drive a motor vehicle?

13D REVIEW SET

1 **a** A car travels 252 km in 4 h and 19 min. Calculate its average speed.

b A train averages 84 km/h for 2 h and 36 min. How far does it travel?

c If a cyclist can average 15 km/h, how long will it take her to travel 28 km?

2 Convert the following.

a 55 km/h to m/s **b** 21.4 m/s to km/h

3 Calculate the reaction-time distance for a car travelling at 60 km/h. Assume a reaction time of 2.5 s.

4 Use the formula $d = 0.1v^2$ to calculate the braking distance for a car travelling at 80 km/h in good conditions.

5 For a car travelling on a slippery road, the formula for braking distance becomes $d = 0.015v^2$. What is the braking distance of a car travelling at 100 km/h on this road?

6 Find the total stopping distance for a car travelling at 90 km/h in good conditions. Assume a reaction time of 2.5 s and a braking distance of $d = 0.01v^2$.

7 Find the total stopping distance for a car travelling at 80 km/h in good conditions. Use the formula $d = 0.7v + 0.01v^2$, where d is the stopping distance in metres and v is the speed in km/h.

8 For a driver under the influence of alcohol and driving in poor road conditions, the formula for the stopping distance of a car becomes $d = 1.1v + 0.018v^2$.

a Complete the table for this driver, and draw a graph of the relationship between speed and stopping distance.

Speed (km/h)	0	20	40	60	80	100
Stopping distance (m)						

b From the graph estimate the stopping distance at:

i 50 km/h **ii** 70 km/h **iii** 110 km/h

13 EXAMINATION QUESTION (15 MARKS)

a Harry goes to a party and drinks three stubbies (375 mL) of full strength beer (4.7% alc/vol) in the first hour and two stubbies per hour for the next 3 hours.

i Calculate the number of standard drinks he has consumed. (1 mark)

ii Calculate Harry's blood alcohol content after 4 hours if his mass is 78 kg. (2 marks)

iii How long will it be until his BAC drops to zero? (1 mark)

b This table gives the monthly repayments ($) for every $1000 borrowed on a reducing-balance loan.

Interest rate (% p.a.)	Term of loan (months)				
	12	24	36	48	60
8	86.99	45.23	31.34	24.41	20.28
9	87.45	45.68	31.80	24.89	20.76
10	87.92	46.14	32.27	25.36	21.25

i Jenny borrows $21 500 to buy a new car. Use the table to calculate the monthly repayment on this loan at 9% p.a. over 3 years. (1 mark)

ii What is the total amount of interest Jenny pays on this loan? (1 mark)

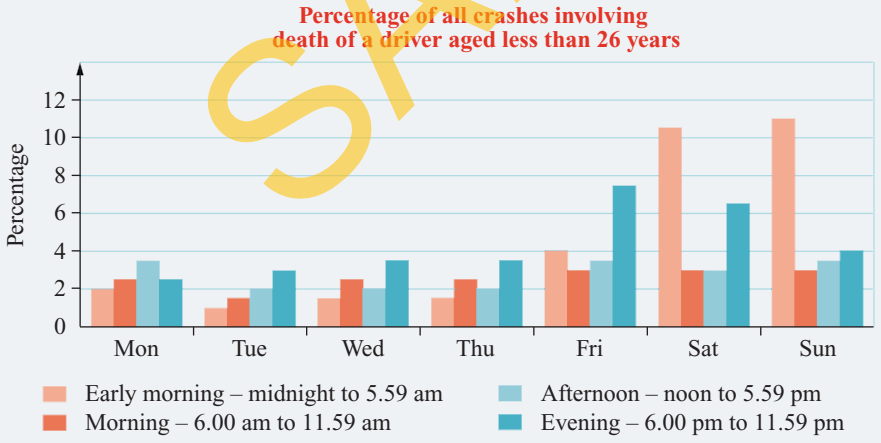
iii Jack's monthly repayment on a loan at 8% over 5 years is $334.62. Use the table above to calculate how much Jack borrowed. (1 mark)

c The total stopping distance, d metres, of a car travelling at v km/h under good conditions is given by the formula $d = 0.8v + 0.01v^2$.

i Calculate the stopping distance of a car travelling at 60 km/h. (1 mark)

ii If the speed of the car is increased by 10 km/h, what is the increase in the stopping distance? (2 marks)

d The graph below shows the percentage of crashes resulting in the death of a driver aged less than 26 years, by time of the day and day of the week.



i What percentage of fatal crashes involving a driver under 26 occurred between noon and 5:59 pm on a Tuesday? (1 mark)

ii At what time of the week do most fatal crashes occur? (1 mark)

iii On what day of the week do the most fatal crashes occur? (1 mark)

e How far can a car travel on 54 L of fuel if the fuel consumption is 7.8L/100 km? (1 mark)

f A car is bought for $29 800. If it depreciates by 24% per year, what will its book value be after 4 years? (1 mark)