30. [Probability]

Skill 30.1   Describing the probability of an event using probability scales (1).

- Find the number of favourable outcomes for the event.
- Find the total number of possible outcomes.
- Divide the number of favourable outcomes by the number of possible outcomes:

$$\text{Pr(event)} = \frac{\text{number of favourable outcomes}}{\text{number of possible outcomes}} = \frac{FO}{PO}$$

OR

Example: Experiment   throwing a standard die
Event   throwing a number greater than 4
Possible outcomes (PO)   6   (throwing a 1, 2, 3, 4, 5 or a 6)
Favourable outcomes (FO) 2   (throwing a 5 or a 6)
Probability (Pr)   2 out of 6 = $\frac{2}{6}$ (FO out of PO)

Impossible ← Unlikely — Equally likely — Likely → Certain

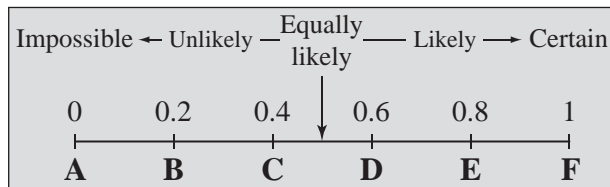| 0	$\frac{1}{6}$	$\frac{2}{6}$	$\frac{3}{6}$	$\frac{4}{6}$	$\frac{5}{6}$	1
A	B	C	D	E	F	G

Hints: Probability ranges from 0 to 1.
The closer the probability is to 1, the more likely the event is to happen.
The closer the probability is to 0, the more unlikely the event is to happen.

Q. Which letter A to F best describes the probability of this event?

'A class captain will be elected from 5 candidates.'

Impossible ← Unlikely — Equally likely — Likely → Certain

0	0.2	0.4	0.6	0.8	1
A	B	C	D	E	F

A. $PO = 5$
$FO = 1$
$Pr\ (event) = \dfrac{FO}{PO}$
$\qquad\quad = \dfrac{1}{5}$
$\qquad\quad = 0.2$
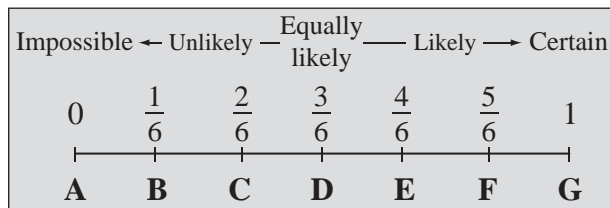*The answer is* **B**.

a) Which letter A to G best describes the probability of this event?

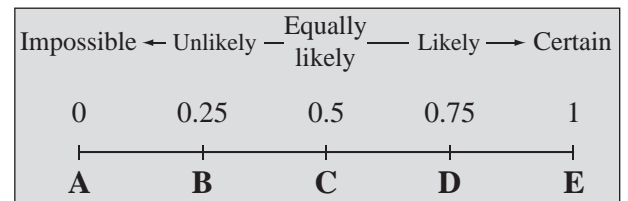'A standard die is rolled and a number less than 5 turns up.'

Impossible ← Unlikely — Equally likely — Likely → Certain

0	$\frac{1}{6}$	$\frac{2}{6}$	$\frac{3}{6}$	$\frac{4}{6}$	$\frac{5}{6}$	1
A	B	C	D	E	F	G

$PO = 6$ $FO = 4$

$\dfrac{FO}{PO} = \dfrac{4}{6}$ ⇒ ☐

b) Which letter A to E best describes the probability of this event?

'A tossed coin lands heads.'

Impossible ← Unlikely — Equally likely — Likely → Certain

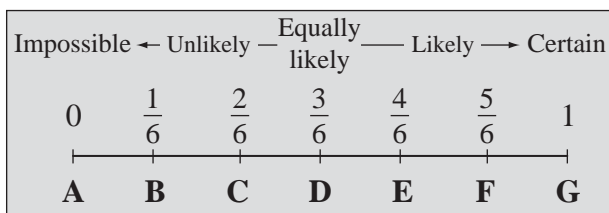| 0	0.25	0.5	0.75	1
A	B	C	D	E

$PO = $ $FO = $

$\dfrac{FO}{PO} = $ ⇒ ☐

Skill 30.1   Describing the probability of an event using probability scales (2).
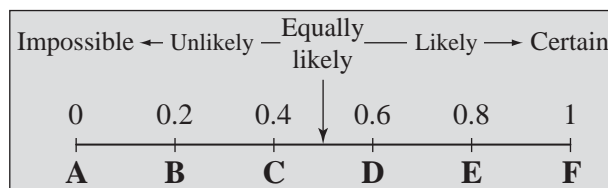
MM5.2 **1** 11 22 33 44
MM6.1 11 22 33 44

c) Which letter A to G best describes the probability of this event?
'A standard die is rolled and a number greater than 6 turns up.'

Impossible ← Unlikely — Equally likely — Likely → Certain

$0 \quad \frac{1}{6} \quad \frac{2}{6} \quad \frac{3}{6} \quad \frac{4}{6} \quad \frac{5}{6} \quad 1$

A   B   C   D   E   F   G

$PO =$ $FO =$

$\dfrac{FO}{PO} =$ $\Rightarrow$ ☐

d) Which letter A to F best describes the probability of this event?
'Mathematics is taught at our school.'

Impossible ← Unlikely — Equally likely — Likely → Certain

$0 \quad 0.2 \quad 0.4 \quad 0.6 \quad 0.8 \quad 1$

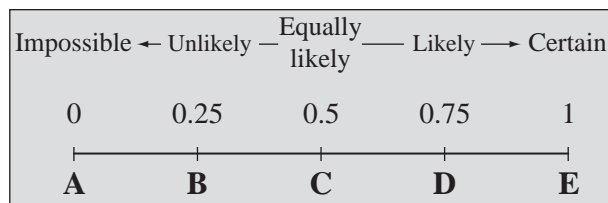A   B   C   D   E   F

$PO =$ $FO =$

$\dfrac{FO}{PO} =$ $\Rightarrow$ ☐

e) Which letter A to E best describes the probability of this event?
'The next baby born in a family will be a boy.'

Impossible ← Unlikely — Equally likely — Likely → Certain

$0 \quad \frac{1}{4} \quad \frac{1}{2} \quad \frac{3}{4} \quad 1$

A   B   C   D   E

$PO =$ $FO =$

$\dfrac{FO}{PO} =$ $\Rightarrow$ ☐

f) Which letter A to E best describes the probability of this event?
'There is a holiday on 1 January.'

Impossible ← Unlikely — Equally likely — Likely → Certain

$0 \quad 0.25 \quad 0.5 \quad 0.75 \quad 1$

A   B   C   D   E

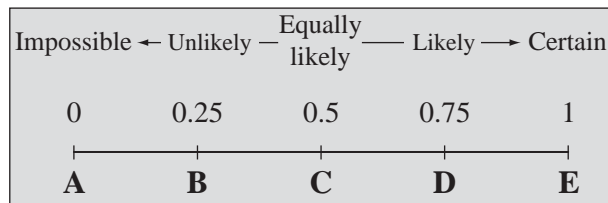$PO =$ $FO =$

$\dfrac{FO}{PO} =$ $\Rightarrow$ ☐

g) Which letter A to G best describes the probability of this event?
'A standard die is rolled and a number greater than 1 turns up.'

Impossible ← Unlikely — Equally likely — Likely → Certain

$0 \quad \frac{1}{6} \quad \frac{2}{6} \quad \frac{3}{6} \quad \frac{4}{6} \quad \frac{5}{6} \quad 1$

A   B   C   D   E   F   G

$PO =$ $FO =$

$\dfrac{FO}{PO} =$ $\Rightarrow$ ☐

h) Which letter A to E best describes the probability of this event?
'A spinner numbered 1 to 8 is spun and a multiple of 3 is obtained.'

Impossible ← Unlikely — Equally likely — Likely → Certain

$0 \quad 0.25 \quad 0.5 \quad 0.75 \quad 1$

A   B   C   D   E

$PO =$ $FO =$

$\dfrac{FO}{PO} =$ $\Rightarrow$ ☐

Skill 30.2 Calculating the probability of a simple event (1).

MM5.2 1 1 2 2 3 3 4 4
MM6.1 1 1 2 2 3 3 4 4

- Find the total number of possible outcomes.
- Find the number of favourable outcomes for the event.
- Divide the number of favourable outcomes by the number of possible outcomes:

$$Pr(event) = \frac{\text{number of favourable outcomes}}{\text{number of possible outcomes}} = \frac{FO}{PO}$$

Example:
Experiment	throwing a standard die	OR
Event	throwing a number greater than 4	
Possible outcomes (PO)	6	(throwing a 1, 2, 3, 4, 5 or a 6)
Favourable outcomes (FO)	2	(throwing a 5 or a 6)
Probability (Pr)	2 out of 6 = $\frac{2}{6}$	(FO out of PO)

Q. A number from 10 to 17 is chosen at random. What is the probability that the number chosen is a multiple of 3? [Give your answer as a decimal.]

A. PO = 8   (10, 11, 12, 13, 14, 15, 16, 17)

FO = 2   (12 and 15)

$$Pr(multiple\ of\ 3) = \frac{FO}{PO}$$
$$= \frac{2 \div 2}{8 \div 2}$$
$$= \frac{1}{4}$$
$$= \boldsymbol{0.25}$$

a) A standard die is rolled. What is the probability of rolling a multiple of 2?

$PO = 6$ $FO = 3\ (2, 4, 6)$

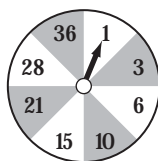$$Pr(multiple\ of\ 2) = \frac{FO}{PO} = \frac{3 \div 3}{6 \div 3} = \boxed{}$$

b) A 52-card deck of playing cards is shuffled and one card is dealt from the top of the deck. What is the probability that it is a nine?

$PO = $ $FO = $

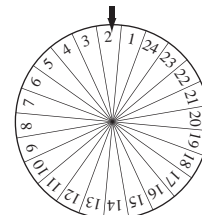$$Pr(nine) = \frac{FO}{PO} = \qquad = \boxed{}$$

c) This spinner is spun once. What is the probability of spinning a multiple of 3?

$PO = $ $FO = $
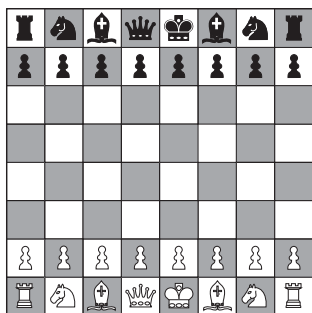
$$Pr(multiple\ of\ 3) = \qquad = \qquad = \boxed{}$$

d) This spinner is spun once. What is the probability of spinning a prime number?

$PO = $ $FO = $

$$Pr(prime\ number) = \qquad = \qquad = \boxed{}$$

Skill 30.2   Calculating the probability of a simple event (2).

MM5.2 1 1 **2 2** 3 3 4 4
MM6.1 **1 1** 2 2 3 3 4 4
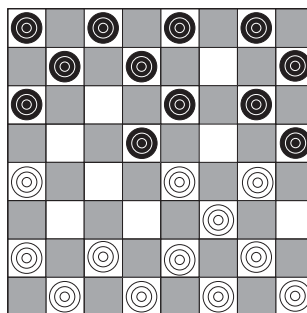
e)   A fly lands onto one square of this chess board. What is the probability that the fly lands on a square containing a knight (♞ or ♘)?

PO =   *FO =*

....

Pr(knight) =   =   = ☐

....

f)   A fly lands onto one square of this draught board. What is the probability that the fly lands on an empty white square?

PO =   *FO =*

....

Pr(empty white) =   =   = ☐

....

g)   A standard die is rolled. What is the probability of rolling a number greater than 2?

PO =   *FO =*

....

Pr(> 2) =   =   = ☐

....

h)   A standard die is rolled. What is the probability of rolling a prime number?

PO =   *FO =*

....

Pr(prime number) =   =   = ☐

....

i)   Based on these speed figures, find the probability that a driver, chosen at random, was travelling at more than 110 km/h.

Speed (km/h)	Frequency
81 - 90	9
91 - 100	12
101 - 110	11
111 - 120	8

PO =   *FO =*

....

Pr(> 110) =   =   = ☐

....

j)   Based on these conference figures, find the probability that a participant, chosen at random, comes from Queensland (QLD).

STATE	PARTICIPANTS
VIC	35
NSW	28
QLD	15
SA	15
WA	12

PO =   *FO =*

....

Pr(Qld) =   =   = ☐

....

k)   Amanda has six 50-cent coins, nine 20-cent and nine 10-cent coins in her purse. Find the probability that the first coin she takes out of her purse will be a 10-cent coin.

PO =   *FO =*

....

Pr(10-cent coin) =   =   = ☐

....

l)   In a lotto draw, balls numbered 1 to 45 are mixed together. What is the probability that the first number drawn is greater than 33?

PO =   *FO =*

....

Pr(> 35) =   =   = ☐

....

- Identify the complementary events.
- Find or calculate the probability of the event.

$$Pr(event) = \frac{number\ of\ favourable\ outcomes}{number\ of\ possible\ outcomes} = \frac{FO}{PO}$$

- Subtract this value from 1 in order to find the probability of the complementary event:

Pr(complementary event) = 1 – PR(event)

Hints: The complement of the event "the aeroplane will be on time" is "the aeroplane will not be on time".
Winning - not winning, voting "yes" - voting "no" are examples of complementary events.

Q. If the probability of winning a prize is $\frac{3}{200}$, what is the probability of not winning a prize?

A. *Event = winning a prize*
Complementary event = not winning a prize
$Pr(winning\ a\ prize) = \frac{3}{200}$
$Pr(not\ winning\ a\ prize)\ = 1 - \frac{3}{200}$
$= \frac{200}{200} - \frac{3}{200} = \boldsymbol{\frac{197}{200}}$

---

a) If the probability of raining on New Year's Eve is $\frac{7}{20}$, what is the probability of not raining?

$Pr(raining) = \frac{7}{20}$
....
$Pr(not\ raining) = 1 - \frac{7}{20} \quad = \boxed{}$
....

b) If the probability of Scott winning his next tennis match is $\frac{3}{5}$, what is the probability of him not winning?

$Pr(winning) =$
....
$Pr(not\ winning) = 1 - \quad = \boxed{}$
....

c) The probability that Nina votes "yes" in the referendum is 0.37. What is the probability that she votes "no"?

$Pr(yes) =$
....
$Pr(no) = 1 - \quad = \boxed{}$
....

d) The probability that a couple will have a child with blue eyes is $\frac{1}{4}$. What is the probability that the child will not have blue eyes?

$Pr(blue) =$
....
$Pr(not\ blue) = 1 - \quad = \boxed{}$
....

e) There are 10 purple, 24 yellow and 16 green discs. Find, as a decimal, the probability that a disc drawn at random from the barrel is not yellow.

$\overset{\overbrace{FO = 24,\ PO = 50}}{}$
$Pr(yellow) = \frac{24}{50}\overset{\div 2}{}_{\div 2} = \frac{12}{25}$
....
$Pr(not\ yellow) = 1 - \frac{12}{25} = \frac{25}{25} - \frac{12}{25} = \frac{13}{25}$
....
$= \frac{13}{25}\overset{\times 4}{}_{\times 4} = \frac{52}{100} = \boxed{0.52}$

f) A bag contains 15 green, 10 red and 20 blue marbles. Find the probability that a marble drawn at random from the bag will not be blue.

$Pr(blue) =$
....
$Pr(not\ blue) = 1 - \quad = \boxed{}$
....

Skill 30.4 Finding the possible outcomes (sample spaces) of an event by completing tree diagrams.
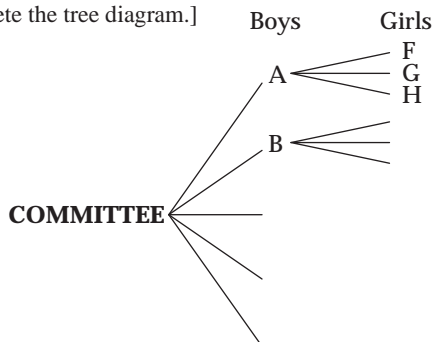
- Complete the tree diagram to show all the possible outcomes (sample space).
- Count the number of favourable outcomes.
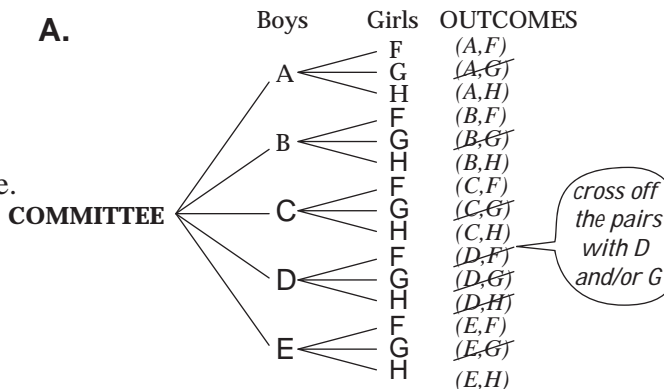- Divide the number of favourable outcomes by the number of possible outcomes.

$$Pr(event) = \frac{\text{number of favourable outcomes}}{\text{number of possible outcomes}} = \frac{FO}{PO}$$

Q. A committee consisting of one boy and one girl is to be selected from 5 boys (Aaron, Brad, Chris, Dean and Ethan) and 3 girls (Fiona, Gemma and Hannah). Find the probability that Dean and Gemma are not on the committee.
[Complete the tree diagram.]

A.

cross off the pairs with D and/or G

$PO = 5 \times 3 = 15$

$FO = 15 - 7 = 8$

$Pr(no\ Dean,\ no\ Gemma) = \frac{FO}{PO} = \frac{8}{15}$

a) The ice cream at the cinema is sold with one fruit (strawberry, blueberry and lemon) and one nut topping (macadamia, pecans, walnuts, almonds). What is the probability of choosing a lemon topping? [Complete the tree diagram.]

ICE CREAMS

fruit topping: strawberry blueberry lemon

nut topping: M P W A

$PO = 12 \qquad FO = 4$

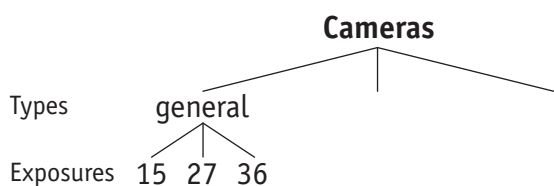$Pr(lemon) = \frac{4 \div 4}{12 \div 4} \qquad = \boxed{}$

b) Umbrellas are sold in four styles, straight, golf, 2-folded and 3-folded. They can be manual (M) and automatic (A). What is the probability of receiving an automatic umbrella for your birthday? [Complete the tree diagram.]

Umbrellas

straight

$PO = \qquad FO =$
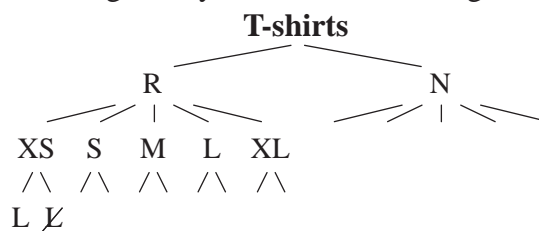
$Pr(automatic) = \qquad = \boxed{}$

c) A store is selling general, outdoor and waterproof disposable cameras. Each type comes with 15, 27 and 36 exposures. What is the probability of choosing an outdoor disposable camera? [Complete the tree diagram.]

Cameras

Types: general

Exposures: 15 27 36

$PO = \qquad FO =$

$Pr(outdoor) = \qquad = \boxed{}$

d) The T-shirts displayed for sale come in two colours (red, navy) and in 5 sizes (XS, S, M, L, XL). The T-shirts can be purchased with or without a logo. What is the probability of choosing a navy T-shirt without a logo?

T-shirts

R   N

XS S M L XL

L Ł

$PO = \qquad FO =$

$Pr(navy,\ no\ logo) = \qquad = \boxed{}$

Skill 30.5   Calculating the probability of multiple events by using tree diagrams or two-way tables to represent the sample spaces (1).

MM5.2 11 22 33 **4** 4
MM6.1 11 **2** 2 33 44

- Complete the tree diagram or two-way table to show all the possible outcomes (sample space).
- Count the number of favourable outcomes.
- Divide the number of favourable outcomes by the number of possible outcomes.

$$\text{Pr(event)} = \frac{\text{number of favourable outcomes}}{\text{number of possible outcomes}} = \frac{FO}{PO}$$

Q. A die is tossed and a spinner labelled 1, 2 and 3 is spun. What is the probability of obtaining one even number and one odd number when the die is tossed and the spinner is spun once? [Complete the table.]

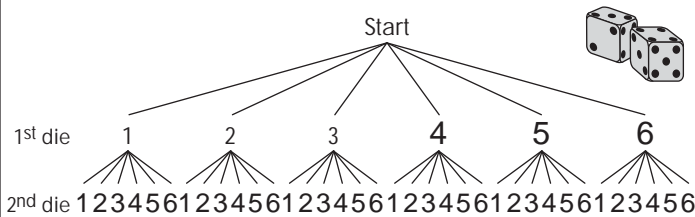| Possible outcomes		Die					
		1	2	3	4	5	6
Spinner	1	(1,1)	(1,2)				
	2	(2,1)	(2,2)				
	3						

A.

Possible outcomes		Die					
		1	2	3	4	5	6
Spinner	1	(1,1)	(1,2)	(1,3)	(1,4)	(1,5)	(1,6)
	2	(2,1)	(2,2)	(2,3)	(2,4)	(2,5)	(2,6)
	3	(3,1)	(3,2)	(3,3)	(3,4)	(3,5)	(3,6)

$PO = 6 \times 3 = 18$

$FO = 9$

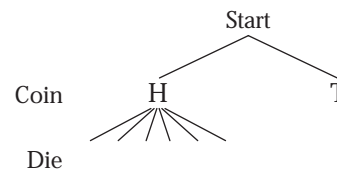$$\text{Pr(one odd, one even)} = \frac{FO}{PO}$$
$$= \frac{9 \div 9}{18 \div 9} = \frac{1}{2}$$

a) A pair of standard dice are rolled. Find the probability of rolling a total of 7. [Complete the tree diagram.]

Start

1st die   1   2   3   4   5   6

2nd die 123456 123456 123456 123456 123456 123456

$PO = 36$ $FO = 6$

$$\text{Pr(total of 7)} = \frac{FO}{PO} = \frac{6 \div 6}{36 \div 6} = \boxed{\frac{1}{6}}$$

b) A coin is tossed and a die is rolled. Find the probability of tossing heads and rolling a number less than 5. [Complete the tree diagram.]

Start

Coin   H   T

Die

$PO = $ $FO = $

$$\text{Pr(H and < 5)} = \quad = \quad = \boxed{}$$

c) A pair of standard dice are rolled. What is the probability of rolling any pair of identical numbers? [Complete the table.]

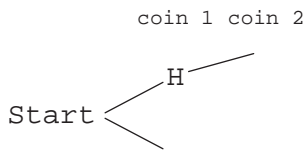| Possible outcomes		Die 1					
		1	2	3	4	5	6
Die 2	1	(1,1)	(1,2)				
	2	(2,1)					
	3	(3,1)					
	4						
	5						
	6						

$PO = $ $FO = $

$$\text{Pr(identical no.)} = \quad = \quad = \boxed{}$$

d) A pair of standard dice are rolled. Find the probability of rolling no prime numbers in the pair. [Complete the table.]

Possible outcomes		Die 1					
		1	2	3	4	5	6
Die 2	1	(1,1)	(1,2)				
	2	(2,1)					
	3	(3,1)					
	4						
	5						
	6						

$PO = $ $FO = $

$$\text{Pr(no primes)} = \quad = \quad = \boxed{}$$

Skill 30.5   Calculating the probability of multiple events by using tree diagrams or two-way tables to represent the sample spaces (2).
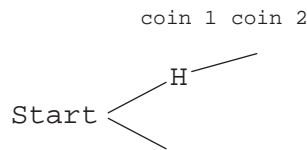
MM5.2 11 22 33 **4** 4
MM6.1 11 2 **2** 33 44

e) Two coins are tossed at the same time. Find the probability of tossing at least one head.
[Complete the tree diagram.]

coin 1 coin 2

Start `<` H `<`

PO =   *FO =*

Pr(at least 1 H) =   =   = ☐

f) Two coins are tossed at the same time. Find the probability of tossing two tails.
[Complete the tree diagram.]

coin 1 coin 2

Start `<` H `<`
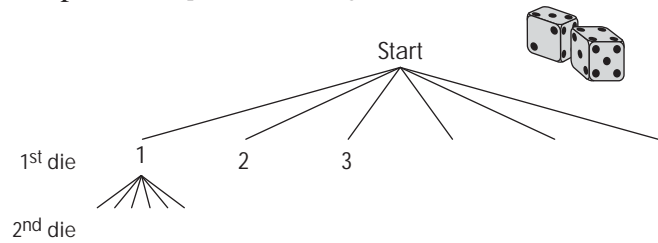
PO =   *FO =*

Pr(2 tails) =   =   = ☐

g) A die is tossed and a spinner labelled 1, 2 and 3 is spun. What is the probability of obtaining two odd numbers when the die is tossed and the spinner is spun once? [Complete the tree diagram.]

Start

Spinner   1

Die

PO =   *FO =*

Pr(2 odd no.) =   =   = ☐

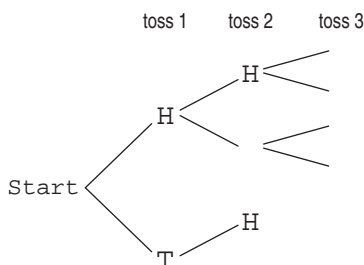**h)** A pair of standard dice are rolled. Find the probability of rolling two even numbers in the pair. [Complete the tree diagram.]

Start

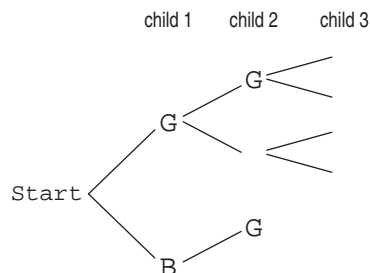1st die   1   2   3

2nd die

PO =   *FO =*

Pr(2 even no.) =   =   = ☐

i) A coin is tossed three times. What is the probability of tossing at least one tail?
[Complete the tree diagram.]

toss 1   toss 2   toss 3

H `<`
H
Start `<`
H
T

PO =   *FO =*

Pr(at least 1 T) =   =   = ☐

j) Chris and Klaus wish to start a family. They plan to have 3 children. If the chance of having a girl or a boy is equal, find the probability that they have 3 children of the same sex.

child 1   child 2   child 3

G `<`
G
Start `<`
G
B

PO =   *FO =*

Pr(3 of same sex) =   =   = ☐

Skill 30.6 Calculating the probability of mutually exclusive events by using the Addition Law of Probability.

- Find the probability of each separate event.

$$Pr(event) = \frac{\text{number of favourable outcomes}}{\text{number of possible outcomes}} = \frac{FO}{PO}$$

- Add the probabilities of each event in order to find the probability of either event occurring.

Addition Law of Probability: $Pr(A \text{ or } B) = Pr(A) + Pr(B)$

Hint: Mutually exclusive events cannot occur at the same time.

Q. A 52-card deck of playing cards is shuffled and one card is dealt from the top of the deck. What is the probability that it is an eight or a court card?

A. $Pr(8) = \dfrac{4}{52}$ — 8 in all four suites

$Pr(court) = \dfrac{12}{52}$ — J, Q, K in all four suites

$Pr(8 \text{ or } court) = Pr(8) + Pr(court)$

$$= \frac{4}{52} + \frac{12}{52} = \frac{16}{52} \begin{smallmatrix} \div 4 \\ \div 4 \end{smallmatrix} = \frac{4}{13}$$

---

a) Based on these car dealership figures, find the probability that a buyer, chosen at random purchased a Toyota or a Holden.

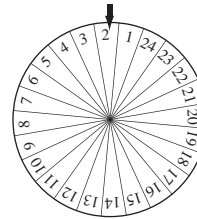| CAR MODEL	SALES
Ford	90
Holden	140
Mitsubishi	55
Toyota	180
Nissan	15

$Pr(T) = \dfrac{180}{480}$ $\qquad$ $Pr(H) = \dfrac{140}{480}$

$Pr(T \text{ or } H) = Pr(T) + Pr(H) =$

$$= \frac{180}{480} + \frac{140}{480} = \frac{320}{480} \begin{smallmatrix} \div 160 \\ \div 160 \end{smallmatrix} = \boxed{}$$

b) This spinner is spun once. What is the probability of spinning a multiple of 3 or a multiple of 10?

$Pr(M3) = \dfrac{8}{24}$ $\qquad$ $Pr(M10) =$

$Pr(M3 \text{ or } M10) = \qquad + \qquad =$

$$= \qquad\qquad = \boxed{}$$

c) A bowl contains 40 marbles, numbered 1 to 40. A marble is drawn from the bowl. Find the probability of drawing a multiple of 6 or a multiple of 7.

$Pr(M6) = \qquad\qquad Pr(M7) =$

$Pr(M6 \text{ or } M7) =$

$$= \qquad\qquad = \boxed{}$$

d) A jar contains 23 black, 18 red and 31 white jelly beans. Find the probability that a jelly bean drawn at random from the jar will be white or black.

$Pr(white) = \qquad\qquad Pr(black) =$

$Pr(white \text{ or } black) =$

$$= \qquad\qquad = \boxed{}$$

Skill 30.7   Calculating the probability of non-exclusive events.

MM5.2 11 22 33 4**4**
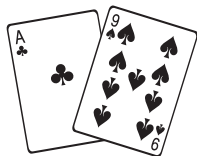MM6.1 11 22 **3** 3 44

- Find the probability of each separate event.

$$Pr(event) = \frac{number\ of\ favourable\ outcomes}{number\ of\ possible\ outcomes} = \frac{FO}{PO}$$

- Add the probabilities of each event and then subtract the probability of both events occuring at the same time, in order to find the probability of either event occuring.

$$Pr(A\ or\ B) = Pr(A) + Pr(B) - Pr(A\ and\ B)$$

Hint: Non-exclusive events can occur at the same time.

Q. A 52-card deck of playing cards is shuffled and one card is dealt from the top of the deck. What is the probability that it is an odd number or a club?

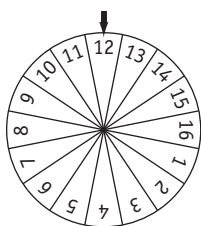**A.** $Pr(odd\ number) = \frac{20}{52}$ *1, 3, 5, 7, 9 in all four suites*

$Pr(club) = \frac{13}{52}$ *A quarter of the deck are clubs*

$Pr(odd\ and\ club) = \frac{5}{52}$

$Pr(O\ or\ C) = Pr(O) + Pr(C) - Pr(O\ and\ C)$

$$= \frac{20}{52} + \frac{13}{52} - \frac{5}{52} = \frac{28}{52}\frac{\div 4}{\div 4} = \frac{7}{13}$$

---

a) This spinner is spun once. What is the probability of spinning a multiple of 2 or a multiple of 3?
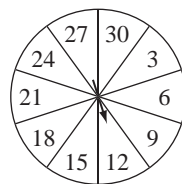
$Pr(M2) = \frac{8}{16}$

$Pr(M3) = \frac{5}{16}$

$Pr(M2\ and\ M3) = \frac{2}{16}$

$Pr(M2\ or\ M3) = \frac{8}{16} + \frac{5}{16} - \frac{2}{16}$

$= \frac{13}{16} - \frac{2}{16}$ = ☐

b) This spinner is spun once. What is the probability of spinning an even number or a number greater than 15?

$Pr(even) =$ ....

$Pr(>15) =$ ....

$Pr(even\ and\ >15) =$ ....

$Pr(even\ or\ >15) =$ +   −

$=$ ....   = ☐

c) A 52-card deck of playing cards is shuffled and one card is dealt from the top of the deck. What is the probability that it is a red court card or a heart?

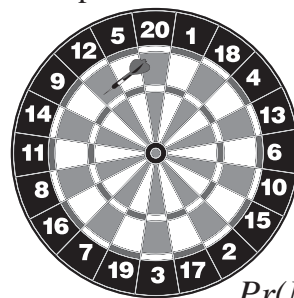$Pr(red\ court) =$ ....

$Pr(heart) =$ ....

$Pr(red\ court\ and\ heart) =$ ....

$Pr(red\ court\ or\ heart) =$ +   −

$=$ ....   = ☐

d) A dart is thrown and hits the board. What is the probability that the dart lands inside a multiple of 3 or a multiple of 4?

$Pr(M3) =$ ....

$Pr(M4) =$ ....

$Pr(M3\ and\ M4) =$ ....

$Pr(M3\ or\ M4) =$ +   −

$=$ ....   = ☐

- Determine the probability of the event.
- Use the formula:

$$Pr(event) = \frac{\text{number of favourable outcomes}}{\text{number of possible outcomes}} = \frac{FO}{PO}$$

> Expected number of successful events = total number of events + probability of the event

---

Q. A roulette wheel has 37 compartments, numbered 0 to 36. The 0 is green and the remaining numbers are divided evenly between red and black. The wheel is spun 740 times. How many times would you expect the marble to land on a red number?

A. $Pr(red) = \dfrac{18}{37}$

Expected successful outcomes $= \overset{20}{\cancel{740}} \times \dfrac{18}{\cancel{37}_{1}} =$

$= 20 \times 18$

$= \boldsymbol{360}$

---

a) In a class of 28 students, how many would you expect to celebrate their birthday on a Saturday next year?

$Pr(Saturday) = \dfrac{1}{7}$

....

Expected birthdays on Sat =

....

$= 28 \times \dfrac{1}{7}$ $=$ ☐

....

b) A coin is tossed 32 times. How many times would you expect heads to turn up?

$Pr(heads) =$

....

Expected heads up =

....

$=$ $=$ ☐

....

c) This spinner is spun 100 times. How many times would you expect an even number to be spun?

$Pr(even) =$

....

Expected even numbers =

....

$=$ $=$ ☐

....

d) A 52-card deck of playing cards is shuffled and one card is dealt from the top of the deck. If you repeat this 65 times, how many times would you expect a queen to be dealt?

$Pr(Q) =$

....

Expected Queen =

....

$=$ $=$ ☐

....

e) The unemployment rate in Australia at the end of March 2007 was approximately 4.5%. Based on this figure, how many people were expected to be unemployed in a population sample of 5000 people?

$Pr(unemployed) =$

....

Expected unemployed =

....

$=$ $=$ ☐

....

f) A school survey found that 5 out of 9 students voted "yes" in favour of the canteen menu. There are 630 students in the school. How many students would you expect to have voted "yes"?

$Pr(yes) =$

....

Expected yes votes =

....

$=$ $=$ ☐

....

Skill 30.9 Calculating the probability of independent events by using the Multiplication Law of Probability.

MM5.2 11 22 33 44
MM6.1 11 22 33 **4** 4

- Find the probability of each event.

$$Pr(event) = \frac{number\ of\ favourable\ outcomes}{number\ of\ possible\ outcomes} = \frac{FO}{PO}$$

- Multiply the probabilities of each event in order to find the probability of both events occuring.

Multiplication Law of Probability: Pr(A and B) = Pr(A) × Pr(B)

Hint: The probability of independent events is not dependent on the outcome of any other event.

Q. A bag contains 4 red marbles and 6 green marbles. You select a marble at random, replace it, and draw another marble. Find the probability that both marbles are green.

A. $Pr(G) = \frac{6}{10}$

$Pr(G\ and\ G) = Pr(G) \times Pr(G)$

$= \frac{6}{10} \times \frac{6}{10}$ — 6 green / 10 possible

$= \frac{36 \div 4}{100 \div 4}$

$= \frac{9}{25}$ or **0.36**

a) The probability of Joseph's tennis team winning is 0.6 and each result is independent of other wins or losses. What is the probability that Joseph's team wins three times running?

$Pr(W\ and\ W\ and\ W) = Pr\ (W) \times Pr\ (W) \times Pr\ (W)$

$= 0.6 \times 0.6 \times 0.6$ = $\boxed{0.216}$

b) What is the probability of a couple having first a boy and then a girl?

$Pr(B) = \underline{\hspace{2cm}}$ $Pr(G) = \underline{\hspace{2cm}}$

$Pr(B\ and\ G) = Pr\ (B) \times Pr\ (G)$

$= \underline{\hspace{2cm}}$ $= \boxed{}$

c) In a school, 25% of the students ride bikes to school and 40% have fair hair. One student is selected at random. What is the probability that the student has fair hair but does not ride a bike?

$= \underline{\hspace{2cm}}$ $= \boxed{}$

d) The Orange-bellied Parrot has a 7 out of 10 fledgling survival rate. From a brood of two chicks, what is the probability that the first will live and the second will die?

$= \underline{\hspace{2cm}}$ $= \boxed{}$

e) You can take 1 duck and 1 chicken to the Sydney show. They will be chosen randomly from the 7 ducks and 9 chickens at your farm. What is the probability that the youngest of each animal will be chosen?

$= \underline{\hspace{2cm}}$ $= \boxed{}$

f) The average error rate resulting in patient harm in Australian hospitals is 12%. Two patients are chosen at random. What is the probability that they will both be harmed by hospital error?

$= \underline{\hspace{2cm}}$ $= \boxed{}$

- From the start, fill in each branch of the tree with the value of the probability of that event.

$$Pr(event) = \frac{\text{number of favourable outcomes}}{\text{number of possible outcomes}} = \frac{FO}{PO}$$
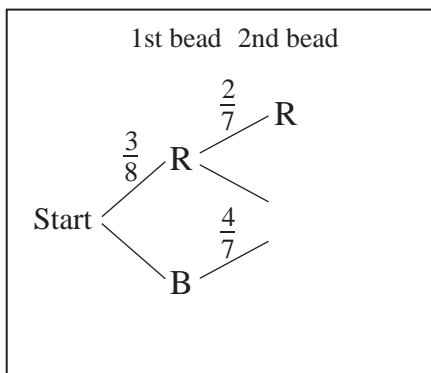
Hint: The values on all the branches starting from the same point always add to 1.
- List all the possible outcomes.
- To find the probability of any outcome, multiply values horizontally, from two or more consecutive branches.
- Where there is more than one outcome to be considered, add all the probabilities.
Hint: Remember in a probability tree diagram, always add vertically and multiply horizontally.

Q. Two beads are taken out in succession, without replacing, from a bag containing three red and five blue beads. What is the probability of drawing one red and one blue bead?
[Complete the probability tree diagram.]

1st bead 2nd bead

$$\frac{3}{8} R \frac{2}{7} R$$
$$Start \quad \frac{4}{7} B$$

A. *Drawing the 1st bead, out of 8:*

$$Pr(blue) = 1 - \frac{3}{8}$$
$$= \frac{5}{8}$$

1st draw 2nd draw

$$\frac{3}{8} R \frac{2}{7} R \longrightarrow RR$$
$$\frac{5}{7} B \longrightarrow RB$$
$$Start \quad \frac{4}{7} R \longrightarrow BR$$
$$\frac{5}{8} B \quad \frac{3}{7} B \longrightarrow BB$$

If 1st bead is red, drawing the 2nd, out of 7:
$$Pr(blue) = 1 - \frac{2}{7} = \frac{5}{7}$$

If 1st bead is blue, drawing the 2nd, out of 7:
$$Pr(blue) = 1 - \frac{4}{7} = \frac{3}{7}$$

Possible outcomes are: RR, RB, BR, BB
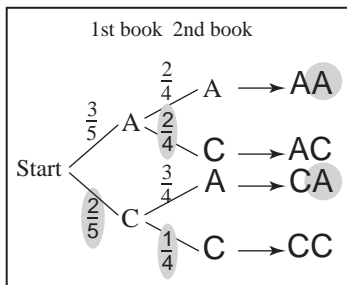
multiply horizontal consecutive branches
$$Pr(RB) = \frac{3}{8} \times \frac{5}{7} = \frac{15}{56}$$
$$Pr(BR) = \frac{5}{8} \times \frac{4}{7} = \frac{20}{56}$$

Addition Law of probability
$$Pr(RB \text{ or } BR) = \frac{15}{56} + \frac{20}{56} = \frac{35}{56} \overset{\div 7}{\underset{\div 7}{}} = \boldsymbol{\frac{5}{8}}$$

---

a) A box contains 3 atlases and 2 comic books. A book is picked from the box and not replaced. What is the probability that a second selection will be an atlas? [Complete the probability tree diagram.]
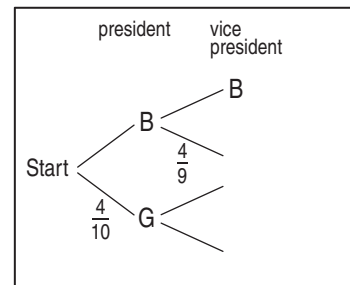
1st book 2nd book

$$\frac{3}{5} A \quad \frac{2}{4} A \longrightarrow AA$$
$$\frac{2}{4} C \longrightarrow AC$$
$$Start \quad \frac{3}{4} A \longrightarrow CA$$
$$\frac{2}{5} C \quad \frac{1}{4} C \longrightarrow CC$$

$$Pr(AA) = \frac{3}{5} \times \frac{2}{4} = \frac{6}{20}$$

$$Pr(CA) = \frac{2}{5} \times \frac{3}{4} = \frac{6}{20}$$

$$Pr(AA \text{ or } CA) = \frac{6}{20} + \frac{6}{20} = \frac{12}{20} \overset{\div 4}{\underset{\div 4}{}} = \boxed{}$$

b) A president and a vice president are to be selected from 6 boys and 4 girls. What is the probability that both people selected are boys?
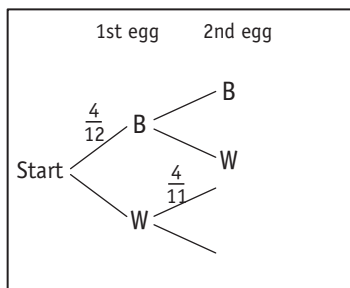[Complete the probability tree diagram.]

president   vice president

$$B \quad B$$
$$Start \quad \frac{4}{9} G$$
$$\frac{4}{10} G$$

$$Pr(BB) = \quad \times \quad = \quad = \boxed{}$$

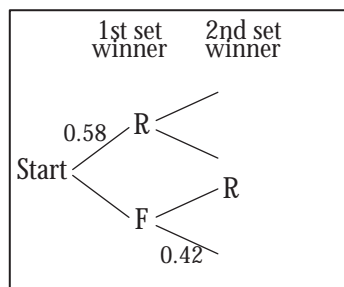**c)** An egg carton has 4 brown eggs and 8 white eggs. Two eggs are picked up one after the other. What is the probability of picking 2 white eggs? [Complete the probability tree diagram.]
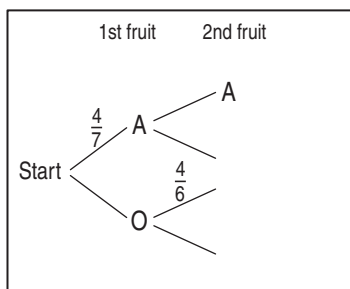
1st egg   2nd egg

$\frac{4}{12}$ B
   B
    B
Start
    W
$\frac{4}{11}$
W

$Pr(WW) = \quad \times \quad = \quad = \quad \boxed{}$

d) Ron and Fred are going to play 2 sets of tennis. Ron's chance of winning a set is 0.58. What is the probability of Ron winning both sets? [Complete the tree diagram. Give the answer correct to two decimal places.]

1st set   2nd set
winner   winner

0.58 R
    R
Start
    R
F
0.42

$Pr(RR) = \quad \times \quad = \quad \approx \quad \boxed{}$

e) A bowl contains 4 apples and 3 oranges. Two pieces of fruit are picked one after another. What is the probability of picking two oranges? [Complete the probability tree diagram.]
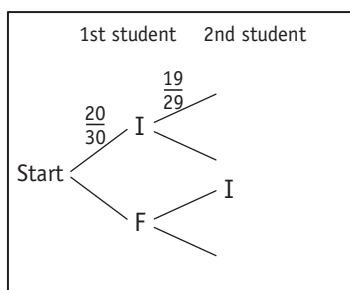
1st fruit   2nd fruit

    A
$\frac{4}{7}$ A
Start
   $\frac{4}{6}$
O

$Pr(OO) = \quad \times \quad = \quad = \quad \boxed{}$

f) Two discs are taken out, without replacing, from a barrel containing 4 white and 5 black discs. What is the probability of choosing two black discs? [Complete the probability tree diagram.]

1st   2nd
disc   disc

$\frac{4}{9}$ W
    W
Start
   $\frac{4}{8}$ W
B

$Pr(BB) = \quad \times \quad = \quad = \quad \boxed{}$

g) Of the thirty students in Jobe's class, 20 study Italian and 10 study French. If two students are selected at random, what is the probability of one studying Italian and one studying French? [Complete the probability tree diagram.]
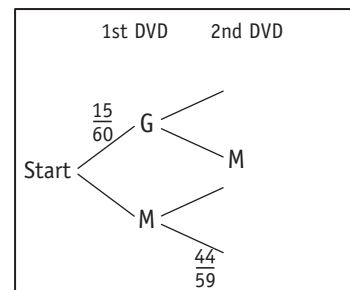
1st student   2nd student

    $\frac{19}{29}$
$\frac{20}{30}$ I
Start
    I
F

$Pr(IF) = \quad\quad =$

$Pr(FI) = \quad\quad =$

$Pr(IF \ or \ FI) = \quad + \quad = \quad \boxed{}$

h) A shelf contains 15 DVD's with games and 45 DVD's with movies. A DVD is picked from the shelf and not replaced. What is the probability that a second DVD selected from the shelf will be a movie? [Complete the tree diagram.]

1st DVD   2nd DVD

$\frac{15}{60}$ G
    M
Start
    M
$\frac{44}{59}$

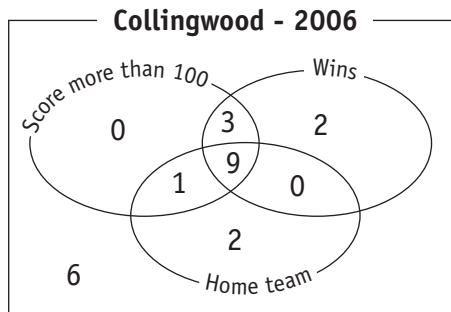$Pr(GM) = \quad\quad =$

$Pr(MM) = \quad\quad =$

$Pr(GM \ or \ MM) = \quad + \quad = \quad \boxed{}$

Skill 30.11 Calculating the probability of an event represented by
Venn diagrams.

MM5.2 11 22 33 44
MM6.1 11 22 33 4 **4**

- Count the total number of possible outcomes.
- Shade the areas inside the Venn diagram that fit the description for favourable outcomes.
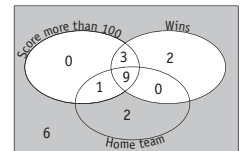- Use the formula for the probability of an event.

$$Pr(event) = \frac{\text{number of favourable outcomes}}{\text{number of possible outcomes}} = \frac{FO}{PO}$$

Q. If one 2006 Collingwood match is selected at random, what is the probability that the selected match was lost with a score of 100 points or less?

Collingwood - 2006

A. PO = total games played — possible outcomes
= 0 + 3 + 2 + 1 + 9 + 0 + 2 + 6
= 23

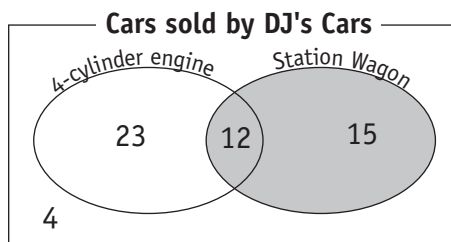*Losses with scores of 100 or less are shown by the shaded area: (white areas are excluded)*

$FO = 8$

$$Pr(event) = \frac{FO}{PO} = \frac{\mathbf{8}}{\mathbf{23}}$$
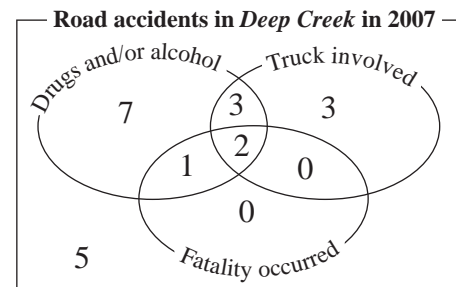
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a) If one car is selected at random, what is the probability that it is a station wagon?

Cars sold by DJ's Cars

$PO = 54$ $FO = 27$

$$Pr(event) = \frac{FO}{PO} = \qquad = \boxed{}$$

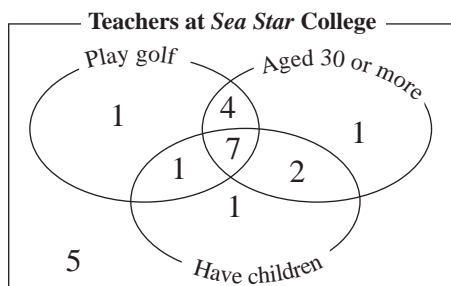**b)** If one accident is selected at random for investigation, what is the probability that the selected accident was fatal?

Road accidents in *Deep Creek* in 2007

$PO = \qquad FO =$

$$Pr(event) = \frac{FO}{PO} = \qquad = \boxed{}$$

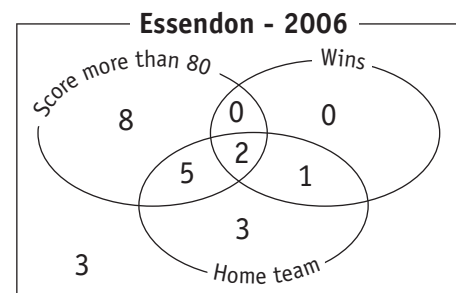**c)** If one teacher is selected at random, what is the probability that she or he is 31 years of age, plays golf and has a child?

Teachers at *Sea Star* College

$PO = \qquad FO =$

$$Pr(event) = \qquad = \boxed{}$$

d) If one match is selected at random, what is the probability that the selected match was lost as an away team?

Essendon - 2006

$PO = \qquad FO =$

$$Pr(event) = \qquad = \boxed{}$$

Skill 30.12 Calculating the probability of an event represented by two-way tables.

MM5.2 1 1 2 2 3 3 4 4
MM6.1 1 1 2 2 3 3 4 **4**

- Fill in the empty spaces of the two-way table by checking that each row and column adds to its respective total.
- Find the total number of possible outcomes, which is the number in the bottom right corner.
- Highlight the areas inside the two-way table that fit the description for favourable outcomes.
- Use the formula for the probability of an event:

$$Pr(event) = \frac{\text{number of favourable outcomes}}{\text{number of possible outcomes}} = \frac{FO}{PO}$$

Q. If one passenger is selected at random, find the probability that he or she flies economy class. [Complete the two-way table.]

	Local	International	Total
First class	500	300	
Business class	1800		2700
Economy class	4300		
Total		3400	

A.

	Local	International	Total
First class	500	start 300	
Business class	1800		2700
Economy class	4300		
Total	6600	3400	10 000

Follow arrows for order of filling

PO = total = 10 000 — possible outcomes

Passengers flying economy are shown by the shaded area:

	Local	International	Total
First class	500	300	800
Business class	1800	900	2700
Economy class	4300	2200	6500
Total	6600	3400	10 000

FO = 6500

$$Pr(event) = \frac{FO}{PO} = \frac{6500}{10\,000} \stackrel{\div\,500}{\underset{\div\,500}{}} = \frac{13}{20}$$

a) If one person is selected at random, find the probability that it is a women who voted 'Yes' at the referendum. [Complete the two-way table.]

	Women	Men	Total
Yes	245	180	425
No		120	
Total	580	300	880

PO = 880   *FO = 245*

$$Pr(event) = \frac{FO}{PO} = \qquad = \boxed{}$$

b) If one car is selected at random for sale, find the probability that it is a manual, 3-door car. [Complete the two-way table.]

	5-door	3-door	Total
Manual	28		
Automatic			90
Total	65	70	

PO =   *FO =*

$$Pr(event) = \frac{FO}{PO} = \qquad = \boxed{}$$

c) If one student is selected at random from the school, find the probability that the person is not blonde. [Complete the two-way table.]

	Boys	Girls	Total
Red hair	16	9	
Blonde hair	105		
Brown hair	75		160
Total		304	

PO =   *FO =*

$$Pr(event) = \qquad = \qquad = \boxed{}$$

d) If one card is dealt from the top of a standard deck of playing cards, find the probability that it is a red court card. [Complete the two-way table.]

	Black	Red	Total
Ace			
Number			
Court card			
Total			52

PO =   *FO =*

$$Pr(event) = \qquad = \boxed{}$$