

GCSE Mathematics
Probability

PROBABILITY



Heads or Tails ?

Lesson 1

GCSE Mathematics Probability

1.1 Twelve Faced Die

Here is a picture of a die[†] with twelve *sides*.

(A mathematician would say this solid is a dodecahedron and has twelve *faces*)



This die is going to be rolled once.

What is :	(i)	$p (8)$	[1 mark]
	(ii)	$p (\text{multiple of } 4)$	[1 mark]
	(iii)	$p (\text{factor of } 12)$	[1 mark]
	(iv)	$p (\text{prime})$	[1 mark]
	(v)	$p (15)$	[1 mark]
	(vi)	$p (> 10)$	[1 mark]

If the die were rolled 144 times, how often would you expect a 5 to be rolled ?

[1 mark]

[†] Technically it is “one die” and “many dice”. However, it has become acceptable to talk of “one dice”.

1.2 Some useful information

Positive integers :	The counting numbers 1, 2, 3, 4, 5, 6, ...
Multiples of x :	The positive integers in the x times table
Factors of x :	The positive integers that divide x exactly
Primes :	The positive integers with exactly two factors 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, ...
$>$	More than
$<$	Less than
Square numbers :	1, 4, 9, 16, 25, 36, 49, 64, 81, 100, ...
Triangular numbers :	1, 3, 6, 10, 15, 21, ...
Vulgar fraction :	A fraction in the form $\frac{p}{q}$, for integer p and q and $q \neq 0$

1.3 Exercise

Marks Available : 36

Question 1

A twenty sided unbiased die is thrown

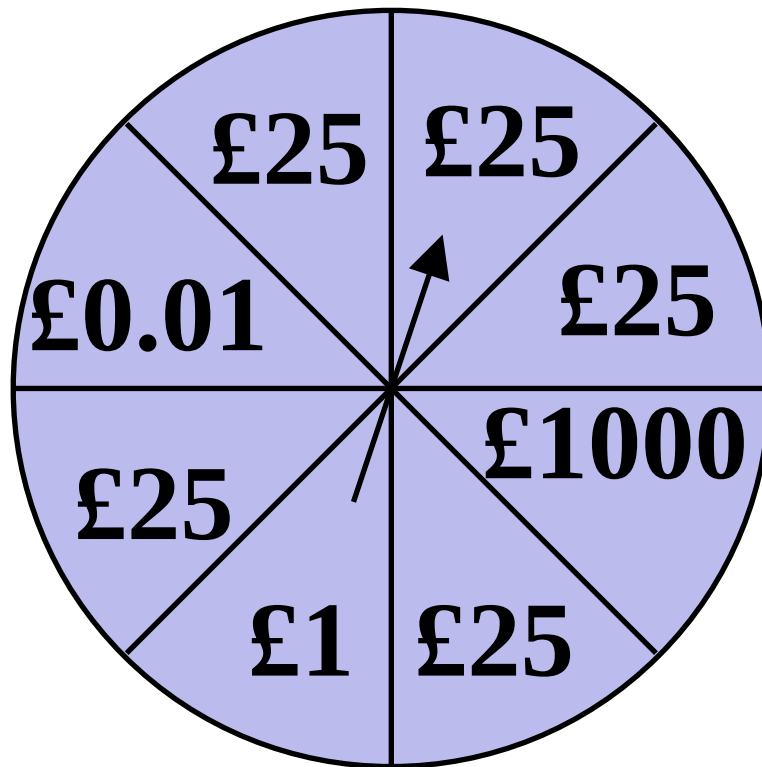
What is	(i)	$p (5)$	[1 mark]
	(ii)	$p (\text{multiple of } 5)$	[1 mark]
	(iii)	$p (\text{factor of } 20)$	[1 mark]
	(iv)	$p (\text{prime})$	[1 mark]
	(v)	$p (\text{square})$	[1 mark]
	(vi)	$p (> 17)$	[1 mark]

If the die were rolled 144 times, how often would you expect an EVEN number to be rolled ?

[1 mark]

Question 2

Tim's dad has decided to give him some money for doing well in a probability test. He spins the *wheel of fortune* shown below.



Each of the eight possible outcomes is equally likely.

What is; (i) $p(\text{£25})$

[1 mark]

(ii) $p(\text{£1000})$

[1 mark]

(iii) $p(> \text{£1})$

[1 mark]

Question 3

A drawer contains eight red T-shirts, six white T-shirts, and one blue T-shirt. One T-shirt is taken out at random.

What is; (i) $p(\text{white})$

[1 mark]

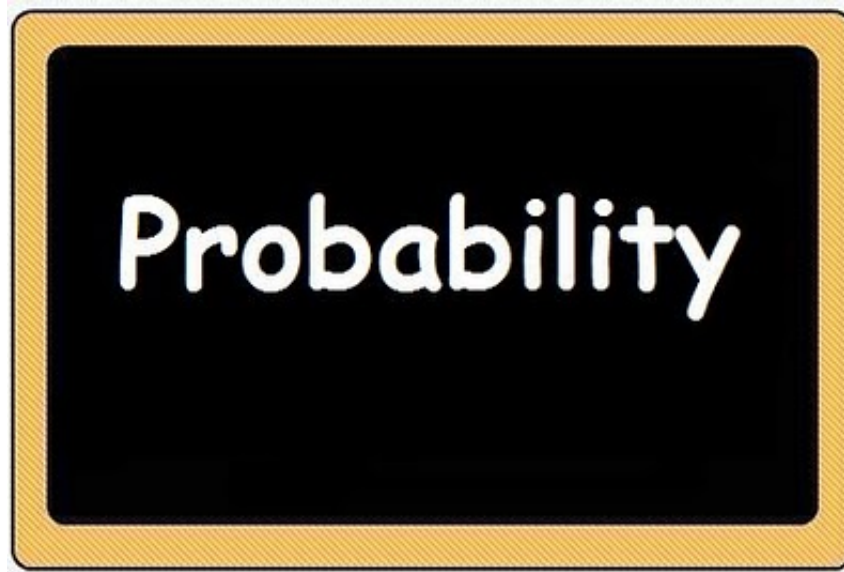
(ii) $p(\text{not blue})$

[1 mark]

(iii) $p(\text{not purple})$

[1 mark]

Question 4



A letter is chosen at random from the word "P r o b a b i l i t y".

What is; (i) $p (y)$

[1 mark]

(ii) $p (b)$

[1 mark]

(iii) $p (\text{vowel})$

[1 mark]

(iv) $p (\text{lower case})$

[1 mark]

Question 5

In a field are fourteen black sheep and thirty-five white sheep.

A sheep from the field is chosen at random.

What is the probability that it is white ?

Give your answer as a vulgar fraction that has been cancelled down.

[2 marks]

Question 6



In a field is estimated to be 10 000 000 clovers.

Of these, 400 are estimated to have four leaves, rather than the usual three.

If a clover is picked at random, what is the probability that it has four leaves ?

Give your answer as a vulgar fraction that has been cancelled down.

[2 marks]

Question 7

An ordinary die with six faces is thrown.

What is; (i) $p(4)$

[1 mark]

(ii) $p(\text{ODD})$

[1 mark]

(iii) $p(0.5)$

[1 mark]

(iv) $p(\leq 2)$

[1 mark]

(v) $p(> 2)$

[1 mark]

(vi) $p(\leq 6)$

[1 mark]

(vii) $p(\text{triangular number})$

[1 mark]

Question 8

A letter is chosen at random from the word "O R I E N T E E R I N G".

What is; (i) $p(G)$

[1 mark]

(ii) $p(N)$

[1 mark]

(iii) $p(E)$

[1 mark]

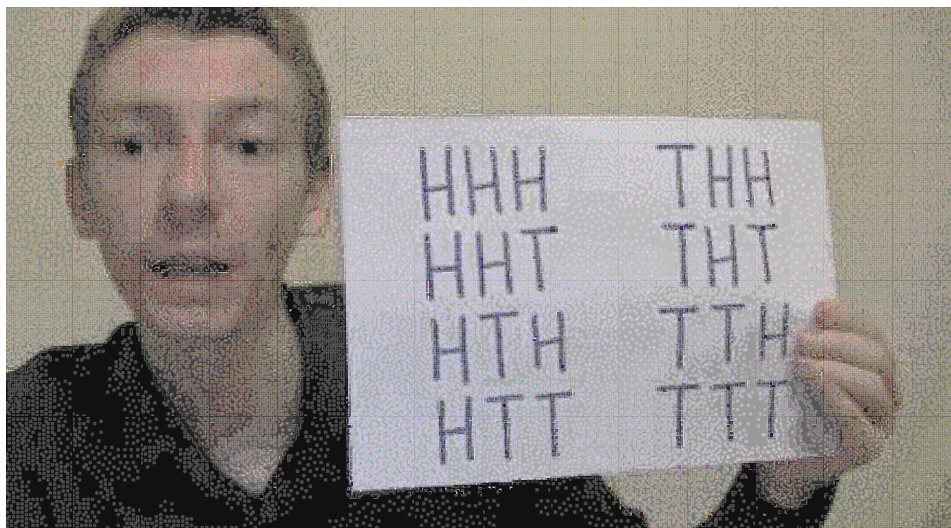
(iv) $p(\text{vowel})$

[1 mark]

(v) $p(\text{it's also found in "C U N N I N G R U N N I N G"})$

[1 mark]

Question 9



A coin is to be spun three times and it will be recorded if it lands 'heads' or 'tails'. On YouTube, Jack is talking about what can happen.

Explain why the probability of the coin landing heads once and tails twice is $\frac{3}{8}$.

[3 marks]

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Teachers may obtain detailed worked solutions to the exercises by email from MHHShrewsbury@Gmail.com

1.4 Answers

GCSE Mathematics Probability

1.4.1 Solution (Introductory Example)

(i) $\frac{1}{12}$

(ii) 4, 8, 12
 $\frac{3}{12}$ or $\frac{1}{4}$

(iii) 1, 2, 3, 4, 6, 12
 $\frac{6}{12}$ or $\frac{1}{2}$

(iv) 2, 3, 5, 7, 11
 $\frac{5}{12}$

(v) $\frac{0}{12}$ or 0

(vi) 11, 12
 $\frac{2}{12}$ or $\frac{1}{6}$

$\frac{1}{12} \times 144 = 12$ times

1.4.2 Solution (Exercise)

Answer 1

(i) $\frac{1}{20}$

(ii) 5, 10, 15, 20
 $\frac{4}{20}$ or $\frac{1}{5}$

(iii) 1, 2, 4, 5, 10, 20
 $\frac{6}{20}$ or $\frac{3}{10}$

(iv) 2, 3, 5, 7, 11, 13, 17, 19
 $\frac{8}{20}$ or $\frac{2}{5}$

(v) 1, 4, 9, 16
 $\frac{4}{20}$ or $\frac{1}{5}$

(vi) 18, 19, 20
 $\frac{3}{20}$

$\frac{1}{2} \times 144 = 72$ times

Answer 2

(i) $\frac{5}{8}$

(ii) $\frac{1}{8}$

(iii) $\frac{6}{8}$ or $\frac{3}{4}$

Answer 3

(i) $\frac{6}{15}$ or $\frac{2}{5}$

(ii) $\frac{14}{15}$

(iii) $\frac{15}{15}$ or 1

Answer 4

(i) $\frac{1}{11}$

(ii) $\frac{2}{11}$

(iii) $\frac{4}{11}$

(iv) $\frac{10}{11}$

Answer 5

$\frac{35}{49}$ which cancels down to $\frac{5}{7}$

Answer 6

$\frac{400}{10\,000\,000}$ which cancels down to $\frac{1}{25\,000}$

Answer 7

- (i) $\frac{1}{6}$ (ii) $\frac{3}{6}$ or $\frac{1}{2}$ (iii) 0
- (iv) $\frac{2}{6}$ or $\frac{1}{3}$ (v) $\frac{4}{6}$ or $\frac{2}{3}$ (vi) 1
- (vii) 1, 3, 6
 $\frac{3}{6}$ or $\frac{1}{2}$

Answer 8

- (i) $\frac{1}{12}$ (ii) $\frac{2}{12}$ or $\frac{1}{6}$ (iii) $\frac{3}{12}$ or $\frac{1}{4}$
- (iv) $\frac{6}{12}$ or $\frac{1}{2}$ (v) $\frac{7}{12}$

Answer 9

Heads once, tails twice can occur in three ways when the order does not matter. As eight possibilities exist, all equally likely, the probability of heads once, tails twice occurring is $\frac{3}{8}$

H H H

H H T
H T H
T H H

T T H
T H T
H T T

T T T

Lesson 2

GCSE Mathematics Probability

2.1 Percentage Probabilities

Suppose that we have the integers from 1 to 10 written on cards.



The cards are shuffled, face down, and one chosen at random.

State the percentage probability that the number on the card chosen is;

(i) 3

[1 mark]

(ii) Even

[1 mark]

(iii) A factor of 4

[1 mark]

(iv) Prime

[1 mark]

(v) A triangular number

[1 mark]

(vi) A multiple of 1

[1 mark]

2.2 Conversion Table : Vulgar Fractions $\Leftrightarrow$ Percentages

Here is a handy table that converts between vulgar fractions and percentages.

At the left hand end, for example, notice that a vulgar fraction probability of

$\frac{1}{100}$ is equivalent to a percentage probability of 1%

$\frac{1}{100}$	$\frac{1}{50}$	$\frac{1}{25}$	$\frac{1}{20}$	$\frac{1}{16}$	$\frac{1}{10}$	$\frac{1}{8}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$
1%	2%	4%	5%	6.25%	10%	12.5%	20%	25%	$33\frac{1}{3}\%$	50%

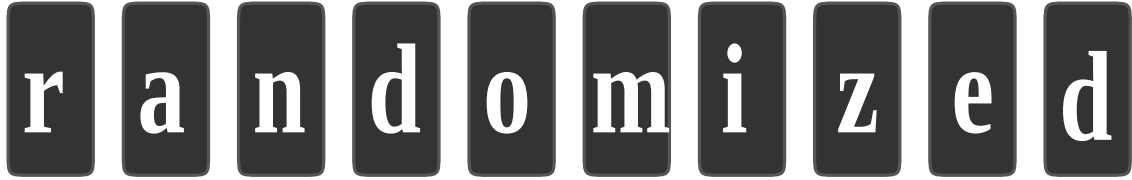
2.3 Exercise

**** Non-Calculator ****

Marks Available : 40

Question 1

Ten letter cards are placed face up on a table.



They are turned face down and randomly moved around the table.

One is then turned face up.

State the percentage probability that the face up card is;

(i) z

[1 mark]

(ii) d

[1 mark]

(iii) a vowel

[1 mark]

Question 2

Given that $\frac{1}{20} = 5\%$, write the following as percentages;

(i) $\frac{3}{20}$

[1 mark]

(ii) $\frac{11}{20}$

[1 mark]

(iii) $\frac{9}{20}$

[1 mark]

(iv) $\frac{19}{20}$

Hint: $\frac{19}{20} = 1 - \frac{1}{20}$

[2 marks]

Question 3

What is the percentage probability of a spun fair coin landing 'tails' ?

[1 mark]

Question 4

Five cards are placed face up on a table.

On their faces are printed the numbers 4, 12, 9, 11, 15.



The cards are turned face down and randomly moved around the table.

One is then turned face up.

State the percentage probability that the face up card is;

(i) Even

[1 mark]

(ii) Odd

[1 mark]

(iii) Divisible by 3

[1 mark]

(iv) Divisible by 4

[1 mark]

(v) Square

[1 mark]

(vi) Prime

[1 mark]

Question 5

Twenty-five of the first one hundred integers are prime numbers.

If an integer between 1 and one hundred (inclusive) is chosen at random, what is the percentage probability of it **NOT** being prime.

[1 mark]

Question 6

Explain what is wrong with the following statement;

The probability that it will rain tomorrow is 120%.

[1 mark]

Question 7

An octahedral die has its faces numbered 1, 2, 3, 4, 5, 6, 7 and 8.
It is to be rolled once.

Giving your answers as percentages, what is,

(i) p (square number)

[1 mark]

(ii) p (triangular number)

[1 mark]

(iii) p (prime number)

[1 mark]

Question 8

Given that $4\% = \frac{1}{25}$ write the following percentage probabilities as vulgar fractions.

(i) 8%

(ii) 24%

(iii) 32%

(iv) 96% Hint : $96\% = 100\% - 4\%$

[4 marks]

Question 9

Write the following vulgar fraction probabilities as percentage probabilities.

(i) $\frac{2}{5}$

Hint : $\frac{1}{5} = 20\%$

[1 mark]

(ii) $\frac{7}{50}$

Hint : $\frac{1}{50} = 2\%$

[1 mark]

(iii) $\frac{3}{20}$

Hint : $\frac{1}{20} = 5\%$

[1 mark]

(iv) $\frac{4}{25}$

Hint : $\frac{1}{25} = 4\%$

[1 mark]

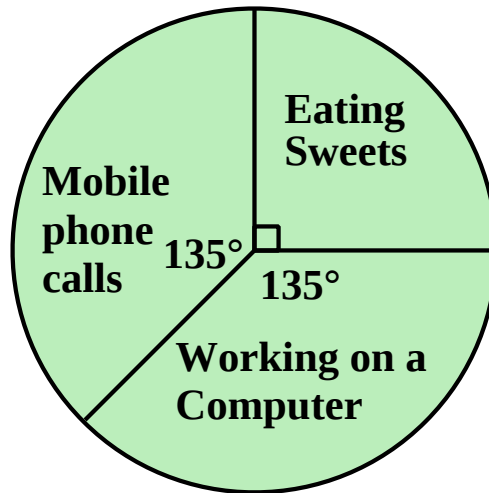
Use your answers to put the four vulgar fraction probabilities in order.

Write your list smallest to biggest.

[2 marks]

Question 10

The pie chart shows the main activity of a school of pupils during a morning break.



If a pupil was to be selected at random what is the percentage probability that their main activity during break was;

(i) Eating sweets

[2 marks]

(ii) Working on a computer

[2 marks]

(iii) Making mobile phone calls ?

[2 marks]

Question 11

If the probability of a certain traffic light being green when I arrive is 37%, what is the probability of it **NOT** being green ?

[1 mark]

Question 12

The probability that a climber will die attempting the summit of Mount Everest is one person in six. As of July 2019, approximately 1842 people have attempted to climb the mountain.

How many does this suggest have died during their attempt ?

[3 marks]

2.4 Answers

GCSE Mathematics Probability

2.4.1 Solution (Introductory Example)

(i)	10%	(ii)	50%	(iii)	30%
(iv)	40%	(v)	40%	(vi)	100%

[6 marks]

2.4.2 Solution (Exercise)

Answer 1

(i)	10%	(ii)	20%	(iii)	40%
-------	-----	--------	-----	---------	-----

[3 marks]

Answer 2

(i)	15%	(ii)	55%	(iii)	45%
-------	-----	--------	-----	---------	-----

[1, 1, 1 marks]

(iv)	95%
--------	-----

[2 marks]

Answer 3

50%

[1 mark]

Answer 4

(i)	40%	(ii)	60%	(iii)	60%
(iv)	40%	(v)	40%	(vi)	20%

[6 marks]

Answer 5

75%

[1 mark]

Answer 6

Percentage probabilities lie between 0% and 100%.

120% is not a probability that makes sense.

[1 mark]

Answer 7

(i)	25%	(ii)	37.5%	(iii)	50%
-------	-----	--------	-------	---------	-----

[3 marks]

Answer 8

(i) $\frac{2}{25}$

(ii) $\frac{6}{25}$

(iii) $\frac{8}{25}$

(iv) $\frac{24}{25}$

[4 marks]

Answer 9

(i) 40%

(ii) 14%

(iii) 15%

(iv) 16%

[4 marks]

List : $\frac{7}{50}, \frac{3}{20}, \frac{4}{25}, \frac{2}{5}$

[2 marks]

Answer 10

(i) 25%

(ii) 37.5%

(iii) 37.5%

[6 marks]

Answer 11

63%

[1 mark]

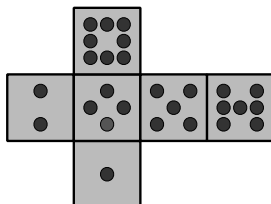
Answer 12

307 people.

[3 marks]

3.1 Possibility Space Diagrams

The net of a *Crazy Dice*TM is shown :



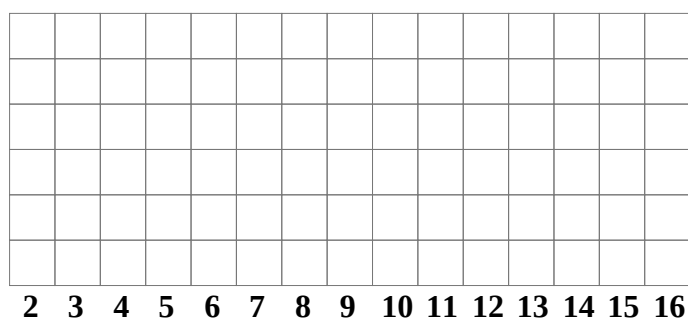
One red and one green *Crazy Dice*TM are rolled.
The pips showing are added together.

- (a) Complete this possibility space diagram to show the thirty-six possible results.

		1	2	3	4	5	6
1							
2							
3							
4							
5							
6							

[4 marks]

- (b) Plot a bar chart of the probabilities.



[2 marks]

- (c) (i) Which score occurs most often ?
(ii) Which of the possible scores are least likely to be rolled ?
(iii) What's the probability of rolling a square number ?

[1 mark]

[1 mark]

[1 mark]

3.2 Exercise

Do NOT use a calculator

Marks Available : 40

Question 1

A cubical die has its six faces numbered from 1 to 6.

A tetrahedral die has its faces numbered from 1 to 4.

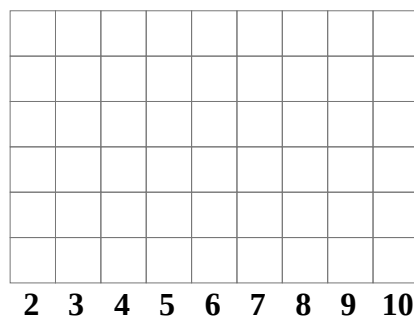
The two dice are rolled and the pips showing added together.

- (a) Complete this possibility space diagram to show the 24 possible results.

		1	2	3	4	5	6
1							
2							
3							
4							

[3 marks]

- (b) Plot a bar chart of the probabilities.



[2 marks]

- (c) Working with vulgar fractions, and NOT cancelling down, what is ;

(i) $p(6)$

[1 mark]

(ii) $p(<6)$

[1 mark]

(iii) $p(>6)$

[1 mark]

- (iv) What should your part (i), (ii) and (iii) answers sum to ?

[1 mark]

Question 2

Two tetrahedral (four-faced) dice are thrown, and their scores are added together.

- (a) Draw a possibility space for the experiment.

[4 marks]

- (b) Find the probability that the result is:

(i) 2

[1 mark]

(ii) 4

[1 mark]

(iii) an even number

[1 mark]

(iv) less than 6

[1 mark]

- (c) What is the most likely score ?

[1 mark]

- (d) State a score which is *less* likely than 2.

[1 mark]

Question 3

A letter is chosen at random from the phrase "W I B B L Y W O B B L Y".

- (a) What is the percentage probability that it is B ?

[1 mark]

- (b) Which letters (if any) are likely to be picked with probability $\frac{1}{12}$?

[1 mark]

Question 4

Two dice, one red and one green, are rolled.

The spots on their faces are MULTIPLIED together to give a score.

- (a) Complete the possibility space diagram to show what scores are possible.

		R E D					
		1	2	3	4	5	6
G R E E N	1						
	2				8		
	3						
	4						
	5					25	
	6			18			

[3 marks]

- (b) Use your possibility space diagram to determine;

(i) $p (\text{ ODD })$

[1 mark]

(ii) $p (> 17)$

[1 mark]

(iii) $p (\text{ square number })$

[1 mark]

(iv) $p (\text{ multiple of } 5)$

[1 mark]

(v) $p (\text{ multiple of } 3)$

[1 mark]

Question 5

Brian has 14 pets, 4 of which are dogs and 6 of which are aardvarks.

He is going to chose one of the pets at random to be called Anastasia.

Find the probability that the chosen pet will be:

- (a) an aardvark

[1 mark]

- (b) not a dog.

[1 mark]

Question 6

One blue and one green cubical (six-faced) dice are thrown.

!!! ==> The score taken is the HIGHEST of the two dice <== !!!

(a) Draw a possibility space for the experiment.

[5 marks]

(b) Find the probability that the result is;

(i) 6

[1 mark]

(ii) not 6

[1 mark]

(iii) less than 3

[1 mark]

(iv) an odd number

[1 mark]

3.3 Answers

GCSE Mathematics Probability

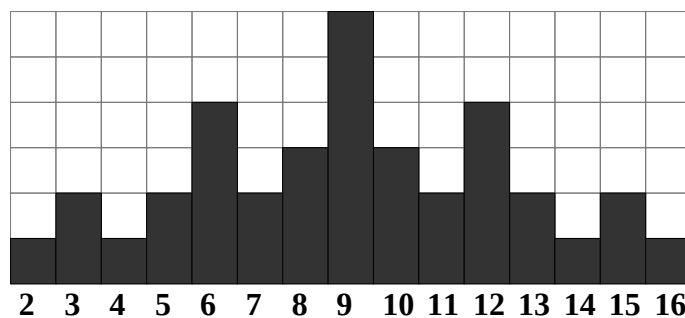
3.3.1 Solution to 3.1 Introduction

(a)

						
	2	3	5	6	8	9
	3	4	6	7	9	10
	5	6	8	9	11	12
	6	7	9	10	12	13
	8	9	11	12	14	15
	9	10	12	13	15	16

[4 marks]

(b)



Each square represents a probability of $\frac{1}{36}$

[2 marks]

(c) (i) 9

[1 mark]

(ii) 2, 4, 14, 16

[1 mark]

(iii) 8 out of 36 which cancels to $\frac{2}{9}$

[1 mark]

3.3.2 Solutions to 3.2 Exercise

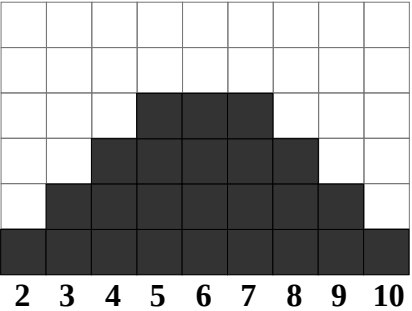
Answer 1

(a)

		•	•	•	•	•	•
•	2	3	4	5	6	7	
•	3	4	5	6	7	8	
•	4	5	6	7	8	9	
•	5	6	7	8	9	10	

[3 marks]

(b)



Each square represents a probability of $\frac{1}{24}$

[2 marks]

(c) (i) $\frac{4}{24}$ (ii) $\frac{10}{24}$ (iii) $\frac{10}{24}$ (iv) 1

[4 marks]

Answer 2

(a)

		•	•	•	•
•	2	3	4	5	
•	3	4	5	6	
•	4	5	6	7	
•	5	6	7	8	

[4 marks]

(b) (i) $\frac{1}{16}$ (ii) $\frac{3}{16}$ (iii) $\frac{8}{16}$ or $\frac{1}{2}$ (iv) $\frac{10}{16}$ or $\frac{5}{8}$ [4 marks]

(c) 5 [1 mark]

(d) 0 or any other number or glyph or symbol ... [1 mark]

Answer 3

(a) $33\frac{1}{3}\%$ (b) I or O [1, 1 marks]

Answer 4

(a)

		R E D					
G R E E N		1	2	3	4	5	6
	1	1	2	3	4	5	6
	2	2	4	6	8	10	12
	3	3	6	9	12	15	18
	4	4	8	12	16	20	24
	5	5	10	15	20	25	30
	6	6	12	18	24	30	36

[3 marks]

(b) (i) $\frac{9}{36}$ or $\frac{1}{4}$ (ii) $\frac{10}{36}$ or $\frac{5}{18}$ (iii) $\frac{8}{36}$ or $\frac{2}{9}$

(iv) $\frac{11}{36}$ (v) $\frac{20}{36}$ or $\frac{5}{9}$

[5 marks]

Answer 5

(a) $\frac{3}{7}$ (b) $\frac{5}{7}$

[1, 1 marks]

Answer 6

(a)

		B L U E					
G R E E N		1	2	3	4	5	6
	1	1	2	3	4	5	6
	2	2	2	3	4	5	6
	3	3	3	3	4	5	6
	4	4	4	4	4	5	6
	5	5	5	5	5	5	6
	6	6	6	6	6	6	6

[5 marks]

(b) (i) $\frac{11}{36}$

(ii) $\frac{25}{36}$

(iii) $\frac{1}{9}$

(iv) $\frac{15}{36}$ or $\frac{5}{12}$

[4 marks]

4.1 The Vulgar Fraction Races



4.1.1 Race #1

What You Need To Know :

Multiplying fractions is easy peasy, lemon squeezy !
 Multiply together the numerators.
 Multiply together the denominators.
 And that's it !
 Job done, son.

The easy peasy, lemon squeezy examples :

(i)

$$\frac{7}{11} \times \frac{5}{8}$$

(ii)

$$\frac{16}{13} \times \frac{2}{3}$$

(iii)

$$\frac{5}{17} \times \frac{5}{2}$$

Now run the first race.

4.1.2 Race #2

There is always a catch :

Before you.....

Multiply together the numerators

Multiply together the denominators

..... Look for the factor that cancels

(i)

$$\frac{6}{11} \times \frac{5}{12}$$

(ii)

$$\frac{7}{12} \times \frac{4}{5}$$

(iii)

$$\frac{15}{16} \times \frac{6}{25}$$

Now run the second race.

4.1.3 Race #3

B O D M A S :

You much work out...

... all multiplications first

Then the additions

Do NOT cancel common factors :

(i)

$$\frac{4}{7} \times \frac{4}{7} + \frac{3}{7} \times \frac{3}{7}$$

(ii)

$$\frac{1}{4} \times \frac{3}{5} + \frac{3}{4} \times \frac{2}{5}$$

(iii)

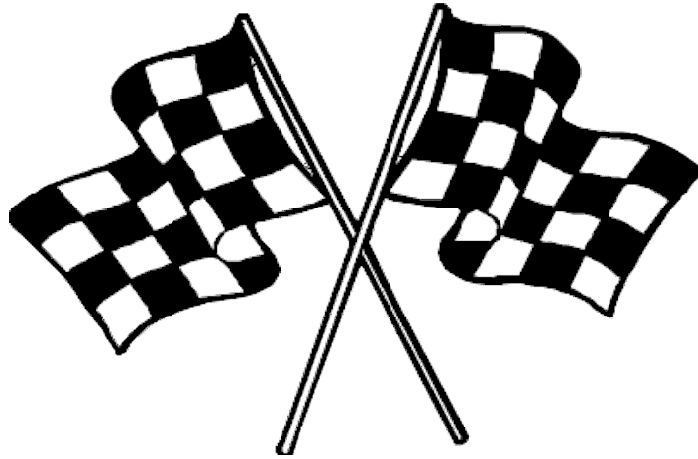
$$\frac{3}{8} \times \frac{4}{5} + \frac{1}{8} \times \frac{1}{5}$$

Now run the third race.

4.2 Exercise

Fractions Race N°. 1

Do NOT use a calculator



None of the answers cancel down

Target time : 10 minutes

If more than five wrong answers are given you are disqualified !

(a) $\frac{2}{5} \times \frac{3}{5}$

(b) $\frac{5}{7} \times \frac{1}{2}$

(c) $\frac{4}{3} \times \frac{2}{3}$

(d) $\frac{1}{10} \times \frac{7}{9}$

(e) $\frac{3}{11} \times \frac{5}{7}$

(f) $\frac{4}{5} \times \frac{6}{11}$

(g) $\frac{5}{6} \times \frac{5}{6}$

(h) $\frac{8}{9} \times \frac{4}{9}$

(i) $\frac{3}{10} \times \frac{9}{13}$

(j) $\frac{7}{9} \times \frac{7}{8}$

(k) $\frac{2}{15} \times \frac{7}{5}$

(l) $\frac{3}{4} \times \frac{7}{8}$

$$(m) \quad \frac{3}{8} \times \frac{5}{8}$$

$$(n) \quad \frac{7}{13} \times \frac{3}{10}$$

$$(o) \quad \frac{5}{9} \times \frac{4}{7}$$

$$(p) \quad \frac{14}{23} \times \frac{1}{3}$$

$$(q) \quad \frac{7}{9} \times \frac{4}{11}$$

$$(r) \quad \frac{5}{12} \times \frac{1}{3}$$

$$(s) \quad \frac{9}{11} \times \frac{9}{11}$$

$$(t) \quad \frac{5}{7} \times \frac{6}{7}$$

$$(u) \quad \frac{8}{9} \times \frac{4}{5}$$

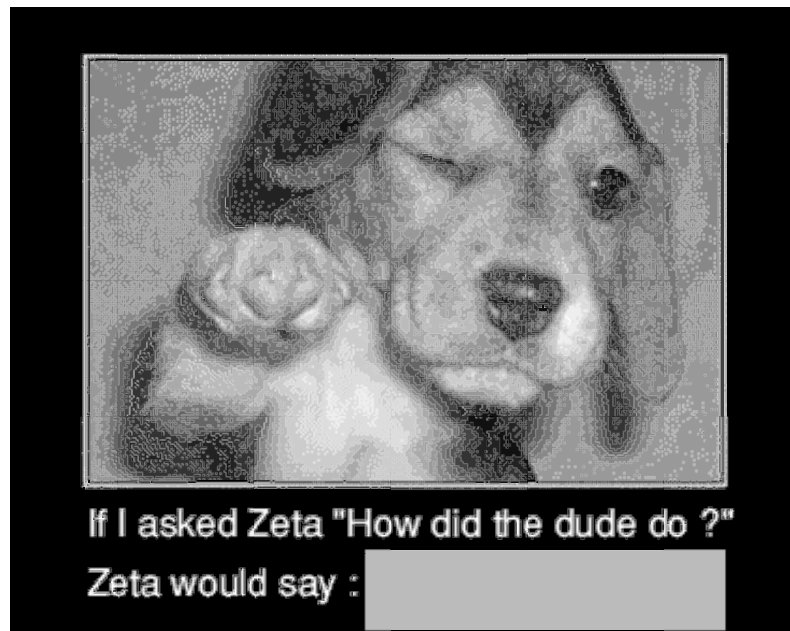
$$(v) \quad \frac{7}{8} \times \frac{3}{5}$$

$$(w) \quad \frac{7}{8} \times \frac{5}{6}$$

$$(x) \quad \frac{5}{9} \times \frac{7}{8}$$

$$(y) \quad \frac{6}{7} \times \frac{6}{7}$$

$$(z) \quad \frac{3}{7} \times \frac{9}{11}$$



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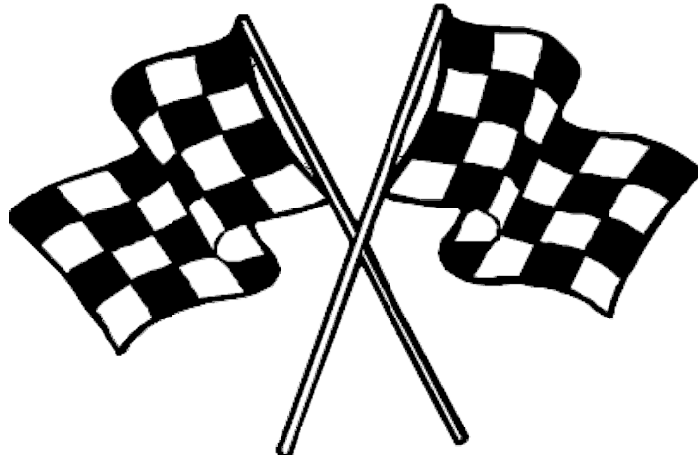
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4.3 Exercise

Fractions Race N°. 2

Do NOT use a calculator



Cancel BEFORE multiplying

Target time : 15 minutes

If more than five wrong answers are given you are disqualified !

(a) $\frac{2}{5} \times \frac{3}{8}$

(b) $\frac{5}{7} \times \frac{2}{15}$

(c) $\frac{4}{3} \times \frac{2}{6}$

(d) $\frac{7}{15} \times \frac{10}{9}$

(e) $\frac{7}{17} \times \frac{13}{14}$

(f) $\frac{12}{7} \times \frac{9}{16}$

(g) $\frac{15}{11} \times \frac{5}{18}$

(h) $\frac{8}{9} \times \frac{9}{31}$

(i) $\frac{1}{24} \times \frac{8}{13}$

(j) $\frac{8}{39} \times \frac{11}{8}$

(k) $\frac{3}{35} \times \frac{7}{16}$

(l) $\frac{14}{15} \times \frac{11}{21}$

$$(m) \quad \frac{13}{16} \times \frac{4}{15}$$

$$(n) \quad \frac{13}{27} \times \frac{25}{26}$$

$$(o) \quad \frac{7}{44} \times \frac{33}{50}$$

$$(p) \quad \frac{5}{12} \times \frac{8}{21}$$

$$(q) \quad \frac{17}{100} \times \frac{25}{9}$$

$$(r) \quad \frac{5}{24} \times \frac{18}{19}$$

$$(s) \quad \frac{3}{17} \times \frac{17}{101}$$

$$(t) \quad \frac{20}{21} \times \frac{7}{25}$$

$$(u) \quad \frac{8}{21} \times \frac{5}{12}$$

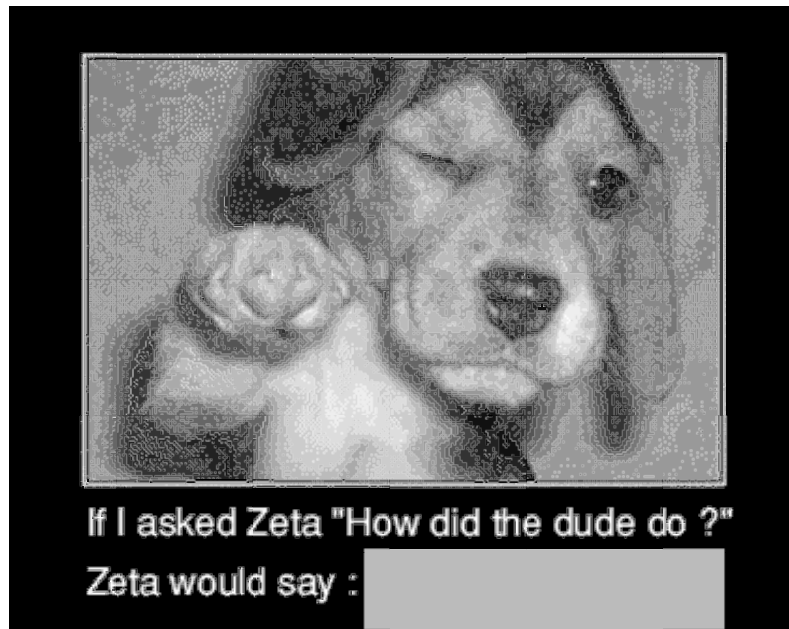
$$(v) \quad \frac{7}{8} \times \frac{3}{28}$$

$$(w) \quad \frac{7}{18} \times \frac{15}{11}$$

$$(x) \quad \frac{5}{9} \times \frac{8}{35}$$

$$(y) \quad \frac{5}{9} \times \frac{6}{7}$$

$$(z) \quad \frac{33}{7} \times \frac{2}{99}$$



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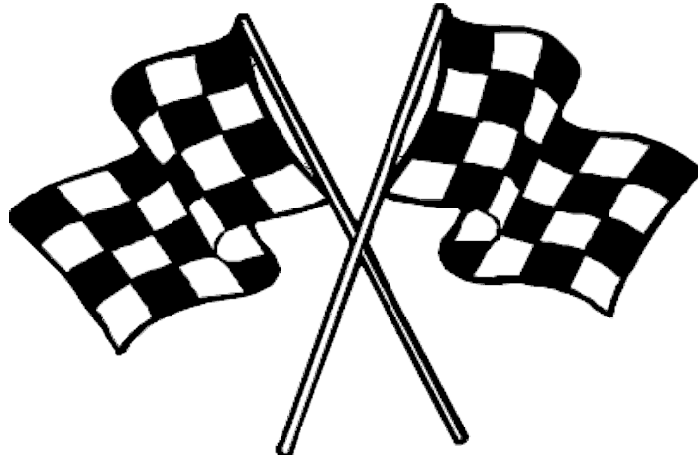
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4.4 Exercise

Fractions Race N°. 3

Do NOT use a calculator



Multiply BEFORE adding
Do not cancel down

Target time : 15 minutes

If more than five wrong answers are given you are disqualified !

(a) $\frac{2}{5} \times \frac{3}{5} + \frac{1}{5} \times \frac{4}{5}$

(b) $\frac{1}{3} \times \frac{5}{7} + \frac{2}{3} \times \frac{3}{7}$

(c) $\frac{3}{8} \times \frac{2}{3} + \frac{5}{8} \times \frac{1}{3}$

(d) $\frac{3}{10} \times \frac{5}{8} + \frac{7}{10} \times \frac{3}{8}$

(e) $\frac{1}{6} \times \frac{1}{6} + \frac{5}{6} \times \frac{5}{6}$

(f) $\frac{3}{11} \times \frac{3}{5} + \frac{7}{11} \times \frac{2}{5}$

$$(g) \quad \frac{13}{20} \times \frac{2}{5} + \frac{7}{20} \times \frac{3}{5}$$

$$(h) \quad \frac{2}{9} \times \frac{7}{9} + \frac{4}{9} \times \frac{5}{9}$$

$$(i) \quad \frac{7}{10} \times \frac{3}{8} + \frac{3}{10} \times \frac{5}{8}$$

$$(j) \quad \frac{10}{11} \times \frac{6}{7} + \frac{2}{11} \times \frac{5}{7}$$

$$(k) \quad \frac{3}{8} \times \frac{7}{10} + \frac{5}{8} \times \frac{9}{10}$$

$$(l) \quad \frac{3}{4} \times \frac{3}{4} + \frac{1}{4} \times \frac{1}{4}$$

$$(m) \quad \frac{1}{10} \times \frac{9}{10} + \frac{3}{10} \times \frac{7}{10}$$

$$(n) \quad \frac{3}{13} \times \frac{3}{13} + \frac{1}{13} \times \frac{1}{13}$$

$$(o) \quad \frac{4}{5} \times \frac{4}{9} + \frac{3}{5} \times \frac{8}{9}$$

$$(p) \quad \frac{6}{11} \times \frac{8}{9} + \frac{5}{11} \times \frac{2}{9}$$

$$(q) \quad \frac{5}{9} \times \frac{6}{7} + \frac{4}{9} \times \frac{3}{7}$$

$$(r) \quad \frac{3}{17} \times \frac{3}{10} + \frac{4}{17} \times \frac{9}{10}$$

$$(s) \quad \frac{8}{21} \times \frac{5}{12} + \frac{7}{12} \times \frac{3}{21}$$

$$(t) \quad \frac{3}{8} \times \frac{3}{8} + \frac{5}{8} \times \frac{5}{8}$$

$$(u) \quad \frac{22}{25} \times \frac{1}{4} + \frac{6}{25} \times \frac{3}{4}$$

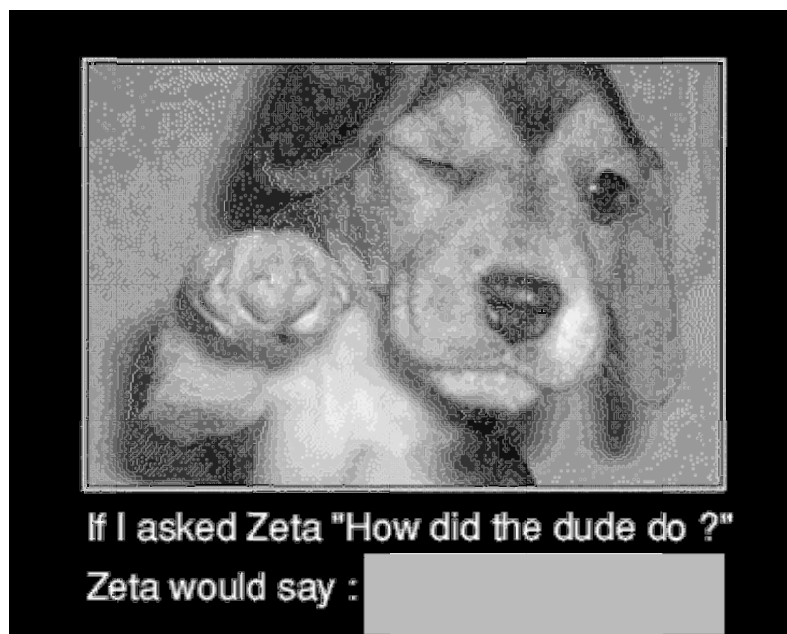
$$(v) \quad \frac{5}{9} \times \frac{6}{7} + \frac{5}{9} \times \frac{5}{7}$$

$$(w) \quad \frac{5}{12} \times \frac{3}{5} + \frac{7}{12} \times \frac{4}{5}$$

$$(x) \quad \frac{8}{11} \times \frac{8}{11} + \frac{7}{11} \times \frac{7}{11}$$

$$(y) \quad \frac{7}{10} \times \frac{5}{11} + \frac{3}{10} \times \frac{6}{11}$$

$$(z) \quad \frac{5}{9} \times \frac{6}{7} + \frac{4}{9} \times \frac{2}{7}$$



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4.5 Solutions

4.5.1 Answers to Fractions Race N° 1 (4.2 Exercise)

Example (i)

$$\frac{35}{88}$$

(a)

$$\frac{6}{25}$$

(d)

$$\frac{7}{90}$$

(g)

$$\frac{25}{36}$$

(j)

$$\frac{49}{72}$$

(m)

$$\frac{15}{64}$$

(p)

$$\frac{14}{69}$$

(s)

$$\frac{81}{121}$$

(v)

$$\frac{21}{40}$$

(y)

$$\frac{36}{49}$$

Example (ii)

$$\frac{32}{39}$$

(b)

$$\frac{5}{14}$$

(e)

$$\frac{15}{77}$$

(h)

$$\frac{32}{81}$$

(k)

$$\frac{14}{75}$$

(n)

$$\frac{12}{130}$$

(q)

$$\frac{28}{99}$$

(t)

$$\frac{30}{49}$$

(w)

$$\frac{35}{48}$$

(z)

$$\frac{27}{77}$$

Example (iii)

$$\frac{25}{34}$$

(c)

$$\frac{8}{9}$$

(f)

$$\frac{24}{55}$$

(i)

$$\frac{27}{130}$$

(l)

$$\frac{21}{32}$$

(o)

$$\frac{20}{63}$$

(r)

$$\frac{5}{36}$$

(u)

$$\frac{32}{45}$$

(x)

$$\frac{35}{72}$$

4.5.2 Answers to Fractions Race N° 2 (4.3 Exercise)

Example (i)

$$\frac{5}{22}$$

(a)

$$\frac{3}{20}$$

(d)

$$\frac{14}{27}$$

(g)

$$\frac{25}{66}$$

(j)

$$\frac{11}{39}$$

(m)

$$\frac{13}{60}$$

(p)

$$\frac{10}{63}$$

(s)

$$\frac{3}{101}$$

(v)

$$\frac{3}{32}$$

(y)

$$\frac{10}{21}$$

Example (ii)

$$\frac{7}{15}$$

(b)

$$\frac{2}{21}$$

(e)

$$\frac{13}{34}$$

(h)

$$\frac{8}{31}$$

(k)

$$\frac{3}{80}$$

(n)

$$\frac{25}{54}$$

(q)

$$\frac{17}{36}$$

(t)

$$\frac{4}{15}$$

(w)

$$\frac{35}{66}$$

(z)

$$\frac{2}{21}$$

Example (iii)

$$\frac{9}{40}$$

(c)

$$\frac{4}{9}$$

(f)

$$\frac{27}{28}$$

(i)

$$\frac{1}{39}$$

(l)

$$\frac{22}{45}$$

(o)

$$\frac{21}{200}$$

(r)

$$\frac{15}{76}$$

(u)

$$\frac{10}{63}$$

(x)

$$\frac{8}{63}$$

4.5.3 Answers to Fractions Race N° 3 (4.4 Exercise)

Example (i)

$$\frac{25}{49}$$

Example (ii)

$$\frac{9}{20}$$

Example (iii)

$$\frac{13}{40}$$

(a)

$$\frac{10}{25}$$

(b)

$$\frac{11}{21}$$

(c)

$$\frac{11}{24}$$

(d)

$$\frac{36}{80}$$

(e)

$$\frac{26}{36}$$

(f)

$$\frac{33}{55}$$

(g)

$$\frac{47}{100}$$

(h)

$$\frac{34}{81}$$

(i)

$$\frac{36}{80}$$

(j)

$$\frac{70}{77}$$

(k)

$$\frac{66}{80}$$

(l)

$$\frac{10}{16}$$

(m)

$$\frac{30}{100}$$

(n)

$$\frac{10}{169}$$

(o)

$$\frac{40}{45}$$

(p)

$$\frac{58}{99}$$

(q)

$$\frac{42}{63}$$

(r)

$$\frac{45}{170}$$

(s)

$$\frac{61}{252}$$

(t)

$$\frac{34}{64}$$

(u)

$$\frac{40}{100}$$

(v)

$$\frac{55}{63}$$

(w)

$$\frac{43}{60}$$

(x)

$$\frac{113}{121}$$

(y)

$$\frac{53}{110}$$

(z)

$$\frac{38}{63}$$

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5.1 The Laws of Probability**5.1.1 The Sum Law** (The *or* means *add* rule)

$$p (A \text{ or } B) = p (A) + p (B)$$

(For Mutually Exclusive events A and B)

5.1.2 The Product Law (The *and* means *multiply* rule)

$$p (A \text{ and } B) = p (A) \times p (B)$$

(For Independent events A and B)

5.2 Probability word sum

Calculate :

$$\frac{3}{11} \text{ and } \frac{4}{5} \text{ or } \frac{5}{11} \text{ and } \frac{3}{5}$$

5.3 Example

One letter is chosen at random from the word B A N A N A S.

It is replaced.

Then a second letter is chosen at random.

Find the probability that;

(i) First an A, *and* then an N is picked.

(ii) The same letter is picked both times.
i.e. B *and* B or A *and* A or N *and* N or S *and* S

5.4 Exercise

Question 1

Remembering that : *or* means *add*
and means *multiply*

Do not cancel answers down

Work out:

(i)

$$\frac{3}{5} \text{ and } \frac{7}{8} \text{ or } \frac{1}{5} \text{ and } \frac{3}{8}$$

(ii)

$$\frac{4}{7} \text{ and } \frac{3}{7} \text{ or } \frac{5}{7} \text{ and } \frac{5}{7}$$

(iii)

$$\frac{6}{11} \text{ and } \frac{3}{7} \text{ or } \frac{9}{11} \text{ and } \frac{5}{7}$$

(iv)

$$\frac{11}{13} \text{ and } \frac{2}{3} \text{ or } \frac{8}{13} \text{ and } \frac{1}{3}$$

Question 2

One letter is chosen at random from the word N O N S E N S E.

It is replaced, then a second letter is chosen at random.

Without cancelling the fractions involved down, find the probability that;

- (i) First an S, and then an O is picked.

- (ii) First an N, then an E is picked.

- (iii) The same letter is picked both times.

Question 3

One letter is chosen at random from the word P O S S I B I L I T I E S.

It is replaced, then a second letter is chosen at random.

Without cancelling the fractions involved down, find the probability that;

- (i) First a P, and then an O is picked.

- (ii) First an S, then an I is picked.

- (iii) First an S, then a letter that is **NOT** S is picked.

Question 4

The probability of a spun coin landing tails is $\frac{1}{2}$

- (i) What is the probability that if the coin is spun twice it will land tails twice ?

HINT : $p(\text{tails})$ and $p(\text{tails})$

HINT : *and* means *multiply*

- (ii) What is the probability that if the coin is spun three times it will land tails three times ?

HINT : $p(\text{tails})$ and $p(\text{tails})$ and $p(\text{tails})$

HINT : *and* means *multiply*

- (iii) What is the probability that if the coin is spun four times it will land tails four times ?

- (iv) Look at answers (i), (ii) and (iii).
Can you spot a pattern ?

Explain any pattern spotted here:

Question 5

Remembering that : or means *add*
and means *multiply*

Do not cancel answers down

Work out:

(i)

$$\frac{1}{11} or \frac{4}{11} or \frac{2}{11} or \frac{3}{11}$$

(ii)

$$\frac{7}{15} and \frac{3}{10} or \frac{11}{15} and \frac{7}{10}$$

(iii)

$$\left(\frac{3}{7}\right)^2 or \left(\frac{4}{7}\right)^2$$

$$**HINT** : \left(\frac{3}{7}\right)^2 = \frac{3}{7} \times \frac{3}{7}$$

(iv)

$$\frac{11}{25} and \frac{5}{8} or \frac{8}{50} and \frac{3}{4}$$

Question 6

Jack's gone crackers !

He spins a coin, (*then does ten press ups*)

before rolling a red die, (*then does ten star jumps*)

and finally rolls a yellow die, (*before doing a hand-stand*).

- (i) What is the probability that the coin lands heads, the red die rolls an EVEN number and the yellow die rolls five ?

- (ii) What is the probability that the coin lands tails, the red die does NOT roll 2, and the yellow die rolls an ODD number.

- (iii) What is the probability that the coin lands heads, the red die does NOT roll 6, and the yellow die does NOT roll 6 ?

Question 7

Complete the following "FIVE FACTS ABOUT PROBABILITIES".

FIVE FACTS ABOUT PROBABILITIES

FACT 1 : Probabilities are numbers between _____ and one.

FACT 2 : An event that can not happen has a probability of _____.

FACT 3 : An event that definitely will happen has a probability of _____.

FACT 4 : The closer a probability is to _____ the less likely it is to happen.

FACT 5 : The closer a probability is to one the _____ likely it is to happen.

Question 8

On the diagram below mark on (roughly) the following probabilities

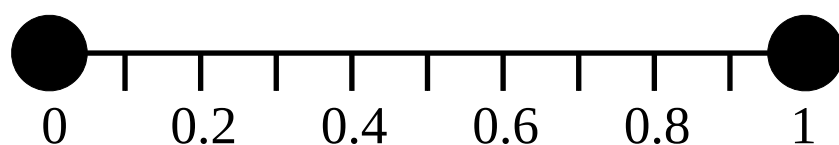
A : The probability of meeting a living, fire-breathing dragon tomorrow.

B : The probability of a spun coin ending up "tails".

C : The probability of a randomly picked day being "Friday".

D : The probability that you will pass your GCSE mathematics examination.

E : The probability that the next person you meet will have two legs.



Question 9

One letter is chosen at random from the words;

S H R E W S B U R Y S C H O O L

It is replaced.

Then a second letter is chosen at random.

Find the probability that;

(i) First a Y, and then a Y is picked.

(ii) First an S, then an H is picked.

(iii) A vowel is NOT picked both times.

Question 10

A test the following marks are obtained,

$$\frac{55}{60} \quad \frac{52}{60} \quad \frac{48}{60} \quad \frac{51}{60} \quad \frac{50}{60}$$

In reporting the marks, the pupils involved are told they have scored,

$$\frac{17}{20} \quad \frac{13}{15} \quad \frac{19}{20} \quad \frac{5}{6} \quad \frac{11}{12} \quad \frac{4}{5}$$

- (i) Explain why reporting the marks in this way is unhelpful.

- (ii) Which mark in the list of reported marks is a mistake ?

- (iii) Explain carefully a situation where it is helpful to cancel a fraction down and a situation, different to the one above, where it's better not to cancel the fractions down.

Question 11

"Coincidences" is a probability amusement.

You might like to try it out on an unsuspecting friend.

To play, you first roll a dice.

Your friend will think this is a bit odd but you then say something like:

That confirms it !

There's something really creepy about this place.

Look - I just rolled a three on this die.

Then I realised I was sitting in a row of three desks, with three chairs.

Look around, each set of shelves in this room has three shelves.

The lights - How many are there in each row ?

Three !

They are in rows of three !

This morning, on my way in, I saw three black cats. (*Naughty - you made that bit up*)

And in the night, I woke up just as the clock struck three. (*Also made up*)

Keep your eyes open.

I tell you, there's something really weird going on with three today.

Make up your own list of "Coincidences" for a number other than three.

5.5 Answers

GCSE Mathematics Probability

5.5.1 Solution to 5.2 Probability word sum

$$\begin{aligned}\frac{3}{11} \text{ and } \frac{4}{5} \text{ or } \frac{5}{11} \text{ and } \frac{3}{5} &= \frac{3}{11} \times \frac{4}{5} + \frac{5}{11} \times \frac{3}{5} \\ &= \frac{12}{55} + \frac{15}{55} \\ &= \frac{27}{55}\end{aligned}$$

5.5.2 Solution to 5.3 Example

(i)

$$\frac{3}{7} \times \frac{2}{7} = \frac{6}{49}$$

(ii)

$$\begin{aligned}\frac{1}{7} \times \frac{1}{7} + \frac{3}{7} \times \frac{3}{7} + \frac{2}{7} \times \frac{2}{7} + \frac{1}{7} \times \frac{1}{7} &= \frac{1}{49} + \frac{9}{49} + \frac{4}{49} + \frac{1}{49} \\ &= \frac{15}{49}\end{aligned}$$

5.5.3 Solution to 5.4 Exercise

Answer 1

(i)

$$\frac{24}{40}$$

(ii)

$$\frac{37}{49}$$

(iii)

$$\frac{63}{77}$$

(iv)

$$\frac{30}{39}$$

Answer 2

(i)

$$\frac{2}{64}$$

(ii)

$$\frac{6}{64}$$

(iii)

$$\frac{18}{64}$$

Answer 3

(i)

$$\frac{1}{169}$$

(ii)

$$\frac{12}{169}$$

(iii)

$$\frac{30}{169}$$

Answer 4

(i)

$$\frac{1}{4}$$

(ii)

$$\frac{1}{8}$$

(iii)

$$\frac{1}{16}$$

(iv)

$$\dots, \frac{1}{32}, \frac{1}{64}, \frac{1}{128}, \dots,$$

Answer 5**(i)**

$$\frac{10}{11}$$

(ii)

$$\frac{98}{150}$$

(iii)

$$\frac{25}{49}$$

(iv)

$$\frac{79}{200}$$

Answer 6**(i)**

$$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{6} = \frac{1}{24}$$

(ii)

$$\frac{1}{2} \times \frac{5}{6} \times \frac{1}{2} = \frac{5}{24}$$

(iii)

$$\frac{1}{2} \times \frac{5}{6} \times \frac{5}{6} = \frac{25}{72}$$

Answer 7

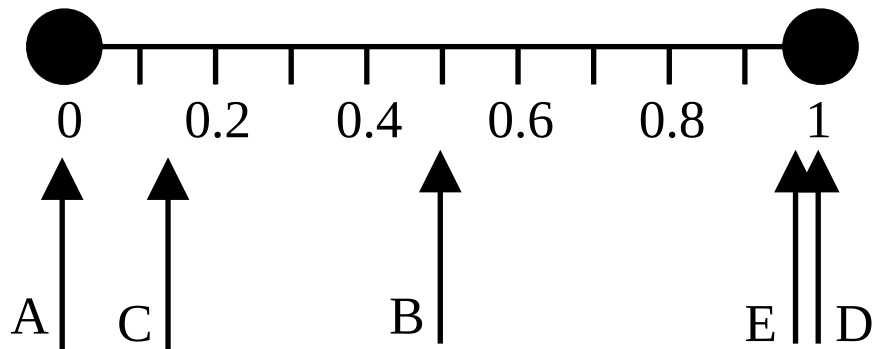
Fact 1 : zero

Fact 2 : zero

Fact 3 : one

Fact 4 : zero

Fact 5 : more

Answer 8**Answer 9****(i)**

$$\frac{1}{256}$$

(ii)

$$\frac{6}{256}$$

(iii)

$$\frac{144}{256}$$

Answer 10

- (i) It's harder to order the marks, or make other comparisons between them..
(ii) ... or spot mistakes.

$$\frac{19}{20} \text{ is the mistake}$$

- (iii) If you wanted to mentally square root $\frac{18}{8}$ it is easy if it's cancelled down;

$$\sqrt{\frac{18}{8}} = \sqrt{\frac{9}{4}} = \frac{3}{2}$$

If you want to add these two fractions,

$$\frac{8}{12} + \frac{10}{12}$$

it would made it harder to cancel down first,

$$\frac{2}{3} + \frac{5}{6}$$

In probability questions it's often best not to cancel down.

Lesson 6

GCSE Mathematics Probability

6.1 It's not fair ! (Homework)

An tetrahedral (four sided) die is rolled 200 times.

What is expected ?

Here are the rolls, with rolls of 4 missed out.

2	3	3	2	1	3	3	1	2	3
1	1	3	3	2	1	3	3	3	1
1	2	1	1	3	1	2	1	1	3
3	3	1	2	3	1	3	3	1	2
3	1	2	1	3	2	1	3	1	1

Table of the experiment's frequencies.

Roll	1	2	3	4
Frequency				

Table of the experiment's probabilities.

Roll	1	2	3	4
Probability (%)				

What can you say about this tetrahedral die ?

6.2 Exercise

Question 1

Each of these groups of numbers adds up to 100%.

In each case determine the value of x

(i)	45%	20%	5%	$x\%$
(ii)	30%	10%	$x\%$	20%
(iii)	$x\%$	25%	40%	15%
(iv)	15%	15%	40%	$2x\%$
(v)	35%	$7x\%$	20%	10%
(vi)	5%	15%	$0.5x\%$	45%
(vii)	$x\%$	44%	36%	$x\%$
(viii)	42%	20%	28%	$10x\%$
(ix)	14%	$(x + 25)\%$	7%	9%
(x)	32%	$2.5x\%$	44%	14%
(xi)	$5x\%$	15%	30%	$6x\%$
(xii)	18%	50%	$0.25x\%$	16%

Question 2

A *biased* die rolls scores of 1, 2, 3, 4, 5, 6 with these percentage probabilities;

Score	1	2	3	4	5	6
Probability (%)	10	30	10	20	10	x

State the percentage probability that the score obtained is a

- (i) 5
- (ii) an odd number
- (iii) 3 or 4
- (iv) 6
- (v) not 2

Question 3

A traffic light can show red, amber or green.

A certain traffic light is red 65% of the time.

It is amber for 5% of the time.

What is the percentage probability that a car, arriving at the light at random, finds it showing green ?

Question 4

Tomorrow night Jenny will do one of three things.

- ◇ go to the theatre
- ◇ visit her grandma's house
- ◇ stay at home

- (i) Complete the following table:

Activity	Theatre	Grandma	Stay home
Probability	25%	35%	

- (ii) Which of the three things is Jenny most likely to do ?

Question 5

When Shrewsbury Town football club play they can win, draw or lose.

The percentage probability that they will WIN a match is 24%.

The percentage probability that they will DRAW a match is 48%.

(i) Complete the following table:

Result	Win	Draw	Lose
Probability			

(ii) Find the probability that, in a randomly chosen game:

(a) Shrewsbury Town FC lose.

(b) Shrewsbury Town FC draw or lose.

Question 6

When Matthew plays chess he can win, draw or lose.

The percentage probability that they will WIN a match is 69%.

The percentage probability that they will DRAW a match is 13%.

(i) Complete the following table:

Result	Win	Draw	Lose
Probability			

(ii) Find the probability that, in a randomly chosen game:

(a) Matthew will lose.

(b) Matthew will NOT win.

Question 7

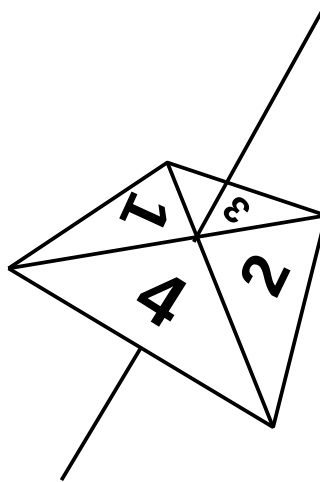
Each of these groups of numbers adds up to 1.

In each case determine the value of x

(i)	0.2	0.1	0.3	x
(ii)	x	0.1	0.1	0.1
(iii)	0.15	0.15	x	0.25
(iv)	0.1	0.1	0.2	$2x$
(v)	0.25	$5x$	0.15	0.1
(vi)	0.05	0.25	0.25	x
(vii)	0.1	x	0.15	0.1
(viii)	$3x$	0.10	0.45	$6x$
(ix)	0.24	$0.5x$	0.24	0.12
(x)	0.14	0.44	0.32	x
(xi)	0.05	0.25	$11x$	0.15
(xii)	0.18	0.5	0.16	x

Question 8

Here is a four sided spinner.



Its sides are labelled 1, 2, 3 and 4.

The spinner is biased.

The probability that the spinner lands on each of the numbers 1, 2 and 3 is given in the following table.

Number	Probability
1	0.25
2	0.25
3	0.1
4	

The spinner is spun once.

(a) Work out the probability that the spinner lands on 4.

(b) Work out the probability that the spinner lands on either 2 or 3.

Question 9

Four types of bird visit my garden.

The four types of bird are not equally likely to be seen.

The table shows the *decimal* probability that a randomly observed bird is of a particular type.

Type of bird	Blackbird	Sparrow	Starling	Robin
Probability (decimal)	0.35	0.25		0.15

- (i) Complete the probability table.
- (ii) Which type of bird is the most common in my garden ?

A bird is observed at random.

State the *decimal* probability that:

- (iii) it is NOT a blackbird
- (iv) it is a sparrow or a starling.

Question 10

A spinner can land on red or blue or yellow.

The spinner is biased.

The probability that it will land on red is 0.5

The probability that it will land on blue is 0.2

- (a) Imad spins the spinner once.
Work out the probability that it will land on yellow.
- (b) Janet spins the spinner 30 times.
Work out an estimate for the number of times the spinner will land on blue.

Question 11

Four girls run in a race.

The table shows the probability that each of three girls will win the race.

Name	Probability
Angela	0.5
Beverly	0.1
Caris	0.3
Danielle	

Calculate the probability that either Caris or Danielle will win the race.

Question 12

A *biased* die rolls scores of 1, 2, 3, 4, 5, 6 with these percentage probabilities;

Score	1	2	3	4	5	6
Probability (%)	5	15	10	x	20	y

The probability of rolling a 3 is the same as the probability of rolling a 6.

State the percentage probability that the score obtained is a

- (i) 5
- (ii) an odd number
- (iii) 4 or 6
- (iv) 4
- (v) not 1

Question 13

For years Robert uses a tetrahedral (four faced) die to decide if he should;

- ◇ go to the **Cinema**
- ◇ walk the **Dog**
- ◇ dine out : **Pizza**
- ◇ go ten pin **Bowling**

However, he thinks the die may be *biased* (not fair) and so rolls it 50 times.
Here are the results with the Bowling scores missed out.

Dog	Cinema	Dog	Dog	Dog
Pizza	Dog	Cinema	Pizza	Dog
Dog	Dog	Dog	Dog	Pizza
Cinema	Pizza	Dog	Dog	Dog
Dog	Pizza	Dog	Cinema	Cinema

Complete the following tables;

Table of the experiment's frequencies.

Roll	Cinema	Dog	Pizza	Bowling
Frequency				

Table of the experiment's probabilities.

Roll	Cinema	Dog	Pizza	Bowling
Probability (%)				

What can you say about this tetrahedral die ?

Question 14

Alexei has a tin of crayons.

Each crayon is either red or blue or yellow or green.

The number of yellow crayons is the same as the number of green crayons.

Alexei chooses a crayon at random from the tin.

The probability that he chooses a red crayon is 0.3

The probability he chooses a blue crayon is 0.4

Find the probability that the crayon is;

(i) red or blue

(ii) yellow or green

(iii) green

6.3 Answers

GCSE Mathematics Probability

6.3.1 Solution to the Introductory Question

Expected is,

$$p(1) = p(2) = p(3) = p(4) = 0.25$$

Roll	1	2	3	4
Frequency	20	10	20	150

Roll	1	2	3	4
Probability (%)	10	5	10	75

This tetrahedral die is biased in favour of 4

6.3.2 Solution to 6.2 Exercise

Answer 1

(i)	30	(ii)	40	(iii)	20	(iv)	15
(v)	5	(vi)	70	(vii)	10	(viii)	1
(ix)	45	(x)	4	(xi)	5	(xii)	64

Answer 2

(i)	10%	(ii)	30%	(iii)	30%
(iv)	20%	(v)	70%		

Answer 3

30%

Answer 4

(i)

Activity	Theatre	Grandma	Stay home
Probability	25%	35%	40%

(ii) stay home

Answer 5

(i)

Result	Win	Draw	Lose
Probability	24%	48%	28%

(ii) (a) 28% (b) 76%

Answer 6**(i)**

Result	Win	Draw	Lose
Probability	69%	13%	18%

(ii) (a) 18%**(b) 31%****Answer 7**

(i) 0.4 (ii) 0.7 (iii) 0.45 (iv) 0.3
(v) 0.1 (vi) 0.45 (vii) 0.65 (viii) 0.05
(ix) 0.8 (x) 0.1 (xi) 0.05 (xii) 0.16

Answer 8**(a) 0.4****(b) 0.35****Answer 9****(i)**

Type of bird	Blackbird	Sparrow	Starling	Robin
Probability (decimal)	0.35	0.25	0.25	0.15

(ii) Blackbird**(iii) 0.65****(iv) 0.5****Answer 10****(a) 0.3****(b) 6****Answer 11****0.4****Answer 12****(i) 20%****(ii) 35%****(iii) 50%****(iv) 40%****(v) 95%****Answer 13**

Roll	Cinema	Dog	Pizza	Bowling
Frequency	5	15	5	25

Roll	Cinema	Dog	Pizza	Bowling
Probability (%)	10	30	10	50

This tetrahedral die is biased in favour of bowling

Answer 14**(i) 0.7****(ii) 0.3****(iii) 0.15**This document is a part of a **Mathematics Community Outreach Project** initiated by Shrewsbury School

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Teachers may obtain detailed worked solutions to the exercises by email from MHHShrewsbury@Gmail.com

7.1 The Letter Picking Puzzles

Example



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) T first, *and* then O

HINT : T *and* O
and means *multiply*
 $p(T) \times p(O)$

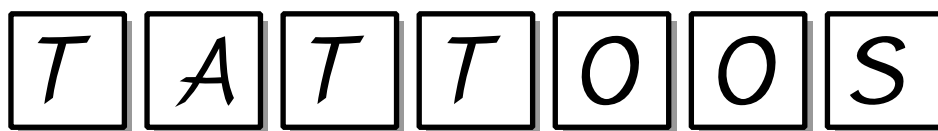
(ii) T *and* O

HINT : T *and* O or O *and* T
and means *multiply*
or means *add*
 $p(T) \times p(O) + p(O) \times p(T)$

(iii) T *and* T

NOTICE :

- (i) One way of getting T first, and then O
- (ii) Two ways of getting a T and an O
- (iii) One way of getting T and a T



(iv) vowel first, *and* then consonant

(v) vowel *and* consonant

(vi) two consonants

7.2 Vulgar Fractions Vs Decimal Fractions

In our example we are able to easily give *exact* answers by using vulgar fractions. That is, fractions written in the form,

$$\frac{p}{q} \text{ where } p \text{ and } q \text{ are integers, } q \neq 0$$

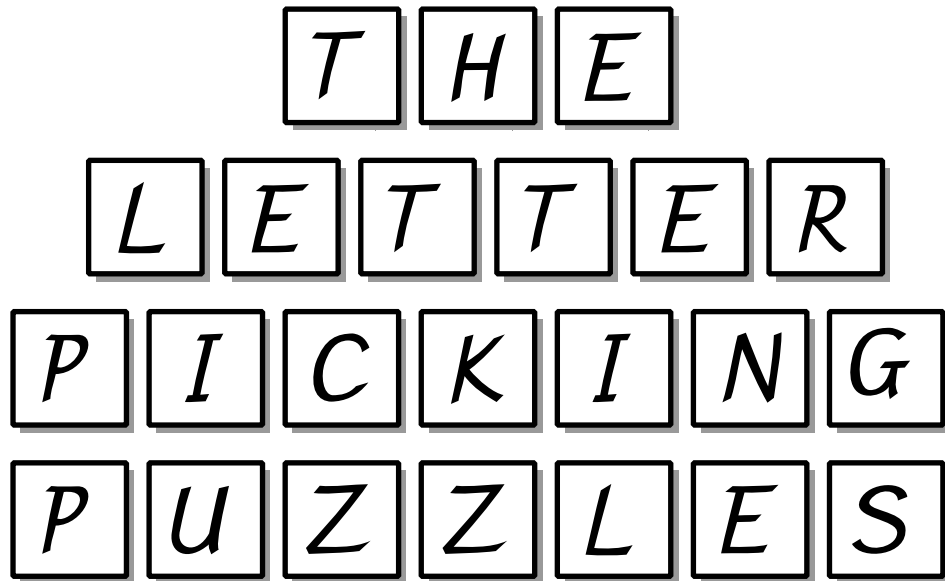
Decimal fractions in our example would necessitated rounding. For example,

$$\frac{6}{49} = 0.122\ 448\ 979\ 6... \quad \text{rounds to} \quad 0.122$$

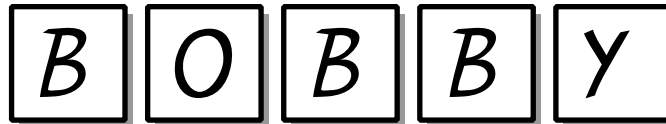
Squaring a vulgar fraction mentally is typically easier than squaring a decimal fraction.

Thus, in probability, it's often preferable to use vulgar fractions rather than decimal fractions. However, some GCSE questions will use terminating decimals to make a question more accessible to candidates who are not confident with manipulating vulgar fractions.

7.3 Exercise



Question 1



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) **B** first, *and* then **Y**

(ii) **B** *and* **Y**

(iii) **B** *and* **B**

Question 2



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) **A** first, *and* then **T**

(ii) **A** *and* **T**

(iii) **T** *and* **T**

(iv) vowel first, *and* then consonant

(v) vowel *and* consonant

(vi) two vowels

Question 3



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) S first, *and* then K

(ii) S *and* K

(iii) S *and* S

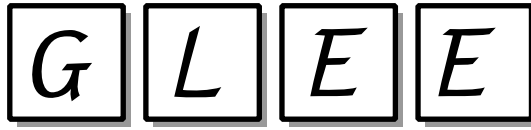
(iv) consonant first, *and* then vowel

(v) consonant *and* vowel

(vi) two consonants

Question 4

In this question, don't cancel down any fractions.



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) **G and G**

(ii) **L and L**

(iii) **E and E**

(iv) **The same letter is picked twice.**

Question 5



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) C first, *and* then U

(ii) C *and* U

(iii) U *and* U

(iv) consonant first, *and* then vowel

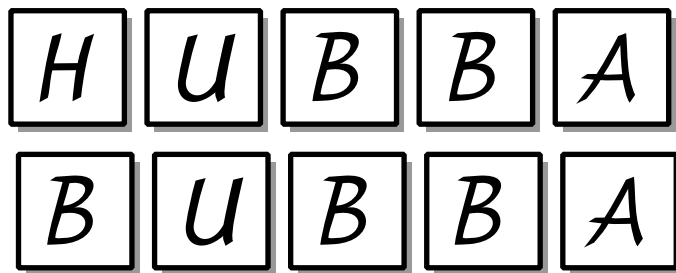
(v) consonant *and* vowel

(vi) two consonants



Question 6.

In this question, don't cancel down any fractions.



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) **B** first, *and* then **U**

(ii) **H** *and* **A**

(iii) vowel *and* consonant

Question 7

A multipack bag of crisps contains

- * 3 *ready salted*
- * 4 *salt & vinegar*
- * 2 *cheese & onion*
- * 2 *prawn cocktail*

A bag is chosen at random then replaced.

A second bag is then chosen at random.

What is the probability that the following are chosen:

(i) First *salt & vinegar*, then *prawn cocktail*.

(ii) First *prawn cocktail*, then *salt & vinegar*.

(iii) *Prawn cocktail* and *salt & vinegar*.

(iv) *Ready salted* and *cheese & onion*.

Question 8

An iPod holds five tunes.

- * *American π* .
- * *Do the Fraction Frolic NOW !*
- * *I kissed Pythagoras (and I liked it)*.
- * *She were number crazy*.
- * *The Spinner Takes It All*.

Two tracks are played at random.

What is the probability that the following are the first two tunes played:

(i) First *American π* , then *She were number crazy*.

(ii) *American π* and *She were number crazy*.

Question 9

I've decided to use a coin to walk randomly along a corridor.

If I spin Heads I walk ten steps forward.

If I spin Tails I walk ten steps back.

What is the probability that after four spins that I've walked from my starting position:

- (i) Forty steps forward.
- (ii) Thirty steps forward.
- (iii) Twenty steps forward.

Question 10

One letter is chosen at random from the word;

I L L U M I N A T I O N

It is replaced, and then a second letter is chosen, again at random.

Find the probability that;

(So that answers may be easily compared, do not cancel down your answers)

- (i) the M is chosen first and the M is chosen second
- (ii) an N is chosen first and an N is chosen second
- (iii) the U is chosen first and the O is chosen second
- (iv) the U and the O are chosen
- (v) an I is chosen first and an L is chosen second
- (vi) a vowel is chosen each time
- (vii) a vowel is chosen once
- (viii) no vowel is chosen

Question 11

A number is chosen at random from the following list;

3, 5, 6, 8, 14.

It is replaced and a second number is chosen from the list.

Find the probability that;

- (i) The 5 is chosen first and the 14 is chosen second.

- (ii) The 5 and 14 are chosen.

- (iii) No numbers other than the 5 and the 14 are involved.

Question 12

First one and then a second letter is chosen at random from this sentence.

What is the probability that it is an "e" both times ?

(Assume that the same letter can be picked twice)

Question 13

The PIN numbers used in the "chip & pin" system are four digit numbers.

In trying to access an account, three attempts are permitted.

What is the probability of a thief, entering one four digit number at random, gets in ?

7.4 Answers

GCSE Mathematics Probability

7.4.1 Solutions to the Introductory Example

(i)

$$\begin{aligned}p(T) \times p(O) &= \frac{3}{7} \times \frac{2}{7} \\&= \frac{6}{49}\end{aligned}$$

(ii)

$$\begin{aligned}p(T) \times p(O) + p(O) \times p(T) &= \frac{3}{7} \times \frac{2}{7} + \frac{2}{7} \times \frac{3}{7} \\&= \frac{6}{49} + \frac{6}{49} \\&= \frac{12}{49}\end{aligned}$$

(iii)

$$\begin{aligned}p(T) \times p(T) &= \frac{3}{7} \times \frac{3}{7} \\&= \left(\frac{3}{7}\right)^2 \\&= \frac{9}{49}\end{aligned}$$

(iv)

$$\begin{aligned}p(v) \times p(c) &= \frac{3}{7} \times \frac{4}{7} \\&= \frac{12}{49}\end{aligned}$$

(v)

$$\begin{aligned}p(v) \times p(c) + p(c) \times p(v) &= \frac{3}{7} \times \frac{4}{7} + \frac{4}{7} \times \frac{3}{7} \\&= \frac{24}{49}\end{aligned}$$

(vi)

$$\begin{aligned}p(c) \times p(c) &= \frac{4}{7} \times \frac{4}{7} \\&= \left(\frac{4}{7}\right)^2 \\&= \frac{16}{49}\end{aligned}$$

7.4.2 Solutions to 7.3 Exercise

Answer 1

(i)

$$\frac{3}{25}$$

(ii)

$$\frac{6}{25}$$

(iii)

$$\frac{9}{25}$$

Answer 2

(i)

$$\frac{6}{49}$$

(ii)

$$\frac{12}{49}$$

(iii)

$$\frac{9}{49}$$

(iv)

$$\frac{10}{49}$$

(v)

$$\frac{20}{49}$$

(vi)

$$\frac{4}{49}$$

Answer 3

(i)

$$\frac{2}{49}$$

(ii)

$$\frac{4}{49}$$

(iii)

$$\frac{4}{49}$$

(iv)

$$\frac{12}{49}$$

(v)

$$\frac{24}{49}$$

(vi)

$$\frac{16}{49}$$

Answer 4

(i)

$$\frac{1}{16}$$

(ii)

$$\frac{1}{16}$$

(iii)

$$\frac{4}{49}$$

(iv)

$$\frac{6}{16}$$

Answer 5

(i)

$$\frac{1}{49}$$

(ii)

$$\frac{2}{49}$$

(iii)

$$\frac{1}{49}$$

(iv)

$$\frac{12}{49}$$

(v)

$$\frac{24}{49}$$

(vi)

$$\frac{16}{49}$$

Answer 6

(i)

$$\frac{10}{25}$$

(ii)

$$\frac{4}{100}$$

(iii)

$$\frac{48}{100}$$

Answer 7

(i)	(ii)	(iii)	(iv)
$\frac{8}{121}$	$\frac{8}{121}$	$\frac{16}{121}$	$\frac{12}{121}$

Answer 8

(i)	(ii)
$\frac{1}{25}$	$\frac{2}{25}$

Answer 9

(i)	(ii)	(iii)
$\frac{1}{16}$	0	$\frac{4}{16}$

Answer 10

(i)	(ii)	(iii)	(iv)
$\frac{1}{144}$	$\frac{4}{144}$	$\frac{1}{144}$	$\frac{2}{144}$
(v)	(vi)	(vii)	(viii)
$\frac{6}{144}$	$\frac{36}{144}$	$\frac{72}{144}$	$\frac{36}{144}$

Answer 11

(i)	(ii)	(iii)
$\frac{1}{25}$	$\frac{2}{25}$	$\frac{4}{25}$

Answer 12

$$\left(\frac{9}{60} \right)^2 = \left(\frac{3}{20} \right)^2 = \frac{9}{400}$$

Answer 13

$$\frac{1}{10000} \text{ or } 0.0001 \quad \text{which is a } 0.01 \% \text{ chance}$$

8.1 An Introduction to Tree Diagrams

Example

One drawer contains 8 black socks and 5 brown socks.

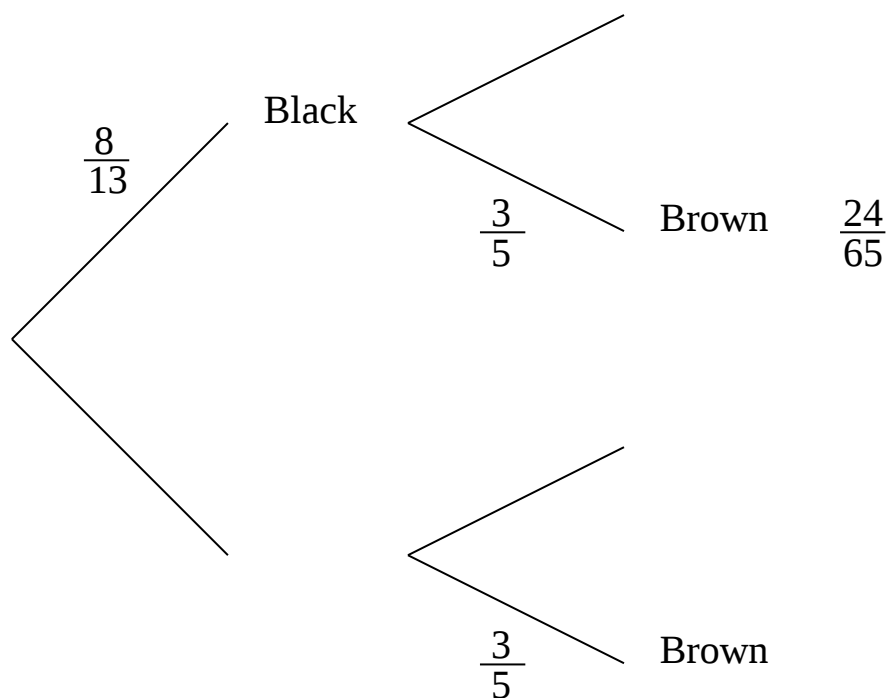
A second drawer contains 2 white socks and 3 brown socks.

A sock is chosen at random from each drawer.

- (i) Complete the tree diagram

First drawer

Second drawer



- (ii) What is the probability of getting a black sock and a white sock ?
- (iii) What is the probability that both socks are the same colour ?

8.2 Exercise

Question 1

One pencil case contains 4 pink pencils and 3 blue pencils.

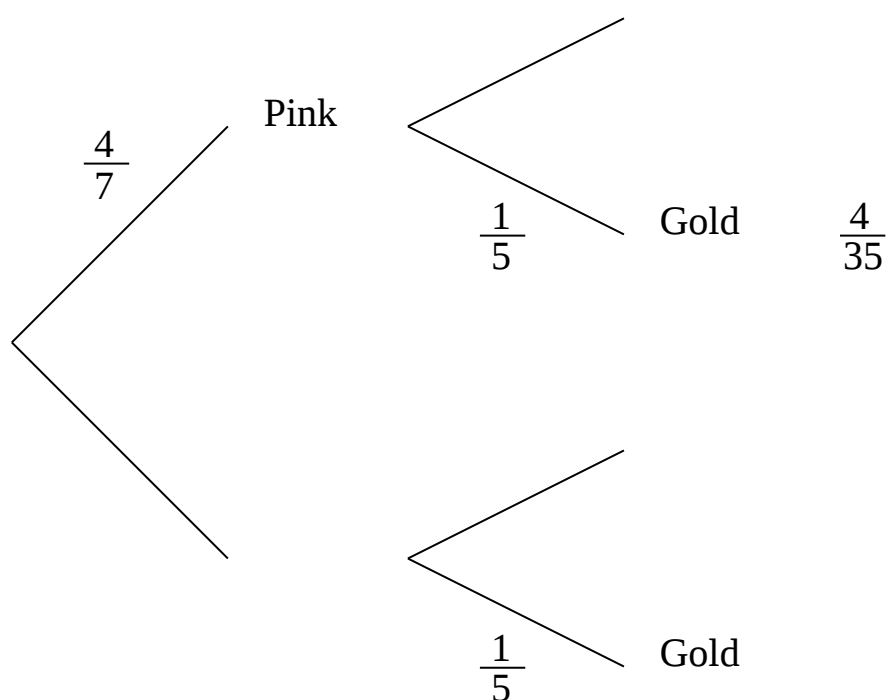
A second pencil case contains 1 gold pencil and 4 blue pencils.

A pencil is chosen at random from each pencil case.

- (i) Complete the tree diagram

First pencil case

Second pencil case



- (ii) What is the probability of getting a pink pencil and a gold pencil ?

- (iii) What is the probability that both pencils are the same colour ?

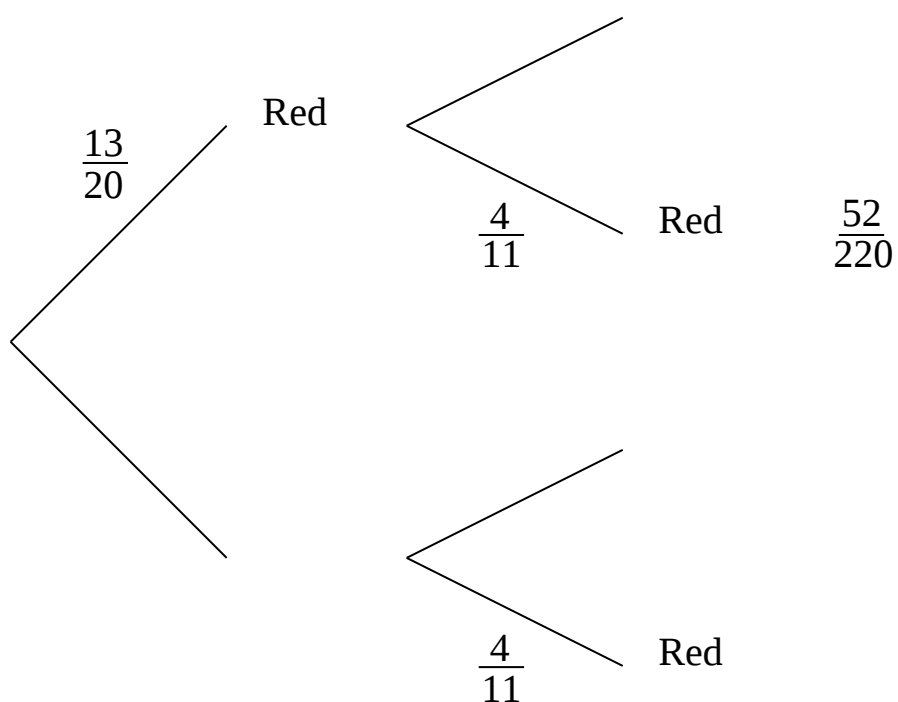
Question 2

One bag of sweets contains 13 red boiled sweets and 7 green boiled sweets.
A second bag of sweets contains 7 blue boiled sweets and 4 red boiled sweets.

A sweet is chosen at random from each bag.

- (i) Complete the tree diagram

First bag of sweets Second bag of sweets



- (ii) What is the probability of getting a green sweet and a blue sweet ?

- (iii) What is the probability of **NOT** getting two red sweets ?

Question 3

One drawer contains 3 black socks and 8 grey socks.

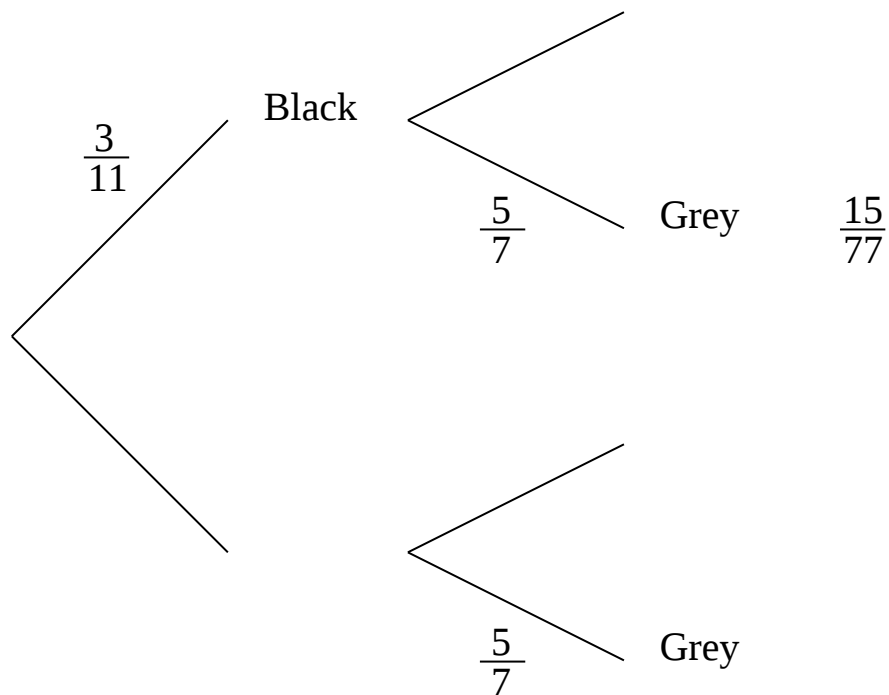
A second drawer contains 2 black socks and 5 grey socks.

A sock is chosen at random from each drawer.

(i) Complete the tree diagram

First drawer

Second drawer



(ii) What is the probability of getting two black socks ?

(iii) What is the probability that both socks are the same colour ?

(iv) What is the probability of the pair not being of a matching colour ?

Question 4

One spinner has 4 orange sectors and 5 purple sectors all of equal size.

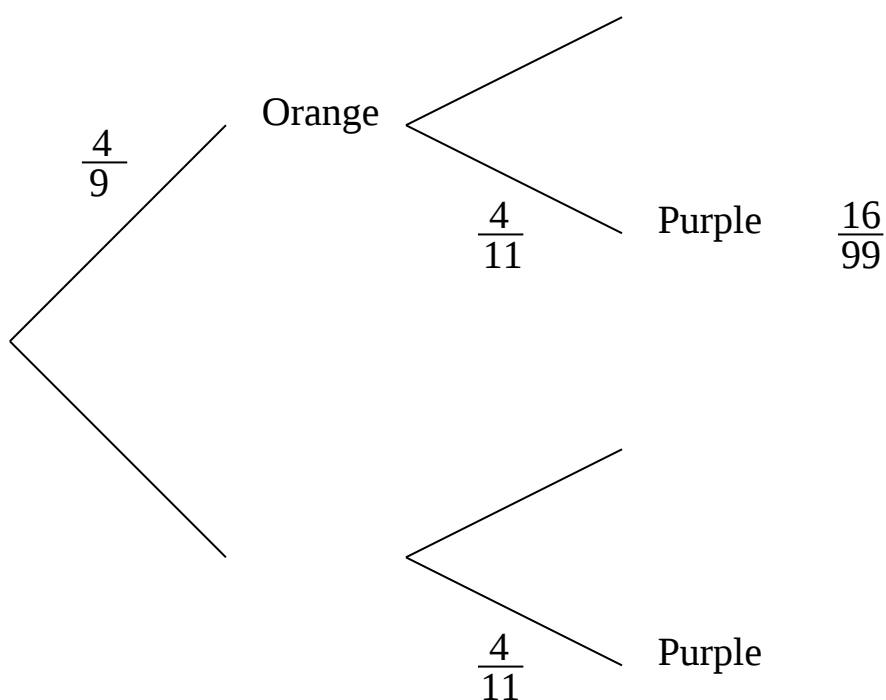
A second spinner has 7 orange sectors and 4 purple sectors all of equal size.

Each is spun once.

- (i) Complete the tree diagram

First spinner

Second spinner



- (ii) What is the probability of spinning two orange sectors ?
- (iii) What is the probability that both spinners spin the same colour ?
- (iv) What is the probability of the spinners not being of a matching colour ?

Question 5

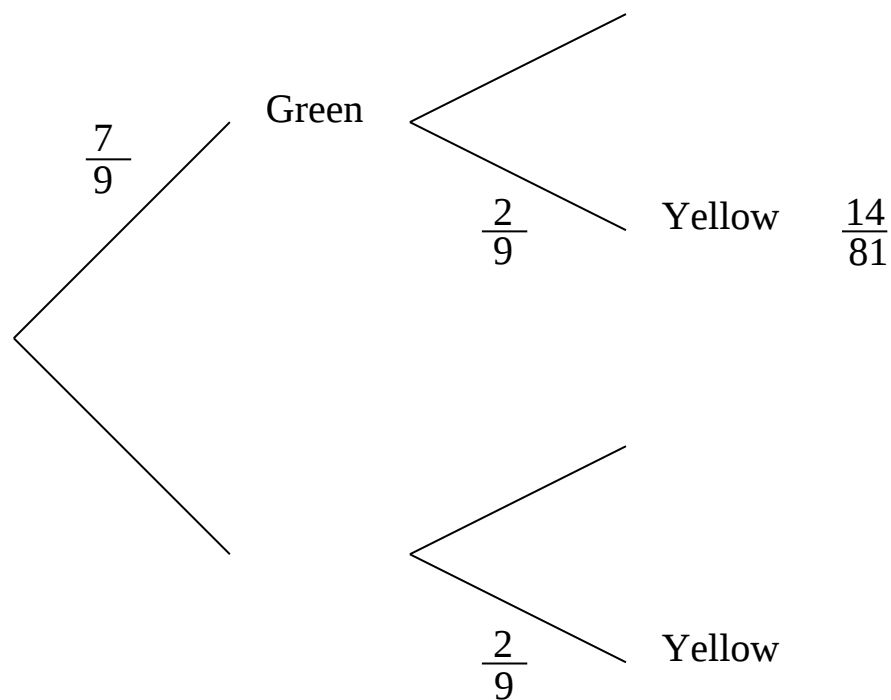
A spinner has 7 green sectors and 2 yellow sectors, all of equal size.

It is spun twice.

- (i) Complete the tree diagram

First spin

Second spin



- (ii) What is the probability that both spins are green ?
- (iii) What is the probability that both spins are the same colour ?
- (iv) What is the probability of the two spins not being of a matching colour ?

Question 6

A spinner has 5 indigo sectors and 6 puce sectors, all of equal size.

It is spun twice.

(i) Draw a tree diagram of a similar style to those of previous questions.

(ii) What is the probability that both spins are indigo ?

(iii) What is the probability that both spins are the same colour ?

(iv) What is the probability of the two spins not being of a matching colour ?

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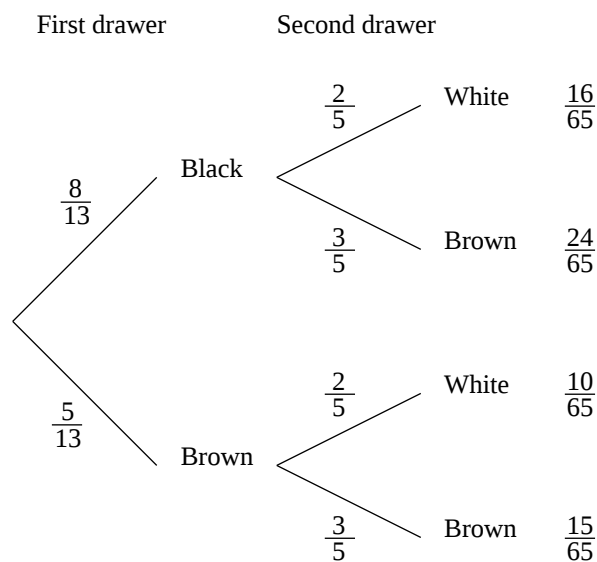
Teachers may obtain detailed worked solutions to the exercises by email from MHHShrewsbury@Gmail.com

8.3 Answers

GCSE Mathematics Probability

8.3.1 Solution to the Example

(i)



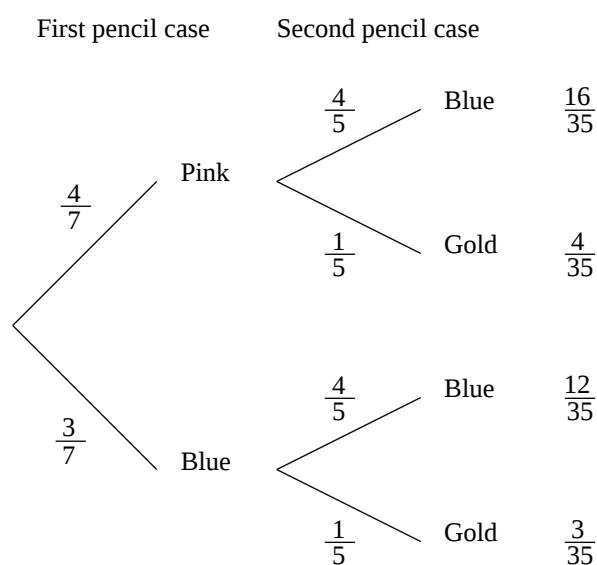
(ii) $\frac{16}{65}$

(iii) $\frac{15}{65}$

8.3.2 Solutions to the Exercise

Answer 1

(i)

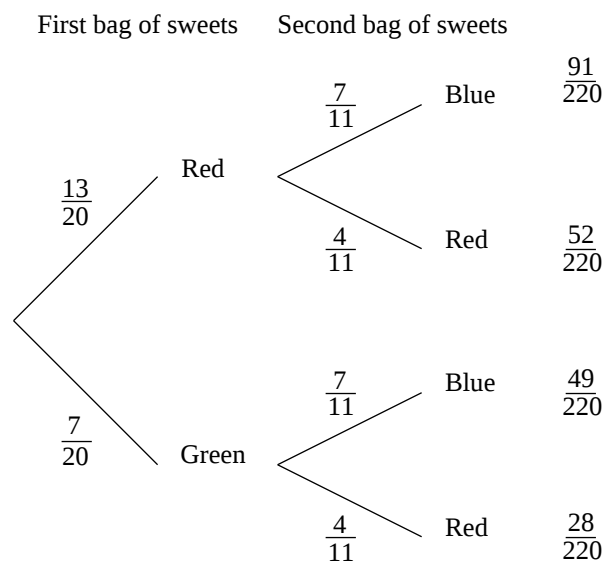


(ii) $\frac{4}{35}$

(iii) $\frac{12}{35}$

Answer 2

(i)

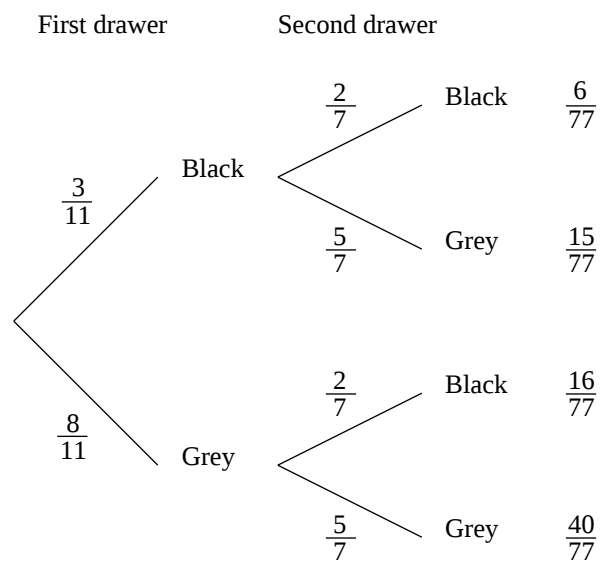


(ii) $\frac{49}{220}$

(iii) $\frac{168}{220}$ or $\frac{42}{55}$

Answer 3

(i)



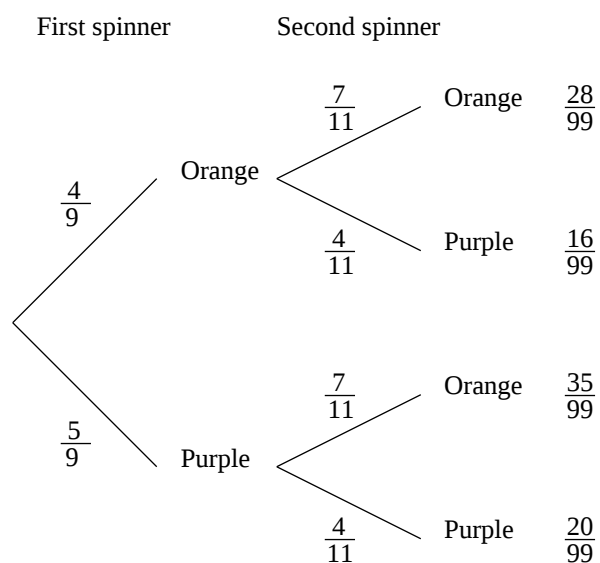
(ii) $\frac{6}{77}$

(iii) $\frac{46}{77}$

(iv) $\frac{31}{77}$

Answer 4

(i)



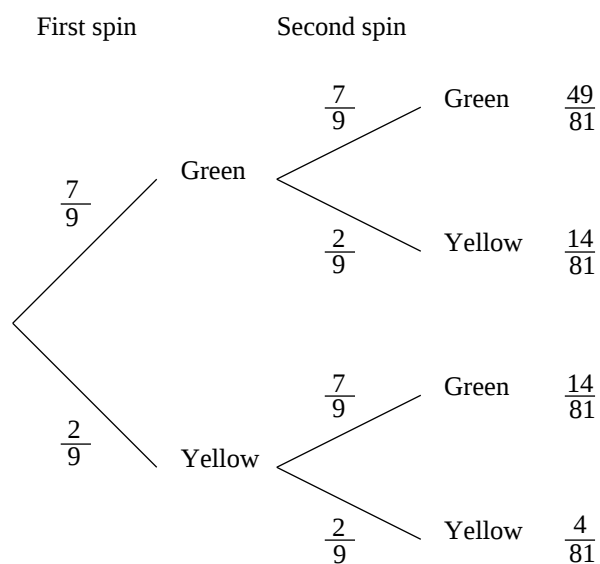
(ii) $\frac{28}{99}$

(iii) $\frac{48}{99}$ or $\frac{16}{33}$

(iv) $\frac{51}{99}$ or $\frac{17}{33}$

Answer 5

(i)



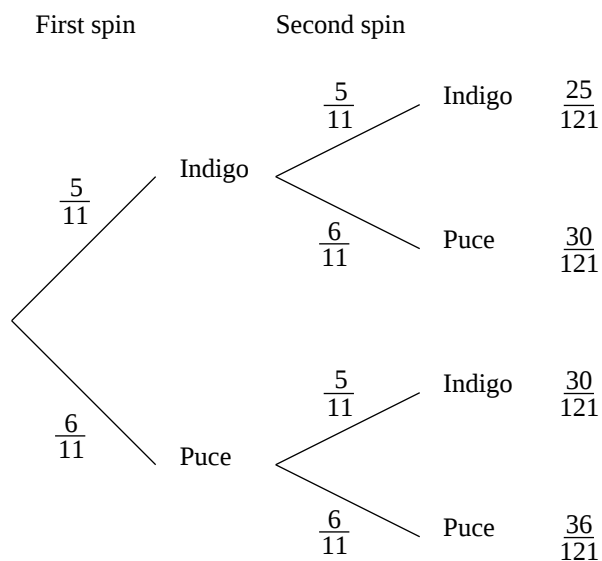
(ii) $\frac{49}{81}$

(iii) $\frac{53}{81}$

(iv) $\frac{28}{81}$

Answer 6

(i)



(ii) $\frac{25}{121}$

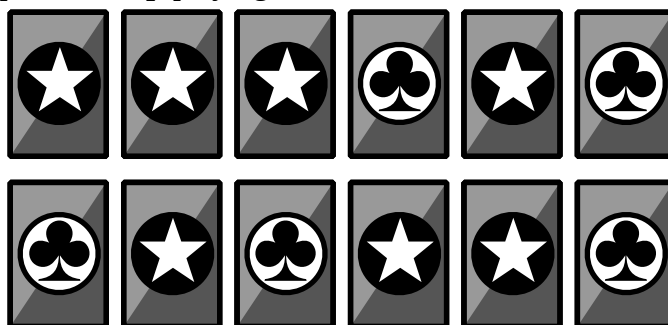
(iii) $\frac{61}{121}$

(iv) $\frac{60}{121}$

9.1 Tree Diagrams

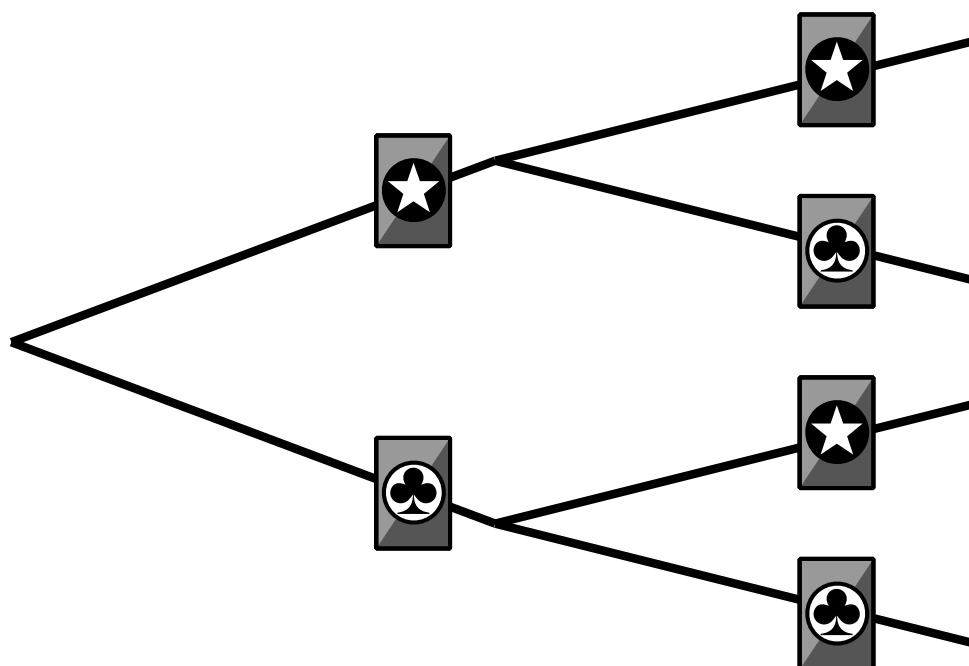
Example

A children's pack of *snap* playing cards is shown below;



The cards are shuffled. Then, first one is placed face up on the table, then a second.

- (i) Complete this tree diagram by marking each branch with a probability to show all possible outcomes.

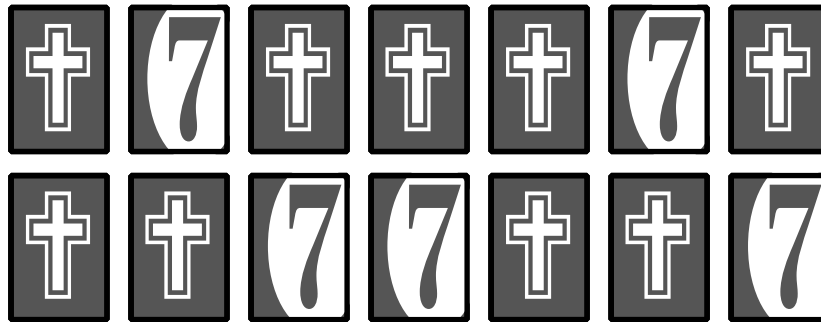


- (ii) Use your tree diagram to determine the probability of a *snap*.
- (iii) What is the probability of **NOT** obtaining a *snap* ?

9.2 Exercise

Question 1

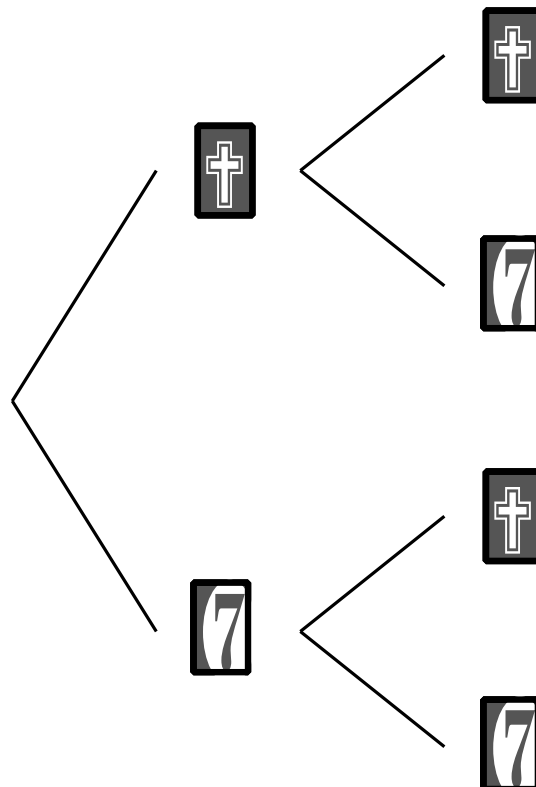
A pack of children's *snap* playing cards is shown below.



The cards are shuffled.

Then a first, followed by a second are placed face up on the table.

(i) Complete this tree diagram to show all possible outcomes.



(ii) Use your tree diagram to determine the probability of a *snap*.

(iii) What is the probability of NOT obtaining a *snap* ?

Question 2

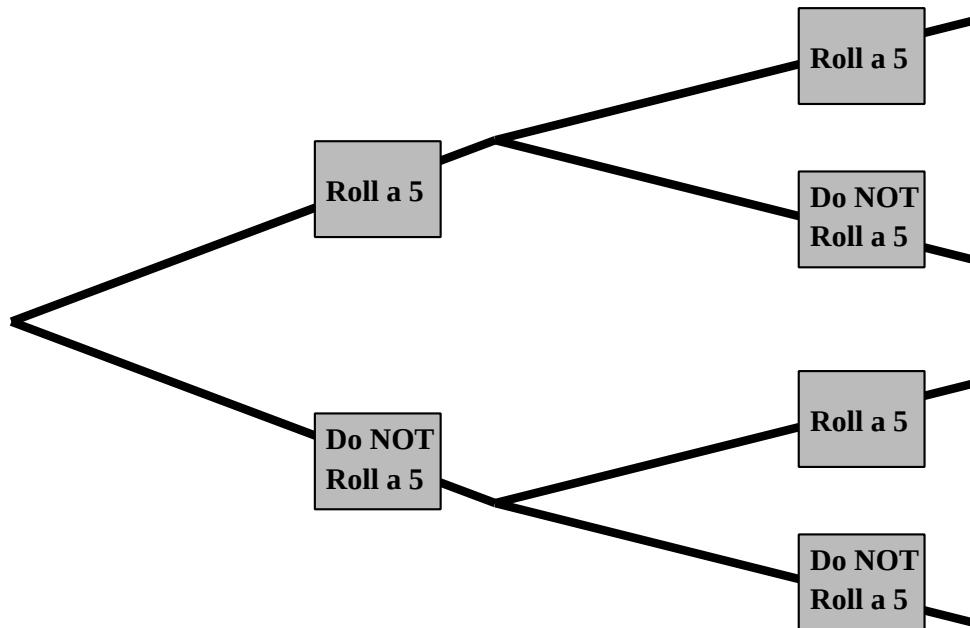
Be Careful !

This question is like those done previously where the probabilities do not change.

Five is my lucky number.

I roll an ordinary six sided dice once, then roll it again.

(a) Complete the probability tree diagram.



(b) Calculate the probability that I will roll my lucky number

(i) Twice

(ii) Exactly once

(c) Richard's lucky number is 4.
He's going to roll the dice thrice.

What is the probability that he will roll his lucky number exactly once ?

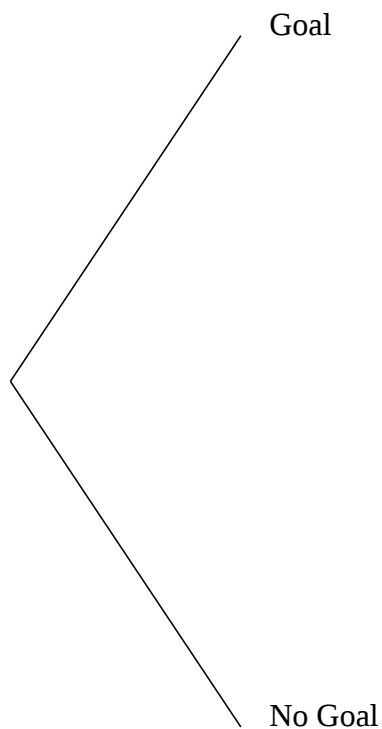
Question 3

Each time Astrid takes a shot at goal, the probability that she will score is $\frac{1}{3}$.
Astrid takes two shots.

(a) Complete the probability tree diagram.

First shot

Second shot



[3 marks]

(b) Calculate the probability that Astrid scores at least 1 goal.

[3 marks]

Question 4

GCSE Examination Question from 6th November 2008, paper 3H, Q15.

This question does not tell you to draw a tree diagram but please do.

Notice the words "without replacement".

It's Question 15 so it's an A grade question and worth 4%.

There are 9 counters in a bag.

7 of the counters are red and 2 of the counters are white.

Ajit takes at random two counters from the bag without replacement.

(a) Calculate the probability that the two counters are red.

[2 marks]

(b) Calculate the probability that the two counters have different colours.

[2 marks]

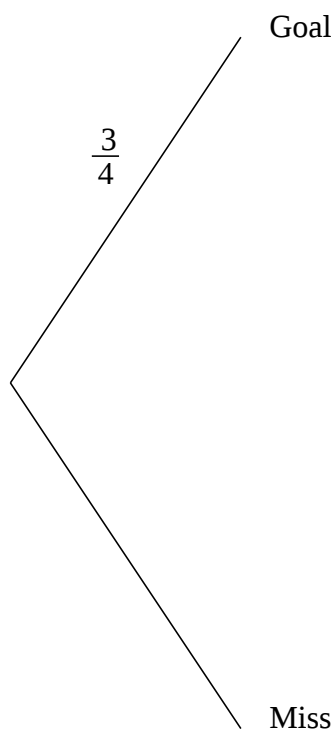
Question 5

Each time Nikos has a shot at goal, the probability that he will score a goal is $\frac{3}{4}$.
Nikos takes two shots.

(a) Complete the probability tree diagram.

First shot

Second shot



[2 marks]

- (b) Calculate the probability that Nikos will score
(i) two goals

[2 marks]

- (ii) exactly one goal

[3 marks]

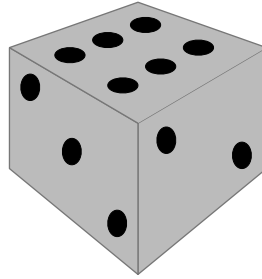
Nikos now takes another three shots.

- (c) Calculate the probability that he will score exactly 1 goal or exactly 2 goals.

[3 marks]

Question 6

Here is a fair dice.



It has faces numbered 1, 2, 3, 4, 5 and 6

The dice shows a score of 6

Hari throws the dice three times.

(a) Work out the probability that the sum of the scores is 3

[2 marks]

(b) Work out the probability that the dice shows a score of 1 on exactly one of the three throws

[3 marks]

Question 7

A pack of PENGUIN biscuits contains wrappers coloured as follows:

- * 4 **red**
- * 3 **blue**
- * 2 **green**
- * 2 **purple**

A biscuit is chosen at random then replaced. (I didn't like the wrapper colour !)

A second biscuit is then chosen at random.

What is the probability that the following are chosen:

(i) First **red**, and then **purple**.

(ii) First **purple**, and then **red**.

(iii) **Purple** and **red**.

(iv) **Green** and **blue**.

(v) The same colour, twice.

Question 8

I've decided to use a coin to walk randomly along a corridor.

If I spin Heads I walk ten steps forward.

If I spin Tails I walk ten steps back.

What is the probability that after **three** spins I've walked from my starting position:

(i) Thirty steps forward.

(ii) Twenty steps forward.

(iii) Ten steps forward.

Question 9

I start facing North.

I walk forward ten paces then spin a coin to decide if I should turn 90° to the right or 90° to the left.

I do this four times.

What is the probability that I am back where I started, facing North ?

Question 10

I've decided to keep spinning a coin until it lands Heads.

What is the probability that I'll spin it:

- (i) Once only.
- (ii) More than once.
- (iii) Twice exactly.
- (iv) More than twice. (Be careful !)
- (v) Thrice exactly.
- (vi) More than thrice.

Toby argues that as a HEAD must eventually be spun:

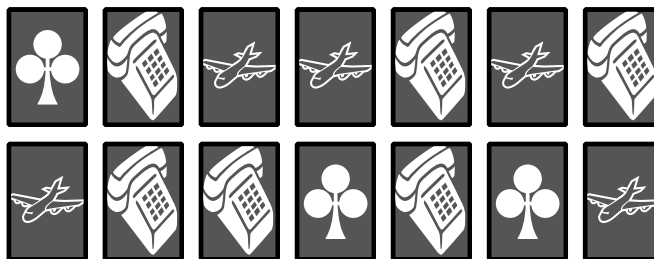
$$p(H) + p(T,H) + p(T,T,H) + p(T,T,T,H) + \dots = 1$$

Write out this with $p(H)$, $p(T,H)$, $p(T,T,H)$... replaced with numbers.

This is an example of an infinite series that has a finite sum.

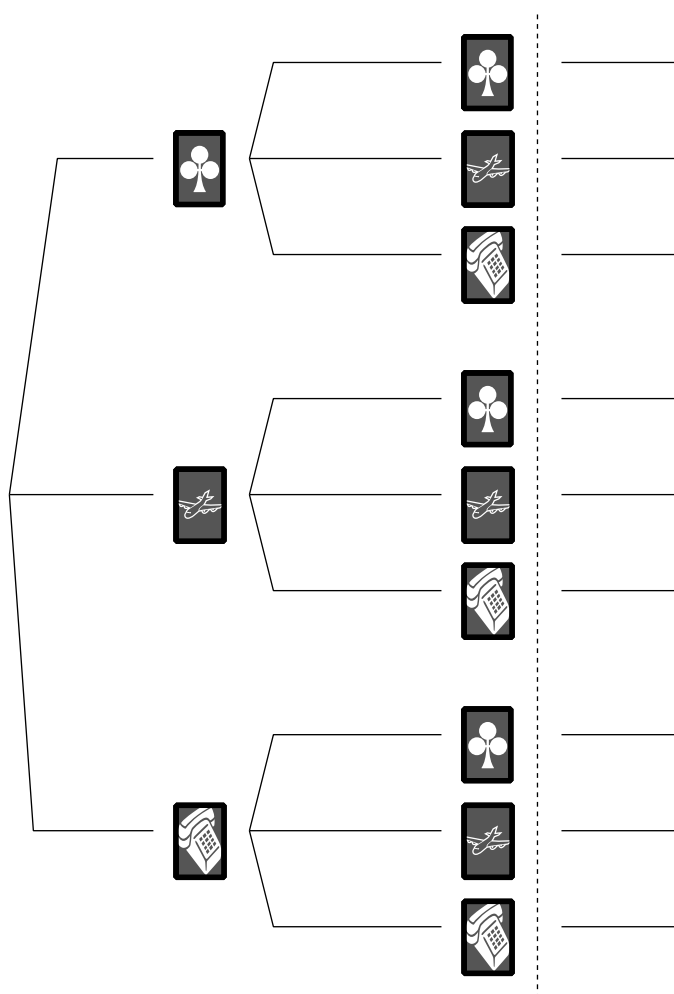
Question 11

A children's pack of "snap" playing cards is shown below;



The cards are shuffled and then first one is placed face up on the table, then a second.

(i) Complete this tree diagram to show all possible outcomes.



(ii) Use your tree diagram to determine the probability of a "snap".

Question 12

A number is chosen at random from the following list;

13, 25, 46, 81, 12.

It is replaced and a second number is chosen from the list.

Find the probability that;

- (i) An ODD number is chosen twice.
- (ii) A SQUARE number is chosen first, and a PRIME number second.
- (iii) The number 46 is not chosen.

Question 13

First one and then a second letter is chosen at random from this sentence.

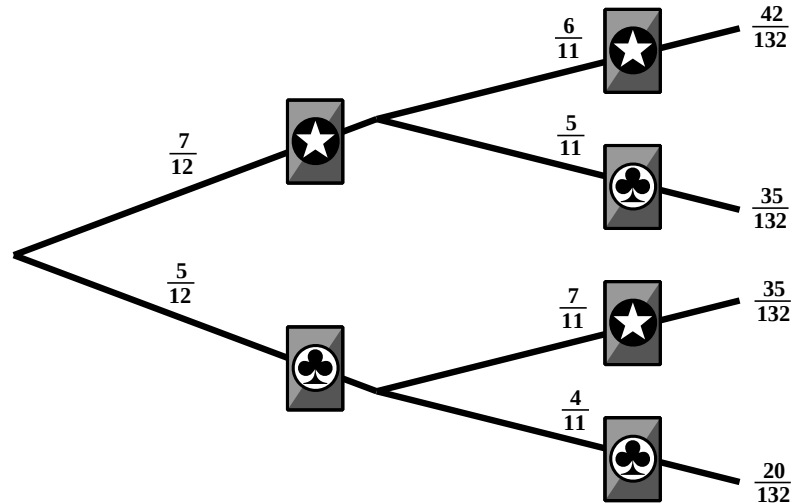
What is the probability that it is a vowel both times ?

9.3 Answers

GCSE Mathematics Probability

9.3.1 Solution (Introductory Example)

(i)



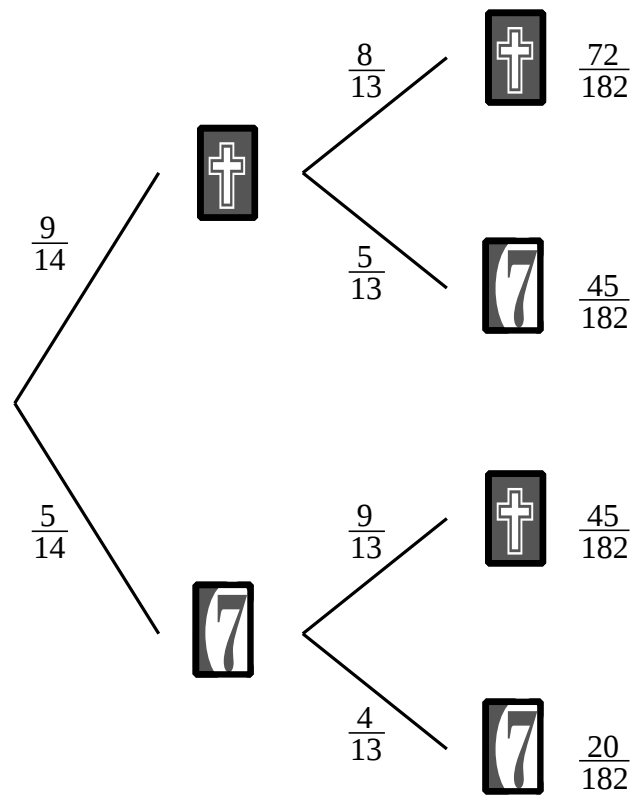
(ii) $\frac{62}{132} = \frac{31}{66}$ or 0.470

(iii) $\frac{70}{132} = \frac{35}{66}$ or 0.530

9.3.2 Solutions (9.2 Exercise)

Answer 1

(i)

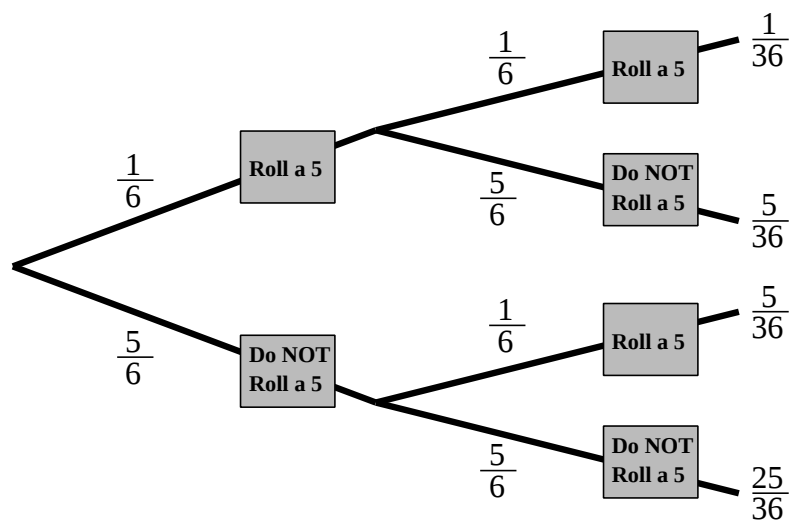


(ii) $\frac{92}{182} = \frac{46}{91}$ or 0.505

(iii) $\frac{90}{182} = \frac{45}{91}$ or 0.495

Answer 2

(a)



(b) (i) $\frac{1}{36}$

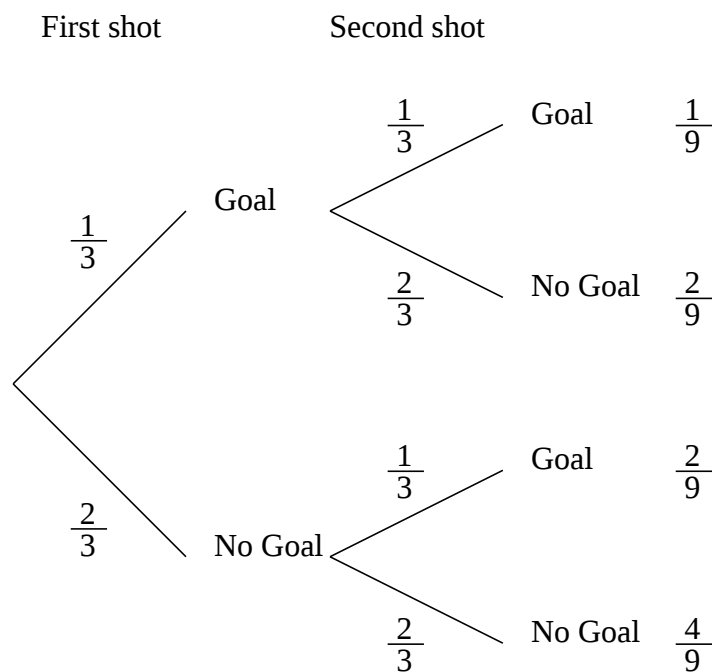
(ii) $\frac{10}{36}$

(c)

$$3 \times \left(\frac{1}{6} \times \frac{5}{6} \times \frac{5}{6} \right) = \frac{75}{216} \quad \text{which is about } 0.347$$

Answer 3

(a)



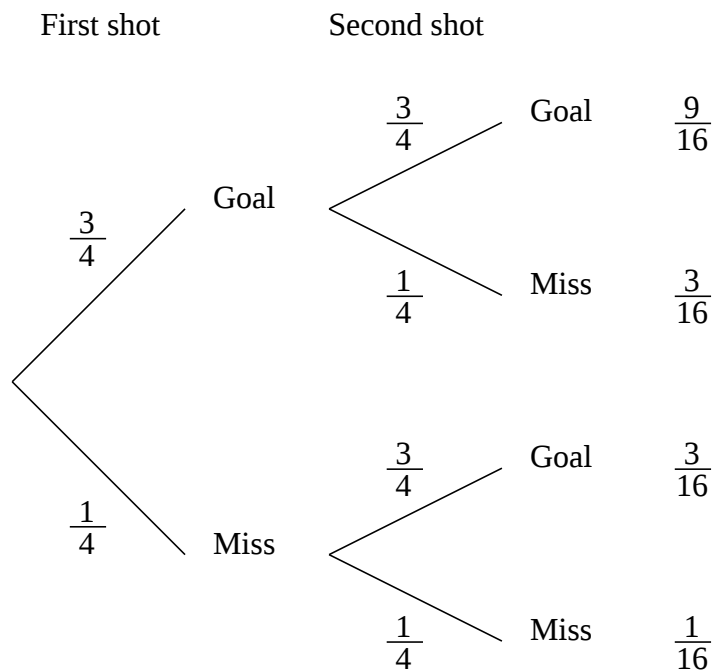
(b) $\frac{5}{9}$

Answer 4**(a)**

$$p(R, R) = \frac{7}{9} \times \frac{6}{8} = \frac{42}{72} \text{ or } \frac{7}{12} \text{ or } 0.583$$

(b)

$$p(R, W) + p(W, R) = 2 \times \left(\frac{7}{9} \times \frac{2}{8} \right) = \frac{28}{72} \text{ or } \frac{7}{18} \text{ or } 0.388$$

Answer 5**(a)**

(b) (i) $\frac{9}{16}$ or 0.5625

(ii) $\frac{6}{16}$ or $\frac{3}{8}$ or 0.375

(c)

$$\begin{aligned} 1 - p(M, M, M) - p(G, G, G) &= 1 - \frac{1}{64} - \frac{27}{64} \\ &= \frac{36}{64} \text{ or } \frac{9}{16} \text{ or } 0.5625 \end{aligned}$$

Answer 6**(a)**

$$p(1, 1, 1) = \frac{1}{216} \text{ or } 0.00463$$

(b)

$$3 \times \left(\frac{1}{6} \times \frac{5}{6} \times \frac{5}{6} \right) = \frac{75}{216} \text{ or } 0.347$$

Answer 7

$$\text{(i) } \quad \frac{8}{121} \text{ or } 0.0661$$

$$\text{(ii) } \quad \frac{8}{121} \text{ or } 0.0661$$

$$\text{(iii) } \quad \frac{16}{121} \text{ or } 0.132$$

$$\text{(iv) } \quad \frac{12}{121} \text{ or } 0.0992$$

$$\text{(v) } \quad \frac{33}{121} \text{ or } 0.273$$

Answer 8

$$\text{(i) } \quad \frac{1}{8} \text{ or } 0.125$$

$$\text{(ii) } \quad 0$$

$$\text{(iii) } \quad \frac{3}{8} \text{ or } 0.375$$

Answer 9

$$\frac{1}{8} \text{ or } 0.125$$

Answer 10

$$\text{(i) } \quad \frac{1}{2}$$

$$\text{(ii) } \quad \frac{1}{2}$$

$$\text{(iii) } \quad \frac{1}{4}$$

$$\text{(iv) } \quad \frac{1}{4}$$

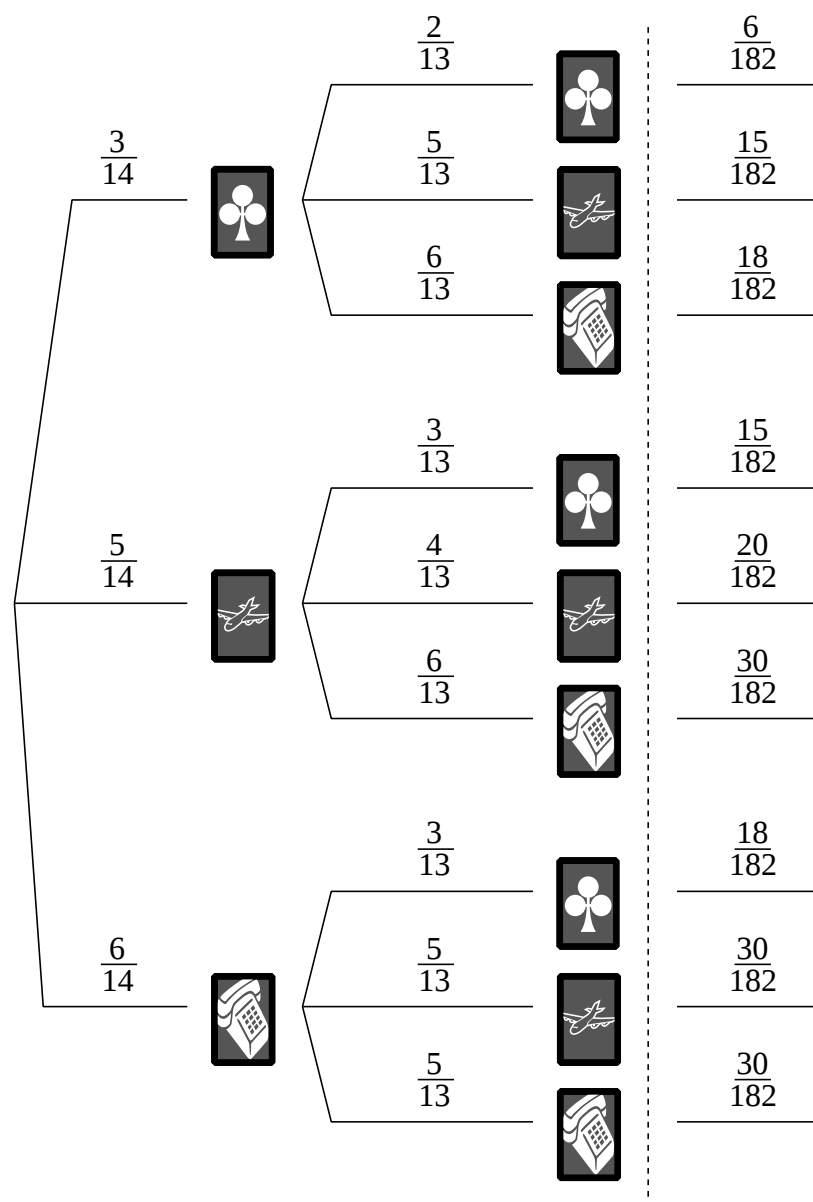
$$\text{(v) } \quad \frac{1}{8}$$

$$\text{(vi) } \quad \frac{1}{8}$$

$$\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \frac{1}{32} + \frac{1}{64} + \dots = 1$$

Answer 11

(i)



(ii) $\frac{56}{182}$ or $\frac{4}{13}$ or 0.308 or 31%

Answer 12

(i) $\frac{9}{25}$ (ii) $\frac{2}{25}$ (iii) $\frac{16}{25}$

Answer 13

21 vowels, 60 in total $\therefore \frac{441}{3600}$ or $\frac{49}{400}$ or 0.1225

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10.1 Experimental Probability

Our study of probability so far has been theoretical.

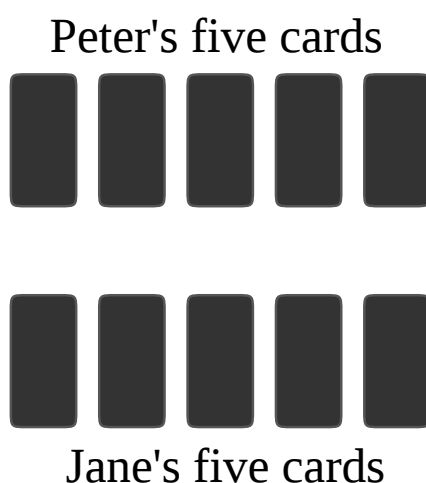
However, we can obtain probabilities by experimentation.

10.2 The “Snap Count” Experiment

Two people, Peter and Jane, sit on opposite sides of a table.

Each has five cards with the letters J, Z, E, H and K printed on their faces.

Each shuffles their five cards and places them in a row, face down, on the table.



They now turn their cards over and look to see how high the Snap Count is.
The diagram below shows a Snap Count of three.



You are now going to do this experiment 25 times and each time record the Snap Count in the following table.

Be sure to shuffle the cards thoroughly each time !

10.3 Table of Results

Snap Count	Tally	Frequency	Probability
0			
1			
2			
3			
4			
5			

- (i) What is the most probable Snap Count ?
- (ii) What is the least probable Snap Count ?
Explain why this answer is not a surprise.
- (iii) To get highly accurate probabilities out of this experiment what
should you do ?

10.4 Table for Whole Class Results

Snap Count	Whole Class Frequency	Probability
0		
1		
2		
3		
4		
5		

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11.1 Homework (Revision)

Question 1



One letter is chosen at random from the word R A C E C A R.

- (a) What is the probability that it is;
- (i) C
 - (ii) not E
 - (iii) Q
 - (iv) a vowel
- (b) This word reads the same when read
- from left to right
 - from right to left
- What is such a word called ?

Question 2

An icosahedral die is rolled.

Its twenty faces are numbered as would be expected.

i.e. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20.

- (a) What is the percentage probability that the number rolled is;
- (i) 13
 - (ii) > 14
 - (iii) prime
- (b) If this die were rolled 400 times, how many 9s are expected ?

Question 3

In a bag of "maths shapes" are

- 15 septagons
- 5 nonagons
- 5 triangles

(a) What is the percentage probability that a shape picked at random is a

(i) septagon

(ii) nonagon

(iii) not a triangle

(b) How many sides has a septagon ?

Question 4

A *biased* die rolls scores of 1, 2, 3, 4, 5, 6 with these percentage probabilities;

Score	1	2	3	4	5	6
Probability (%)	21%	24%	19%		11%	17 %

State the percentage probability that the score obtained is a

(i) 3

(ii) an odd number

(iii) 2 or 5

(iv) 4

(v) not 1

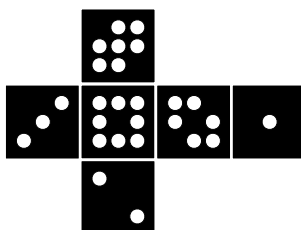
Question 5

The probability that it will rain tomorrow is 13.7%.

What is the percentage probability that it will not rain tomorrow ?

Question 6

The net of a *Lucky-Strike Dice*TM is shown :

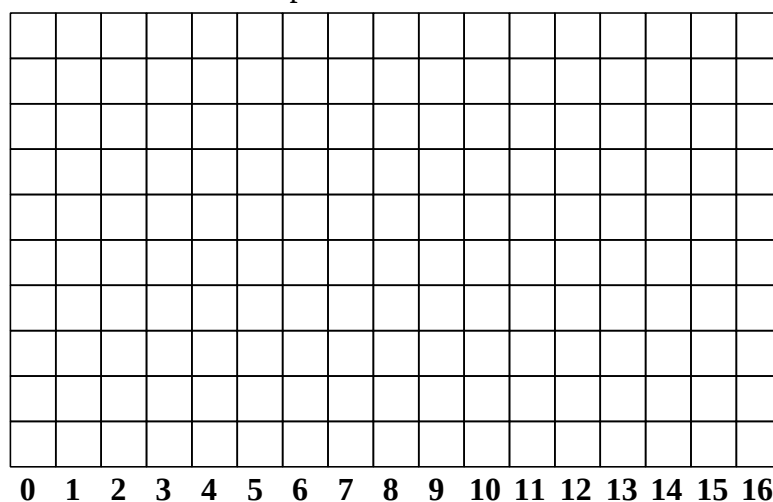


One orange and one blue *Lucky-Strike Dice*TM are rolled.
The pips showing are added together.

(a) Complete this possibility space diagram to show the thirty-six possible results.

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

(b) Plot a bar chart of the probabilities.



(c) (i) Which score occurs most often ?

(ii) Of the possible scores rolled, which are least likely ?

(iii) What is the probability of rolling an odd number ?

Question 7

Michael is trying to decide what to buy his mum for Mothers' day.

Unable to decide, he uses a tetrahedral (four faced) die.

The possibilities are;

- ◇ **Perfume**
- ◇ **Jewellery**
- ◇ **Flowers**
- ◇ **Chocolate**

However, he thinks the die may be *biased* (not fair) and so rolls it 40 times.

Here are the results with the Chocolate rolls missed out.

Jewellery	Jewellery	Perfume	Jewellery	Flowers
Jewellery	Perfume	Flowers	Jewellery	Flowers
Perfume	Jewellery	Perfume	Perfume	Jewellery
Flowers	Perfume	Jewellery	Perfume	Perfume
Jewellery	Perfume	Flowers	Jewellery	Perfume

Complete the following tables;

Table of the experiment's frequencies.

Roll	Perfume	Jewellery	Flowers	Chocolate
Frequency				

Table of the experiment's probabilities.

Roll	Perfume	Jewellery	Flowers	Chocolate
Probability (%)				

What can you say about this tetrahedral die ?

Question 8

In this question, don't cancel down any fractions.



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) **B and B**

HINT : B and B
and means *multiply*
 $p(B) \times p(B)$

(ii) **L and L**

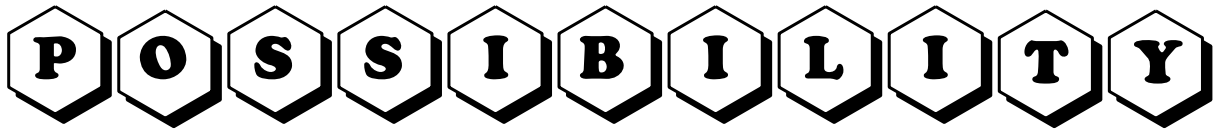
(iii) **O and O**

(iv) **D and D**

(iv) The same letter is picked twice.

HINT : B and B or L and L or O and O or D and D

Question 9



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) S first, *and* then T

(ii) S *and* T

(iii) I *and* I

(iv) vowel first, *and* then consonant

(v) vowel *and* consonant

(vi) two vowels

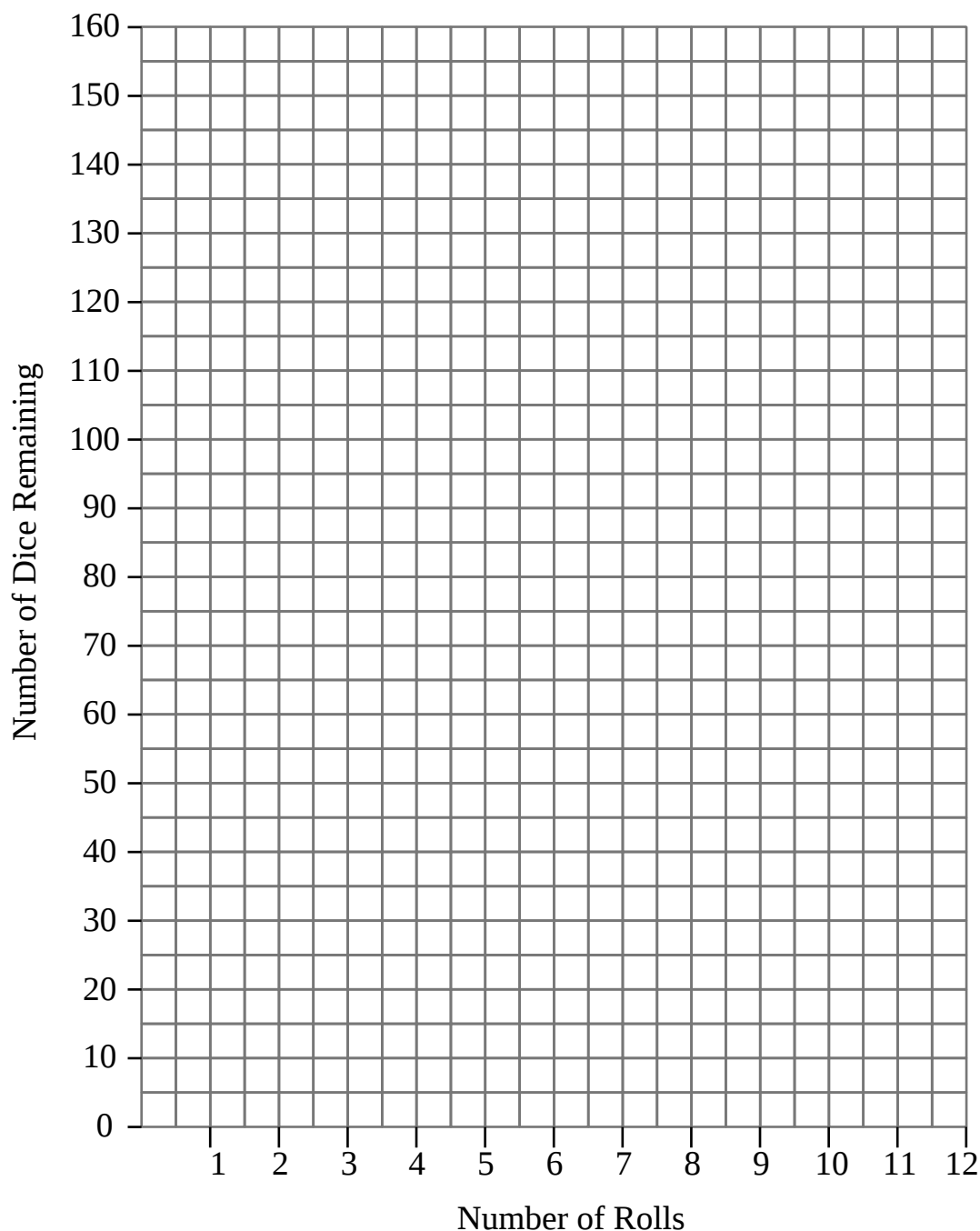
Question 10

Imagine that you've got 144 cubical (six-sided) dice.

You are going to roll them twelve times.

Each time you roll the dice, remove any that show a "6".

Plot a graph of the "Number of Dice Remaining" against the "Number of Rolls".



From your graph, after how many throws is the number of dice left less than half of what you started with ?

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11.2 Answers

11.2.1 Solutions (Homework Revision)

Answer 1

- (a) (i) $\frac{2}{7}$ (b) It's palindromic (A palindrome)
 (ii) $\frac{6}{7}$
 (iii) 0
 (iv) $\frac{3}{7}$

Answer 2

- (a) (i) $\frac{1}{20} = 5\%$ (b) 20
 (ii) $\frac{6}{20} = 30\%$
 (iii) $\frac{8}{20} = 40\%$

Answer 3

- (a) (i) 60% (b) 7
 (ii) 20%
 (iii) 80%

Answer 4

- (i) 19%
(ii) 51%
(iii) 35%
(iv) 8%
(v) 79%

Answer 5

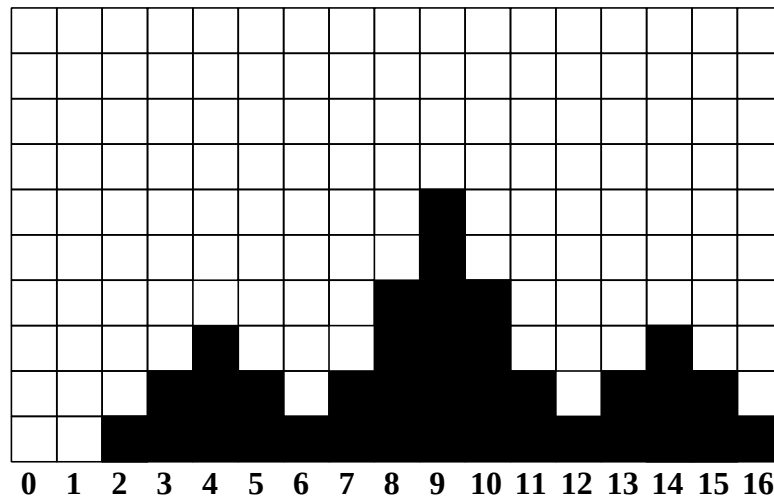
86.3%

Answer 6

(a)

						
	2	3	4	7	8	9
	3	4	5	8	9	10
	4	5	6	9	10	11
	7	8	9	12	13	14
	8	9	10	13	14	15
	9	10	11	14	15	16

(b)



Make a note that either each square represents a probability of $\frac{1}{36}$ on add numbers and labels to the y-axis

- (c) (i) 9
(ii) 2, 6, 12, 16
(iii) $\frac{18}{36}$ or $\frac{1}{2}$

Answer 7

Frequencies : 10 10 5 15
Probabilities ; 25% 25% 12.5% 37.5%

The die may be biased against rolling “flowers” and in favour of rolling “chocolate”.

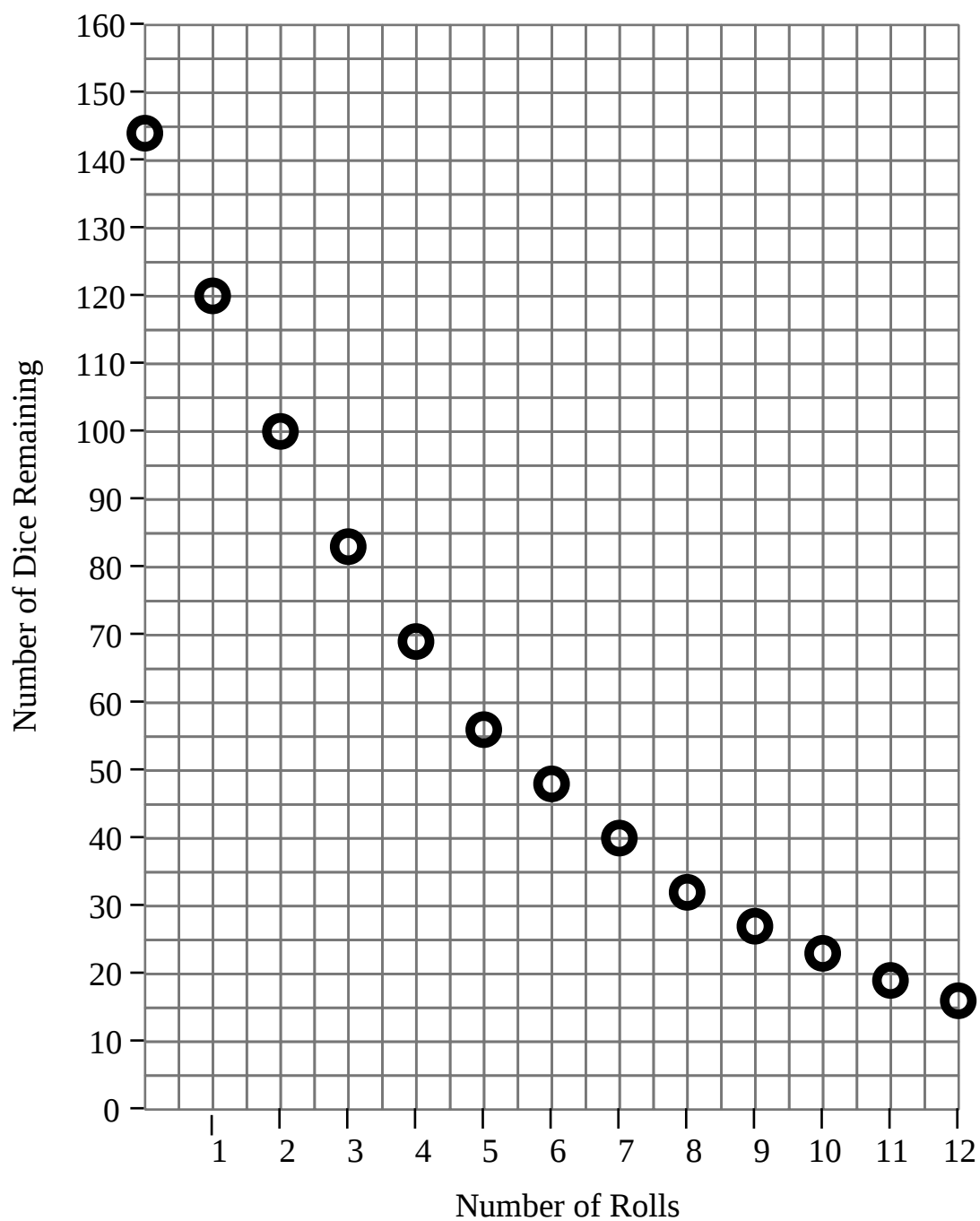
Answer 8

- (i) $\frac{1}{25}$
(ii) $\frac{1}{25}$
(iii) $\frac{4}{25}$
(iv) $\frac{1}{25}$
(v) $\frac{7}{25}$

Answer 9

- (i) $\frac{2}{121}$
(ii) $\frac{4}{121}$
(iii) $\frac{9}{121}$
(iv) $\frac{28}{121}$
(v) $\frac{56}{121}$
(vi) $\frac{16}{121}$

Answer 10



N° of Rolls	0	1	2	3	4	5	6	7	8	9	10	11	12
N° of Dice	144	120	100	69	57	48	40	33	28	23	19	16	13

To half takes about 3.8 throws. $\therefore$ After 4 throws

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12.1 Revision

Marks available: 50

Question 1



One letter is chosen at random from the word R E V I V E R.

(a) What is the probability that it is;

(i) R

(ii) not V

(iii) Z

(iv) a vowel

(b) This word reads the same when read

- from left to right
- from right to left

What is such a word called ?

[5 marks]

Question 2

A fair octahedral die, with faces numbered 1, 2, 3, 4, 5, 6, 7, 8, is rolled.

(a) What is;

(i) $p(3)$

(ii) $p(<4)$

(iii) $p(\text{prime})$

(b) If this die were rolled 200 times, how many 7s would you expect ?

[4 marks]

Question 3

In a bag of "maths shapes" are

- 5 hexagons
- 8 octagons
- 7 squares

(a) What is the percentage probability that a shape picked at random is a

(i) hexagon

(ii) octagon

(iii) square

(b) What should the three answers of part (a) add up to ?

[4 marks]

Question 4

A *biased* die rolls scores of 1, 2, 3, 4, 5, 6 with these percentage probabilities;

Score	1	2	3	4	5	6
Probability (%)	12%	28%		15%	17%	13 %

State the percentage probability that the score obtained is a

(i) 5

(ii) an even number

(iii) 2 or 5

(iv) 3

(v) not 2

[5 marks]

Question 5

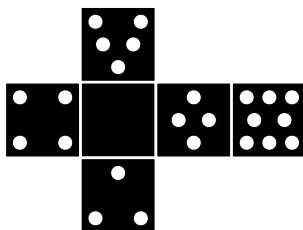
The probability that it will rain tomorrow is 24%.

What is the percentage probability that it will not rain tomorrow ?

[1 mark]

Question 6

The net of a *Racey Roller Dice*TM is shown :

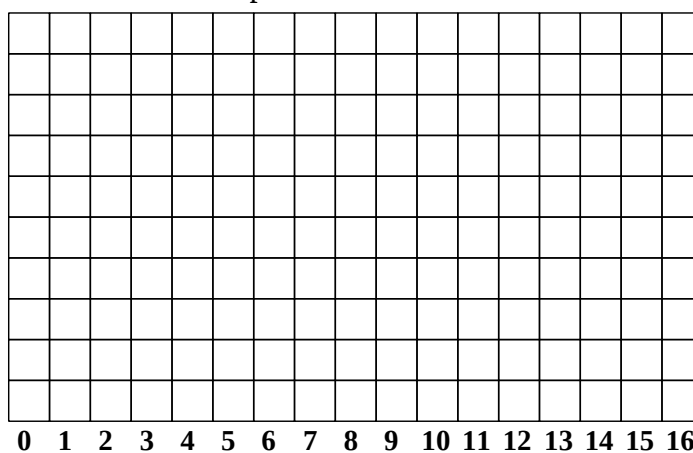


One red and one green *Racey Roller Dice*TM are rolled.

The pips showing are added together.

(a) Complete this possibility space diagram to show the thirty-six possible results.

(b) Plot a bar chart of the probabilities.



(c) (i) Which score occurs most often ?

(ii) Of the possible scores rolled, which are least likely ?

(iii) What is the probability of rolling an odd number ?

[5 marks]

Question 7

Each weekend Henry has used a tetrahedral (four faced) die to decide if he should;

- ◇ **Canoe**
- ◇ **Hillwalk**
- ◇ **Rock Climb**
- ◇ **Mountain Bike**

However, he thinks the die may be *biased* (not fair) and so rolls it 80 times.

Here are the results with the Mountain Bike rolls missed out.

Canoe	Rock	Rock	Hillwalk	Hillwalk
Rock	Canoe	Canoe	Rock	Hillwalk
Hillwalk	Canoe	Canoe	Hillwalk	Canoe
Canoe	Hillwalk	Rock	Canoe	Canoe
Hillwalk	Canoe	Rock	Canoe	Hillwalk
Canoe	Canoe	Canoe	Hillwalk	Hillwalk
Canoe	Hillwalk	Rock	Canoe	Canoe
Rock	Hillwalk	Hillwalk	Canoe	Hillwalk
Canoe	Hillwalk	Hillwalk	Canoe	

Complete the following tables;

Table of the experiment's frequencies.

Roll	Canoe	Hillwalk	Rock Climb	Mountain Bike
Frequency				

Table of the experiment's probabilities.

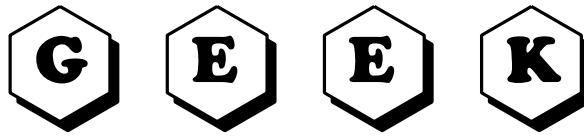
Roll	Canoe	Hillwalk	Rock Climb	Mountain Bike
Probability (%)				

What can you say about this tetrahedral die ?

[5 marks]

Question 8

In this question, don't cancel down any fractions.



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) **G and G**

HINT : *G and G*
and means *multiply*
 $p(G) \times p(G)$

(ii) **K and K**

(iii) **E and E**

(iv) The same letter is picked twice.

[5 marks]

Question 9



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) **M** first, *and* then **S**

(ii) **M** *and* **S**

(iii) **P** *and* **P**

(iv) vowel first, *and* then consonant

(v) vowel *and* consonant

(vi) two vowels

[6 marks]

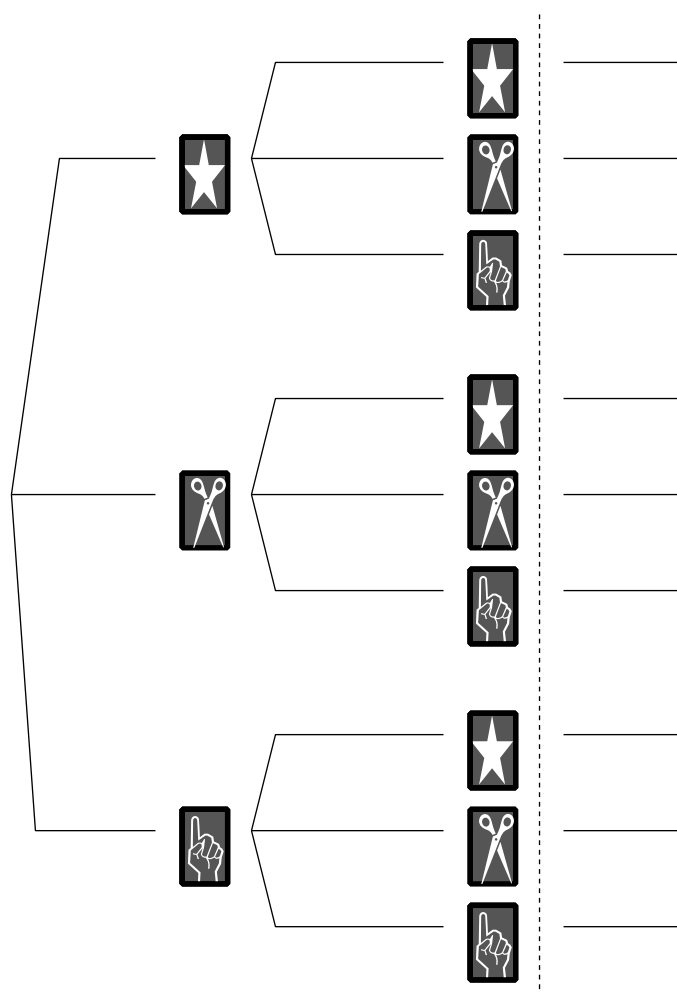
Question 10

A pack of children's "snap" playing cards are shown below.



The cards are shuffled and then first one is placed face up on the table, then a second.

(i) Complete this tree diagram to show all possible outcomes.



(ii) Use your tree diagram to determine the probability of a "snap".

[5 marks]

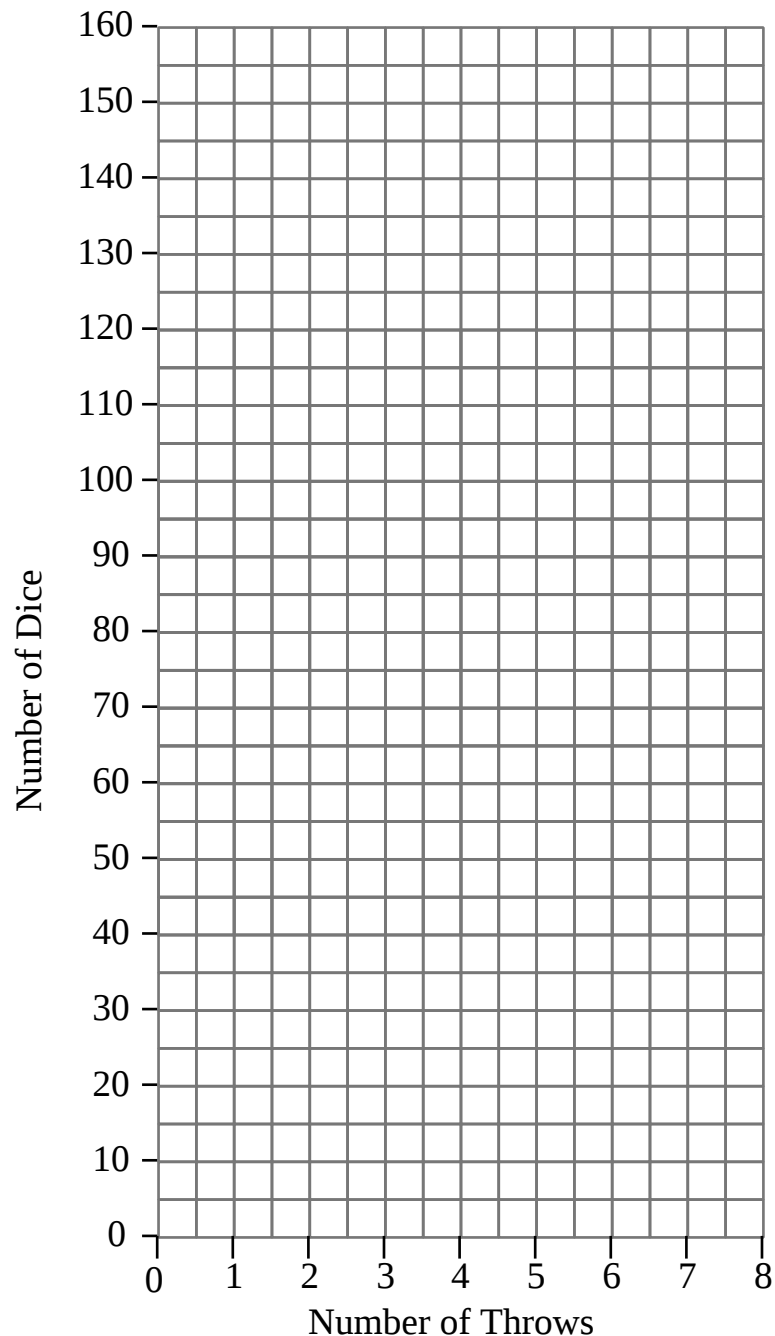
Question 11

Imagine that you've got 48 cubical (six-sided) dice.

You are going to roll them eight times.

Each time you roll all the dice, you add one die extra for every "6" that is showing.

Plot a graph of the "number of dice" against the "number of throws".



From your graph, after how many throws is the number of dice left more than double what you started with ?

[5 marks]

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12.2 Answers

GCSE Mathematics Probability

12.2.1 Solutions (12.1 Revision)

Answer 1

- (a)

(i)

$\frac{2}{7}$
- (b)

It's palindromic (A palindrome)
- (ii)

$\frac{5}{7}$
- (iii)

0
- (iv)

$\frac{3}{7}$

Answer 2

- (a)

(i)

$\frac{1}{8}$
- (b)

25
- (ii)

$\frac{3}{8}$
- (iii)

$\frac{4}{8}$ or $\frac{1}{2}$

Answer 3

- (a)

(i)

25%
- (b)

100%
- (ii)

40%
- (iii)

35%

Answer 4

- (i)

17%
- (ii)

56%
- (iii)

45%
- (iv)

15%
- (v)

72%

Answer 5

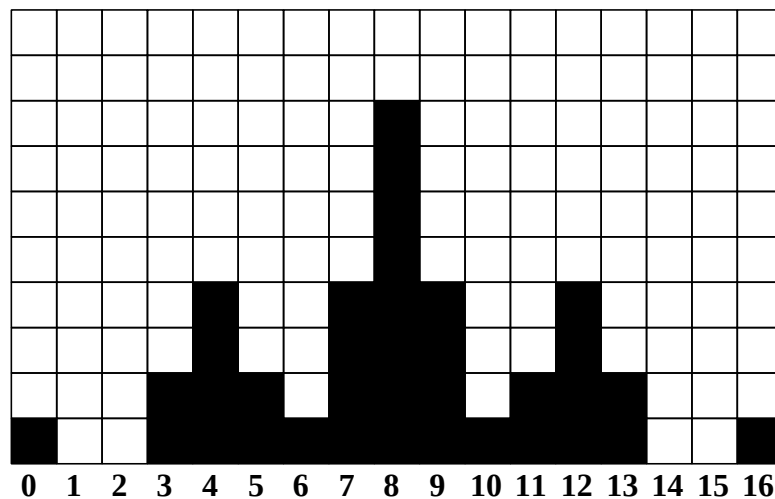
76%

Answer 6

(a)

						
	0	3	4	4	5	8
	3	6	7	7	8	11
	4	7	8	8	9	12
	4	7	8	8	9	12
	5	8	9	9	10	13
	8	11	12	12	13	16

(b)



Make a note that either each square represents a probability of $\frac{1}{36}$
on add numbers and labels to the y-axis

- (c) (i) 8
(ii) 0, 6, 10, 16
(iii) $\frac{16}{36}$ or $\frac{8}{18}$ or $\frac{4}{9}$

Answer 7

Frequencies : 20 16 8 36
Probabilities ; 25% 20% 10% 45%

The die does indeed seem to be biased.

Answer 8

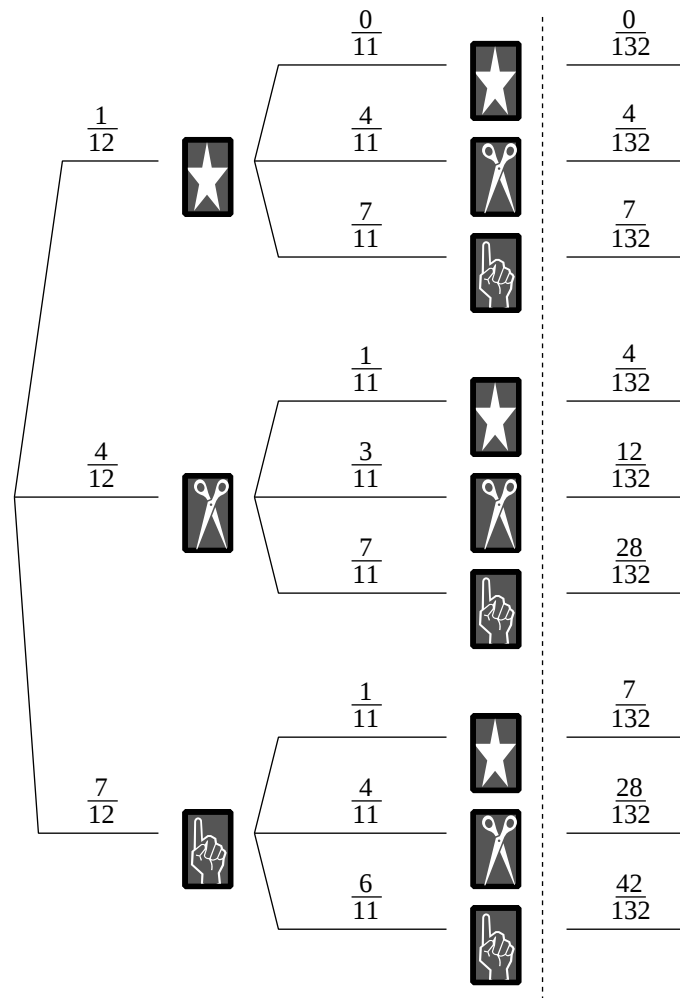
- (i) $\frac{1}{16}$
(ii) $\frac{1}{16}$
(iii) $\frac{4}{16}$
(iv) $\frac{6}{16}$ or $\frac{3}{8}$

Answer 9

- (i) $\frac{4}{121}$
(ii) $\frac{8}{121}$
(iii) $\frac{4}{121}$
(iv) $\frac{28}{121}$
(v) $\frac{56}{121}$
(vi) $\frac{16}{121}$

Answer 10

(i)

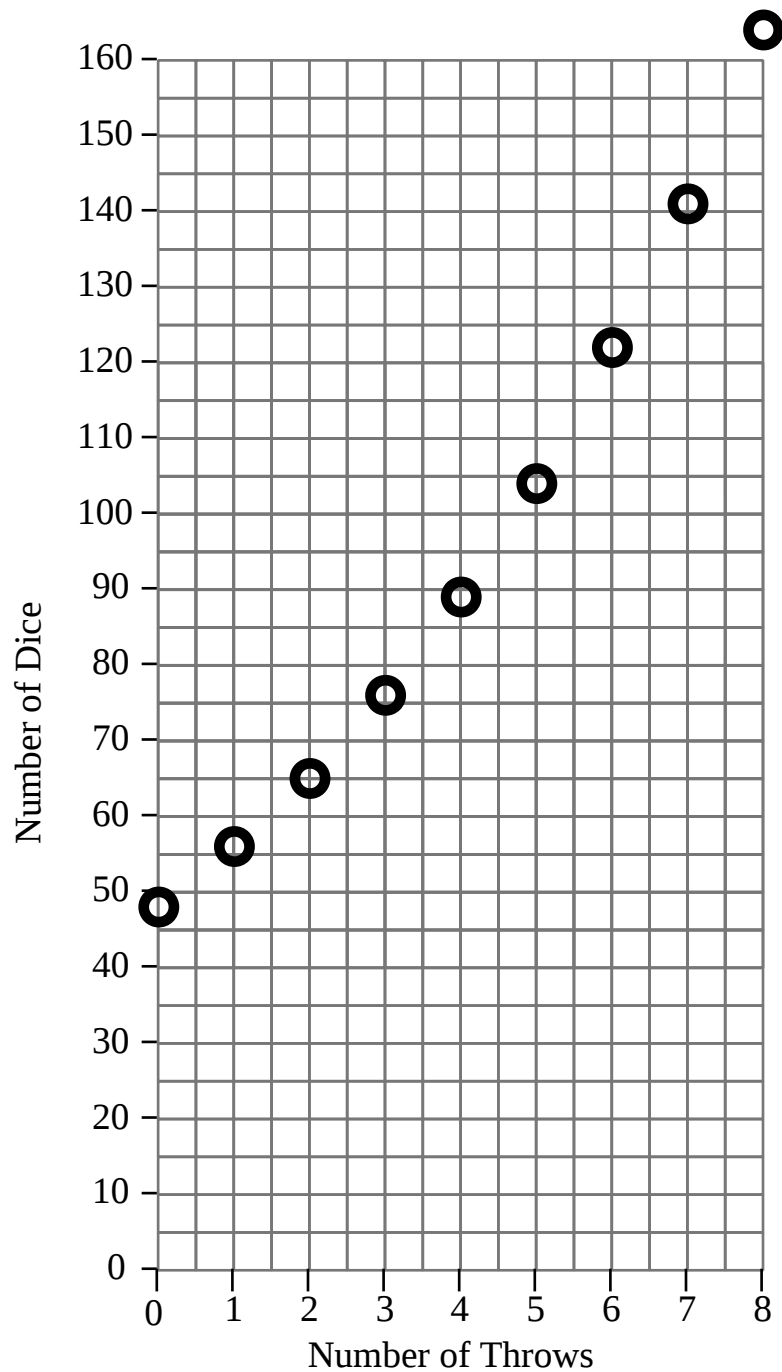


(ii)

$$\begin{aligned}
 p(\text{snap}) &= \frac{0}{132} + \frac{12}{132} + \frac{42}{132} \\
 &= \frac{54}{132}
 \end{aligned}$$

This is about 0.409, that is 41%

Answer 11



N° of Rolls	0	1	2	3	4	5	6	7	8
N° of Dice	48	56	65	76	89	104	121	141	165

To double takes about 4.5 throws. $\therefore$ After 5 throws

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13.1 Test

Marks Available : 50

Question 1



One letter is chosen at random from the word R O T A T O R.

- (a) What is the probability that it is;
- (i) A
 - (ii) not R
 - (iii) T
 - (iv) a consonant
- (b) This word reads the same when read
- from left to right
 - from right to left

What is such a word called ?

[5 marks]

Question 2



A decahedral die, with faces numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 is rolled.

- (a) What is the percentage probability that the number rolled is;
- (i) 3
 - (ii) ≥ 4
 - (iii) prime
- (b) If this die were rolled 400 times, how many 9s are expected ?

[4 marks]

Question 3

In a bag of "maths shapes" are

- 12 decagons
- 8 pentagons
- 4 squares

(a) What is the percentage probability that a shape picked at random is a

(i) decagon

(ii) pentagon

(iii) square

(b) What should the three part (a) answers add up to ?

[4 marks]

Question 4

A *biased* die rolls scores of 1, 2, 3, 4, 5, 6 with these percentage probabilities;

Score	1	2	3	4	5	6
Probability (%)	15%	25%		15%	17%	16 %

State the percentage probability that the score obtained is a

(i) 2

(ii) an even number

(iii) 2 or 5

(iv) 3

(v) not 2

[5 marks]

Question 5

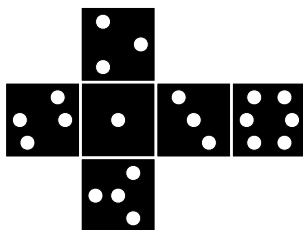
The probability that it will rain tomorrow is 28.6%.

What is the percentage probability that it will not rain tomorrow ?

[1 mark]

Question 6

The net of a *Lot-O-Luck Dice™* is shown :



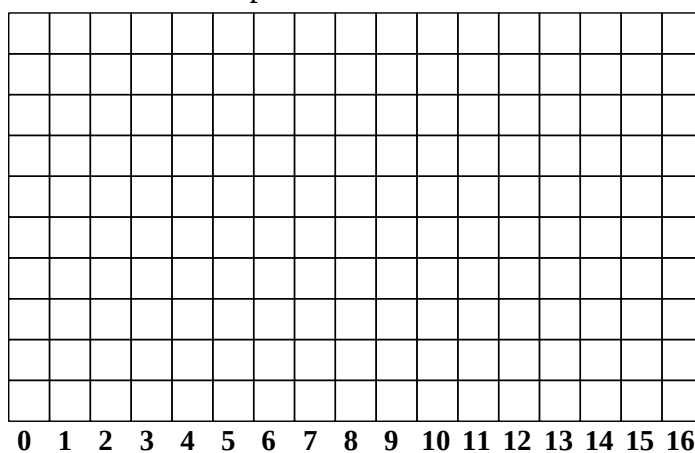
One pink and one green *Lot-O-Luck Dice™* are rolled.

The pips showing are added together.

(a) Complete this possibility space diagram to show the thirty-six possible results.

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

(b) Plot a bar chart of the probabilities.



(c) (i) Which score occurs most often ?

(ii) Of the possible scores rolled, which are least likely ?

(iii) What is the probability of rolling an even number ?

[5 marks]

Question 7

Every Friday evening Cedric uses a tetrahedral (four faced) die to decide if he should;

- ◇ Watch **TV**
- ◇ Go to **Bingo**
- ◇ Surf the **Web**
- ◇ Go night **Clubbing**

However, he thinks the die may be *biased* (not fair) and so rolls it 60 times.

Here are the results with the Clubbing rolls missed out.

TV	TV	TV	Bingo	TV
Bingo	Web	Bingo	TV	TV
TV	Bingo	TV	TV	Bingo
Web	TV	Web	TV	TV
TV	TV	Bingo	Bingo	Bingo
TV	Bingo	TV	TV	Bingo
Bingo	TV	Bingo	Bingo	TV
TV	TV	Bingo	TV	TV
TV	Bingo			

Complete the following tables;

Table of the experiment's frequencies.

Roll	TV	Bingo	Web	Clubbing
Frequency				

Table of the experiment's probabilities.

Roll	TV	Bingo	Web	Clubbing
Probability (%)				

What can you say about this tetrahedral die ?

[5 marks]

Question 8

In this question, don't cancel down any fractions.



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) *S and S*

HINT : *S and S*
and means *multiply*
 $p(S) \times p(S)$

(ii) *K and K*

(iii) *U and U*

(iv) *L and L*

(iv) The same letter is picked twice.

HINT : *S and S or K and K or U and U or L and L*

[5 marks]

Question 9



One letter is chosen at random from the letter tiles.

It is replaced.

Then a second letter is chosen at random.

Find the probability that the letters picked are;

(i) A first, *and* then T

(ii) A *and* T

(iii) E *and* E

(iv) vowel first, *and* then consonant

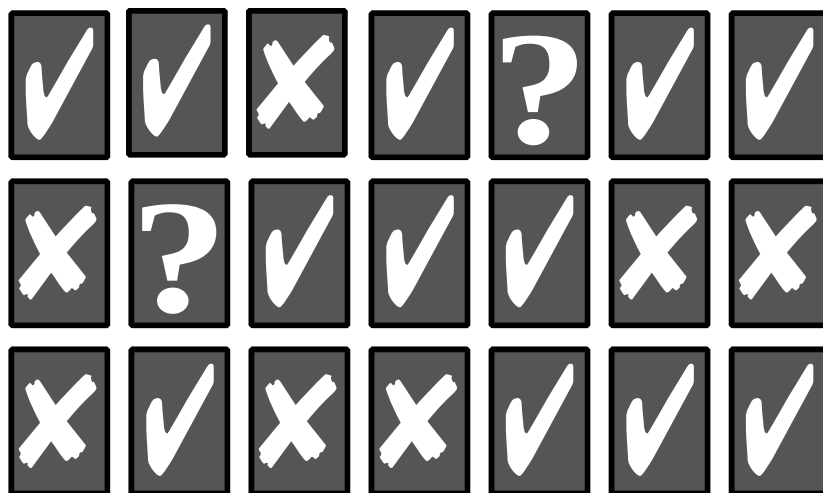
(v) vowel *and* consonant

(vi) two vowels

[6 marks]

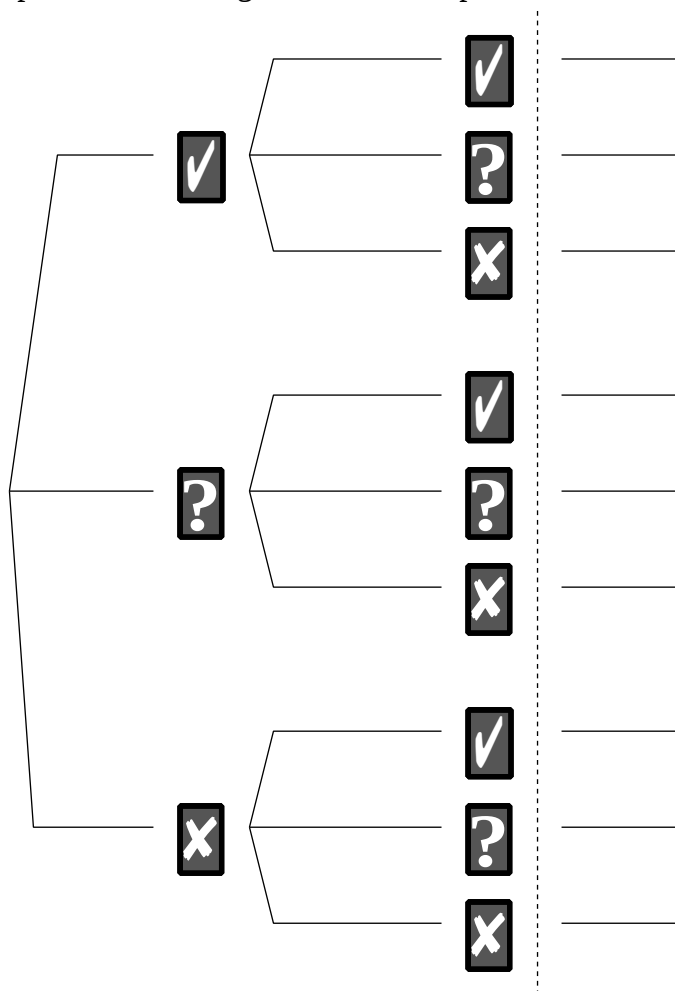
Question 10

A pack of children's "snap" playing cards is shown below.



The cards are shuffled and then first one is placed face up on the table, then a second.

(i) Complete this tree diagram to show all possible outcomes.



(ii) Use your tree diagram to determine the probability of a "snap".

[5 marks]

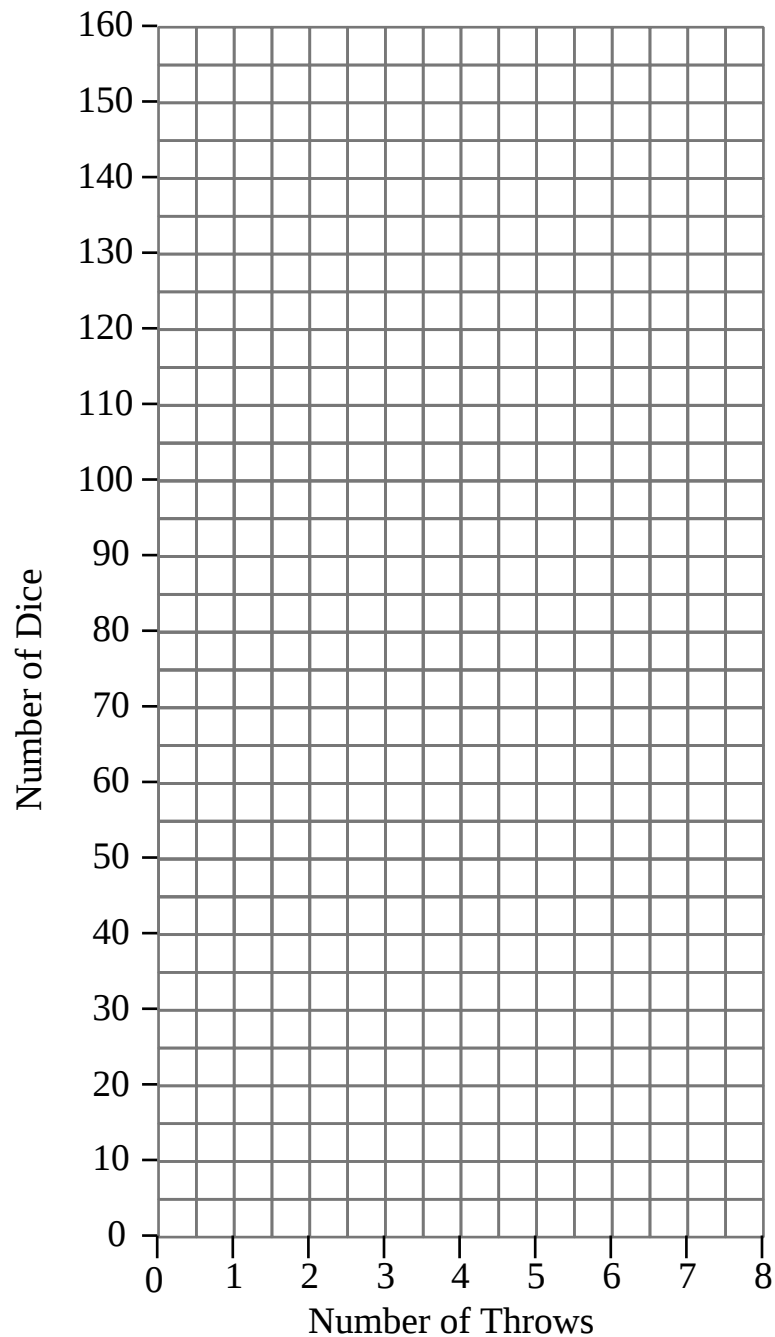
Question 11

Imagine that you've got 160 octagonal (eight-sided) dice.

You are going to roll them eight times.

Each time you roll the dice, remove any that show an "8".

(i) Plot a graph of the "Number of Dice" against the "Number of Throws".



(ii) From your graph, after how many throws is the number of dice left less than half of what you started with ?

[5 marks]

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13.2 Answers

13.2.1 Solutions (13.1 Test)

Answer 1

- (a) (i) $\frac{1}{7}$ (b) It's palindromic (A palindrome)
 (ii) $\frac{5}{7}$
 (iii) $\frac{2}{7}$
 (iv) $\frac{4}{7}$

Answer 2

- (a) (i) 10% (b) 40
 (ii) 70%
 (iii) 40%

Answer 3

- (a) (i) 50% (b) 100%
 (ii) $33\frac{1}{3}\%$
 (iii) $16\frac{2}{3}\%$

Answer 4

- (i) 25%
(ii) 56%
(iii) 42%
(iv) 12%
(v) 75%

Answer 5

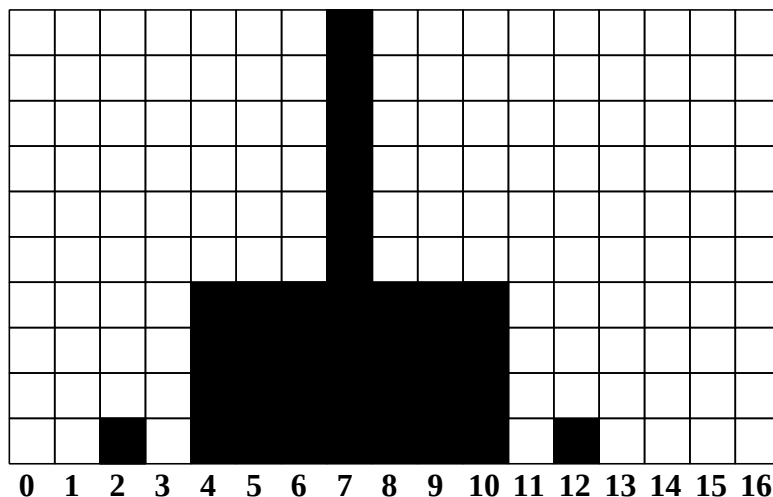
71.4%

Answer 6

(a)

						
	2	4	4	5	5	7
	4	6	6	7	7	9
	4	6	6	7	7	9
	5	7	7	8	8	10
	5	7	7	8	8	10
	7	9	9	10	10	12

(b)



Make a note that either each square represents a probability of $\frac{1}{36}$
on add numbers and labels to the y-axis

- (c) (i) 7
(ii) 2, 12
(iii) $\frac{18}{36}$ or $\frac{1}{2}$

Answer 7

Frequencies : 24 15 3 18
Probabilities ; 40% 25% 5% 30%

The dice may be biased against “web” and in favour of “TV”

Answer 8

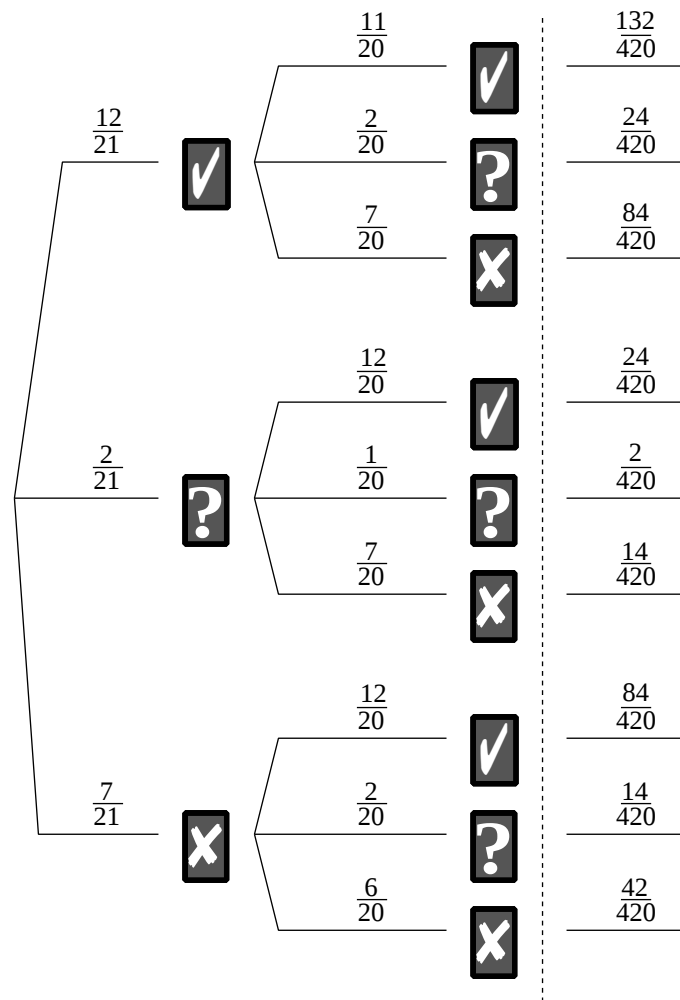
- (i) $\frac{1}{25}$
(ii) $\frac{1}{25}$
(iii) $\frac{1}{25}$
(iv) $\frac{4}{25}$
(v) $\frac{7}{25}$

Answer 9

- (i) $\frac{3}{121}$
(ii) $\frac{6}{121}$
(iii) $\frac{1}{121}$
(iv) $\frac{30}{121}$
(v) $\frac{60}{121}$
(vi) $\frac{25}{121}$

Answer 10

(i)

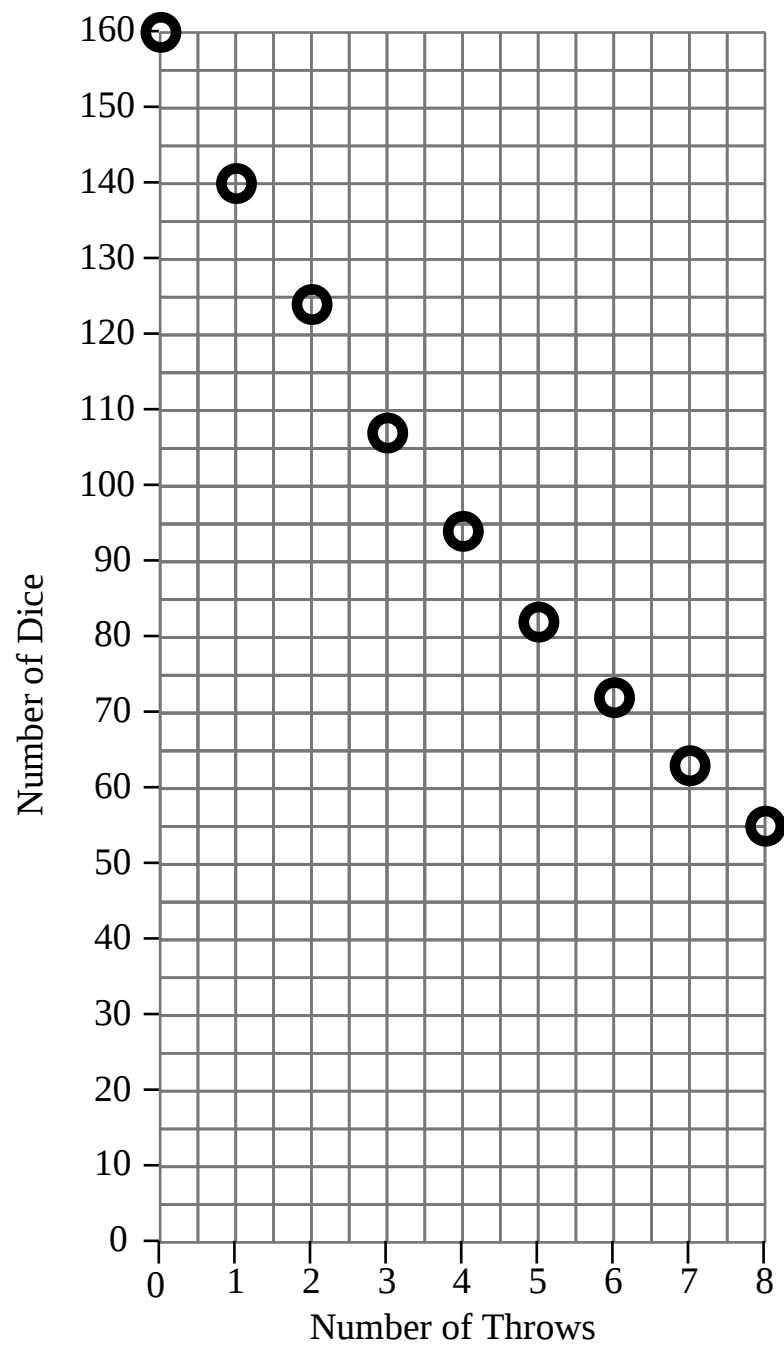


(ii)

$$\begin{aligned}
 p(\text{snap}) &= \frac{132}{420} + \frac{2}{420} + \frac{42}{420} \\
 &= \frac{176}{420}
 \end{aligned}$$

This is about 0.419, that is 42%

Answer 11



N° of Rolls	0	1	2	3	4	5	6	7	8
N° of Dice	160	140	123	107	94	82	72	63	55

To half takes about 5.2 throws. $\therefore$ After 6 throws.

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