



eClassroom

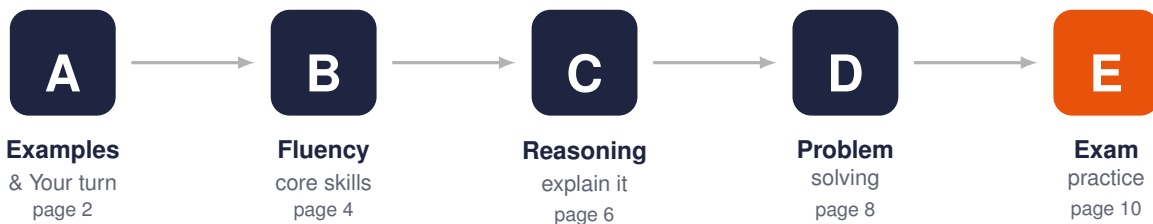
GCSE MATHEMATICS • PROBABILITY

Relative Frequency

Worksheet

Pearson Edexcel GCSE (1MA1) & International GCSE (4MA1) • Calculator allowed

Free Relative Frequency worksheet for GCSE and iGCSE Maths, with full worked solutions



Tap a section to jump straight to it

By the end of this worksheet you can: work out relative frequencies and use them to estimate probabilities • find expected frequencies • complete and use frequency trees • decide whether something is fair, and explain why more trials are better • *Higher:* expected profit, working backwards, and probabilities from frequency trees.

Which questions are for me?

FOUNDATION Everyone starts here. These skills appear on both tiers.

HIGHER The same skills where Higher papers use them: expected profit, working backwards, probabilities from frequency trees, and equations. Grades 6 to 9.

Every section has both, clearly labelled. Questions get harder as you go, and every skill in Sections A to D is needed in Section E.

Track your progress

Section	B	C	D	E
Foundation marks	23	10	13	16
Higher marks	16	14	16	15
My score				

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A

Worked examples & Your turn

Read each example carefully. Cover it up, then answer the question beside it using the same method.

FOUNDATION

Everyone starts here

Worked example A1

A spinner is spun 80 times. It lands on red 28 times. Work out the relative frequency of red.

Relative frequency = frequency $\div$ number of trials

$$28 \div 80 = 0.35$$

0.35

Your turn A1

A coin is thrown 120 times. It lands on heads 51 times. Work out the relative frequency of heads.

Worked example A2

A fair dice is rolled 90 times. How many sixes would you expect?

Expected frequency = probability $\times$ number of trials

$$\frac{1}{6} \times 90 = 15$$

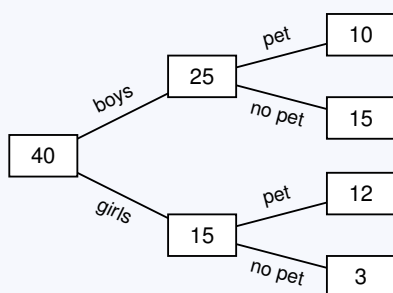
15

Your turn A2

The relative frequency of red on a spinner is 0.35. It is spun 400 times. Estimate the number of reds.

Worked example A3

40 students: 25 boys and 15 girls. 10 of the boys and 12 of the girls have a pet. A student is picked at random. Find $P(\text{girl with no pet})$.

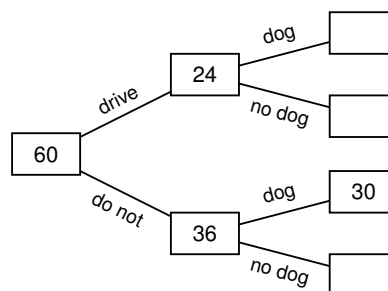


Fill each branch by subtracting: $15 - 12 = 3$

$\frac{3}{40}$

Your turn A3

60 adults: 24 drive and 36 do not. 30 of the adults who do not drive own a dog. An adult is picked at random. Find $P(\text{does not drive and has no dog})$.



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HIGHER*Higher strategies: these are new ways of thinking, not longer sums***Worked example A4: expected profit**

A game costs £1 to play. The probability of winning £4 is 0.2. It is played 100 times. Work out the expected profit for the organiser.

Money in – expected prizes paid out

In: £100 Out: $0.2 \times 100 \times 4 = £80$

£20

Your turn A4

A game costs 50p to play. The probability of winning £3 is 0.1. It is played 300 times. Work out the expected profit for the organiser.

Worked example A5: working backwards to a count

Counters are taken from a bag and replaced. The relative frequency of red is 0.25. There are 18 counters that are not red. Estimate the number of red counters.

Not red is 0.75 of the bag, and that is 18

Total = $18 \div 0.75 = 24$ $24 - 18 = 6$

6

Your turn A5

A bag holds only red and blue counters. The relative frequency of blue is 0.4. There are 15 red counters. Estimate the number of blue counters.

Worked example A6: probability from a frequency tree

1000 people are tested. 2% have a condition. The test is positive for 95% of them and for 10% of the others. A person tests positive. Find the probability that they have the condition.

Positive: 19 with it and 98 without, 117 in all

$$\frac{19}{117}$$

Your turn A6

500 emails arrive. 20% are spam. A filter flags 90% of spam and 5% of other emails. An email is flagged. Find the probability that it is spam.

Worked example A7: is it biased?

A dice is rolled 300 times and lands on 6 81 times. Is it likely to be fair?

Fair: expect $\frac{1}{6} \times 300 = 50$ sixes. 81 is far more, with many trials.

probably biased

Your turn A7

A coin is thrown 500 times and lands on heads 262 times. Is it likely to be fair?



B**Fluency**

Each question is a designed sequence. From one part to the next, ask yourself: what changed, and what did it do to the answer?

FOUNDATION

Everyone starts here

- B1** A spinner is spun 50 times. It lands on red 20 times, blue 15 times, green 10 times and yellow 5 times. Work out the relative frequency of

(a) red (b) blue (c) green (d) yellow

[4 marks]

- B2** Work out the expected number of times the event happens.

(a) probability 0.3, 200 trials

(b) probability $\frac{1}{8}$, 200 trials

(c) probability 0.3, 50 trials

(d) probability 0.004, 2500 trials

[4 marks]

- B3** A dice is rolled 60 times and lands on 6 12 times.

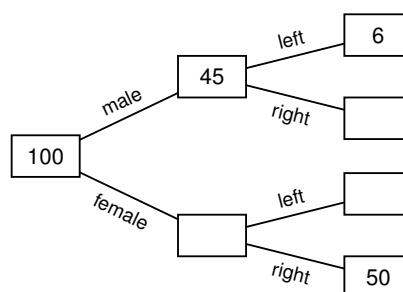
(a) Work out the relative frequency of a 6 (b) Estimate the number of 6s in 450 rolls.

(c) Work out the relative frequency of **not** a 6 (d) Estimate the number of rolls that are not a 6 in 450 rolls.

[4 marks]

- B4** 100 people are asked whether they are left-handed.

- (a) How many are female?
 (b) How many males are right-handed?
 (c) How many females are left-handed?
 (d) How many people are left-handed altogether?



[4 marks]



FOUNDATION *continued: estimates and trials*

B5 Three people each throw the same coin. Work out each relative frequency of heads.

(a) Amy: 7 heads in 10 throws

(b) Ben: 46 heads in 100 throws

(c) Cal: 508 heads in 1000 throws

[3 marks]

B6 Four students spin the same spinner.

Ann: 6 reds in 20 spins Ben: 16 reds in 50 spins

Cat: 11 reds in 30 spins Dev: 29 reds in 100 spins

(a) Find the total number of reds. (b) Find the total number of spins.

(c) Work out the best estimate of $P(\text{red})$. (d) Estimate the number of reds in 1000 spins. [4 marks]

HIGHER *Higher tier only*

B7 A game costs 50p to play and is played 200 times. The probability of winning £2 is 0.2

(a) How much money is paid to play? (b) Work out the expected amount paid out in prizes.

(c) Work out the expected profit. (d) What prize, instead of £2, would give an expected profit of £0?

[4 marks]

B8 (a) In 150 trials, 45 reds are expected. What is $P(\text{red})$?

(b) The relative frequency of an event is 0.2. How many trials are needed to expect it 30 times?

(c) The relative frequency of red is 0.4, and 12 counters are not red. Estimate the number of red counters.

(d) The relative frequency of blue is 0.45, and 22 counters are not blue. Estimate the number of blue counters. [4 marks]

B9 400 people are surveyed. 25% own a dog. 60% of dog owners and 20% of the others walk every day.

(a) How many dog owners walk every day? (b) How many people without a dog walk every day?

(c) Find the probability that a person walks every day. (d) A person walks every day. Find the probability they own a dog. [4 marks]

B10 If each item is fair, how many times would you expect

(a) heads in 200 throws of a coin

(b) a 6 in 300 rolls of a dice

(c) a 3 in 480 spins of a 4-sided spinner

(d) a number less than 4 in 250 rolls of a 10-sided dice

[4 marks]



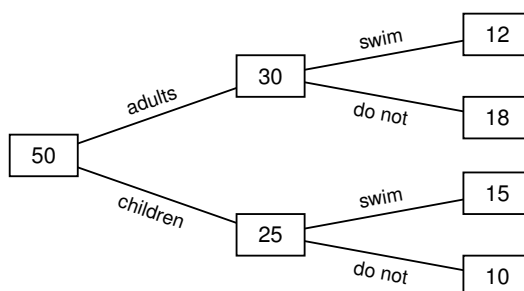
C**Reasoning**

Show your working and explain your thinking. A correct answer without a reason does not score full marks.

FOUNDATION

Everyone starts here

- C1** Ben throws a coin 10 times. It lands on heads 7 times.
Ben says, "The coin must be biased." Explain why Ben cannot be sure. [2 marks]
- C2** Amy says, "A dice is fair, so if I roll it 60 times I will get exactly ten 6s."
Is Amy correct? Explain your answer. [2 marks]
- C3** Kim draws this frequency tree for 50 people.



- (a) Explain why Kim's tree must be wrong.
- (b) The numbers of adults and of children who swim are correct. How many children are there? [3 marks]
- C4** Stuart throws a coin 10 times and gets 7 heads. Maxine throws the same coin 50 times and gets 30 heads.
Sam says, "Using all the results, the best estimate of $P(\text{heads})$ is 0.65, halfway between 0.7 and 0.6"
Show that Sam is wrong, and find the best estimate. [3 marks]



HIGHER*Higher tier only*

- C5** A game costs £1 to play. The probability of winning £5 is 0.18
Is it worth playing the game many times? Give a reason using the expected amount won per game. [3 marks]
- C6** Spinner A lands on red 10 times in 40 spins. Spinner B lands on red 300 times in 1000 spins.
Jo says, "Spinner B is more likely to land on red than spinner A."
Explain why Jo cannot be sure, and say which estimate is more reliable. [3 marks]
- C7** A spinner has $P(\text{red}) = r$. It is spun n times.
The expected number of results that are **not** red is 3 times the expected number of reds. Show that $r = \frac{1}{4}$ [3 marks]
- C8** A condition affects a fraction p of people. A test is positive for 90% of people with the condition, and for 10% of people without it.
- (a) Show that the probability that a person who tests positive has the condition is $\frac{9p}{8p+1}$
- (b) Find the value of p for which this probability is $\frac{1}{2}$ [5 marks]



D**Problem solving**

You decide the method. Read the whole question first, and show every step.

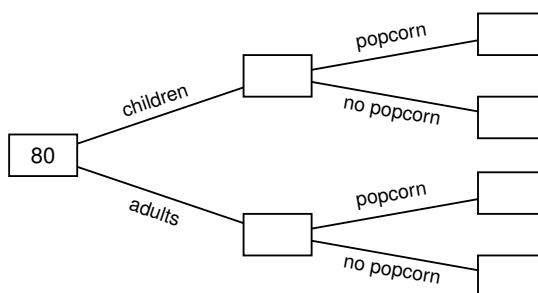
FOUNDATION

Everyone starts here

- D1** Over 40 school days, a bus was late on 6 days.

There are 190 days in a school year. Estimate the number of days in a school year that the bus will be late. [3 marks]

- D2** 80 people go to the cinema. 30 are children. 18 of the children and 20 of the adults buy popcorn.



Complete the frequency tree. A person is picked at random. Find the probability that it is an adult who did not buy popcorn. [4 marks]

- D3** A factory estimates that the relative frequency of a faulty light bulb is 0.02

How many bulbs should it expect to test to find 15 faulty bulbs? [3 marks]

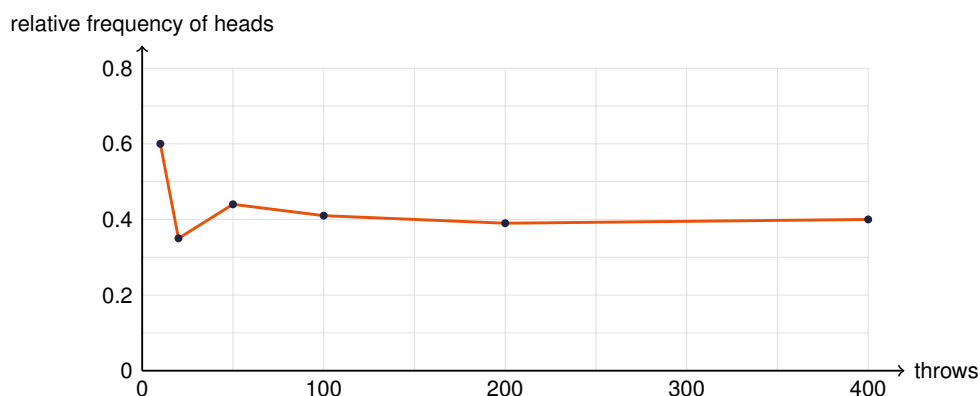
- D4** Spinner A lands on red 18 times in 60 spins. Spinner B lands on red 27 times in 100 spins.

Which spinner is more likely to land on red? You must show your working. [3 marks]



HIGHER*Higher tier only*

- D5** Leo throws a coin and works out the relative frequency of heads after different numbers of throws.



- (a) Write down the best estimate of $P(\text{heads})$. (b) Estimate the number of heads in 250 throws.

- (c) Is the coin fair? Give a reason for your answer. [4 marks]

- D6** A factory tests 400 bulbs and finds 14 faulty. It makes 25 000 bulbs a week. Each faulty bulb costs £2.40 to replace.

Estimate the weekly cost of replacing faulty bulbs. [3 marks]

- D7** A four-sided spinner has $P(1) = 0.3$ and $P(2) = 0.2$. $P(3) = P(4)$

- (a) The spinner is spun 500 times. Work out the expected number of 4s.

- (b) How many spins would give an expected 150 threes? [4 marks]

- D8** A stall charges £ c to play a game. The prize is £($c + 4$) and the probability of winning is $\frac{c}{20}$

The stall expects to make £2.40 profit per game, on average. The probability of winning is less than $\frac{1}{2}$

Find the value of c [5 marks]



E**Exam practice**

Exam-style questions. Write your answers in the spaces. Aim for about one minute per mark.

FOUNDATION

Foundation and Higher crossover

E1 Jen spins a spinner 50 times. The table shows her results.

Colour	red	blue	green	yellow
Frequency	18	12	15	5

(a) Work out the relative frequency of green.

.....

(1)

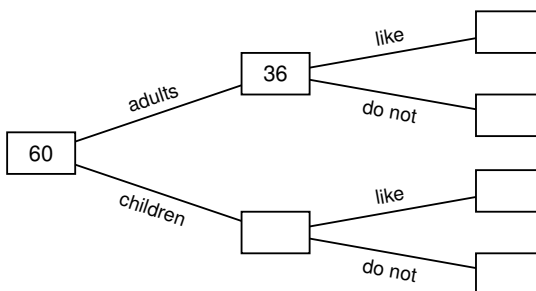
(b) Jen spins the spinner 400 times. Estimate the number of times it lands on red.

.....

(2)

(Total for Question E1 is 3 marks)

E2 60 people were asked if they like jazz. 36 are adults. 22 of the adults and 18 of the children like jazz.



(a) Complete the frequency tree.

(2)

(b) A person is picked at random. Find the probability that it is a child who likes jazz.

.....

(1)

(Total for Question E2 is 3 marks)



- E3** Ali rolls a dice 20 times and gets 7 sixes. Ben rolls the same dice 300 times and gets 52 sixes. Whose results give the better estimate of the probability of a six? Give a reason.

(Total for Question E3 is 2 marks)

- E4** A fair dice is rolled 150 times.

(a) How many sixes would you expect?

.....
(1)

(b) Kay rolls a different dice 150 times and gets 41 sixes. What does this suggest about Kay's dice?

(1)

(Total for Question E4 is 2 marks)

- E5** A biased spinner is spun 250 times. The relative frequency of the spinner landing on 1 is 0.28

(a) How many times did the spinner land on 1?

.....
(2)

(b) Jo says, "The probability of landing on 1 is exactly 0.28" Explain why Jo is wrong.

(1)

(Total for Question E5 is 3 marks)

- E6** A team plays matches. $P(\text{win}) = 0.35$ and $P(\text{lose}) = 0.4$. A match can also be drawn. The team plays 60 matches. Work out the expected number of draws.

.....
(Total for Question E6 is 3 marks)



HIGHER*Higher tier only*

- E7** 40 fish in a lake are caught, tagged and released. Later, 50 fish are caught and 8 of them are tagged. Estimate the number of fish in the lake.

.....
(Total for Question E7 is 3 marks)

- E8** A spinner is spun 200 times. The table shows the frequencies.

Number	1	2	3	4
Frequency	$2x$	$3x + 5$	x	45

The spinner is spun 750 more times. Estimate the number of times it lands on 2

.....
(Total for Question E8 is 4 marks)

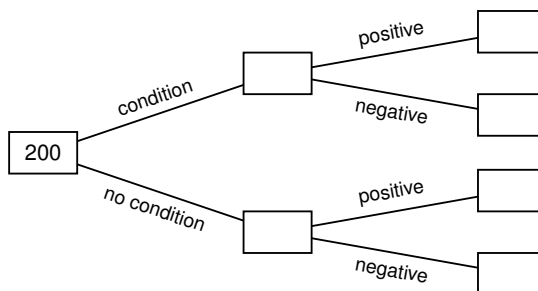
- E9** Counters are taken from a bag and replaced. In 80 picks, 32 are red. The bag holds only red counters and 12 blue counters.

Estimate the number of red counters in the bag.

.....
(Total for Question E9 is 3 marks)



- E10** 200 people are tested for a condition. 10% of them have the condition. The test is positive for 90% of the people with the condition, and for 5% of the people without it.



- (a) Complete the frequency tree.

(2)

- (b) A person tests positive. Find the probability that they have the condition.

.....

(2)

- (c) Explain why a positive result does not mean a person is very likely to have the condition.

(1)

(Total for Question E10 is 5 marks)

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