



eClassroom

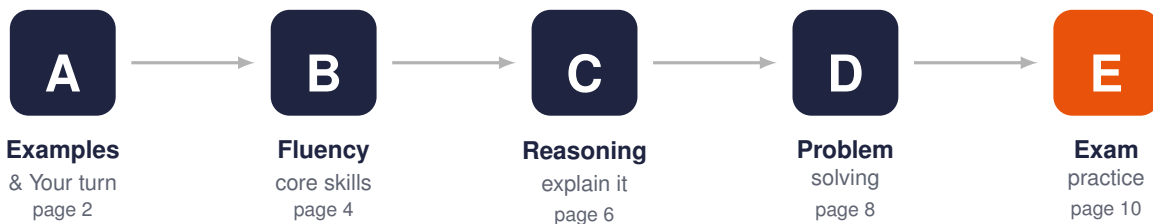
GCSE MATHEMATICS • RATIO & PROPORTION

Growth & Decay

Worksheet

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

Free Growth and Decay 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 compound interest and depreciation with a multiplier • compare simple and compound interest • find how many years it takes to reach a target • *Higher:* work back to the original amount, find the rate of growth, use iteration, and find a and b in $y = ab^x$

Which questions are for me?

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

HIGHER Higher only: working back to the original, finding the rate, iteration, and exponential functions $y = ab^x$. 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	14	18
Higher marks	16	13	16	14
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**

£3000 is invested for 2 years at 4% per year compound interest. Work out the value after 2 years.

Increase by 4% means multiply by 1.04, once for each year.

$$3000 \times 1.04^2 = 3244.8$$

£3244.80

Your turn A1

£2500 is invested for 3 years at 3% per year compound interest. Work out the value after 3 years.

Worked example A2

A van costs £20 000. Its value falls by 12% each year. Work out its value after 3 years.

A decrease of 12% leaves 88%: the multiplier is 0.88

$$20\,000 \times 0.88^3 = 13\,629.44$$

£13 629.44

Your turn A2

A bike costs £800. Its value falls by 15% each year. Work out its value after 2 years.

Worked example A3

A town has 5000 people. The population grows by 8% each year. After how many years will it first be more than 7000?

Multiply by 1.08 each year and stop when you pass 7000

$$4 \text{ years: } 5000 \times 1.08^4 = 6802.4\dots$$

$$5 \text{ years: } 5000 \times 1.08^5 = 7346.6\dots$$

5 years

Your turn A3

A painting is worth £9000. Its value falls by 10% each year. After how many years will it first be worth less than £6000?



HIGHER*Higher only: working backwards, rates, iteration and exponential functions***Worked example A4: working back to the original**

After 2 years of 5% compound interest, an account holds £4410. How much was invested?

Forwards is $\times 1.05^2$, so backwards is $\div 1.05^2$

$$4410 \div 1.05^2 = 4410 \div 1.1025$$

£4000

Your turn A4

After 3 years of losing 10% of its value each year, a machine is worth £2187. What was it worth at the start?

Worked example A5: finding the rate

£5000 grows to £5832 in 2 years at a fixed compound rate. Find the rate.

Overall multiplier, then undo the square.

$$5832 \div 5000 = 1.1664 \quad \sqrt{1.1664} = 1.08$$

8% per year

Your turn A5

A car's value falls from £8000 to £4096 in 3 years, by the same percentage each year. Find the percentage.

Worked example A6: iteration

$$u_{n+1} = 1.1u_n + 50 \text{ and } u_0 = 200$$

Work out u_2

Put each answer back into the formula.

$$u_1 = 1.1 \times 200 + 50 = 270$$

$$u_2 = 1.1 \times 270 + 50 = 347$$

$u_2 = 347$

Your turn A6

$$u_{n+1} = 0.9u_n + 30 \text{ and } u_0 = 500$$

Work out u_3

Worked example A7: finding a and b in $y = ab^x$

$y = ab^x$ passes through (1, 6) and (3, 54), with $b > 0$. Find a and b .

Divide the equations to remove a .

$$\frac{ab^3}{ab} = \frac{54}{6}, \text{ so } b^2 = 9 \text{ and } b = 3 \quad 6 = 3a$$

$a = 2, b = 3$

Your turn A7

$y = ab^x$ passes through (2, 48) and (4, 12), with $b > 0$. Find a and b .



FOUNDATION continued: halving

B6 (*non-calculator*) A radioactive substance loses half of its mass every 5 years. There are 640 g now.

- (a) What mass is left after 5 years? (b) What mass is left after 15 years?
(c) What mass is left after 30 years? (d) After how many years will 5 g be left? [4 marks]

HIGHER Higher tier only

B7 Work out the original amount.

- (a) 605 after 2 years of 10% growth (b) 486 after 2 years of 10% decay
(c) 1728 after 3 years of 20% growth (d) 50 after 4 years of 50% decay [4 marks]

B8 Each value changes by the same percentage each year. Work out the annual percentage change.

- (a) 400 to 484 in 2 years (b) 400 to 324 in 2 years
(c) 1000 to 1728 in 3 years (d) 2560 to 1080 in 3 years [4 marks]

B9 Work out u_3 in each case.

- (a) $u_{n+1} = 1.2u_n$, $u_0 = 50$ (b) $u_{n+1} = 1.2u_n - 10$, $u_0 = 50$
(c) $u_{n+1} = 1.2u_n - 10$, $u_0 = 60$ (d) $u_{n+1} = 0.5u_n + 8$, $u_0 = 40$ [4 marks]

B10 (*non-calculator*) $y = ab^x$, where $b > 0$. Find a and b when the graph passes through

- (a) (0, 5) and (1, 15) (b) (0, 80) and (2, 20) (c) (1, 12) and (2, 18) (d) (1, 10) and (3, 250) [4 marks]



C**Reasoning**

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

FOUNDATION

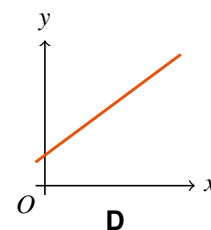
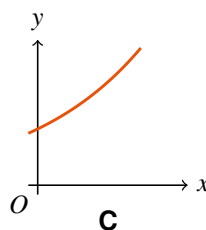
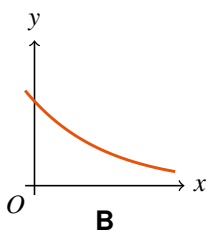
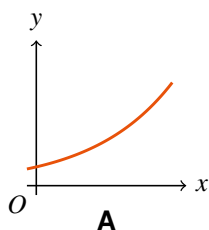
Everyone starts here

- C1** Eve says, “3% compound interest for 4 years is the same as 12% interest.”
Is Eve correct? You must show your working. [2 marks]
- C2** Tom works out the value of £500 after 3 years at 4% compound interest. He writes $500 \times 1.04 \times 3 = 1560$
(a) Explain Tom’s mistake. (b) Work out the correct value. [2 marks]
- C3** A car loses 20% of its value each year.
Ben says, “After 5 years the car will be worth nothing, because $5 \times 20\% = 100\%$.”
(a) Explain why Ben is wrong. (b) What percentage of its value does the car keep after 5 years? [3 marks]
- C4** Show that money invested at 5% per year compound interest first doubles after 15 years. [3 marks]



HIGHER

Higher tier only

C5 Here are sketches of four graphs.

(a) Match each equation to a graph: $y = 2 \times 3^x$ $y = 5 \times 0.5^x$ $y = 5 \times 1.5^x$

(b) Explain why graph D cannot have an equation of the form $y = ab^x$

[3 marks]**C6** $u_{n+1} = 0.8u_n + 30$ and $u_0 = 50$

(a) Show that if $u_n = 150$ then $u_{n+1} = 150$

(b) Work out u_1 and u_2 , and describe what happens to u_n as n gets larger.

[3 marks]**C7** Account A pays 6% interest once a year. Account B pays 3% interest every 6 months.

Both are compound interest. Show that Account B gives more interest in a year.

[3 marks]**C8** The value of an antique doubles every 12 years. It grows by the same percentage each year.

(a) Show that the annual percentage increase is about 5.9%

(b) Work out the percentage increase in its value over 30 years.

[4 marks]

D**Problem solving**

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

FOUNDATION

Everyone starts here

D1 Nia has £4000 to invest for 3 years.

Account A pays 2% per year compound interest, plus a bonus of £100 at the end of 3 years.

Account B pays 3% per year compound interest.

Which account gives Nia more money after 3 years, and by how much?

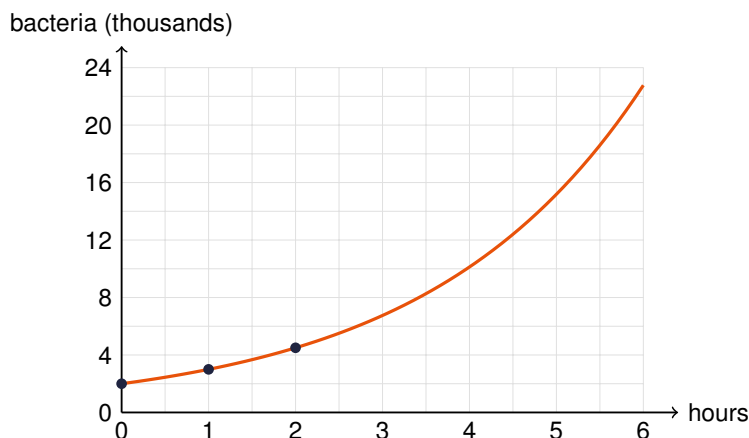
[4 marks]

D2 The population of a town is 42 000. It is falling by 3% each year.

The council says, "The population will be less than 35 000 in 6 years' time." Is the council correct?

[3 marks]

D3 A scientist counts the bacteria in a dish every hour. The number grows by the same percentage each hour.



(a) Use the graph to estimate the number of bacteria after 3 hours.

(b) Use the graph to estimate when there are 12 000 bacteria.

(c) The marked points show 2000, 3000 and 4500 bacteria. Work out the percentage increase each hour.

[4 marks]

D4 (*non-calculator*) The amount of a medicine in a patient's body halves every 6 hours.

The patient takes 400 mg at 8 am. How much of the medicine is left at 2 am the next day?

[3 marks]



HIGHER*Higher tier only*

- D5** Town A has 60 000 people, and its population falls by 2% each year.
Town B has 45 000 people, and its population grows by 3% each year.
After how many whole years will Town B first have more people than Town A? [4 marks]
- D6** A car loses 15% of its value each year. After 2 years it is worth £13 005
Work out its value after 5 years. [3 marks]
- D7** A fish farm has 800 fish. Each month the number of fish increases by 10%, and then 60 fish are sold.
After how many months will the farm first have more than 1000 fish? [4 marks]
- D8** Asha invests £ P at 5% per year compound interest.
Ben invests £1000 more than Asha, at 3% per year compound interest.
After 10 years they have the same amount of money. Find P , to the nearest pound. [5 marks]





Exam practice

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

FOUNDATION

Foundation and Higher crossover

- E1** Jo invests £4000 for 3 years at 2.5% per year compound interest.
Work out the value of Jo's investment at the end of 3 years.

£

(Total for Question E1 is 3 marks)

- E2** Amir invests £5000 for 4 years at 3% per year simple interest.
Bea invests £5000 for 4 years at 2.8% per year compound interest.
Who gets more interest, and how much more? You **must** show your working.

.....
(Total for Question E2 is 4 marks)

- E3** There are 500 fish in a lake. The number of fish falls by 20% each year.
After how many years will there first be fewer than 200 fish?

.....
(Total for Question E3 is 3 marks)



- E4** (a) Money is invested for 6 years at 3.5% per year compound interest. Which expression gives the multiplier for the 6 years?

1.35^6

1.035×6

1.035^6

0.965^6

.....

(1)

- (b) Write down the multiplier for a decrease of 4% each year.

.....

(1)

(Total for Question E4 is 2 marks)

- E5** A car costs £18 000. Its value falls by 15% each year.
Work out the value of the car after 4 years.

£

(Total for Question E5 is 3 marks)

- E6** Kai has £1000 to save for one year. He can choose

Plan 1: 12% per year simple interest

Plan 2: 1% per month compound interest

Which plan gives more money after one year? You **must** show your working.

.....

(Total for Question E6 is 3 marks)



HIGHER*Higher tier only*

- E7** After 3 years of 4% per year compound interest, the money in an account is £5624.32
How much money was put into the account at the start?

£

(Total for Question E7 is 3 marks)

- E8** A painting was worth £12 000 in 2020 and £15 972 in 2023
Its value increased by the same percentage each year. Work out this percentage.

..... %

(Total for Question E8 is 3 marks)

- E9** Sam has £3000 in an account. At the end of each year, 5% interest is added and then Sam takes out £200
 $A_{n+1} = 1.05A_n - 200$ gives the amount at the end of each year, where $A_0 = 3000$
Work out the amount in the account at the end of 3 years.

£

(Total for Question E9 is 3 marks)

- E10** The number of bacteria, N , after t hours is given by $N = ab^t$, where a and b are positive constants. The graph passes through the points $(2, 720)$ and $(5, 2430)$

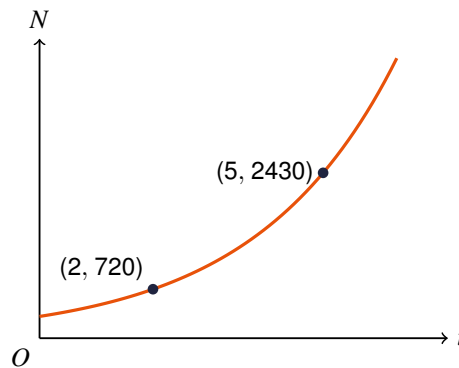


Diagram NOT accurately drawn

- (a)** Find the value of a and the value of b

$a = \dots\dots\dots b = \dots\dots\dots$

(3)

- (b)** After how many whole hours will N first be greater than 10 000?

$\dots\dots\dots$
(2)

(Total for Question E10 is 5 marks)

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