

Reverse percentages and compound interest, **with multipliers**

Learn how to find original prices and calculate compound interest using the price-tag machine.

1 One number does the whole change

2 Change over original

3 Run the machine backwards

4 The same machine, once a year

5 Practice + answers

22
EXAM-STYLE
QUESTIONS

A jumper costs £36 in a 20% off sale. Why was it NOT £43.20 before the sale?

Reverse percentages and compound interest can feel tricky because you're working backwards. Think of each percentage change as a price-tag machine. To find the original price, run the machine backwards.

The picture to keep in your head: The price-tag machine

Every percentage change is a machine you feed a price into. A 20% increase is the 'times 1.2' machine; a 20% decrease is the 'times 0.8' machine, because you keep 80%. Reverse percentages run the machine backwards: divide by the multiplier. Compound interest is the same machine run once every year, so 3 years at 5% is times 1.05 three times, or times 1.05^3 .

The method, every time

1. Use the price-tag machine to find the new price after a percentage change.
2. To reverse a percentage change, divide by the multiplier used in the machine.
3. For compound interest, apply the multiplier each year and raise it to the power of years.
4. Check your answer by reversing the steps or using the original value.
5. Always round your final answer to two decimal places for money.

Words you'll see: **multiplier** = A number that shows the effect of a percentage change, like 1.2 for 20% increase.
 · **reverse** = Working backwards to find the original value before a percentage change. · **compound** = Interest that grows on both the original amount and any previous interest. · **original** = The starting value before any percentage change is applied. · **round** = Make sure to round money to two decimal places at the end of calculations.

One number does the whole change

The price-tag machine does all the work. Whether you increase or decrease a price, the machine multiplies it by a special number. For a 15% decrease, the machine is times 0.85. This method is quick and works for any percentage change. Just remember: increase by $r\%$ is multiply by $1 + r/100$, and decrease by $r\%$ is multiply by $1 - r/100$.

WORKED EXAMPLE Decrease £65 by 15%

65

Start with the original price

65×0.85

Multiply by 0.85 for 15% decrease

55.25

Calculate the new price after the decrease

£55.25

answer

Watch out

- **Using 0.15 instead of 0.85 for a decrease** Remember: decrease by $r\%$ is multiply by $1 - r/100$
- **Writing 1.5 for a 5% increase instead of 1.05** Increase by $r\%$ is multiply by $1 + r/100$

Change over original

The price-tag machine shows how much the price has changed. To find the percentage change, you compare the change to the original price. Always divide by the original amount. Percentage change = change $\div$ original $\times$ 100.

WORKED EXAMPLE A phone's price rises from £240 to £276. Find the percentage increase.

$$276 - 240$$

Find the change in price

$$36$$

Subtract original from new price

$$36 \div 240$$

Divide change by original price

$$0.15$$

Calculate the fraction of the change

$$0.15 \times 100$$

Convert fraction to percentage

$$15$$

Multiply by 100 to get percentage

$$15\%$$

answer

Watch out

- **Dividing by the new amount** Always divide by the original amount, not the new one
- **Forgetting to multiply by 100** Multiply by 100 to convert the fraction to a percentage

Run the machine backwards

The price-tag machine can run backwards. If you know the final price after a percentage change, you can reverse the machine by dividing by the multiplier. This gives you the original price before the change. Never take the percentage of the new amount and add or subtract it.

WORKED EXAMPLE After a 20% discount a jumper costs £36. Find the original price.

36	Price after 20% discount
$36 \div 0.8$	Divide by the multiplier for 20% discount
45	Original price before discount
45×0.8	Check by applying the discount
36	Matches the given final price
£45	answer

Watch out

- **Adding 20% of £36** Don't add the percentage to the new amount
- **Dividing by 0.2** Use the multiplier for the change, not its percentage
- **Taking the percentage of the new amount** Always use the original amount for percentage changes

The same machine, once a year

The price-tag machine runs once each year for compound interest. You multiply the original amount by the yearly multiplier, repeated for each year. The formula is $\text{amount} = \text{original} \times \text{multiplier}^{\text{years}}$. This grows faster than simple interest because you earn interest on your interest.

WORKED EXAMPLE £2000 is invested at 3% compound interest per year. Work out its value after 4 years.

2000

Start with the original amount

1.03

3% increase is the multiplier for 1 year

1.03^4

Multiply the multiplier 4 times for 4 years

2000×1.03^4

Multiply original amount by the yearly multiplier 4 times

2251.02

Final amount after 4 years of compound interest

£2251.02

answer

Watch out

- **Adding 3% of £2000 four times** Use the multiplier, not simple interest
- **Rounding each year instead of at the end** Round only at the end to avoid errors

Exam-style questions

Show your working: most marks are for the method. F = Foundation / IGCSE Core, H = Higher / IGCSE Extended. Answers at the back.

A • MULTIPLIERS

- 1 Write the multiplier for a 12% increase. F [2]

- 2 Write the multiplier for a 35% decrease. F [2]

- 3 Write the multiplier for a 2.5% increase. F [2]

- 4 Increase £40 by 150%. F [2]

- 5 Decrease £80 by 2.5%. F [2]

B • PERCENTAGE CHANGE

- 6 A bike's price goes up from £250 to £290. Find the percentage increase. F [3]

- 7 A car worth £12 000 is now worth £9600. Find the percentage decrease. F [3]

- 8 A shop buys a lamp for £40 and sells it for £58. Find the percentage profit. F [3]

- 9 Sam's time for a run falls from 25 minutes to 22 minutes. Find the percentage decrease. F [3]

C • REVERSE

- 10 A jacket costs £240 after a 20% discount. What was the original price? F/H [3]

- 11 A laptop is sold for £630, making a 10% profit. What did it cost the shop? F/H [3]

- 12 A salary is increased by 4% to £3120. What was the original salary? F/H [3]

- 13 A TV costs £450 including 20% VAT. What was the price before VAT? F/H [3]

- 14 A car is sold for £14 520 after a 12% increase. What was the original price? F/H [3]

D • COMPOUND

- 15 £5000 is invested at 2% compound interest per year. Find its value after 3 years. F/H [3]

- 16 A car worth £18 000 loses 15% of its value each year. Find its value after 2 years. F/H [3]

- 17 A town of 24 000 people grows by 3% a year. Estimate its population after 5 years, to the nearest whole number. F/H [3]

18 A population of 10 000 grows by 5% each year. After how many years will it first be more than 13 000? F/H [3]

19 A population of 8000 grows by 4% each year. After how many years will it first be more than 10 000? F/H [3]

E · MIXED

20 A price goes up by 10%, then down by 10%. Is it back where it started? Explain. H [4]

21 £1000 is invested for 3 years at 5% per year. How much more does compound interest earn than simple interest? H [4]

22 After 2 years of 4% compound interest, an account holds £5408. How much was invested? H [4]

Marks are a guide to how much working an exam would expect. Questions written by Bloom Education in the style of GCSE (AQA, Edexcel, OCR) and Cambridge IGCSE papers.

Check your work

- 1** 1.12 Keep 100% and add 12%; $1 + 0.12 = 1.12$.
- 2** 0.65 Keep 100% – 35% = 65%; $1 - 0.35 = 0.65$.
- 3** 1.025 $1 + 0.025 = 1.025$.
- 4** £100 Multiplier $1 + 1.5 = 2.5$; $40 \times 2.5 = 100$.
- 5** £78 Multiplier $1 - 0.025 = 0.975$; $80 \times 0.975 = 78$.
- 6** 16% Change 40; $40 \div 250 \times 100 = 16$.
- 7** 20% Change 2400; $2400 \div 12\ 000 \times 100 = 20$.
- 8** 45% Profit 18; $18 \div 40 \times 100 = 45$.
- 9** 12% Change 3; $3 \div 25 \times 100 = 12$.
- 10** £300 Multiplier 0.8; $240 \div 0.8 = 300$.
- 11** £572.73 Multiplier 1.1; $630 \div 1.1 = 572.727...$
- 12** £3000 Multiplier 1.04; $3120 \div 1.04 = 3000$.
- 13** £375 Multiplier 1.2; $450 \div 1.2 = 375$.
- 14** £12 964.29 Multiplier 1.12; $14\ 520 \div 1.12 = 12\ 964.285...$
- 15** £5306.04 $5000 \times 1.02^3 = 5306.04$.
- 16** £13 005 $18\ 000 \times 0.85^2 = 13\ 005$.
- 17** 27 823 $24\ 000 \times 1.03^5 = 27\ 822.56...$
- 18** 6 years 1.05^5 gives 12 763, 1.05^6 gives 13 401.
- 19** 6 years $8000 \times 1.04^5 = 9733$, $8000 \times 1.04^6 = 10\ 123$.
- 20** No, it is 1% lower $\times 1.1$ then $\times 0.9$ is $\times 0.99$: 99% of the start.
- 21** £7.63 Compound: $1000 \times 1.05^3 = 1157.63$. Simple: $1000 + 3 \times 50 = 1150$.
- 22** £5000 Run the machine backwards twice: $5408 \div 1.04^2 = 5000$.

Exam checklist

- Increase by $r\%$: multiply by $1 + r/100$. Decrease: multiply by $1 - r/100$.
- Percentage change = $\text{change} \div \text{original} \times 100$.
- Reverse percentage: divide by the multiplier, never take the percentage of the new amount.
- Compound interest: $\text{original} \times \text{multiplier}^{\text{years}}$.
- Keep full values in your calculator; round money to 2 decimal places at the end.
- Check by running the machine forwards again.

Got stuck on a question?

- Find the section it belongs to and go through its worked example again, line by line.
- Put your answer back into the question. If it doesn't work, look for a sign or a step you skipped.
- Still stuck? Message us on Instagram (@bloom_education_international). We read every message.

Mocks coming up? **Your first lesson is free.**

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