# Algebraic Percentage Changes

*Practice Worksheet (Edexcel 1MA1 Style)*

## I Do

Emma owns a house.

During 2024, the value of Emma's house increased by $x\%$.
During 2025, the value of Emma's house increased by $2x\%$.

Overall, during 2024 and 2025, the value of Emma's house increased by 45.92%.

Work out the value of $x$.
Show clear algebraic working.

$x =$ .....

**(Total for Question is 4 marks)**

# We Do

Tom owns a flat.

During 2024, the value of Tom's flat decreased by $x\%$.
During 2025, the value of Tom's flat decreased by $3x\%$.

Overall, during 2024 and 2025, the value of Tom's flat decreased by 30.08%.

Work out the value of $x$.
Show clear algebraic working.

$x =$ .....

**(Total for Question is 4 marks)**

# You Do 1

Catherine invests some money in a savings account.

In year 1, her investment increases in value by $x\%$.
In year 2, her investment increases in value by $x\%$.

Overall, across the two years, her investment increases by 16.64%.

Work out the positive value of $x$.
Show clear algebraic working.

$x =$ .....

**(Total for Question is 3 marks)**

# You Do 2

John buys a rare painting.

In year 1, the value of the painting increases by $2x\%$.
In year 2, the value of the painting increases by $5x\%$.

Overall, across the two years, the value of the painting increases by $45.6\%$.

Work out the positive value of $x$.
Show clear algebraic working.

$x =$ .....

**(Total for Question is 4 marks)**

# You Do 3

Ryan buys a vintage sports car.

In year 1, its value increases by $3x\%$.
In year 2, its value decreases by $x\%$.

Overall, across the two years, the value increases by 17%.

Work out the positive whole-number value of x.
Show clear algebraic working.

$x =$ .....

**(Total for Question is 4 marks)**

# Challenge 1

Paul starts a new business.

In year 1, the value of the business increases by $x\%$.
In year 2, the value of the business increases by $(x + 5)\%$.

Overall, across the two years, the value of the business increases by $38\%$.

Work out the value of $x$.
Show clear algebraic working.

$x =$ .....

**(Total for Question is 4 marks)**

# Challenge 2

Sophie buys a brand new car.

In year 1, the value of the car decreases by $x\%$.
In year 2, the value of the car decreases by $(x - 4)\%$.

Overall, across the two years, the value of the car decreases by 22.6%.

Work out the value of $x$.
Show clear algebraic working.

$x =$ .....

**(Total for Question is 4 marks)**

# Extreme Challenge

Katie invests in a technology startup.

In 2024, the value of her investment increases by $x\%$.
In 2025, the value of her investment increases by $y\%$.

You are given that $y = 3x$.

Overall, across the two years, the value of her investment increases by $52.32\%$.

Work out the exact value of $x$ and the value of $y$.
You must show all your algebraic working clearly.

$x =$ .....

$y =$ .....

**(Total for Question is 5 marks)**

# Worked Answers

### I Do

The multiplier for an $x\%$ increase is $\left(1+\frac{x}{100}\right)$.
The multiplier for a $2x\%$ increase is $\left(1+\frac{2x}{100}\right)$.
Overall multiplier $= 1+\frac{45.92}{100} = 1.4592$.
Form an equation: $\left(1+\frac{x}{100}\right)\left(1+\frac{2x}{100}\right) = 1.4592$.
Multiply both sides by $10,000$ (which is $100\times 100$) to clear the fractions:
$(100+x)(100+2x) = 14592$.
Expand the brackets:
$10000+200x+100x+2x^2 = 14592$.
$2x^2+300x+10000 = 14592 \implies 2x^2+300x-4592 = 0$.
Divide the entire equation by 2:
$x^2+150x-2296 = 0$.
Use the quadratic formula, where $a=1, b=150, c=-2296$:
$x = \frac{-150\pm\sqrt{150^2-4(1)(-2296)}}{2} = \frac{-150\pm\sqrt{22500+9184}}{2} = \frac{-150\pm\sqrt{31684}}{2}$.
$x = \frac{-150\pm 178}{2}$.
Taking the positive root (since house value increased): $x = \frac{28}{2} = \mathbf{14}$.

### We Do

The multiplier for an $x\%$ decrease is $\left(1-\frac{x}{100}\right)$.
Overall multiplier $= 1-0.3008 = 0.6992$.
$\left(1-\frac{x}{100}\right)\left(1-\frac{3x}{100}\right) = 0.6992$.
Multiply by 10,000: $(100-x)(100-3x) = 6992$.
$10000-300x-100x+3x^2 = 6992 \implies 3x^2-400x+3008 = 0$.
Use the quadratic formula:
$x = \frac{-(-400)\pm\sqrt{(-400)^2-4(3)(3008)}}{2(3)} = \frac{400\pm\sqrt{160000-36096}}{6} = \frac{400\pm\sqrt{123904}}{6}$.
$x = \frac{400\pm 352}{6}$.
$x = \frac{752}{6}$ (125.3%, invalid since decrease $>100\%$) or $x = \frac{48}{6} = \mathbf{8}$.

### You Do 1

$\left(1+\frac{x}{100}\right)\left(1+\frac{x}{100}\right) = 1.1664$.
$\left(1+\frac{x}{100}\right)^2 = 1.1664$.
Square root both sides: $1+\frac{x}{100} = 1.08$.
$\frac{x}{100} = 0.08 \implies \mathbf{x = 8}$.

**You Do 2**

$\left(1+\frac{2x}{100}\right)\left(1+\frac{5x}{100}\right)=1.456.$
Multiply by 10,000: $(100+2x)(100+5x)=14560.$
$10000+500x+200x+10x^2=14560.$
$10x^2+700x-4560=0.$
Divide by 10: $x^2+70x-456=0.$
Factorise (or use formula): $(x-6)(x+76)=0.$
Since $x$ is positive, $\mathbf{x=6}$.

**You Do 3**

$\left(1+\frac{3x}{100}\right)\left(1-\frac{x}{100}\right)=1.17.$
Multiply by 10,000: $(100+3x)(100-x)=11700.$
$10000-100x+300x-3x^2=11700.$
$3x^2-200x+1700=0.$
Factorise: $(3x-170)(x-10)=0.$
$x=\frac{170}{3}$ or $x=10$. Only x = 10 is a whole number.
$\mathbf{x=10}$.

**Challenge 1**

$\left(1+\frac{x}{100}\right)\left(1+\frac{x+5}{100}\right)=1.38.$
Multiply by 10,000: $(100+x)(105+x)=13800.$
$10500+100x+105x+x^2=13800.$
$x^2+205x-3300=0.$
Factorise: $(x-15)(x+220)=0.$
Taking the positive root, $\mathbf{x=15}$.

**Challenge 2**

Overall multiplier $=1-0.226=0.774.$
$\left(1-\frac{x}{100}\right)\left(1-\frac{x-4}{100}\right)=0.774.$
Multiply by 10,000: $(100-x)(104-x)=7740.$
$10400-100x-104x+x^2=7740.$
$x^2-204x+2660=0.$
Factorise: $(x-14)(x-190)=0.$
Since a single year's decrease must be $<100\%$, $x\neq 190.$
Therefore, $\mathbf{x=14}$.

**Extreme Challenge**

Substitute $y=3x$ directly into the relationship.
$\left(1+\frac{x}{100}\right)\left(1+\frac{3x}{100}\right)=1.5232.$
Multiply by 10,000: $(100+x)(100+3x)=15232.$
$10000+300x+100x+3x^2=15232.$
$3x^2+400x-5232=0.$
Use the quadratic formula:
$x=\frac{-400\pm\sqrt{160000-4(3)(-5232)}}{6}=\frac{-400\pm\sqrt{160000+62784}}{6}=\frac{-400\pm\sqrt{222784}}{6}.$
$\sqrt{222784}=472.$
$x=\frac{-400+472}{6}=\frac{72}{6}=12.$

Therefore, $\mathbf{x=12}$, and $y=3(12)=\mathbf{36}$.