Student Name

Mathematics Stage 4

EQUATIONS

Book 1 Solve linear equations up to 2 steps

Version: 260207

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CONTENTS

OVERVIEW

SYLLABUS CONTENT

MA4-EQU-C-01 solves linear equations of up to 2 steps and quadratic equations of the form $ax^2 = c$

Solve linear equations up to 2 steps

- Represent number sentences involving unknown quantities using pronumerals
- Describe number sentences as equations
- Distinguish between and compare algebraic expressions and equations
- Solve linear equations with integer and non-integer solutions using algebraic techniques that involve up to 2 steps, including equations with pronumerals on both sides
- Model and solve word problems using equations of up to 2 steps

Solve and verify linear equations by substitution

- Verify solutions to equations by substitution

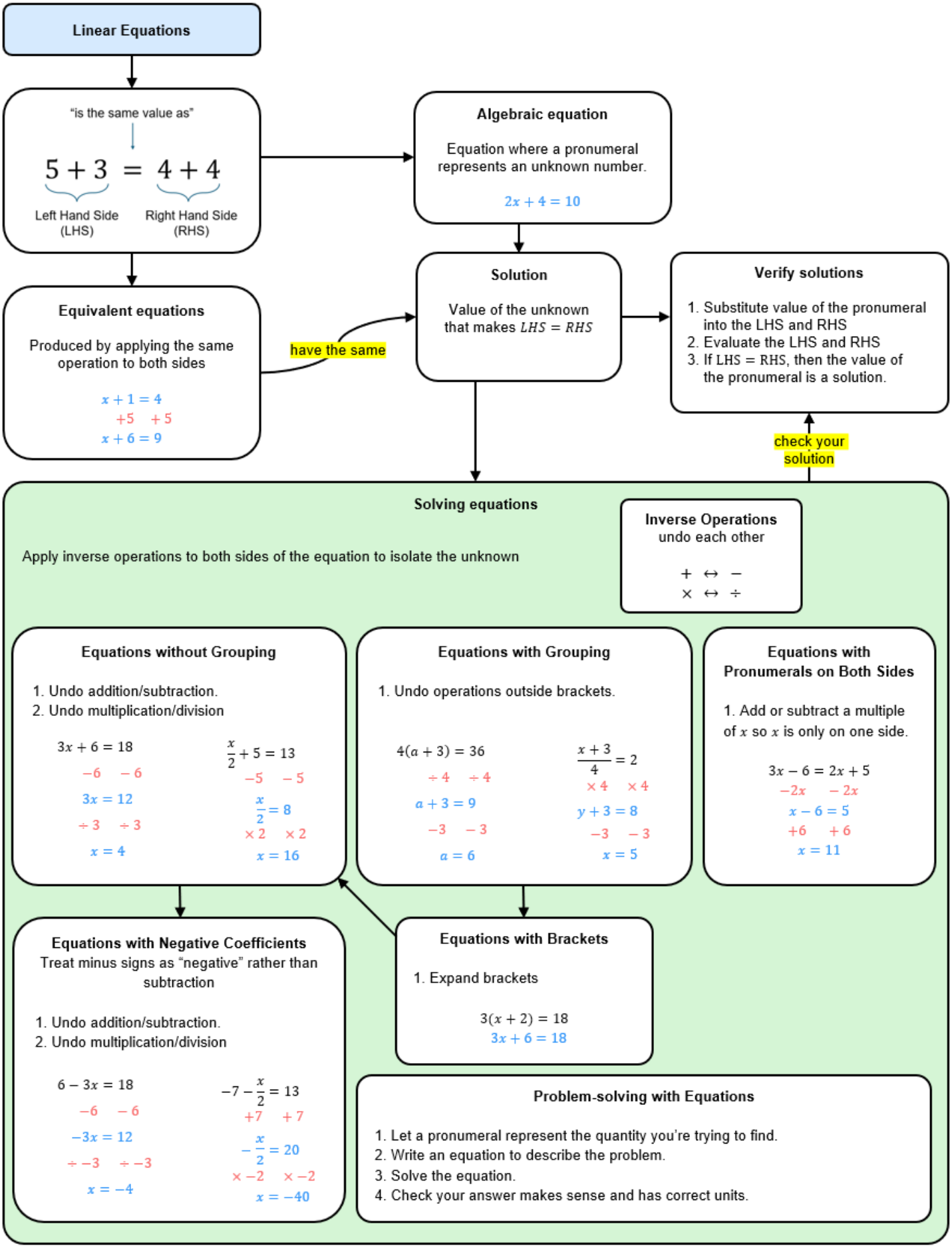
HISTORY

- The earliest records of equations come from the ancient Egyptians, who used simple equations to solve practical problems such as determining the distribution of bread and beer among workers.
- Later, around 800 AD, a Persian mathematician named al-Khwarizmi introduced systematic methods for solving linear equations in his book *kitab al-jabr al-muqabala.*
- The word *algebra* comes from *al-jabr,* meaning *completion* (finding what's missing) and *al-muqabala* meaning *balancing*, the key principles of solving algebraic equations.

RELEVANCE

- Equations communicate a relationship and we use them to represent real-life scenarios mathematically.
- This book involves solving the simplest type of equation: linear equations (x has a power of 1), this skill is fundamental to all future learning in mathematics and has universal applications in science, engineering, and finance.

KNOWLEDGE STRUCTURE



REVIEW OF PRIOR KNOWLEDGE

1 A scale is balanced if the left side and the right side have the same value.
Which of these scales are balanced?

a $7+13 \quad 20$

b $6+7 \quad 12$

c $4 \quad 8-3$

d $3\times5 \quad 15$

e $18\times\frac{1}{9} \quad 2$

f $3\times2 \quad 9-3$

2 Put the correct symbol $=$ or $\neq$ between these calculations.

a $3+4 \bigcirc 4+3$

b $7-2 \bigcirc 8-3$

c $9+7 \bigcirc 10+8$

d $6-4 \bigcirc 7-3$

3 Determine whether these statements are true or false.

a $8+2=7+3$

b $14-3=13-4$

c $4\times2=10-2$

d $3\times9=30-3$

4 Using the order of operations, determine the relationship between LHS and RHS using relational symbols =, >, or <

a $9+2\times4 \;\square\; 30-8\times2$ (8, 16; 17 > 14)

b $10+15\times2 \;\square\; 40+10$

c $86-6\times11 \;\square\; 5+3\times3$

d $10\div2\times5 \;\square\; 15+5\times2$

e $6+3\times11 \;\square\; 9+24\div3$

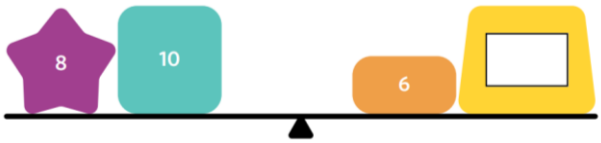
f $99-81\div9 \;\square\; 48\div6\times2$

g $12+64\div8 \;\square\; 80\div5+5$

h $15+55\div5 \;\square\; 7+39\div3$

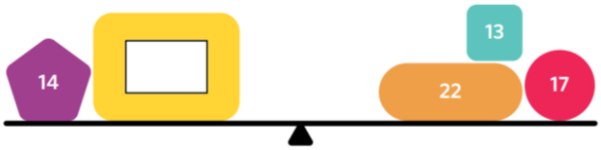
5 Complete the equation to balance the scale, then write the number sentence.

a



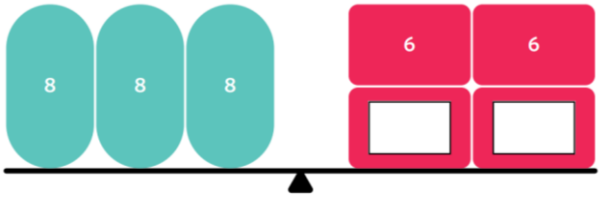
$10 + 8 = 6 + \ldots\ldots\ldots$

b



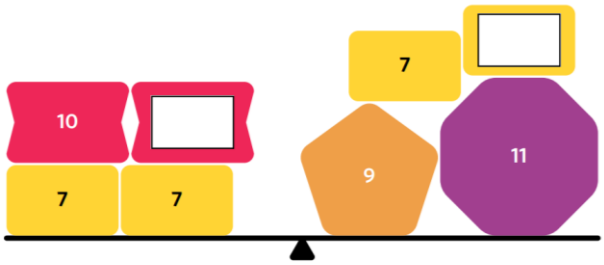
$14 + \ldots\ldots\ldots = 2 + 3 + 17$

c



$8 + 8 + 8 = 6 + 6 + \ldots\ldots\ldots + \ldots\ldots\ldots$

d

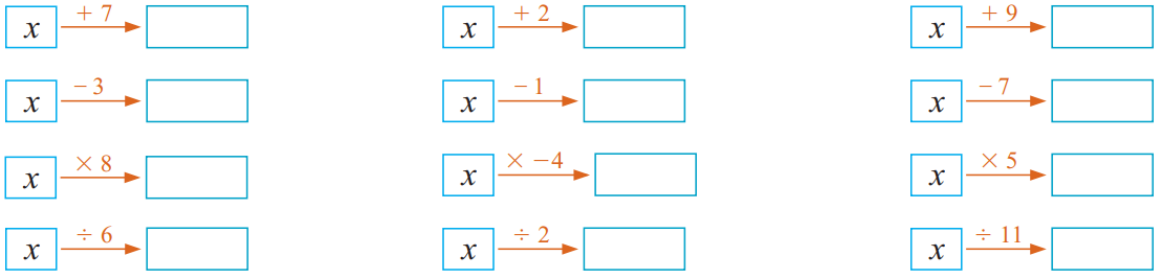


$10 + \ldots\ldots\ldots + 7 + 7 = \ldots\ldots\ldots + 7 + 9 + 11$

6 Simplify these expressions.

a	$3x + 2 - 2$	**b**	$2x - 5 + 5$	**c**	$2x + 5 - 2x$
d	$12x \times 2$	**e**	$3(x + 5)$	**f**	$7(2x + 1)$
g	$12x \div 4$	**h**	$(4x + 6) \div 2$	**i**	$\frac{6x+3}{3}$
j	$3(3x - 5)$	**k**	$5(8 - x)$	**l**	$\frac{10x-25}{5}$

7 Complete the following algebraic expressions.



8 Write the inverse operation that will undo these operations.

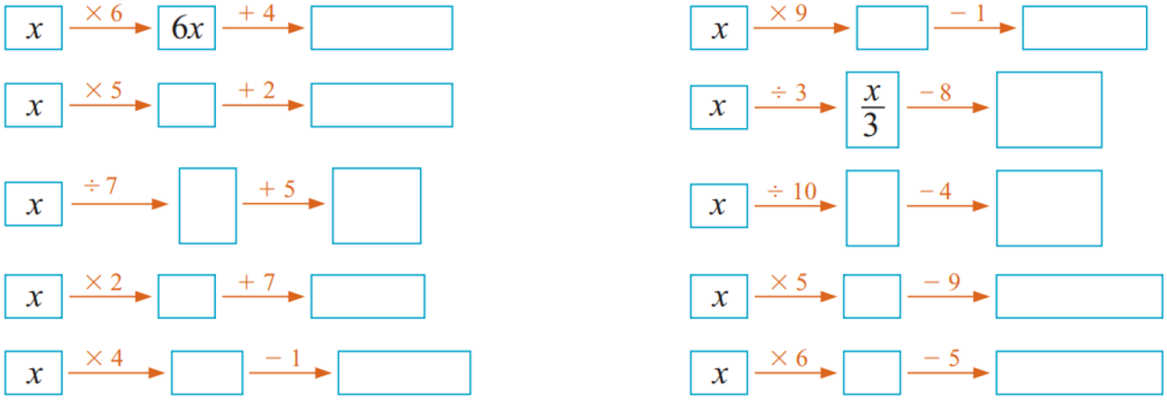
a $+12$	**b** -12	**c** $\times 12$	**d** $\div 12$

9 Complete these function machines using your knowledge of inverse operations.

10 Show the operation needed get to x

a $x+4 \rightarrow x$	**b** $x-5 \rightarrow x$	**c** $x-11 \rightarrow x$
d $x+6 \rightarrow x$	**e** $2x \rightarrow x$	**f** $7x \rightarrow x$
g $\frac{x}{3} \rightarrow x$	**h** $\frac{x}{10} \rightarrow x$	**i** $-9x \rightarrow x$

11 Complete the following algebraic expressions.



12 Match each function machine to the correct expression.

A $x \rightarrow \boxed{\times 2} \rightarrow \boxed{+5} \rightarrow$

B $x \rightarrow \boxed{\times 5} \rightarrow \boxed{+2} \rightarrow$

C $x \rightarrow \boxed{\div 2} \rightarrow \boxed{+5} \rightarrow$

D $x \rightarrow \boxed{+2} \rightarrow \boxed{\div 5} \rightarrow$

E $5x + 2$

F $\frac{x+2}{5}$

G $2x + 5$

H $\frac{x}{2} + 5$

13 Determine the operations needed to get back to x.

$\boxed{6x + 2} \rightarrow \boxed{6x} \rightarrow \boxed{x}$

$\boxed{-3x - 1} \rightarrow \boxed{-3x} \rightarrow \boxed{x}$

$\boxed{7x + 10} \rightarrow \boxed{7x} \rightarrow \boxed{x}$

$\boxed{\frac{x}{5} - 8} \rightarrow \boxed{\frac{x}{5}} \rightarrow \boxed{x}$

$\boxed{2 + \frac{x}{3}} \rightarrow \boxed{\frac{x}{3}} \rightarrow \boxed{x}$

$\boxed{\frac{x}{11} + 1} \rightarrow \boxed{\frac{x}{11}} \rightarrow \boxed{x}$

$\boxed{3x + 2} \rightarrow \boxed{3x} \rightarrow \boxed{x}$

$\boxed{11 + 2x} \rightarrow \boxed{2x} \rightarrow \boxed{x}$

14 Identify the terms of these expressions.

a $5x + 12$	**b** $12 + 5x$	**c** $12 - 5x$
d $-12 - 5x$	**e** $-12 + 5x$	**f** $9 - 7x$

15 Complete the following algebraic expressions.

a $\boxed{x} \xrightarrow{\times(-9)} \boxed{} \xrightarrow{-1} \boxed{}$

b $\boxed{x} \xrightarrow{\div(-7)} \boxed{} \xrightarrow{+5} \boxed{}$

c $\boxed{x} \xrightarrow{\times(-4)} \boxed{} \xrightarrow{-1} \boxed{}$

16 Determine the operations needed to get back to x.

a $\boxed{-2x} \rightarrow \boxed{x}$

a $\boxed{-9x} \rightarrow \boxed{x}$

b $\boxed{-\frac{x}{3}} \rightarrow \boxed{x}$

b $\boxed{\frac{x}{-4}} \rightarrow \boxed{x}$

c $\boxed{-3x-1} \rightarrow \boxed{-3x} \rightarrow \boxed{x}$

c $\boxed{2-6x} \rightarrow \boxed{-6x} \rightarrow \boxed{x}$

d $\boxed{-8-\frac{x}{5}} \rightarrow \boxed{-\frac{x}{5}} \rightarrow \boxed{x}$

d $\boxed{11-7x} \rightarrow \boxed{-7x} \rightarrow \boxed{x}$

e $\boxed{1-\frac{x}{11}} \rightarrow \boxed{-\frac{x}{11}} \rightarrow \boxed{x}$

e $\boxed{2-\frac{x}{3}} \rightarrow \boxed{-\frac{x}{3}} \rightarrow \boxed{x}$

17 Evaluate these expressions.

a $5(4)+3$

b $5(4+3)$

c $\frac{20}{4}+8$

d $\frac{20+8}{4}$

18 Complete the following algebraic expressions.

a $\boxed{m} \rightarrow \boxed{\times 2} \rightarrow \boxed{2m} \rightarrow \boxed{+5} \rightarrow \boxed{2m+5}$

b $\boxed{m} \rightarrow \boxed{+5} \rightarrow \boxed{m+5} \rightarrow \boxed{\times 2} \rightarrow \boxed{2(m+5)}$

c $\boxed{n} \rightarrow \boxed{-4} \rightarrow \boxed{} \rightarrow \boxed{\times 5} \rightarrow \boxed{}$

d $\boxed{n} \rightarrow \boxed{\times 5} \rightarrow \boxed{} \rightarrow \boxed{-4} \rightarrow \boxed{}$

e $\boxed{n} \rightarrow \boxed{\div 10} \rightarrow \boxed{} \rightarrow \boxed{-2} \rightarrow \boxed{}$

f $\boxed{n} \rightarrow \boxed{-2} \rightarrow \boxed{} \rightarrow \boxed{\div 10} \rightarrow \boxed{}$

g $\boxed{n} \rightarrow \boxed{\div 3} \rightarrow \boxed{} \rightarrow \boxed{+7} \rightarrow \boxed{}$

h $\boxed{n} \rightarrow \boxed{+7} \rightarrow \boxed{} \rightarrow \boxed{\div 3} \rightarrow \boxed{}$

19 Expand these expressions.

a	$3(x+2)$	**b**	$5(q-2)$	**c**	$5(x+7)$
d	$11(q-4)$	**e**	$3(2a+7)$	**f**	$6(4a-1)$

20 Simplify

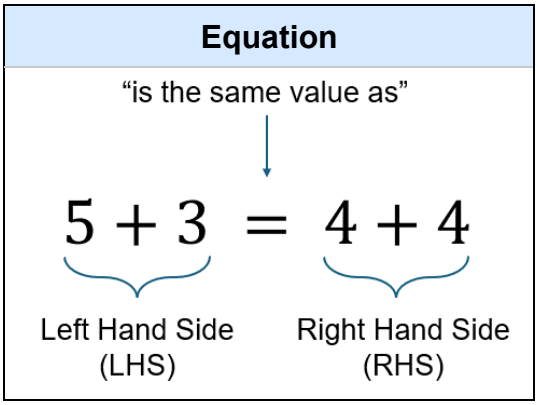
a	$3a+a+2$	**b**	$5+2x+x$	**c**	$2b-4+b$
d	$3k+6-2k$	**e**	$7+2b-1$	**f**	$6k-k+1$
g	$5x+5(2+3x)$	**h**	$3(4x-5)+x$	**i**	$4+6(4q-4)$

21 Write expressions to represent the following:

a	Josh is n years old this year. How old will be he in 2 years' time?	**b**	Erica is n years old this year. Her brother is 3 years younger than her. What is the age of her brother?
c	Find the total cost of 3 movie tickets at m dollars each.	**d**	The total cost of an excursion of 15 students is C. What is the cost per student?
e	Elijah is x years old. His sister is 2 years younger than him. Write an expression for the sum of their ages.	**f**	Mike saved x dollars. Georgia saved double Mike's amount. Write an expression to represent the total amount they have saved.
g	A rectangle has a width of x cm. The length is 1 cm longer than the width. Write an expression for the perimeter of the rectangle.	**h**	A taxi costs \$10 to start and \$8 per kilometre. Write an expression to represent the cost of a trip of distance n kilometres.

ALGEBRAIC EQUATIONS

- An **equation** has an equals symbol (=) with expressions on both sides.
- Equations have a **Left-Hand Side** (LHS) with the same value as the **Right-Hand Side** (RHS),



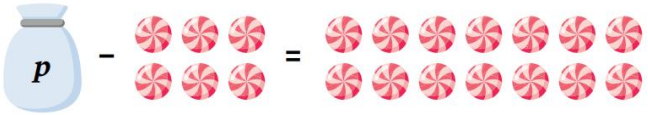
Algebraic Expression	Algebraic Equation
$2x + x + 6$	$2x + x = 6$
No equals sign. x is a variable; it represents any number. You ***simplify*** expressions.	Equals sign relates two expressions. x usually represents a fixed value. You ***solve*** equations.

Example Identify equations.

x	Equation	Not equation
$4x$	Equation	Not equation
$4x + x$	Equation	Not equation
$4x + 1$	Equation	Not equation
$4x + 1 =$	Equation	Not equation
$4x + 1 = 7$	Equation	Not equation
$4x + 1 = x$	Equation	Not equation
$x = 4x + 1$	Equation	Not equation
$y = 4x + 1$	Equation	Not equation
$4x + 1 = 7x - 2$	Equation	Not equation
$0 = x^2 + 2x + 1$	Equation	Not equation

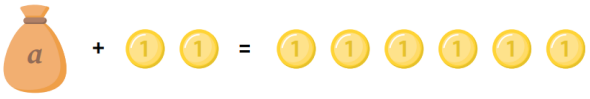
WRITING EQUATIONS FROM SCENARIOS

Example Write equations from a scenario.

After 6 lollies are taken out of a bag, there are still 14 left.  $p - 6 = 14$	What does p represent? *p represents the ..... of lollies in the bag.* In this scenario, can p represent *any* value, or a specific value? *p can only be ..... to make the equation true.*
Subtracting 5 from a number is 22. $x - 5 = 22$	Why is $5 - x = 22$ is not correct? *The word "....." tells you to switch the order of the numbers.*
Half a number is 4 times 22. $\frac{x}{2} = 4 \times 22$	Why is half of a number $\frac{x}{2}$? *Halving a number is the same as ..... by 2.*

Write equations for these scenarios.

a After adding 2 coins to a bag, there are 6 coins in total.



$a + 2 = 6$

b Two bags of coins and 4 loose coins is worth the same as 10 coins.

$2b + 4 = 10$

c The sum of a number x and 7 is 20

$x + 7 = 20$

d The number of cards in a deck is x.
In 7 decks there are 56 cards.

$7x = 56$

e Prim is currently p years old.
In 5 years she'll be 18.

$p + 5 = 18$

f If you double the amount of money in Jimmy's wallet, the amount would be $80

$2x = 80$

Key ideas

1. If a statement has an equals symbol and an expression on either side of the symbol, then it is an .....
2. If LHS = RHS, then an equation is .....
3. Equations are useful because they ..... information involving unknown numbers.

1 b represents the number of apples in each box. Write an equation for each scenario.

a

..... = ...

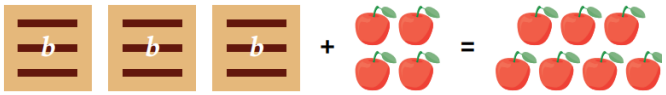
$b + 6 = 10$

b

..... = ...

$b - 3 = 2$

c



.....

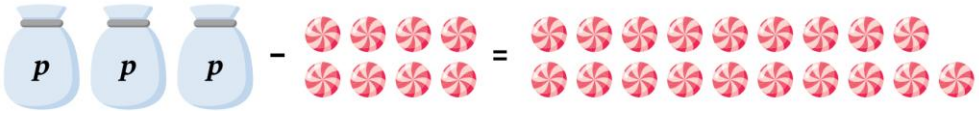
$3b + 4 = 7$

d

.....

$2b - 2 = b$

2



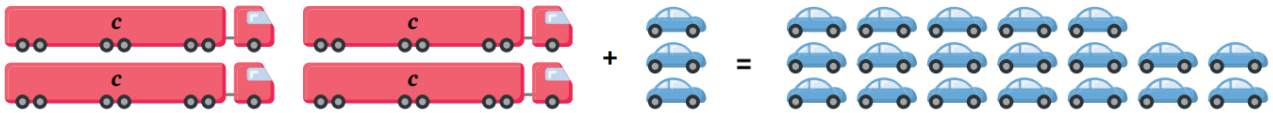
a Write an equation describing this scenario.

$3p - 8 = 19$

b What might p represent?

Number of lollies in each bag

3



a Write an equation describing this scenario.

$4c + 3 = 19$

b What might c represent?

Number of cars in each truck

4 Write equations for these scenarios.

a The sum of 3 and x is equal to 10.

$3 + x = 10$

b When k is multiplied by 5, the result is 1005.

$5k = 1005$

c When d is doubled, the result is 78.

$2d = 78$

d The product of 8 and x is 56.

$8x = 56$

e When p is tripled, the result is 21.

$3p = 21$

f One-quarter of t is 12.

$\frac{t}{4} = 12$

5 Write an equation to represent these statements.

a 8 less than t is equal to 14

$t - 8 = 14$

b Half of y is 13

$\frac{y}{2} = 13$

c 45 is 3 times greater than x

$45 = 3x$

d The value of a is 4 times greater than the sum of 8 and 12

$a = 4(8 + 12)$

e A quarter of z is 3 larger than 12

$\frac{z}{4} = 12 + 3$

f One-fifth of double of t is 12.

$\frac{2t}{5} = 12$

g Chairs cost $\$c$ at a store. The cost of 6 chairs is \$546.

$6c = 546$

h Amy is f years old. In 10 years' time her age will be 27.

$f + 10 = 27$

6 Match the sentence to the equation. Each equation can be used more than once.

$n - 5 = 20$ $\quad$ $n + 5 = 20$ $\quad$ $5 - n = 20$ $\quad$ $\frac{n}{2} + 5 = 20$

$5n = 20$ $\quad$ $\frac{n}{5} = 20$ $\quad$ $2n + 5 = 20$ $\quad$ $2(n + 5) = 20$

a A number is increased by 5 to give 20

$n + 5 = 20$

b Five times a number is 20.

$5n = 20$

c Dividing a number by 5 gives 20.

$\frac{n}{5} = 20$

d A number is doubled and then 5 is added to give 20.

$2n + 5 = 20$

e A number is increased by 5 and then the result is doubled to give 20.

$2(n + 5) = 20$

f What number can be subtracted from 5 to give 20?

$5 - n = 20$

g The sum of a number and 5 is 20.

$n + 5 = 20$

h A number is halved, then 5 is added to give 20.

$\frac{n}{2} + 5 = 20$

i The product of 5 and a number is 20.

$5n = 20$

j One-fifth of a number is 20.

$\frac{n}{5} = 20$

k A number is decreased by 5 to give 20.

$n - 5 = 20$

l Five more than half of a number is 20.

$\frac{n}{2} + 5 = 20$

7 Match the number sentence to the equation.

$\frac{n}{2}+4=20$ $n+4=20$ $4n=20$ $\frac{n}{2}-4=20$ $2(n+4)=20$

$\frac{n+4}{2}=20$ $4n+4=20$ $\frac{n}{4}=20$ $2n-4=20$ $\frac{n}{4}+2=20$

a Twice a number is decreased by 4 to give 20.

$2n-4=20$

b 4 more than four times a number is 20.

$4n+4=20$

c Dividing a number by 4 gives 20.

$\frac{n}{4}=20$

d A number is doubled, then 4 is subtracted to give 20.

$2n-4=20$

e A number is increased by 4, then the result is doubled to give 20.

$2(n+4)=20$

f The sum of a number and 4 is 20.

$n+4=20$

g A number is halved, then 4 is added to give 20.

$\frac{n}{2}+4=20$

h The product of 4 and a number is 20.

$4n=20$

i A number is increased by 4, then the result is halved to give 20.

$\frac{n+4}{2}=20$

j A number is increased by 4 to give 20.

$n+4=20$

k 4 less than half of a number is 20.

$\frac{n}{2}-4=20$

l 2 more than a quarter of a number is 20.

$\frac{n}{4}+2=20$

8 Write an equation to represent these scenarios.

a Each class has the same number (x) of students in it. There are six classes with a total of 132 students.

$6x=132$

b 12 students shared b books equally. Each student received 9 books.

$\frac{b}{12}=9$

c Ronnie has a number of basketball cards (r). The number of basketball cards Mick has (m) is 4 more than Ronnie.

$m=r+4$

d There are p lollies in a bag. Gilbert bought 7 bags and ate 5 lollies. He then has 128 lollies left.

$7p-5=128$

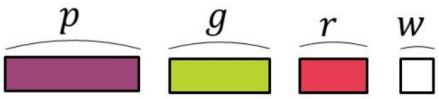
e Lola placed c cookies on a tray for baking. Charlie added three more cookies to her tray. They then tripled the number of trays to make 32 cookies.

$3(c+3)=32$

f Simon had d stickers then collected 4 more before sharing them between 3 friends. Each friend got 9 stickers each.

$\frac{d+4}{3}=9$

9 Consider these rods, laid end to end. The pronumeral represents the length of a rod.



Use the diagram to answer these questions. Circle **one** option in each question.

a $3r =$ .....

p | $3w$ | $2p$ | $2g$

2g

b $2p =$ .....

$3g$ | $5r$ | $8w$ | $8r$

8w

c $2w + r =$ .....

p | $4p$ | $2p$ | $\frac{p}{2}$

p

d $2g + 3r =$ .....

$14w$ | $6p$ | $3p$ | $10w$

3p

e $6g =$ .....

$5p$ | $8r$ | $9r$ | $4p$

9r

f $8r =$ .....

$6g$ | $4p$ | $14w$ | $5g$

4p

g Jo says $w = \frac{g}{3}$. Paul says $w = 4p$. Who is correct?

Only Jo | Only Paul | Both | Neither

Only Jo

h Jo says: $3(2w + r) = 4g$. Paul says: $2(p + 2w) = 4g$. Who is correct?

Only Jo | Only Paul | Both | Neither

Only Paul

VERIFYING SOLUTIONS

- A **solution** is a pronumeral value that makes an equation true.
- We say that a solution **satisfies** the relationship shown in the equation.
- **Verify** (or check) solutions by:
  1. Substitute the value of the pronumeral into the LHS and RHS of the equation.
  2. Evaluate the LHS and RHS
  3. If $\text{LHS} = \text{RHS}$, then the value of the pronumeral is a solution.

Example Verify solutions to algebraic equations.

Verify whether $x = 5$ is a solution of

$$4x = 24$$

1. $4(5) \mid 24$
2. 20
3. $\text{LHS} \neq \text{RHS}$
   $x = 5$ is not a solution.

Verify whether $x = 0.5$ is a solution of

$$x + 1 = 2 - x$$

1. $0.5 + 1 \mid 2 - 0.5$
2. $1.5 \mid 1.5$
3. $\text{LHS} = \text{RHS}$
   $x = 0.5$ is a solution.

What does "verify" mean?

Verify means to ..... if something is true.

What is LHS and RHS?

LHS is the expression on the ..... of the =

RHS is the expression on the ..... of the =

Describe the process of verifying a solution.

..... the given value into the ..... and ....., then compare the result.

The given value is a solution if LHS ..... RHS

It is not a solution if LHS ..... RHS

a Verify whether $x = 3$ is a solution of

$$5 + x = 7$$

LHS ..... RHS

$x = 3$ ..... a solution.

b Verify whether $x = 5$ is a solution of

$$15 = 3x$$

LHS ..... RHS

$x = 5$ ..... a solution.

c Verify whether $x = 7$ is a solution of

$$2x + 3 = 17$$

d Verify whether $x = 1.5$ is a solution of

$$2x + 3 = 7.5 - x$$

Key ideas

1. A solution of an equation is the value of the unknown that makes the equation .....
2. An equation is true if $\text{LHS} = \text{RHS}$; an equation is false if .....
3. We verify by ..... the value into the equation and ..... the LHS and RHS

1

a Verify whether $x = 3$ is a solution of $x + 1 = 4$

yes

b Verify whether $x = 4$ is a solution of $12 - 3x = 4 - x$

yes

c Verify whether $b = 4$ is a solution of $12 - 3b = 5 - b$

no

d Verify whether $x = 0.5$ is a solution of $\frac{4x}{6} = \frac{1}{3}$

yes

e Verify whether $x = 5$ is a solution of $15 + 2x = x^2$

yes

f Verify whether $x = 3$ is a solution of $7x + 2 = 8x$

no

g Verify whether $x = -1$ is a solution of $x(x + 1) = 0$

yes

h Verify whether $x = -3$ is a solution of $3x + 3 = 3(x + 1)$

yes

i Verify whether $x = 7.5$ is a solution of $\frac{2x}{5} + 5 = 10$

no

j Verify whether $x = -2$ is a solution of $x^2 + 4x + 4 = 0$

yes

SOLVING EQUATIONS BY INSPECTION

- A **solution** is a pronumeral value that makes an equation true.
- **Solving** an equation means to find the solution.
- We can solve simple equations by **inspection** – noticing the answer.

Example Solve equations by inspection.

$\square \times 3 = 12 + 9$ The solution is 7.	Describe what a solution is. *A solution is a number that makes the equation ……* Why is the solution 7? *The RHS of the equation is ……* *7×3 would make the LHS ……*
$\frac{x}{3} = 10 + 2$ $x = 36$	Why is the solution 36? *The RHS of the equation is ……* *$36 \div 3$ would make the LHS ……*

Solve these equations.

a $3 + 8 = 6 + x$

$x = 5$

b $100 - 17 = 101 - x$

$x = 18$

c $10 \times 3 = 29 + x$

$x = 1$

d $112 - 99 = x - 100$

$x = 113$

e $28 - x = 30 - 15$

$x = 13$

f $80 \times 5 = 10x$

$x = 40$

Key ideas

1. Solving an equation means to find the ……
2. A solution of an equation is the value of the unknown that makes the equation ……

1 Find the solution to these equations.

a $4 + \square = 7$ — 3

b $13 = \square + 3$ — 10

c $42 = \square \times 7$ — 6

d $15 + 6 = \square + 1$ — 20

e $2 \times \square = 12$ — 6

f $10 = 6 + \square$ — 4

g $100 - \square = 30$ — 70

h same number in both $\square + 11 = 49 - \square$ — 19

2 Solve these equations by inspection. Pay attention to how each question changes.

a $3 + x = 8$ — 5

b $x + 3 = 8$ — 5

c $8 = x + 3$ — 5

d $8 = x - 3$ — 11

e $9 = x - 3$ — 12

f $9 = x - 4$ — 13

g $7 = x - 6$ — 13

h $-7 = x - 6$ — −1

i $-7 = -6 + x$ — −1

j $-7 + x = -6$ — 1

k $-7 + x = -7$ — 0

l $7 + x = -7$ — −14

m $7 + x = 0$ — −7

n $-7 + x = 0$ — 7

o $-7 + x = \frac{1}{2}$ — 7.5

p $x - 7 = \frac{1}{2}$ — 7.5

q $x + 7 = \frac{1}{2}$ — −6.5

3 Solve these equations by inspection. Pay attention to how each question changes.

a $3x = 18$ — 6

b $3x = 15$ — 5

c $3x = 5$ — $\frac{5}{3}$

d $\frac{x}{3} = 5$ — 15

e $5 = \frac{x}{3}$ — 15

f $-5 = \frac{x}{3}$ — −15

g $-5 = -\frac{x}{3}$ — 15

h $-15 = -\frac{x}{3}$ — 45

i $-15 = -3x$ — 5

j $-16 = 2x$ — −8

k $-16 = 4x$ — −4

l $-16 = 16x$ — −1

4 Solve these equations by inspection. Pay attention to how each question changes.

a $2x + 3 = 21$

9

b $3 + 2x = 21$

9

c $2x - 3 = 21$

12

d $3 - 2x = 21$

−9

e $2x + 4 = 21$

8.5

f $2x + 23 = 21$

−1

g $\frac{x}{2} + 3 = 21$

36

h $3x + 3 = 21$

6

i $6x + 3 = 21$

3

j $\frac{x}{4} + 3 = 21$

72

5 Solve these equations by inspection. Pay attention to how each question changes.

a $x + 5 = 11$

6

b $2x + 7 = 13$

3

c $2x + 10 = 16$

3

d $3x + 10 = 19$

3

e $4x + 10 = 22$

3

f $10 + 4x = 22$

3

g $100 + 4x = 220$

30

h $4x + 100 = 110$

2.5

i $2x + 100 = 110$

5

j $20x + 100 = 110$

0.5

6 Find the solution to these equations.

a $2(x - 1) = 4 + 2$

4

b $2 = 17 - x - 1$

14

c $x \div 2 = 60 \div 4$

120

d $12 \times 5 = 2 \times (x + 3)$

27

7 Find two possible values of t that make the equation $t(10-t)=21$ true.

3 or 7

8 List possible solutions to $y=x+10$

Is there a limit to the number of solutions?

$x=1, y=9$ | $x=2, y=8$ | $x=-42.39, y=-32.39$. No limit.

9 Explain why the equation $x+3=x$ has no solutions.

It is not possible to add 3 to a number and have the number be unchanged.

10 Solve these equations by inspection.

a $3p-1=13$ 4	**b** $4m+6=23$ 4.25	**c** $\frac{x}{2}+4=8$ 8
d $7y+1=20$ $\frac{19}{7}$	**e** $\frac{n}{5}+2=5$ 15	**f** $2x+12=6$ -3
g $7=\frac{c}{3}-4$ 33	**h** $10x+1=7$ 0.6	**i** $10+\frac{t}{2}=2$ -16
j $4(3y-1)=0$ $\frac{1}{3}$	**k** $5(g+1)=22$ 3.4	**l** $\frac{y}{4}+10=4$ -24
m $1=\frac{-2u-3}{5}$ -4	**n** $-2=\frac{4d}{5}+2$ -5	**o** $0=12+\frac{2u}{5}$ -30
p $3\left(\frac{2x+9}{4}\right)-5=7$ $\frac{7}{2}$	**q** $7\left(\frac{4y-3}{9}\right)+5=17$ $\frac{129}{28}$	**r** $4(2x+3)-3(4x+5)=0$ $-\frac{3}{4}$

EQUIVALENT EQUATIONS

Investigation Equivalent equations

1 Find the value of x in these equations.

a $x + 1 = 4$ .....

$+5 \quad +5$

b $x + 6 = 9$ .....

$-3 \quad -3$

c $x + 3 = 6$ .....

$\times 2 \quad \times 2$

d $2x + 6 = 12$ .....

$\times 3 \quad \times 3$

e $6x + 18 = 36$ .....

$\div 2 \quad \div 2$

f $3x + 9 = 18$ .....

What do you notice about your answers?

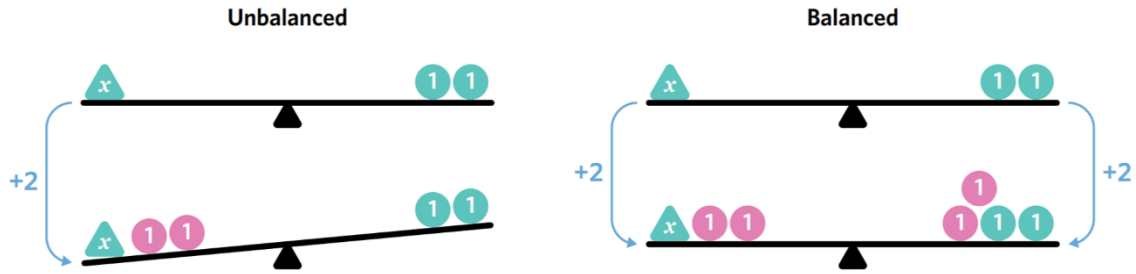
.....

All the equations above are “equivalent.” What might that mean?

.....

EQUIVALENT EQUATIONS

- **Equivalent** equations have the **same solution**.
- Applying the same operation to both sides creates an equivalent equation.



- When working with equations, line up the equal symbols and write a new line for each operation you do.

Example Produce equivalent equations by addition/subtraction.

Determine the equation after -2 is applied to both sides.

$3x + 2 = 11$

$-2 \quad -2$

$\ldots\ldots\ldots = \ldots\ldots\ldots$

$3x + 2 = 11$

$-2 \quad -2$

$3x = 9$

Why did $+2$ disappear from the LHS?

$+2$ and -2 make .....

Identify the operation done to both sides.

$2x = 5$

$\ldots\ldots\ldots \quad \ldots\ldots\ldots$

$2x + 10 = 15$

$2x = 5$

$+10 \quad +10$

$2x + 10 = 15$

Why does $2x + 10$ not become $12x$?

$2x$ and $+10$ are not ..... terms.

Fill in the blanks.

a $10x + 5 = 20$

$-5 \quad -5$

$\ldots\ldots\ldots = \ldots\ldots\ldots$

$10x = 15$

b $3x = 7$

$+2 \quad +2$

$\ldots\ldots\ldots = \ldots\ldots\ldots$

$3x + 2 = 9$

c $x - 6 = 5$

$\ldots\ldots \quad \ldots\ldots$

$x = 11$

$+6 \quad +6$

Example Produce equivalent equations by multiplication/division.

Determine the equation after $\times 2$ is applied to both sides.

$3x + 1 = 4$

$\times 2 \quad \times 2$

$\ldots\ldots\ldots = \ldots\ldots\ldots$

$3x + 1 = 4$

$\times 2 \quad \times 2$

$6x + 2 = 8$

Why does multiplying $3x + 1$ by 2 make $6x + 2$

$2(3x + 1)$, *the ..... law says to multiply ..... number inside the brackets.*

Identify the operation done to both sides.

$6x + 2 = 4$

$\ldots\ldots\ldots \quad \ldots\ldots\ldots$

$3x + 1 = 2$

$6x + 2 = 4$

$\div 2 \quad \div 2$

$3x + 1 = 2$

When do we have to apply an operation to every term?

When ..... or ..... either side of an equation.

Fill in the blanks.

a $4x = 20$

$\div 4 \quad \div 4$

$\ldots\ldots\ldots = \ldots\ldots\ldots$

$x = 5$

b $3x = 7$

$\times 2 \quad \times 2$

$\ldots\ldots\ldots = \ldots\ldots\ldots$

$6x = 14$

c $x - 3 = 4$

$\times 2 \quad \times 2$

$\ldots\ldots\ldots = \ldots\ldots\ldots$

$2x - 6 = 8$

d $6x + 9 = 12$

$\div 3 \quad \div 3$

$\ldots\ldots\ldots = \ldots\ldots\ldots$

$2x + 3 = 4$

e $2x - 4 = 3$

$\ldots\ldots \quad \ldots\ldots$

$6x - 12 = 9$

$\times 3 \quad \times 3$

f $2x - 3 = 6$

$\ldots\ldots \quad \ldots\ldots$

$x - \frac{3}{2} = 3$

$\div 2 \quad \div 2$

Key ideas

1. If two equations are equivalent, then they have the same .....
2. If we apply the same operation to ..... sides of an equation, then the resulting equation will be equivalent to the original.
3. When adding and subtracting, remember to simplify by combining ..... terms.
4. When multiplying and dividing, remember to multiply or divide every ..... of the equation using the ..... law.

1 For each equation, show the equivalent equation after the operation shown is applied to both sides.

a $10d + 5 = 20$

$+10 \quad +10$

..... = ...

$10d + 15 = 30$

b $7e = 31$

$+3 \quad +3$

..... = ...

$7e + 3 = 34$

c $5 + x = 10$

$+1 \quad +1$

..... = ...

$6 + x = 11$

d $3x = 7$

$\times 2 \quad \times 2$

..... = ...

$6x = 14$

e $12 = 8q$

$\div 4 \quad \div 4$

..... = ...

$3 = 2q$

f $9 + a = 13$

$-3 \quad -3$

..... = ...

$6 + a = 10$

g $7 + b = 10$

$+5 \quad +5$

..... = ...

$2 + b = 5$

h $5 = 3b + 7$

$-5 \quad -5$

..... = ...

$0 = 3b + 2$

i $12x - 3 = 3$

$+5 \quad +5$

..... = ...

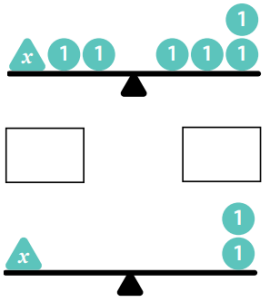
$12x + 2 = 8$

2 Determine the operation done to both sides.

a $x + 2 = 4$

....

$x = 2$

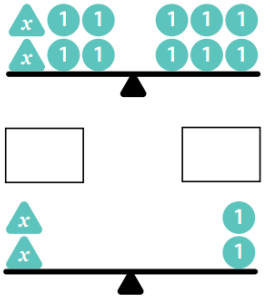


-2

b $2x + 4 = 6$

....

$2x = 2$

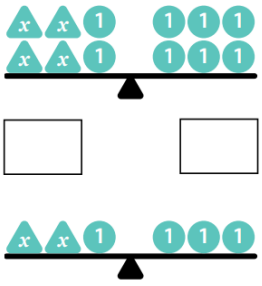


-4

c $4x + 2 = 6$

....

$2x + 1 = 3$

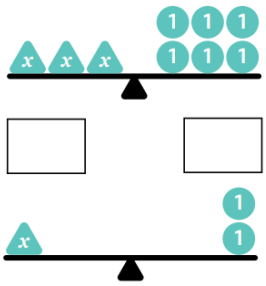


$\div 2$

d $3x = 6$

....

$x = 2$

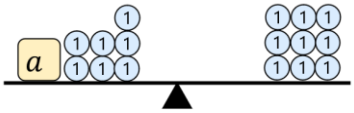


$\div 3$

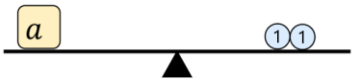
3 Identify the operation done to both sides of these balance models.

a

$a + 7 = 9$



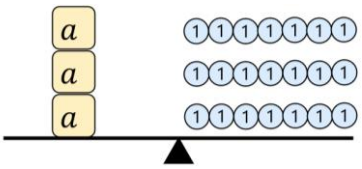
$a = 2$



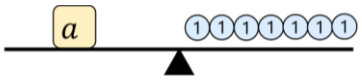
-7

b

$3a = 21$



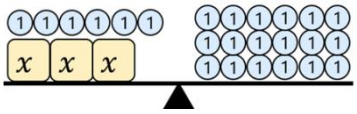
$a = 7$



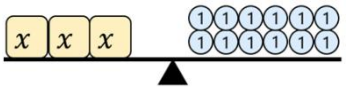
$\div 3$

c

$3x + 6 = 18$



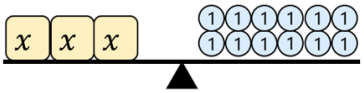
$3x = 12$



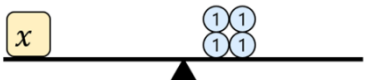
-6

d

$3x = 12$



$x = 4$



$\div 3$

4 Draw lines to match up the equation on the top with the equivalent equation on the bottom, where 3 has been added to both sides.

a $10 + x = 14$ $+3$ $+3$

b $x + 1 = 13$ $+3$ $+3$

c $12 = x + 5$ $+3$ $+3$

d $x + 10 = 11x$ $+3$ $+3$

A $x + 13 = 11x + 3$

B $13 + x = 17$

C $x + 4 = 16$

D $15 = x + 8$

a – B, b – C, c – D, d – A

5 Complete the following to show what operation was done to both sides of the equation.

a

$5 + a = 30$

$\square$ $\square$

$a = 25$

-5

b

$10b = 72$

$\square$ $\square$

$b = 7.2$

$\div 10$

c

$12 = \frac{c}{4}$

$\square$ $\square$

$48 = c$

$\times 4$

d

$8 = c - 12$

$\square$ $\square$

$20 = c$

$+12$

6 These equations are equivalent. Determine the operation that has been done to both sides.

a $4x + 2 = 10$

....

$4x = 8$

-2

b $7 + 3b = 12$

....

$9 + 3b = 14$

$+2$

c $20a = 10$

....

$2a = 1$

$\div 10$

d $4 = 12 - x$

....

$8 = 24 - 2x$

$\times 2$

e $18 = 3x$

....

$6 = x$

$\div 3$

f $12 + x = 3$

....

$15 + x = 6$

$+3$

g $40 + 4b = 80$

....

$10 + b = 20$

$\div 4$

h $12x = 5$

....

$12x + 4 = 9$

-4

i $2x + 3 = 5$

....

$x + \frac{3}{2} = \frac{5}{2}$

$\div 2$

7 Write down the missing expressions using the operation shown between each line.

a

$2n - 5 = 15$

$\downarrow +5$

$2n =$

$\downarrow \div 2$

$n =$

$2n = 20$

$n = 10$

b

$3d + 4 = 19$

$\downarrow -4$

$3d =$

$\downarrow \div 3$

$=$

$3d = 15$

$d = 5$

c

$3 + 2p = 13$

$\downarrow -3$

$=$

$\downarrow \div 2$

$=$

$2p = 10$

$p = 5$

d

$\frac{a}{2} + 3 = 8$

$\downarrow -3$

$\frac{a}{2} =$

$\downarrow \times 2$

$a =$

$\frac{a}{2} = 5$

$a = 10$

e

$\frac{h}{3} - 4 = 1$

$\downarrow +4$

$=$

$\downarrow \times 3$

$=$

$\frac{h}{3} = 5$

$h = 15$

f

$\frac{k+6}{7} = 2$

$\downarrow \times 7$

$=$

$\downarrow -6$

$=$

$k + 6 = 14$

$k = 8$

8 Write down the operations done between each line of working out.

a

$4n - 3 = 17$ (+ 3)

$4n = 20$ (÷ 4)

$n = 5$

b

$5d + 6 = 26$ (− 6)

$5d = 20$ (÷ 5)

$d = 4$

c

$3 + 2p = 33$ (−3)

$2p = 30$ (÷ 2)

$p = 15$

d

$\frac{a}{3} + 5 = 9$ (−5)

$\frac{a}{3} = 4$ (× 3)

$a = 12$

e

$\frac{h}{2} - 3 = 7$ (+3)

$\frac{h}{2} = 10$ (× 2)

$h = 20$

f

$\frac{k+3}{5} = 2$ (× 5)

$k + 3 = 10$ (−3)

$k = 7$

g

$\frac{3w - 5}{4} = 7$ (× 4)

$3w - 5 = 28$ (+ 5)

$3w = 33$ (÷ 3)

$w = 11$

h

$3(2b - 4) = 30$ (÷ 3)

$2b - 4 = 10$ (+4)

$2b = 14$ (÷ 2)

$b = 7$

9 For each equation, show the equivalent expression after adding 4 to both sides then multiplying both sides by 3.

a $x = 5$

..... = ...

$x + 4 = 9$

..... = ...

$3x + 12 = 27$

b $2 = a + 1$

..... = ...

$6 = a + 5$

..... = ...

$18 = 3a + 15$

c $d - 4 = 2$

..... = ...

$d = 6$

..... = ...

$3d = 18$

d $7 + a = 8$

..... = ...

$11 + a = 12$

..... = ...

$33 + 3a = 36$

e $3y - 2 = 7$

..... = ...

$3y + 2 = 11$

..... = ...

$9y + 6 = 33$

f $2x = 6$

..... = ...

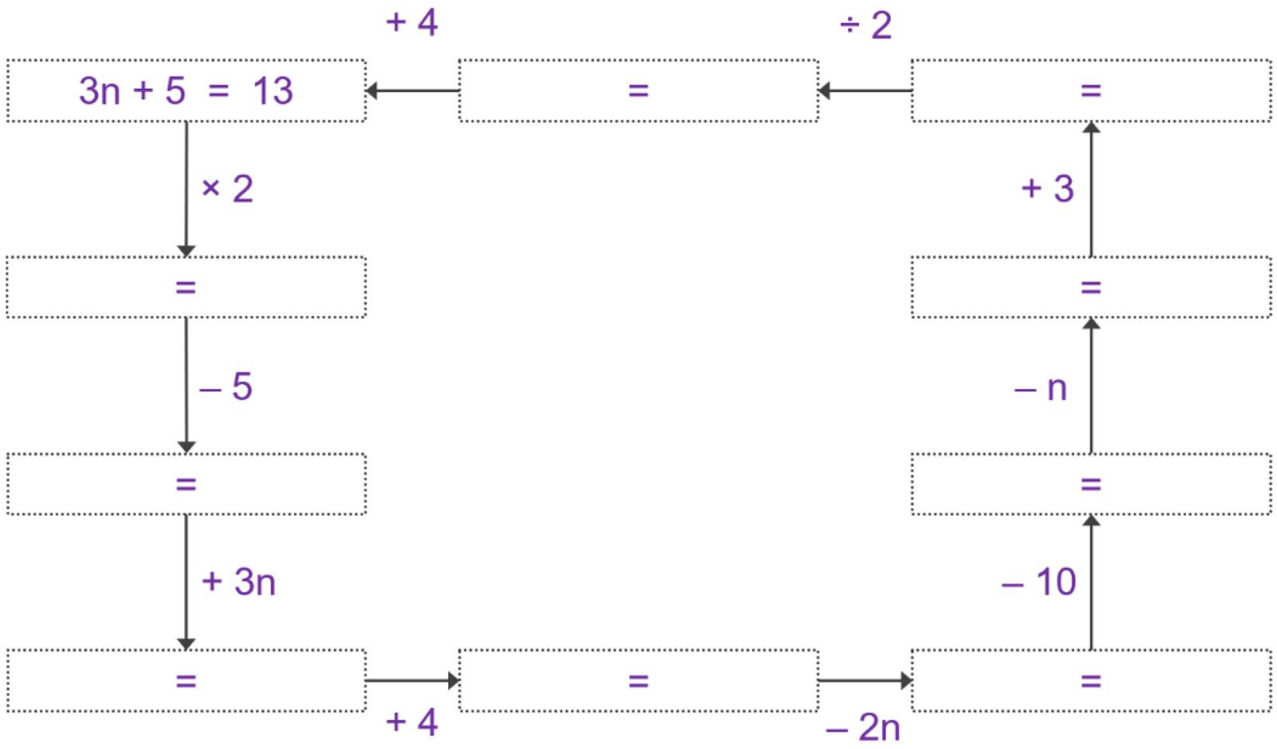
$2x + 4 = 10$

..... = ...

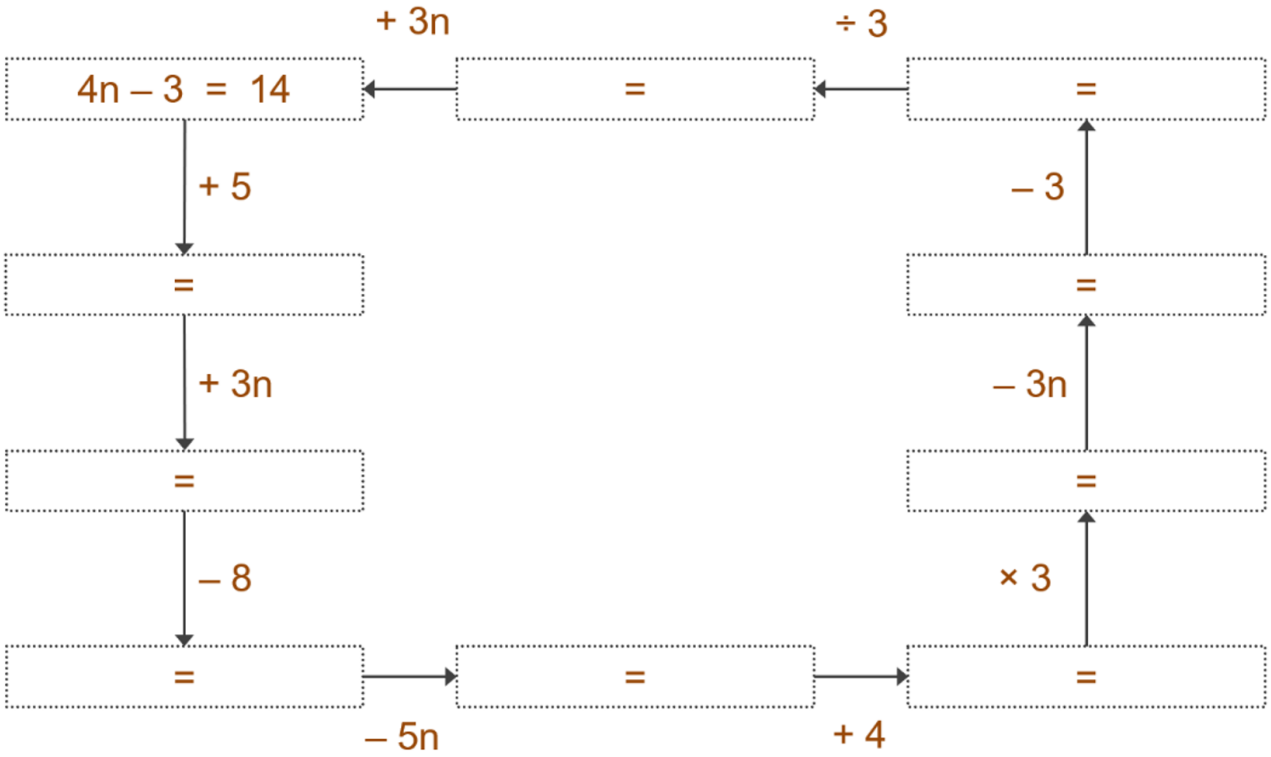
$6x + 12 = 30$

10 Complete the loop by carrying out the operation shown to both sides of the equation.

a



b



11 For each equivalent equation, indicate the operation that has been done to both sides.

a

$3n + 2 = 25$

+ 8

$3n + 10 = 33$

– 11

$3n - 1 = 22$

+ 2n

$5n - 1 = 2n + 22$

+ 6

$5n + 5 = 2n + 28$

– n

$4n + 5 = n + 28$

– 3n

$n + 5 = -2n + 28$

× 2

$2n + 10 = -4n + 56$

+ 4n

$6n + 10 = 56$

– 10

$6n = 46$

b

$4n - 5 = 12$

+ 10

$4n + 5 = 22$

× 2

$8n + 10 = 44$

+ n

$9n + 10 = n + 44$

– 4n

$5n + 10 = -3n + 44$

+ 3n – 4

$8n + 6 = 40$

– 5n – 1

$3n + 5 = -5n + 39$

+ n

$4n + 5 = -4n + 39$

+ 4n – 5

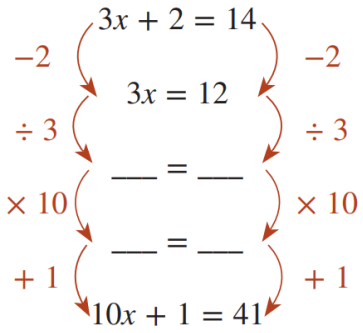
$8n = 34$

÷ 2

$4n = 17$

12

a Complete to show $3x + 2 = 14$ is equivalent to $10x + 1 = 41$



$x = 4$

$10x = 40$

b Do something similar to show that $5x - 3 = 32$ is equivalent to $x + 2 = 9$
(hint: find the value of x first)

13 Given that $\frac{p}{9} = 39$, write down the value of these expressions.

a $\frac{p}{9} + 1$ 40

b p 351

c $127 - \frac{p}{9}$ 88

d $3p$ 1053

14 Use your knowledge of equivalence to find the value of an expression given the value of another expression.

a $3n^2 + 2n = 15$

(a) $3n^2 + 2n + 4 =$ 19

(b) $3n^2 + 2n - 19 =$ −4

(c) $12n^2 + 8n =$ 60

b $2.5d - 3 = 8$

(a) $5d - 6 =$ 16

(b) $100d - 120 =$ 320

(c) $5d + 1 =$ 23

c $0.5b - 5 = 98$

(a) $0.5b + 5 =$ 108

(b) $0.25b - 2.5 =$ 49

(c) $b - 10 =$ 196

d $3e = 5$

(a) $9e^2 =$ 25

(b) $3(e + 5) =$ 20

(c) $3e =$ 5

e $\frac{3}{8}n + 7 = 20$

(a) $\frac{3}{8}n + 2 =$ 15

(b) $\frac{3}{4}n + 14 =$ 30

(c) $3n + 56 =$ 120

f $6(t - 7) = 96$

(a) $t - 7 =$ 16

(b) $\frac{1}{3}(6(t - 7) - 6) =$ 20

(c) $6(t - 3) =$ 120

ONE-STEP EQUATIONS

Investigation Solving equations.

1 Write an equation to represent this scenario:

……

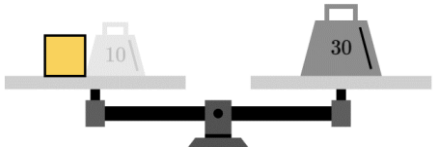
How do we find the weight of one square?

The weight of a square plus …… is 40.

To find the weight of a square, we ……. 10 from both sides.

Show the operation done to both sides to solve this equation.

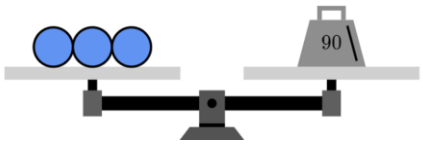
$$x + 10 = 40$$



…… ……

$$x = 30$$

2 Write an equation to represent this scenario:



……

How do we find the weight of one circle?

The weight of ……. circles is 90.

To find the weight of one circle, we divide both sides by ……

Show the operation done to both sides to solve this equation.

$$3x = 90$$

…… ……

$$x = 30$$

SOLVING EQUATIONS

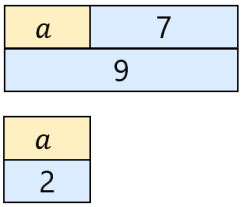
- To solve equations, we **isolate x** using **inverse operations**.
  1. Identify the operation done to x.
  2. Undo the operation done to x by applying the inverse operation to both sides.

Example Solve one-step equations.

$a + 7 = 9$

$-7 \quad -7$

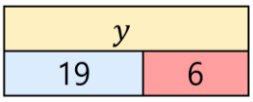
$a = 2$



$y - 6 = 19$

$+6 \quad +6$

$y = 25$



Solve these equations.

a $x + 6 = 10$

....

$x =$ .....

$x = 4$

b $x - 10 = 22$

....

$x =$ .....

$x = 32$

c $a - 15 = 2$

....

$a =$ .....

$a = 17$

d $x + 12 = 15$

....

$x =$ .....

$x = 3$

e $x + 5.5 = 7$

....

$x =$ .....

$x = 1.5$

f $y - 4.2 = 15$

....

$y =$ .....

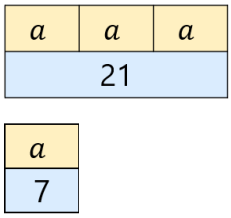
$y = 19.2$

Example Solve one-step equations.

$3a = 21$

$\div 3 \quad \div 3$

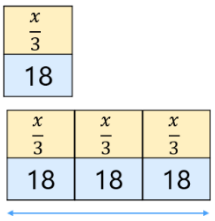
$a = 7$



$18 = \frac{x}{3}$

$\times 3 \quad \times 3$

$54 = x$



Solve these equations.

a $4x = 24$

....

$x =$ .....

$x = 6$

b $\frac{x}{5} = 7$

....

$x =$ .....

$x = 35$

c $\frac{y}{2} = 12$

....

$y =$ .....

$x = 24$

d $7x = 42$

....

$x =$ .....

$x = 6$

e $\frac{x}{8} = 6$

....

$x =$ .....

$x = 48$

f $10x = 15$

....

$y =$ .....

$x = 1.5$

Key ideas

1. To solve equations, we identify the operation done to x, then undo the operation by applying the ..... operation to ..... sides of the equation.

1 Fill in the missing numbers.

a

$x + 11 = 20$

$x = 9$

-11

b

$x - 9 = 10$

$x = 19$

$+9$

c

$3x = 30$

$x = 10$

$\div 3$

d

$\times 4$ $\frac{b}{4} = 11$ $\times 4$

$b = \_\_$

44

e

$\times 5$ $\frac{d}{5} = 3$ $\times 5$

$d = \_\_$

15

f

$\frac{z}{10} = 2$

$z = \_\_$

$\times 10, 20$

g

$\div 10$ $10x = 30$ $\div 10$

$x = \_\_$

3

h

-5 $q + 5 = 12$ -5

$\_\_ = \_\_$

$q = 7$

i

$+3$ $k - 3 = 8$ $+3$

$\_\_ = \_\_$

$k = 11$

j

$\times 3$ $\frac{x}{3} = 10$ $\times 3$

$x = \_\_$

30

k

$\times 5$ $\frac{m}{5} = 2$ $\times 5$

$m = \_\_$

10

l

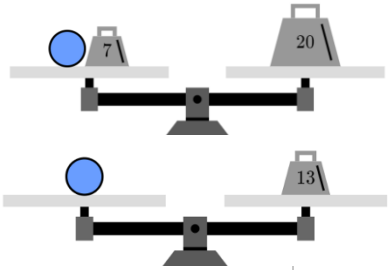
$11 = \frac{q}{2}$

$\_\_ = q$

$\times 2, 22$

2 Solve these equations by applying the inverse operation to both sides.
Use the diagram to help you.

a



$x + 7 = 20$

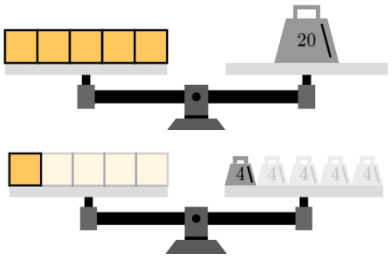
....

-7 -7

$x =$ .....

$x = 13$

b



$5x = 20$

....

$\div 5$ $\div 5$

$x =$ .....

$x = 4$

c

$x - 2 = 7$

$x =$ ☐

$+2, 9$

d

$5x = 25$

$x =$ ☐

$\div 5, 5$

e

$12x = 96$

$x =$ ☐

$\div 12, 8$

f

$\frac{x}{4} = 4$

$x =$ ☐

$\times 4, 16$

3 State the inverse operation to apply to both sides and the solution.

a	$x+3=8$	-3	$x=$ 5	**j**	$-7+x=-6$	+7	$x=$ 1
b	$3+x=8$	−3	$x=$ 5	**k**	$-7+x=-7$	+7	$x=$ 0
c	$8=x+3$	−3	$x=$ 5	**l**	$7+x=-7$	−7	$x=$ −14
d	$8=x-3$	+3	$x=$ 13	**m**	$7+x=0$	−7	$x=$ −7
e	$9=x-3$	+3	$x=$ 12	**n**	$-7+x=0$	+7	$x=$ 7
f	$9=x-4$	+4	$x=$ 13	**o**	$-7+x=\frac{1}{2}$	+7	$x=$ 7.5
g	$7=x-6$	+6	$x=$ 13	**p**	$x-7=\frac{1}{2}$	+7	$x=$ 7.5
h	$-7=x-6$	+6	$x=$ −1	**q**	$x+7=\frac{1}{2}$	−7	$x=$ −6.5
i	$-7=-6+x$	+6	$x=$ −1				

4 State the inverse operation to apply to both sides and the solution.

a	$3x=18$	$\div 3$	$x=$ 6	**h**	$-15=-\frac{x}{3}$	× (−3)	$x=$ 45
b	$3x=15$	÷ 3	$x=$ 5	**i**	$-15=-3x$	÷ (−3)	$x=$ 5
c	$3x=5$	÷ 3	$x=$ $\frac{5}{3}$	**j**	$-16=2x$	÷ 2	$x=$ −8
d	$\frac{x}{3}=5$	× 3	$x=$ 15	**k**	$-16=4x$	÷ 4	$x=$ −4
e	$5=\frac{x}{3}$	× 3	$x=$ 15	**l**	$-16=8x$	÷ 8	$x=$ −2
f	$-5=\frac{x}{3}$	× 3	$x=$ −15	**m**	$-16=16x$	÷ 16	$x=$ −1
g	$-5=-\frac{x}{3}$	× (−3)	$x=$ 15				

5 Show the inverse operations and solve these equations.

a $x - 6 = 24$

$+6$ $+6$

$x =$

x = 30

b $x + 10 = 5$

x = –5

c $3x = 12$

x = 4

d $\frac{x}{5} = 1$

x = 5

e $8 + x = 21$

x = 13

f $x - 4 = -8$

x = –4

g $9x = 3$

x = 3

h $-2x = 20$

x = – 10

i $\frac{x}{7} = -1$

x = –7

j $\frac{x}{10} = 1.2$

x = 12

k $4x = -20$

x = –5

l $2x = -1$

x = –0.5

m $x + 7 = 16$

x = 9

n $y + 15 = 13$

y = –2

o $m - 3 = 8$

m = 11

p $a - 12 = 5$

a = 17

q $3k = 27$

k = 9

r $14w = 42$

w = 3

s $q \div 4 = 24$

q = 96

t $z \div (-2) = 8$

z = – 16

u $b - 13 = -7$

b = 6

v $15 + g = -4$

g = – 19

w $-2r = -13$

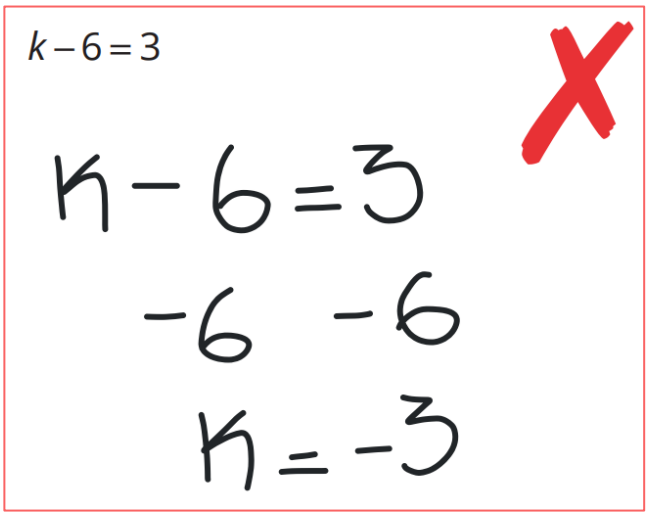
r = 6.5

6 Solve the equations,

a $g + 5 = 20$ g = 15	**b** $g - 5 = 20$ g = 25	**c** $g + 5 = -20$ g = – 25	**d** $g - 5 = -20$ g = – 15
e $5g = 20$ g = 4	**f** $5g = -20$ g = – 4	**g** $\frac{g}{5} = 20$ g = 100	**h** $\frac{g}{5} = -20$ g = – 100

7 Read the examples carefully and answer the questions.

Marvin's work:



Why is Marvin's work incorrect?

He subtracted 6 from both sides instead of adding 6

How could Marvin have checked whether -3 was the correct answer?

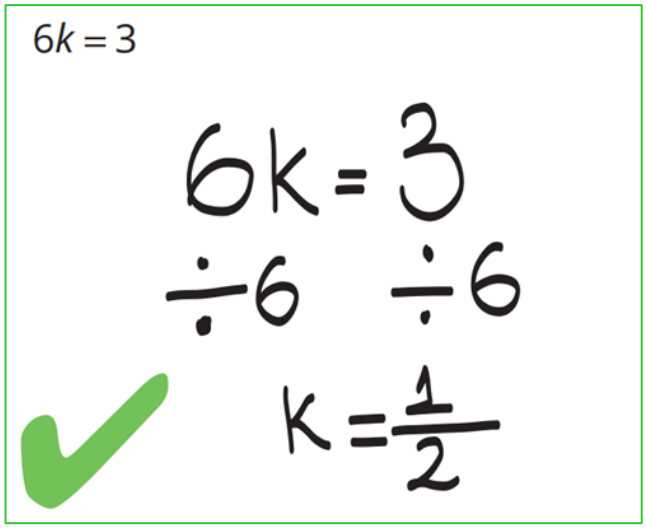
By substituting it back into the equation

Solve:

$$k - 52 = 39$$

91

Hannah's work:



Why couldn't Hannah subtract 6 to get the k by itself?

k was multiplied by 6,
so the inverse operation is to divide, not subtract.

Solve:

$$\frac{k}{6} = 3$$

18

8 Write an equation to represent the scenario, then solve to find the number.

a A number is tripled to obtain the result 21.

$3x = 21, x = 7$

b Six less than a number is 7.

$x - 6 = 7, x = 13$

c A number is doubled and the result is −16.

$2x = -16, x = -8$

d One-quarter of a number is 30.

$\frac{x}{4} = 30, x = 120$

e Six more than a number is −7.

$x + 6 = -7. x = -13$

9 Solve these equations

a $x + \frac{4}{11} = 2$

$x = \frac{18}{11}$

b $\frac{13}{15} = y - \frac{8}{15}$

$y = \frac{7}{5}$

c $z + \frac{14}{23} = \frac{5}{23}$

$z = -\frac{9}{23}$

d $\frac{27}{39} - a = 1$

$a = -\frac{4}{13}$

e $b + \frac{5}{13} = 1 - \frac{15}{13}$

$b = -\frac{7}{13}$

f $2c - \frac{3}{51} = -1$

$c = -\frac{8}{17}$

10 There are six equations in the square below.
Find the values of the pronumerals to make all equations true.

a = ……

b = ……

c = ……

d = ……

e = ……

a	+	12	=	22
×		÷		−
2	×	b	=	c
=		=		=
d	÷	e	=	10

$a = 10, b = 6, c = 12, d = 20, e = 2$

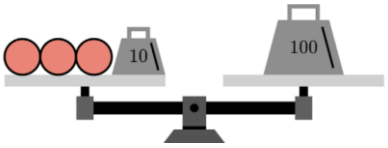
11 Solve these one-step equations involving negative integers.

a $-6 = y - 5$ $y = -1$	**b** $12 + s = 9$ $s = -3$	**c** $-3 = -1 + x$ $x = -2$	**d** $-2 = -3 + n$ $n = 1$
e $-7 = -2 + z$ $z = -5$	**f** $-2 = 3 + t$ $t = -5$	**g** $-15 = -14 + r$ $r = -1$	**h** $-3 + x = -5$ $x = -2$
i $-2 + y = -1$ $y = 1$	**j** $-8 = x - 13$ $x = 5$	**k** $-3 + x = -7$ $x = -4$	**l** $-10 = x - 20$ $x = 10$
m $-4g = 36$ $g = -9$	**n** $10s = -300$ $s = -30$	**o** $-9y = -9$ $y = 1$	**p** $7y = -42$ $y = -6$
q $45 = -5p$ $p = -9$	**r** $3y = -120$ $y = -40$	**s** $-32 = 16y$ $y = -2$	**t** $-7x = -35$ $x = 5$
u $-50 = -10m$ $m = 5$	**v** $-7n = 7$ $n = -1$	**w** $11 = -4q$ $q = -\frac{11}{4}$	**x** $-3 = 6d$ $d = -\frac{1}{2}$
y $\frac{1}{2}x = 8$ $x = 16$	**z** $-1 = \frac{1}{4}x$ $x = -4$	**aa** $-\frac{x}{5} = -20$ $x = 100$	**bb** $-\frac{1}{2}x = 6$ $x = -12$
cc $\frac{k}{3} = -6$ $k = -18$	**dd** $-3 = \frac{1}{3}x$ $x = -9$	**ee** $-2 = -\frac{1}{5}y$ $y = 10$	**ff** $-4 = \frac{1}{7}x$ $x = -28$
gg $-3 = \frac{x}{4}$ $x = -12$	**hh** $-\frac{p}{2} = 18$ $p = -36$	**ii** $-2 = \frac{x}{5}$ $x = -10$	**jj** $-8 = -\frac{k}{6}$ $k = 48$

TWO-STEP EQUATIONS

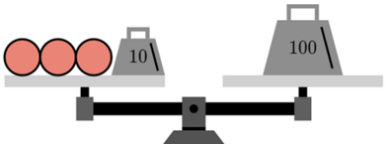
Investigation Solving equations.

1 Write an equation to represent this scenario:



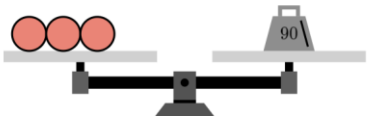
……

Consider the process for finding the weight of a circle below.
Identify the operation done to both sides between each step.



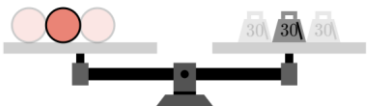
$3x + 10 = 100$

…… ……



$3x = 90$

…… ……

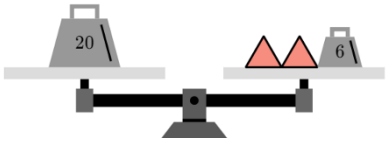


$x = 30$

How do you know the order of inverse operations? Why didn't we divide by 3 first?

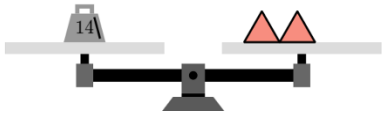
$3x + 10$ means × …… and + ……. To solve, we do ……. operations in the reverse order. So, we … 10 first, then … 3

2 Identify the operation done to both sides between each step.



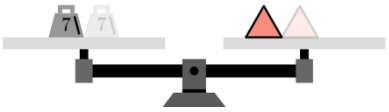
$20 = 2x + 6$

…… ……



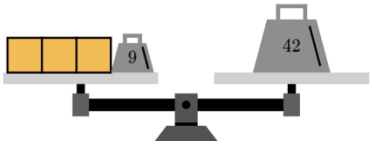
$14 = 2x$

…… ……



$7 = x$

3 Solve this equation.



$3x + 9 = 42$

…… ……

…… = ……

…… ……

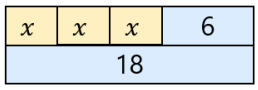
…… = ……

SOLVING TWO-STEP EQUATIONS

- To **solve equations**, we undo operations on x in the opposite order of BIDMAS.
  1. Undo addition/subtraction done to x.
  2. Undo multiplication/division done to x.

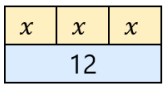
Example Solve two-step equations.

$3x + 6 = 18$



1. undo add $-6 \quad -6$

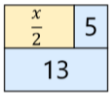
$3x = 12$



2. undo multi $\div 3 \quad \div 3$

$x = 4$

$\frac{x}{2} + 5 = 13$

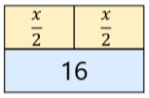


1. undo add $-5 \quad -5$

$\frac{x}{2} = 8$

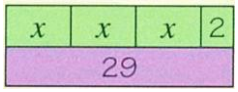
2. undo div $\times 2 \quad \times 2$

$x = 16$



Solve these equations.

a $3x + 2 = 29$



$\ldots\ldots \quad \ldots\ldots$

$3x = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$x = \ldots\ldots$

$x = 9$

b $5 + 4y = 49$

$\ldots\ldots \quad \ldots\ldots$

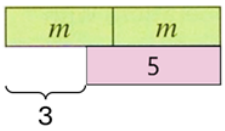
$4y = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$y = \ldots\ldots$

$x = 11$

c $2m - 5 = 3$



$\ldots\ldots \quad \ldots\ldots$

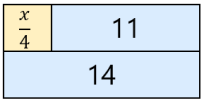
$\ldots\ldots = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$m = \ldots\ldots$

$m = 4$

d $\frac{x}{4} + 11 = 14$



$\ldots\ldots \quad \ldots\ldots$

$\ldots\ldots = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$x = \ldots\ldots$

$x = 12$

e $4x + 3 = 19$

$x = 4$

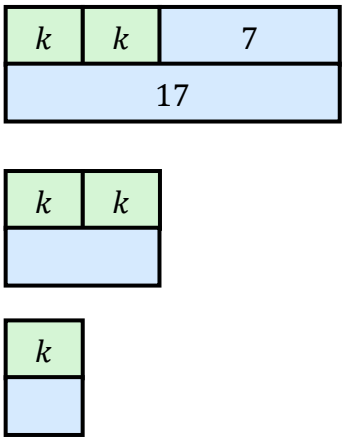
f $\frac{x}{6} - 11 = -10$

$x = 6$

Key ideas

1. To solve these equations, first identify the …… done to x,
2. Then apply the inverse operations in the reverse order to …… sides of the equation

1 The bar model shows the equation $2k + 7 = 17$.
Complete the working to show the steps for solving the equation.



$2k + 7 = 17$

$-$ ☐ $-$ ☐

$2k$ $=$ ☐

$\div$ ☐ $\div$ ☐

k $=$ ☐

-7 -7

10

$\div 2$ $\div 2$

5

2 Fill in the missing numbers.

a

$4x + 2 = 22$

-2 -2

$4x =$ ___

$\div 4$ $\div 4$

___ $=$ ___

20

$x = 5$

b

$4b - 10 = 14$

$+10$ $+10$

___ $=$ ___

☐ ☐

___ $=$ ___

$4b = 24$

$\div 4$ $\div 4$

$b = 6$

c

$26 = 10x - 4$

$+4$ $+4$

___ $=$ ___

☐ ☐

___ $=$ ___

$30 = 10x$

$\div 10$ $\div 10$

$3 = x$

d

$5 = \frac{x}{10} + 3$

-3 -3

___ $= \frac{x}{10}$

☐ ☐

___ $=$ ___

2

$\times 10$ $\times 10$

$20 = x$

e

$3x + 2 = 11$

☐ ☐

☐ $= 9$

☐ ☐

$x =$ ☐

-2 -2

$3x$

$\div 3$ $\div 3$

3

f

$2x - 6 = 10$

☐ ☐

$2x =$ ☐

☐ ☐

$x =$ ☐

$+6$ $+6$

16

$\div 2$ $\div 2$

8

3 What equation does the bar model show?

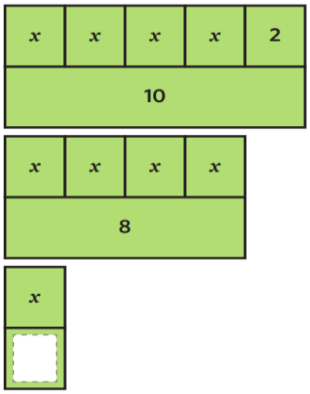
$5 + 4y = 49$

Solve the equation to find the value of y.

$y = 11$

4 Solve these equations. Use the bar model to help you.

a $4x + 2 = 10$



....

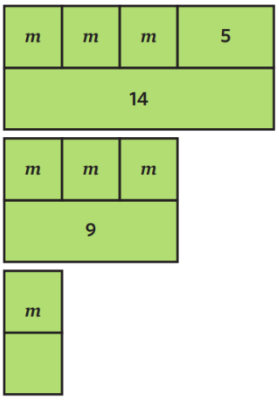
..... = ...

....

$x =$ .....

2

b $3m + 5 = 14$



....

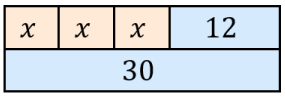
..... = ...

....

$m =$ .....

3

c $3x + 12 = 30$



....

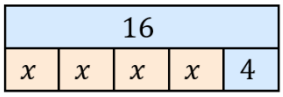
..... = ...

....

$x =$ .....

3

d $16 = 4x + 4$



....

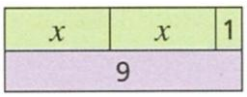
..... = ...

....

..... = x

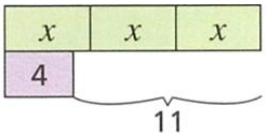
3

e $2x + 1 = 9$



4

f $4x - 4 = 11$



4

g $2x - 4 = 21$

$\frac{25}{2}$

h $4x - 5 = 3$

2

5 Solve these equations.

a $3c + 8 = 29$ $c = 7$	**b** $4n - 3 = 19$ $n = \frac{11}{2}$	**c** $10 + 5k = 80$ $k = 14$	**d** $3c + 8 = 29$ $c = 7$
e $8 + 10q = 2$ $q = -\frac{3}{5}$	**f** $17 = 12 + 5x$ $x = 1$	**g** $2x - 4 = -6$ $x = -1$	**h** $3y + 7 = -11$ $y = -6$
i $5b - 3 = -8$ $b = -1$	**j** $-15 = 6x - 9$ $x = -1$	**k** $17d + 12 = -5$ $d = -1$	**l** $2a + 5 = -11$ $a = -8$

6 Solve these equations.

a $\frac{k}{5} - 3 = 10$ $k = 65$	**b** $6 + \frac{p}{2} = 8$ $p = 4$	**c** $4 + \frac{t}{3} = 1$ $t = -9$	**d** $5 = \frac{a}{9} - 2$ $a = 63$
e $3 = \frac{n}{6} + 4$ $n = -6$	**f** $\frac{x}{2} + 3 = 7$ $x = 8$	**g** $\frac{x}{6} - 16 = -13$ $x = 18$	**h** $7 + \frac{h}{2} = 17$ $h = 20$

7 Solve these equations.

a $\frac{3x}{2} = 9$ $x = 6$	**b** $\frac{15x}{9} = 15$ $x = 9$	**c** $\frac{2x}{3} = 8$ $x = 12$	**d** $\frac{3n}{5} = 3$ $n = 5$
e $18 = \frac{6x}{7}$ $x = 21$	**f** $\frac{5y}{2} = -10$ $y = -4$	**g** $-3 = \frac{3x}{4}$ $x = -4$	**h** $\frac{5m}{2} = 11$ $m = \frac{22}{5}$

12 Solve these two-step equations.

a $3y - 7 = 2$ $y = 3$	**b** $-17 = 2s + 1$ $s = -9$	**c** $3 + 12n = 63$ $n = 5$	**d** $6z - 9 = 33$ $z = 7$
e $11c - 9 = 46$ $c = 5$	**f** $-7 + 20x = 53$ $x = 3$	**g** $-18 = 6 + 3m$ $m = -8$	**h** $7 = 6 + 4x$ $x = \frac{1}{4}$
i $-2 + 2z = -1$ $z = \frac{1}{2}$	**j** $0 = 2r - 1$ $r = \frac{1}{2}$	**k** $18 = 9 + 2s$ $s = \frac{9}{2}$	**l** $0.5n + 0.2 = 0.4$ $n = 0.4$

8 Solve $\frac{x}{3} + 5 = 8$ by:

a Multiplying both sides first. (Distributive law says to multiply every term).

$x + 15 = 24$
$x = 9$

b Subtracting 5 from both sides first.

$\frac{x}{3} = 3$
$x = 9$

c You should have gotten the same solution in **a** and **b**. Which method do you prefer?

9 Solve $5x + 2 = 17$ by:

a Subtracting 2 from both sides first.

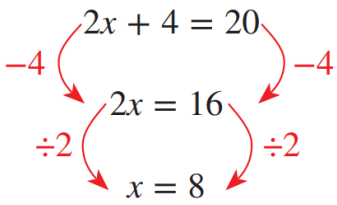
$5x = 15$
$x = 3$

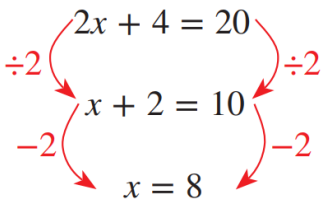
b Dividing both sides by 5 first. (Distributive law says to divide every term).

$x + \frac{2}{5} = \frac{17}{5}$
$x = \frac{15}{5} = 3$

c You should have gotten the same solution in **a** and **b**. Which method do you prefer?

10 It is possible to solve $2x + 4 = 20$ by first dividing both sides by 2, as long as every term is divided by 2.





Use this method of dividing first to solve the following equations, and then check that you get the same answer as if you subtracted first.

a $2x + 6 = 12$

$x = 3$

b $4x + 12 = 16$

$x = 1$

c $10x + 30 = 50$

$x = 2$

d $2x + 5 = 13$

$x = 4$

e $5x + 4 = 19$

$x = 3$

f $3 + 2x = 5$

$x = 1$

g $8 = 2x + 4$

$x = 2$

h $10 = 4x + 10$

$x = 0$

11 Read the examples carefully and answer the questions.

Mackenzie's work:

$6 = 3 + 2k$

$\frac{6}{2} = \frac{3 + 2k}{2}$

$3 = 3 + k$

If Mackenzie wanted to start by getting rid of the 2 in $2k$, what should she have done differently?

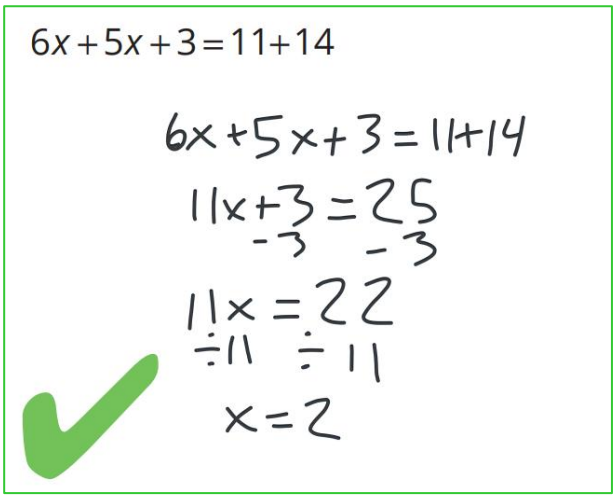
Divide every term by 2, including the 3.

Solve:

$6 = -3 + 2k$

$k = 4.5$

Ken's work:



In the first step, Ken combined $6x$ and $5x$. Why didn't he also add the 3 to get 14x?

3 is not a like term.

Solve:

$$-11 = -6x - 3x - 2$$

$x = 1$

12 Simplify these expressions before solving them.

a $13 + 2n + 2n = 41$

$n = 7$

b $3n + 17 + 2n = 62$

$n = 9$

c $3n + 7 + n - 4 = 35$

$n = 8$

d $3n + 7 - n + 4 = 37$

$n = 13$

e $2x + 37 + 4 - 2x = 41$

x can be any number

f $3 + 2n + 3n - 8 = 14$

$n = \frac{19}{5}$

13 When solving $\frac{2x}{3} = 10$ we first multiply the denominator, but we could have rewritten the equation as $2\left(\frac{x}{3}\right)$ and divided both sides by 2.

a Solve $2\left(\frac{x}{3}\right) = 10$ by dividing first.

$\frac{x}{3} = 5$

$x = 15$

b Solve $\frac{2x}{3} = 10$ by multiplying first.

$2x = 30$

$x = 15$

c Hence solve $\frac{147x}{13} = 1470$

$\frac{x}{13} = 10$

$x = 130$

TWO-STEP EQUATIONS INVOLVING NEGATIVE COEFFICIENTS

- In algebra, we treat minus signs as "negative" rather than subtraction.
  1. Undo addition/subtraction done to x.
  2. Undo multiplication/division done to x.

Example Solve two-step equations involving negative coefficients.

	$6-3x=18$		$-7-\frac{x}{2}=13$
1. undo add	$-6 \quad -6$	1. undo sub	$+7 \quad +7$
	$-3x=12$		$-\frac{x}{2}=20$
2. undo multi	$\div -3 \quad \div -3$	2. undo div	$\times -2 \quad \times -2$
	$x=-4$		$x=-40$

Solve these equations.

a $-3x+5=11$

$\ldots\ldots \quad \ldots\ldots$

$-3x = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$x = \ldots\ldots$

$x=-2$

b $5-4y=49$

$\ldots\ldots \quad \ldots\ldots$

$-4y = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$y = \ldots\ldots$

$x=-11$

c $3-x=5$

$\ldots\ldots \quad \ldots\ldots$

$\ldots\ldots = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$x = \ldots\ldots$

$x=-2$

d $-\frac{x}{4}-11=3$

$\ldots\ldots \quad \ldots\ldots$

$\ldots\ldots = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$x = \ldots\ldots$

$x=-56$

e $7-\frac{x}{3}=19$

$x=-36$

f $-\frac{5x}{6}=-5$

$x=6$

Key ideas

1. Equations like $3-x=5$ and $8-4x=7$ have a negative …… of x
2. The operations done to x in the expression $8-4x$ are ×……, then +……
3. Therefore, the inverse operations should be first −……, then ……

1 Solve these equations.

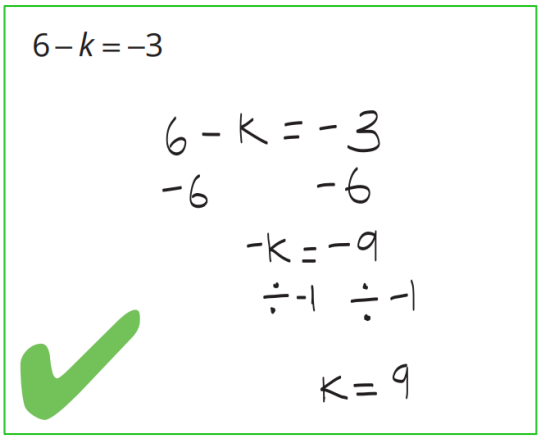
a $-2x + 18 = 4$ $x = 7$	**b** $-3a + 9 = 6$ $a = 1$	**c** $-\frac{x}{3} + 4 = 8$ $x = -12$	**d** $-\frac{x}{2} + 1 = -10$ $x = 22$
e $18 - 2x = 4$ $x = 7$	**f** $9 - 3a = 6$ $a = 1$	**g** $4 - \frac{x}{3} = 8$ $x = -12$	**h** $1 - \frac{x}{2} = -10$ $x = 22$

You should have gotten the same answer in each column. Explain why.

The equations in each column are the same, the terms are just switched around.

2 Read Eliza's work carefully and answer the questions.

Eliza's work:



Why did Eliza subtract 6 from both sides of the equation? Why didn't she add 6?

The 6 term is positive, so we subtract 6.

Why did Eliza divide by –1?

$-k$ means $-1 \times k$, so we divide by – 1.

Solve:

$$8 - k = 3$$

$k = 5$

3 Solve these equations.

a $-x + 5 = 12$ $x = -7$	**b** $5 - x = 12$ $x = -7$	**c** $-a - 9 = 6$ $a = -15$	**d** $-9 - a = 6$ $a = -15$
e $12 - x = 15$ $x = -3$	**f** $-2 - x = 9$ $x = -11$	**g** $2 = -x + 9$ $x = 7$	**h** $-8 = 19 - x$ $x = 27$
i $4x - 5 = 19$ $x = 6$	**j** $\frac{x}{4} - 5 = 19$ $x = 96$	**k** $5 - 4x = 19$ $x = -3.5$	**l** $5 - \frac{x}{4} = 19$ $x = -56$

4 Solve these equations.

a	$2x + 5 = 11$	$x = 3$	**h**	$4x + 100 = 110$	$x = 2.5$	**o**	$4 - 2x = 21$	$x = -8.5$
b	$2x + 7 = 13$	$x = 3$	**i**	$2x + 100 = 110$	$x = 5$	**p**	$21 = -2x + 4$	$x = -8.5$
c	$2x + 10 = 16$	$x = 3$	**j**	$20x + 100 = 110$	$x = 0.5$	**q**	$21 = -2x + 23$	$x = 1$
d	$3x + 10 = 19$	$x = 3$	**k**	$2x + 3 = 21$	$x = 9$	**r**	$23 - 2x = 21$	$x = 1$
e	$4x + 10 = 22$	$x = 3$	**l**	$3 + 2x = 21$	$x = 9$	**s**	$\frac{x}{2} - 3 = 21$	$x = 48$
f	$10 + 4x = 22$	$x = 3$	**m**	$2x - 3 = 21$	$x = 12$	**t**	$3 - \frac{x}{2} = 21$	$x = -36$
g	$100 + 4x = 220$	$x = 30$	**n**	$-2x + 3 = 21$	$x = -9$	**u**	$0.1x + 3 = 21$	$x = 180$

5 Solve these equations involving negative coefficients of x.

a $17 - r = 7$ $r = 10$

b $-1 = -2 - a$ $a = -1$

c $2 - d = 5$ $d = -3$

d $-y - 5 = 14$ $y = -19$

e $15 = -a - 2$ $a = -17$

f $2 = 9 - b$ $b = 7$

g $2 - a = 3$ $a = -1$

h $-c - 4 = 5$ $c = -9$

i $6 = 4 - w$ $w = -2$

j $7 = -x - 2$ $x = -9$

k $-x - 1 = -6$ $x = 5$

l $-2 = 7 - t$ $t = 9$

m $\frac{2x}{5} = 6$ $x = 15$

n $\frac{3t}{5} = 12$ $t = 20$

o $-\frac{2}{3}y = 12$ $y = -18$

p $-5 = \frac{5}{2}p$ $p = -2$

q $\frac{7t}{6} = 14$ $t = 12$

r $-\frac{5}{11}x = 15$ $x = -33$

s $-\frac{5c}{8} = 3$ $c = -\frac{24}{5}$

t $\frac{2}{3}f = -7$ $f = -7$

u $-1 = \frac{7}{4}m$ $m = -\frac{4}{7}$

v $\frac{4x}{3} = -3$ $x = -\frac{9}{4}$

w $-20 = \frac{7}{3}x$ $x = -\frac{60}{7}$

x $-\frac{3}{4}x = 5$ $x = -\frac{20}{3}$

y $-2x + 10 = 30$ $x = -10$

z $31 = 6 - 5s$ $s = -\frac{24}{5}$

aa $35 = -6m + 5$ $m = -5$

bb $16 - 4y = 8$ $y = 2$

cc $16 = -3y + 7$ $y = -3$	**dd** $13 = 5 - 2p$ $p = -4$	**ee** $3t - 1 = -7$ $t = -2$	**ff** $4 - 7t = 32$ $t = -4$
gg $1 - 2y = 9$ $y = -4$	**hh** $45 = -3p + 15$ $p = -10$	**ii** $-5x + 1 = -9$ $x = 2$	**jj** $2 = -5s + 7$ $s = 1$
kk $\frac{1}{3}x - 2 = -2$ $x = 0$	**ll** $-\frac{1}{8}x - 2 = 0$ $x = -16$	**mm** $-4 - \frac{x}{2} = 9$ $x = -26$	**nn** $-\frac{x}{4} + 5 = 6$ $x = -4$
oo $\frac{x}{2} + 3 = 1$ $x = -4$	**pp** $1 - \frac{1}{4}x = 6$ $x = -20$	**qq** $5 - \frac{k}{4} = 6$ $k = -4$	**rr** $5 + \frac{1}{2}m = 11$ $m = 12$
ss $-4 + \frac{k}{5} = 21$ $k = 125$	**tt** $0 = -3 + \frac{1}{4}e$ $e = 12$	**uu** $4 = \frac{x}{3} + 2$ $x = 6$	**vv** $4 = -2 + \frac{1}{4}w$ $w = 24$

6 Consider these three methods of solving $8 - 4x = 12$
Write the inverse operations applied between each line.

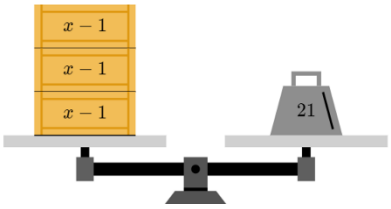
$8 - 4x = 12$	$8 - 4x = 12$	$8 - 4x = 12$
$-4x = 4$	$8 = 12 + 4x$	$2 - x = 3$
$x = -1$	$-4 = 4x$	$-x = 1$
	$-1 = x$	$x = -1$

Which method do you prefer?

TWO-STEP EQUATIONS INVOLVING GROUPING

Investigation Solving equations.

1 Three boxes have an unknown weight.
One kilogram is taken out of each box, and the result is 21 kg.
Write an equation to represent this scenario.



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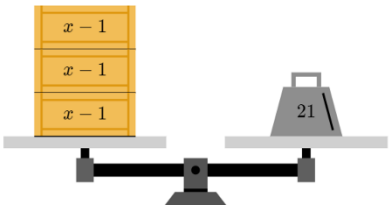
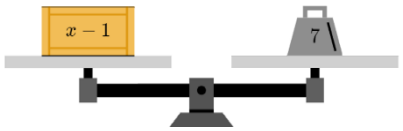
Consider the process for finding the weight of a box below.

Identify the operation done to both sides between each step.



$3(x-1)=21$

....



$x-1=7$

....

$x=8$

How do you know the order of inverse operations? Why didn't we add 1 first?

.....

SOLVING EQUATIONS INVOLVING GROUPING

- If equations involve grouping, then we **undo operations outside brackets first**.
  1. Undo operations outside brackets.
  2. Undo operations inside brackets.

Example Solve equations involving grouping.

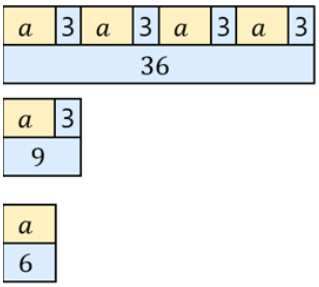
$4(a+3)=36$

1. $\div 4 \quad \div 4$

$a+3=9$

2. $-3 \quad -3$

$a=6$



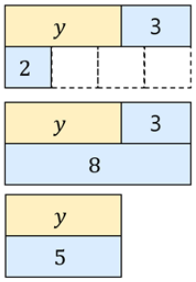
$\frac{y+3}{4}=2$

1. $\times 4 \quad \times 4$

$y+3=8$

2. $-3 \quad -3$

$x=5$



Solve these equations.

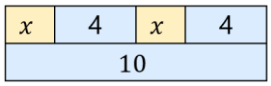
a $2(x+4)=10$

$\ldots\ldots \quad \ldots\ldots$

$x+4 = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$x = \ldots\ldots$



$x=1$

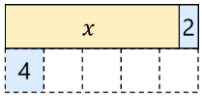
b $\frac{x+2}{5}=4$

$\ldots\ldots \quad \ldots\ldots$

$\ldots\ldots = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$x = \ldots\ldots$



$x=18$

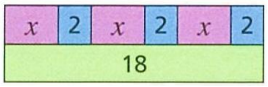
c $3(x+2)=18$

$\ldots\ldots \quad \ldots\ldots$

$\ldots\ldots = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$x = \ldots\ldots$



$x=4$

d $4(x-3)=16$

$\ldots\ldots \quad \ldots\ldots$

$\ldots\ldots = \ldots\ldots$

$\ldots\ldots \quad \ldots\ldots$

$x = \ldots\ldots$

$x=7$

e $\frac{x-5}{2}=7$

$x=19$

f $\frac{12+x}{3}=3$

$x=-3$

Key ideas

1. If an equation involves grouping, we undo operations …… brackets first.

1 Fill in the missing numbers.

a

$2(q + 6) = 20$

÷2 ÷2

$q + 6 = \_\_$

□ □ 10 −6 −6

$\_\_ = \_\_$

$q = 4$

b

$3(x + 1) = 18$

÷3 ÷3

$x + 1 = \square$

□ □ 6 −1 −1

$x = \square$

5

c

$3(x + 1) = 18$

$3x + 3 = 18$

−3 −3

$3x = \square$

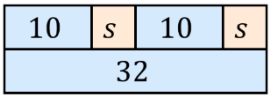
□ □ 15 ÷3 ÷3

$x = \square$

$x = 5$

2 Solve these equations. Use the bar model to help you.

a $2(10 + s) = 32$



....

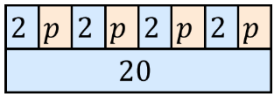
..... = ...

....

$s =$ .....

$s = 6$

b $20 = 4(2 + p)$



....

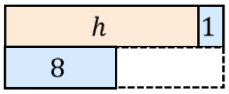
..... = ...

....

..... = p

$p = 3$

c $\frac{h+10}{6} = 2$



....

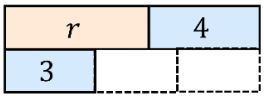
..... = ...

....

$h =$ .....

$h = 15$

d $3 = \frac{r+4}{3}$



....

..... = ...

....

..... = r

$r = 5$

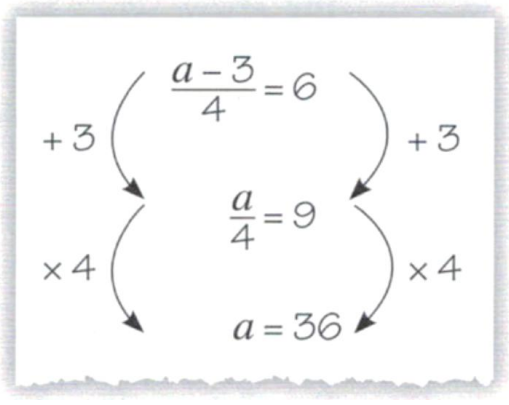
3 Jericho is solving the equation $\frac{a-3}{4} = 6$

a Show by substitution that Jericho is wrong

$\frac{36-3}{4} = \frac{33}{4} \neq 6$

b Explain his mistake

He should have multiplied by 4 first.



c Find the correct solution to the equation.

$a = 27$

4 Solve these equations, showing all inverse operations.

a $3(x+8)=36$

$x=4$

b $4(x+8)=36$

$x=1$

c $4(x+8)=40$

$x=2$

d $4(x+8)=-40$

$x=-18$

e $4(x-8)=-40$

$x=-2$

f $4(x-8)=40$

$x=18$

g $5(x-8)=40$

$x=16$

h $40=5(x-8)$

$x=16$

i $40=5(x+8)$

$x=0$

5 Solve these equations.

a $\frac{x+8}{3}=5$

$x=7$

b $\frac{x+8}{4}=5$

$x=12$

c $\frac{x+8}{4}=6$

$x=16$

d $\frac{x+8}{4}=-6$

$x=-32$

e $\frac{x-8}{4}=-6$

$x=-16$

f $\frac{x-8}{4}=6$

$x=32$

g $\frac{x-8}{5}=6$

$x=38$

h $6=\frac{x-8}{5}$

$x=38$

i $6=\frac{x+8}{5}$

$x=22$

6 Solve the following two equations.

a $\frac{a}{3}+5=7$

$a=6$

b $\frac{a+5}{3}=7$

$a=16$

Explain why the solutions are different.

Order of operations done to x is different.

7 Solve these equations.

a $2p+5=60$

$p=\frac{55}{2}$

b $2(p+5)=60$

$p=25$

c $2(2p+5)=60$

$p=\frac{25}{2}$

d $2(5+4p)=60$

$p=\frac{25}{4}$

e $2p-5=11$

$p=8$

f $2(p-5)=11$

$p=\frac{1}{2}$

8 Describe the mistake made in each of these and provide the correct solution.

a

$4x+2=36$

$\div 4$ $\quad$ $\div 4$

$x+2=9$

-2 $\quad$ -2

$x=7$

Didn't divide every term by 4

$x=\frac{17}{2}$

b

$3x+10=43$

-10 $\quad$ -10

$3x=33$

$\div 3$ $\quad$ $\div 3$

$x=30$

33÷ 3 = 11

$x=11$

c

$2a+5=11$

-5 $\quad$ -5

$2a=16$

$\div 2$ $\quad$ $\div 2$

$a=8$

11 – 5 = 6

$a=3$

d

$7+12a=43$

-12 $\quad$ -12

$7+a=31$

-7 $\quad$ -7

$a=24$

– 12 is the incorrect inverse operation

$x=3$

EXPANDING METHOD FOR EQUATIONS INVOLVING BRACKETS

- If an equation involves brackets, then we can solve by **expanding the brackets first**.
  1. Expand any brackets.
  2. Simplify, if possible.
  3. Solve the equation.

Example Solve equations involving brackets by expanding first.

$3(x+2)=18$ 1. Expand $3x+6=18$ 3. Solve $-6 \quad -6$ $3x=12$ $\div 3 \quad \div 3$ $x=4$	Solve $3(x+2)=18$ by dividing first. $3(x+2)=18$
$3(x+5)+4x=29$ 1. Expand $3x+15+4x=29$ 2. Simplify $7x+15=29$ 3. Solve $-15 \quad -15$ $7x=14$ $\div 7 \quad \div 7$ $x=2$	Why would this question be difficult if you divided first? *If you divided every term by 3, you would have an a…… f……:* $\frac{4x}{3}$

Solve these equations by expanding first.

a $2(10+s)=32$

$20+2s=32$

$s=6$

b $3(p-7)=6$

$p=9$

c $8(4+q)=40$

$q=1$

d $3(2x-4)=18$

$x=5$

e $5(4s+4)+4s=44$

$s=1$

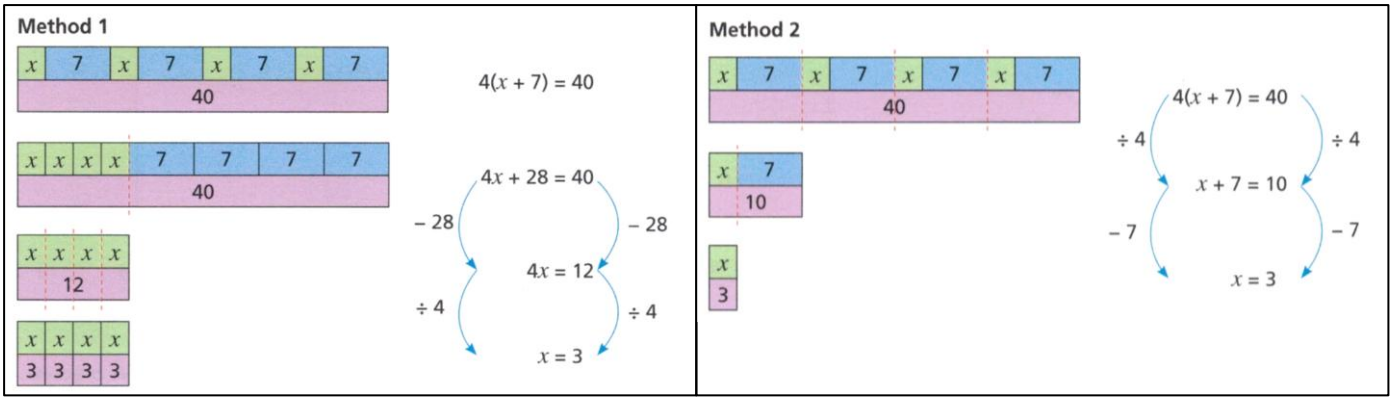
f $3(4+3v)-4v=52$

$v=8$

Key ideas

1. Equations involving brackets can be solved by …… the brackets first.

1 Compare the following two methods of solving $4(x + 7) = 40$, which are illustrated by bar models.



Describe what is different between the two methods.

In method 1, they expanded first. In method 2, they divided first. In this example, method 2 was faster because 4 is a factor of 40.

2 Solve these equations by expanding first.

a $2(5 + l) = 12$

$10 + 2l = 12$

$l = 1$

b $8(y + 9) = 72$

$y = 0$

c $22 = 2(b + 5)$

$b = 6$

d $63 = 7(p + 2)$

$p = 7$

e $2(r + 8) = 32$

$r = 8$

f $8(m + 7) = 96$

$m = 5$

g $3(6e + 3) = 27$

$e = 1$

h $30 = 6(5r - 10)$

$r = 3$

i $3(2q - 9) = 39$

$q = 11$

3 Solve these equations by expanding first.

a $5i + 5(2 + 2i) = 25$

$i = 1$

b $3(4c - 5) + c = 50$

$c = 5$

c $3 = 2(x + 4) + 1$

$x = -3$

d $4(p - 3) + p = -32$

$p = -4$

e $2(5 + x) - 3x = 15$

$x = -5$

f $3(r + 4) + 2r + 40 = 2$

$r = -10$

4 Solve $6(x-9)=24$ by:

a Expanding first.

$6x-54=24$
$6x=78$
$x=13$

b Dividing both sides by 6 first.

$x-9=4$
$x=13$

5 Solve $6(x-9)=22$ by:

a Expanding first.

$6x-54=22$
$6x=76$
$x=\frac{76}{6}=\frac{38}{3}$

b Dividing both sides by 6 first.

$x-9=\frac{22}{6}$
$x=\frac{22}{6}+9$
$x=\frac{11}{3}+\frac{27}{3}$
$=\frac{38}{3}$

6 By considering the two questions above, explain how to determine whether to expand first or divide first when solving equations with brackets.

If dividing first will result in fractions, then we should expand instead.

7 Chloe

I'd choose one of the methods for $7(a+8)=28$
But another for $7(a+8)=30$

Which method do you think is better for each of Chloe's equations? Explain why.

Divide first for $7(a+8)=28$ as 7 is a factor of 18.
Expand first for $7(a+8)=30$ as $30\div 7$ will result in a fraction.

Use your preferred method to solve:

a $5(a+12)=100$

$a=8$

b $3(b+9)=20$

$b=-\frac{7}{3}$

8 Solve these equations.

a $6x + 3 = 45$

$x = 7$

b $6(x + 3) = 45$

$x = \frac{9}{2}$

c $6x - 3 = 45$

$x = 8$

d $6(x - 3) = 45$

$x = \frac{63}{6} = \frac{21}{2}$

9 Solve these equations using any strategy.

a $2(5m + 8) = 66$

$m = 5$

b $-8(m - 3) = 32$

$m = -1$

c $7(3x - 1) = -13$

$x = -\frac{2}{7}$

d $11(3q + 4) = 77$

$q = 1$

10 Solve these equations.

a $4(x - 5) = 40$

$x = 15$

b $4(x - 5) = 30$

$x = \frac{25}{2}$

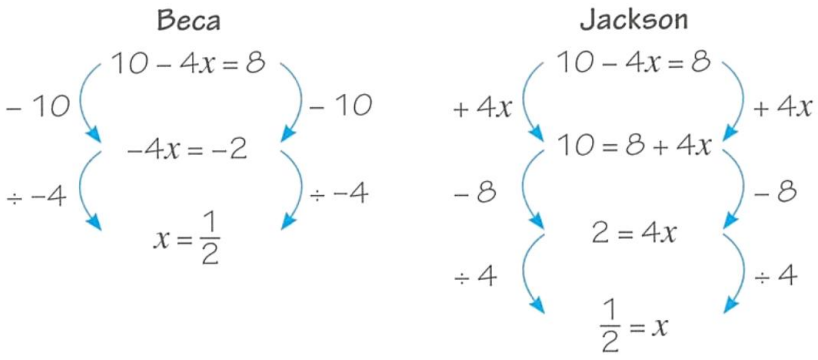
c $4(x + 5) + 20 = 40$

$x = 0$

d $4(x - 5) + 4x = 20$

$x = 5$

11 Here are Beca's and Jackson's methods for solving the equation $10 - 4x = 8$



Whose method do you prefer?

Beca's method is faster, but you need to remember to keep the negative with the $4x$.

Jackson's method takes longer but you don't have to work with negatives.

Solve the equations, using your preferred method.

a $16 - 3x = 4$

$x = 4$

b $72 - 7x = 51$

$x = 3$

c $6 = 10 - 4x$

$x = 1$

d $8 - x = 13$

$x = -5$

e $10 - 3x = 7$

$x = 1$

f $10 - 3(x - 1) = 7$

$x = 2$

g $10 - 3(x + 1) = 7$

$x = 0$

h $10 - \frac{x+1}{3} = 7$

$x = 8$

12 Come up with equations where the solution is $x = -3.5$.

One-step equation:

Two-step equation:

Involving fractions:

Involving grouping:

As complex as you can:

MIXED PRACTICE

- To solve equations:
  1. Identify the order of operations done to the pronumeral. (B I DM AS)
  2. Apply inverse operations in the reverse order to both sides. (SA MD I B)

Note: The solutions to questions in this section won't be positive integers; use a calculator!

Example Solve equations using inverse operations.

Worked Example	Your Turn		
$x - 6.64 = 24$ $+6.64 \quad +6.64$ $x = 30.64$	$x + 0.5 = 3$ $x = 2.5$	$x - \frac{3}{4} = \frac{1}{2}$ $x = \frac{5}{4}$	$x + 13 = -5$ $x = -18$
$4x = 14$ $\div 4 \quad \div 4$ $x = 3.5$	$6x = 25$ $x = \frac{25}{6}$	$-5x = 11$ $x = -\frac{11}{5}$	$2.5x = -20$ $x = -8$
$\frac{x}{4} = 14$ $\times 4 \quad \times 4$ $x = 52$	$\frac{x}{6} = 5$ $x = 30$	$10.2 = \frac{x}{5}$ $x = 51$	$5 = -\frac{x}{4}$ $x = -20$
$215x + 77 = 163$ $-77 \quad -77$ $215x = 86$ $\div 215 \quad \div 215$ $x = 0.4$	$4x - 12 = 25$ $x = \frac{37}{4}$	$3x + 52 = 72$ $x = \frac{20}{3}$	$3x - 18 = -15$ $x = 1$
$\frac{x}{15} - 3 = 21$ $+3 \quad +3$ $\frac{x}{15} = 24$ $\times 15 \quad \times 15$ $x = 360$	$\frac{x}{3} + 12 = 6$ $x = -18$	$12 + \frac{x}{2} = 8$ $x = -8$	$-2 + \frac{x}{6} = 3.5$ $x = 33$

Worked Example	Your Turn		
$\frac{4x}{7} = -12$ $\times 7 \quad \times 7$ $4x = -84$ $\div 4 \quad \div 4$ $x = -21$	$168 = \frac{2x}{5}$ $x = 420$	$\frac{3}{5}x = 30$ $x = 50$	$-\frac{5}{2}x = 15$ $x = -6$
$22 - 7x = 15$ $-22 \quad -22$ $-7x = -7$ $\div -7 \quad \div -7$ $x = 1$	$11 - 2x = 15$ $x = -2$	$35 = 5 - 7x$ $x = -\frac{30}{7}$	$-7 - 15x = 23$ $x = -2$
$2(x - 5) = 13$ $\div 2 \quad \div 2$ $x - 5 = 6.5$ $+5 \quad +5$ $x = 11.5$	$3(x - 16) = 21$ $x = 23$	$4(x + 16) = -84$ $x = -37$	$8(1 + x) = 88$ $x = 10$
$\frac{x - 11}{17} = 2$ $\times 17 \quad \times 17$ $x - 11 = 34$ $+11 \quad +11$ $x = 45$	$\frac{x - 4}{3} = 12$ $x = 40$	$\frac{6 + x}{5} = 5.5$ $x = 21.5$	$\frac{x - 13}{9} = -1$ $x = 4$
$4y + 6(2y - 4) = 40$ $4y + 12y - 24 = 40$ $16y - 24 = 40$ $+24 \quad +24$ $16y = 64$ $\div 16 \quad \div 16$ $x = 4$	$3(x - 16) = 21$ $x = 23$	$4(x + 16) = -84$ $x = -37$	$8(1 + x) = 88$ $x = 10$

1 Solve these equations using inverse operations.

a $3x + 6 = 30$

$\ldots\ldots\ldots = \ldots\ldots\ldots$

$x = \ldots\ldots$

$x = 8$

b $30 = 6 + 3x$

$\ldots\ldots = \ldots\ldots\ldots$

$\ldots\ldots = x$

$x = 8$

c $30 = 6 - 3x$

$\ldots\ldots = \ldots\ldots\ldots$

$\ldots\ldots = x$

$x = -8$

d $30 = 3x - 6$

$\ldots\ldots = \ldots\ldots\ldots$

$\ldots\ldots = x$

$x = 12$

e $30 = -3x - 6$

$x = -12$

f $-30 = 3x + 6$

$x = -12$

g $-30 = \frac{x}{3} + 6$

$x = -108$

h $30 = 6 + \frac{x}{3}$

$x = 72$

i $30 = \frac{6+x}{3}$

$x = 84$

j $30 = \frac{-6+x}{3}$

$x = 96$

k $3 = \frac{-6+x}{30}$

$x = 96$

l $30 = 3(x - 6)$

$x = 16$

m $30 = 3(x + 6)$

$x = 4$

n $30 = \frac{1}{3}(x + 6)$

$x = 84$

o $30 = -\frac{1}{3}(x + 6)$

$x = -96$

2 Solve these equations. Show each line of working.

a $2x + 5 = -7$

-6

b $3y - 2 = -13$

$-\frac{11}{3}$

c $23 = 4 - 7x$

$-\frac{19}{7}$

d $\frac{4x}{3} = -9$

$-\frac{27}{4}$

e $7 = 3a + 2$

$\frac{5}{3}$

f $4b + 7 = 25$

4.5

g $7y - 3 = -8$

$-\frac{5}{7}$

h $2a + \frac{1}{2} = \frac{1}{4}$

$-\frac{1}{8}$

i $-1 = 5n - \frac{1}{4}$

$-\frac{3}{20}$

j $\frac{x}{3} - 7 = -12$

-15

k $\frac{s}{2} - 3 = -7$

-8

l $2 - 5x = 9$

$-\frac{7}{5}$

m $\frac{2x}{5} = -3$

$-\frac{15}{2}$

n $5 + \frac{3d}{2} = -7$

-8

o $5(y - 7) = -12$

$\frac{23}{5}$

p $4(5 - b) = 18$

$\frac{1}{2}$

q $3 - \frac{4z}{3} = 5$

$-\frac{3}{2}$

r $\frac{4+y}{3} = -2$

-10

s $\frac{6+b}{2} = -3$

-12

t $\frac{7x-3}{3} = 9$

$\frac{30}{7}$

u $5 = \frac{3b-6}{2}$

$\frac{16}{3}$

v $2(x + 3) = 11$

$\frac{5}{2}$

w $7(2a + 1) = 8$

$\frac{1}{14}$

x $5(3 - 2x) = 6$

$\frac{9}{10}$

y $2(x - 3) - 3x = 4$

-10

z $7(2z + 1) + 3 = 80$

-2

aa $60 = 3y + 2(y + 5)$

10

bb $3(2x + 3) - 1 - 4x = 4$

-2

3 Solve these equations.
Note that these equations may require 3 steps or more.

a $\frac{2y}{5} - 7 = 11$

$y = 45$

b $\frac{3x}{4} + 1 = 12$

$x = \frac{44}{3}$

c $-4m - 8 = 3$

$m = -\frac{11}{4}$

d $72 = \frac{7x}{5} - 12$

$x = 60$

e $\frac{n}{5} + 2 = 5$

$n = 15$

f $\frac{3y}{5} + 8 = 2$

$y = -10$

g $1 = \frac{-2u-3}{5}$

$u = -4$

h $-2 = \frac{4d}{5} + 2$

$d = -5$

i $0 = 12 + \frac{2u}{5}$

$u = -30$

j $3\left(\frac{2x+9}{4}\right) - 5 = 7$

$x = \frac{7}{2}$

k $7\left(\frac{4y-3}{9}\right) + 5 = 17$

$y = \frac{129}{28}$

l $4(2x + 3) - 3(4x + 5) = 0$

$x = -\frac{3}{4}$

PROBLEM-SOLVING USING EQUATIONS

- Model scenarios with unknown numbers as **equations**.
    1. Let a pronumeral represent an unknown quantity.
    2. Write an equation describing the problem.
    3. Solve the equation.
    4. Check your answer makes sense and has correct units.

Example Model and solve word problems using equations.

When Adam adds his current age and his age next year, the result is 27.
How old is he now?

1. Let a be Adam's current age.
2. $a + (a + 1) = 27$
3. $2a + 1 = 27$
   $2a = 26$
   $a = 13$
4. Adam is 13 years old this year.

Why did we make a represent Adam's current age?

The pronumeral should represent .....

How do we represent Adam's age next year?

If Adam's current age is a, then his age next year is .....

Asher works for 12 hours this week.
He earned a wage and a bonus of $50.
If he earned $410 in total,
how much does he make an hour?

1. Let n be how much he makes an hour.
2. $12n + 50 = 410$
3. $12n = 360$
   $n = 30$
4. Asher makes $30 an hour.

How did we know $12n + 50$ represents Asher's total pay?

a When Mila adds her current age and her age last year, the result is 23.
How old is she now?

1. Let ..... be .....
2.
3.
4.

12 years old

b Charlotte earned $180 total this week.
If this includes a $60 bonus and she earns $15 an hour, how many hours did she work this week?

1. Let ..... be .....
2.
3.
4.

8 hours

1 The sum of the ages of Sam and his brother Bernard is 34.
If Sam is 4 years older than Bernard, find their ages.

Let x be the ☐ of Bernard.

The age of Sam is ☐.

The sum of their ages is 34.

$\therefore x + \square = 34$

$\square + 4 = 34$

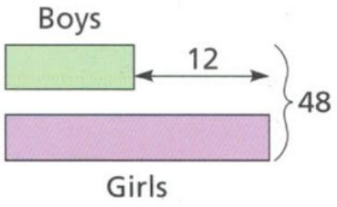
$2x = \square$

$x = \square$

$\therefore$ Bernard is _____ years old and Sam is _____ years old.

15 and 19

2 There are 12 less boys than girls in a choir.
There are 48 students altogether in the choir.
Find the number of girls in the choir.



Let x be the number of girls.

The number of boys is $x -$……

Equation: $x + ($ $) =$ ……

$x + (x - 12) = 48$

30 girls

3 The total price of three pens and one pencil is 99 cents.
The pencil costs 18 cents.
Let the price of one pen be x cents.

Which of these equations represents the information given?

A $\frac{x}{3} + 18 = 99$ B $3(x + 18) = 99$

C $3x + 18 = 99$ D $x + 3 \times 18 = 99$

C

Solve the correct equation to find the price of one pen.

27 cents

4 Jonas is paid \$15 per hour and gets paid a bonus of \$50 each week.
One week he earned \$425. Calculate how many hours Jonas worked that week.

a Let n be the number of hours Jonas worked.
Write an equation relating the information given.

$15n + 50 = 425$

b Solve the equation for n.

25 hours

5 The sum of Kate's age now, and her age next year, is 47.
How old is Kate?
Let x be Kate's current age.
$x + (x + 1) = 47$

$x + (x + 1) = 47$

23 years old

6 The sum of the ages of two sisters Katie and Kathy is 28.
If Kathy is 4 years older than Katie, find their ages.
Let x be the age of Katie.

$x + (x + 4) = 28$

Katie is 12, Kathy is 16

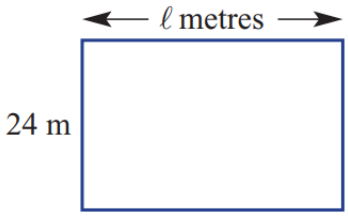
7 A prize of $1000 is divided between Asher and Leo.
Asher receives $287 more than Leo.
How much did Leo receive?
Let x be

Let x be Leo's money

$x + (x + 287) = 1000$

$356.50

8 This rectangular paddock has an area of 720 m. Find the length.



$A = lw$

$720 = 24l$

$l = 30$ m

9 A prize of $1000 is divided between Adele and Benita so that Adele receives $285 more than Benita. How much did each person receive?

Let x be Benita's money

$x + (x + 285) = 1000$

Benita: $357.50

Adele: $642.50

10 A taxi ride is $10 flag fall and $2.50 per kilometre.
How many kilometres did you travel if the final cost was $220?

Let x be number of km travelled.

$10 + 2.5x = 220$

$x = 84$ kilometres

11 Jane and Luke have a combined age of 60.
Given that Jane is twice as old as Luke, find the ages of Luke and Jane.

Let x be Luke's age.

$x + 2x = 60$

Luke is 20, Jane 40

12 Alice buys four copies of a game.
She also buys a gaming accessory for $160.
She spent a total of $388.
How much was the game?

Let x be price of game

$4x + 160 = 388$

The game was $57

13 Two people are eating at a restaurant.
A fancy dish costs three times as much as a regular dish.
If they order one of each and the total bill is $68, how much is the fancy dish?

Let x be price of regular dish

$x + 3x = 68$

$x = 17$

Fancy dish is $51

14 A theme park charges $18 for a child ticket.
The total cost of two adult tickets and three child tickets is $110.

a Find the value of an adult ticket.

Let x be price of adult ticket.

$2x + 3(18) = 110$

$x = \$28$

b Find the cost for a party of 6 adults and 13 children to visit the theme park.

$6(28) + 13(18) = \$402$

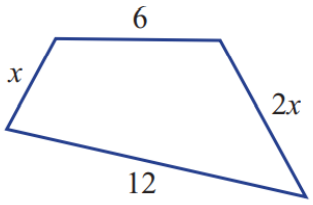
15 Molly is paid $19.50 an hour and gets paid a bonus of $65 each week.
One week she earned $786.50.
How many hours did she work?

$19.5n + 65 = 786.5$

$n = 37$ hours

16 The perimeter of the shape shown is 30.

a Find the value of x by forming an equation.



$x + 6 + 2x + 12 = 30$

$x = 4$

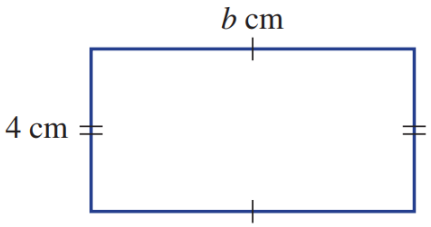
b Explain why it is impossible for the perimeter to be 17.

$3x + 18 = 17$

$x = -\frac{1}{3}$

The side length would be negative.

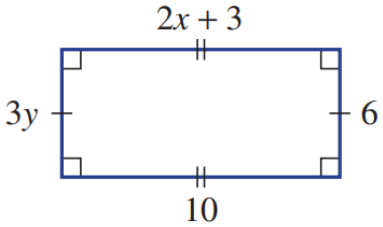
17 Determine the breadth of this rectangle if the perimeter is 72.7 cm.



$2b + 8 = 72.7$

$b = 32.35$ cm

18 Find the values of x and y in the rectangle shown.

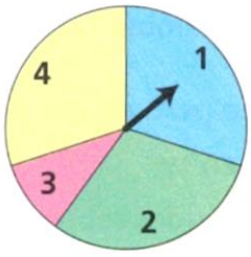


$3y = 6, y = 2$

$2x + 3 = 10, x = 3.5$

19 The spinner is spun once. The table shows the probabilities that it lands on 1, 2, 3 or 4.

Score	1	2	3	4
Probability	0.3	0.3	x	$3x$



a Find the value of x. (hint: the sum of all probabilities is 1)

$0.3 + 0.3 + x + 3x = 1$

$x = 0.1$

b Find the probability that the spinner lands on an even number.

Probability of 2 + Probability of 4 $= 0.3 + 0.3 = 0.6$

20 The equal sides of an isosceles triangle are 12 cm long.
The perimeter is 35 cm. How long is the third side?

Let third side be x

$x + 12 + 12 = 35$

$x = 11$ cm

21 In a rectangle, one side is 4 times as long as the other.
The perimeter is 60 cm. How long is the shorter side?

Let x be length of shorter side

$x + x + 4x + 4x = 60$

$x = 6$ cm

22 In a rectangle, one side is 4 cm longer than the other.
The perimeter is 60 cm. How long is the shorter side?

Let x be length of shorter side

$x + x + (x + 4) + (x + 4) = 13$ cm

$x = 13$ cm

23 In an isosceles triangle, one side is 3 cm longer than the equal sides.
The perimeter is 60 cm. How long are the sides?

Let x be shorter side

$x + x + (x + 3) = 60$

$x = 19$

19 cm, 19 cm, 22 cm

24 I can buy 3 rulers and 4 pencils for $13.50.
The pencils cost $1.50 each. What is the price for each ruler?

Let x be price of ruler

$3x + 4(1.5) = 13.50$

$x = 2.5$

$2.50 per ruler

25 A 50 m long rope is cut into four pieces.
Three of them are equal but the other is 6 m shorter. How long are the pieces?

Let x be longer pieces.

$x + x + x + (x - 6) = 50$

$x = 14$

Pieces are 14 m and 8 m

26 A rectangular paddock has an area of 720 m.
One of the sides is 22.5 m. Calculate its perimeter.

Let x be other side

$22.5x = 720$

$x = 32$

$P = 32 + 32 + 22.5 + 22.5$

$= 109$ m

27 Sarah is x years old. Thomas is 3 years older than Sarah. David is twice as old as Sarah.
The total of their ages is 51. How old is Sarah?

$x + (x + 3) + 2x = 51$

$x = 12$

Sarah is 12

28 Rayyan buys 3 identical pens from a shop. For each pen he was given a 12-cent discount.
He paid \$25 and got \$1.36 change. How much was each pen?

Let x be pen without discount

$3(x - 0.12) = 25 - 1.36$

$x = 8$

Each pen is \$8

29 Maya, Charlotte, and Emma are sharing \$1850. They don't share it evenly.
Let Emma's share be x.
Charlotte gets \$400 more than Emma.
Maya gets \$350 less than double Emma's share.
How much does each person receive?

$x + (x + 400) + (2x - 350) = \$1850$

$x = \$450$

Emma gets \$450

Charlotte gets \$850

Maya gets \$550

30 Shay recorded three songs, A, B and C.
Song B is 40 seconds longer than song A.
Song C is twice as long as song A.
The total length of the three songs is 680 seconds.
Work out the length of song B. Give your answer in minutes and seconds.

Let x be length of song A

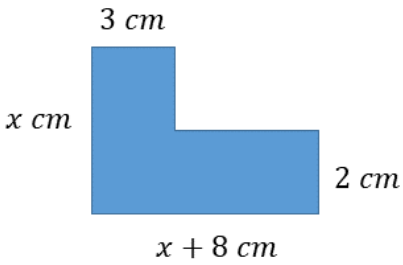
$x + (x + 40) + 2x = 680$

$x = 160$

Song B is 200 seconds long

31 Consider this shape.

a Find the perimeter if $x = 5$.



$3 + (x - 2) + (x + 5) + 2 + (x + 8)$

$= 4x + 16$

$= 4(5) + 16$

$= 36$ cm

b Find the area if $x = 7$.

$A = 3x + 2(x + 5)$

$A = 3(7) + 2(7 + 5)$

$= 45$ cm²

c The perimeter is 46 cm. Find the value of x.

$4x + 16 = 46$

$x = 7.5$ cm

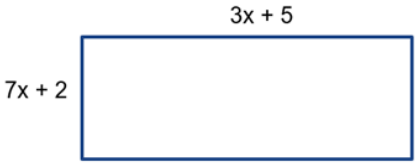
d The area of the shape is 65 cm^2. Find the value of x

$3x + 2(x + 5) = 65$

$x = 11$ cm

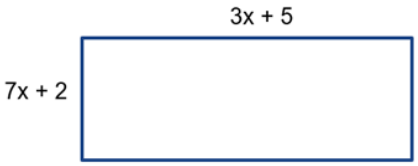
32

a Write an expression to find the perimeter of the rectangle. Simplify the expression



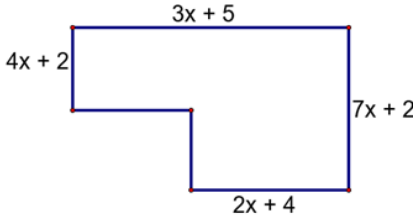
$20x + 14$

b If $x = 2.5$, find the perimeter of the rectangle.



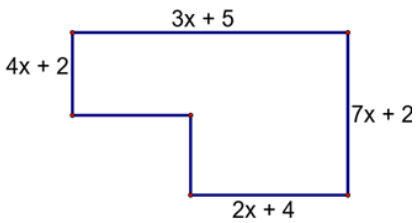
64 cm

c Write an expression to find the perimeter of the shape. Simplify the expression.



$20x + 14$

d Determine the value of x if the perimeter is 64 cm.



2.5 cm

33 Consecutive integers are numbers that occur one after the other, such as 5, 6, 7.

Any number can be represented as n

Consecutive numbers would $n, (n+1), (n+2)$ ...

a The sum of three consecutive integers is 261. Find the integers.

$n + (n+1) + (n+2) = 261$
$n = 86$
86, 87, 88

b The sum of three consecutive integers is 342. Find the integers.

113, 114, 115

Consecutive even numbers are even numbers that occur one after the other, such as 14, 16, 18

Any even number can be represented as $2n$.

Consecutive even numbers would be $2n, (2n+2), (2n+4), (2n+6)$ ...

c Find three consecutive even numbers that add up to 42

$2n + (2n+2) + (2n+4) = 42$
$n = 6$
12, 14, 16

d Find four consecutive even numbers that add up to 52.

10, 12, 14, 16

Consecutive odd numbers are odd numbers that occur one after the other, such as 11, 13, 15

Any odd number can be represented as $2n + 1$.

Consecutive odd numbers would be $2n+1, (2n+3), (2n+5), (2n+7)$ ...

e Find three consecutive odd numbers that add up to 57.

$(2n+1) + (2n+3) + (2n+5) = 57$
$n = 8$
$17, 19, 21$

f Find four consecutive odd numbers that add up to 48.

9, 11, 13, 15

34 Four consecutive numbers add up to 27.

a Find the integers.

$n = 5.25$

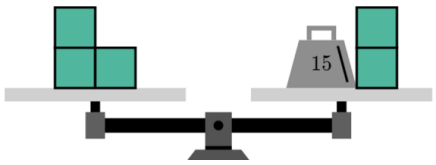
b What do you notice? What does this mean?

n is a decimal, so it is impossible for 4 consecutive integers to add to 27.

EQUATIONS WITH PRONUMERALS ON BOTH SIDES

Investigation Solving equations.

1 Write an equation to represent this scenario:



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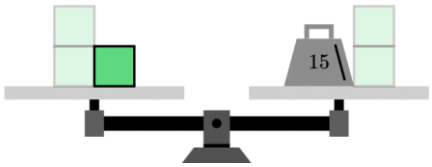
How do we find the weight of one square?

The weight of 3 squares is the same as the weight of …… squares plus 15.

To find the weight of 1 square, we …… 2 squares from both sides.

Show the operation done to both sides to solve this equation.

$$3x = 15 + 2x$$

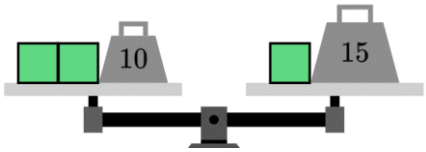


…… ……

$$x = 15$$

2 Write an equation to represent this scenario,

then show the operation done to both sides to solve this equation.



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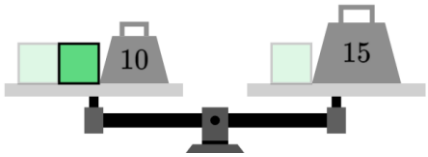
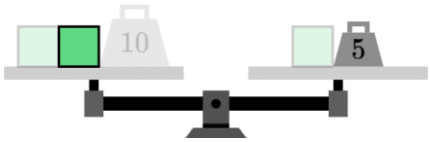
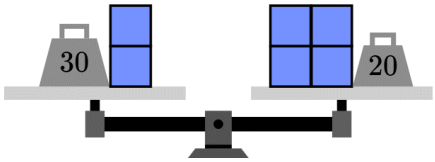




3 Write an equation to represent this scenario,

then show the operations done to both sides to solve this equation.



……

- If an equation has pronumerals on both sides,
  then **move all pronumerals to one side** by adding or subtracting a multiple of x.
  1. Move all pronumerals to one side.
     You should try to keep the coefficient of x positive, if possible.
  2. Solve for x by applying inverse operations to both sides.

Example Solve equations with pronumerals on both sides.

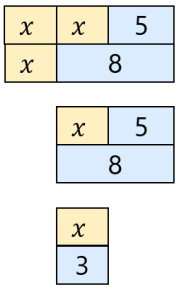
$2x + 5 = x + 8$

1. Move x $\quad -x \quad -x$

$x + 5 = 8$

2. Solve $\quad -5 \quad -5$

$x = 3$



When there are pronumerals on both sides, what is the operation you should do first?

We should try to have the unknown only on ..... side.

This can be achieved by adding or subtracting a ..... of x

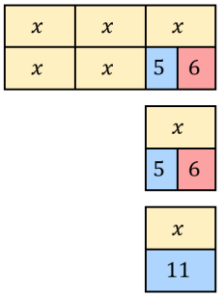
$3x - 6 = 2x + 5$

1. Move x $\quad -2x \quad -2x$

$x - 6 = 5$

2. Solve $\quad +6 \quad +6$

$x = 11$



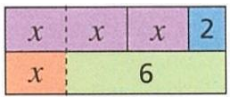
How do we know whether to $-2x$ from both sides or $-3x$ from both sides?

The most efficient method involves trying to keep the ..... of x positive.

Solve these equations.

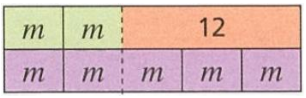
a $3x + 2 = x + 6$

$-x \quad -x$



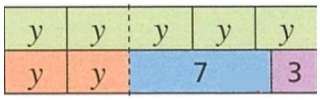
$x = 2$

b $2m + 12 = 5m$



$m = 4$

c $5y - 3 = 2y + 7$



$y = \frac{10}{3}$

d $5x + 12 = 16 + 4x$

$x = 4$

e $7u = 20 - 5u$

$u = \frac{5}{3}$

f $6x = 27 - 3x$

$x = 3$

Key ideas

1. If an equation has x on both sides,
   then add or subtract a ..... of x so that x is only on one side.

1 Fill in the missing operations.

a

$$\square \quad 4g - 2 = 3g + 3 \quad \square$$
$$g - 2 = 3$$

$-3g$

b

$$\square \quad 2 + 4k = 5k + 1 \quad \square$$
$$2 = k + 1$$

$-4k$

2 Complete the following.

a

$$-2x \quad 5x + 3 = 2x + 8 \quad -2x$$
$$\_\_\_ = 8$$

$3x + 3$

b

$$-9q \quad 9q + 5 = 12q + 21 \quad -9q$$
$$\_\_\_ = 3q + 21$$

5

c

$$+2p \quad 2p + 9 = 5 - 2p \quad +2p$$
$$\_\_\_ = \_\_\_$$

$4p + 9 = 5$

d

$$+7k \quad 15k + 12 = 13 - 7k \quad +7k$$
$$\_\_\_ = \_\_\_$$

$22k + 12 = 13$

3 Complete the following.

a $7x = 3x + 4$

$\square = 4$

$4x$

b $9x + 2 = 5x + 10$

$\square + 2 = 10$

$4x$

c $4x + 2 = 8 - 2x$

$\square + 2 = 8$

$6x$

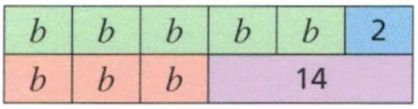
d $4x + 2 = 8 - 2x$

$\square = \square$

$6x + 2 = 8$
or $2 = 8 - 6x$

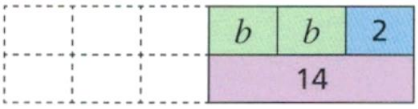
4 Consider the bar model.

a What equation does this bar model show?



$5b + 2 = 3b + 14$

b A section of length $3b$ can be "cut off" each bar. What equation is shown now?



$2b + 2 = 14$

c Solve the equation you wrote for part **b** to find the value of b

$b = 6$

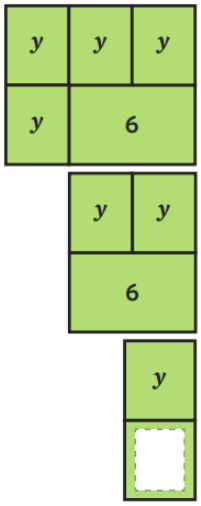
d Check that your value of b gives the same value for both the left-hand side and the right-hand side of the original equation.

LHS = $5b + 2 = 32$

RHS = $3b + 14 = 32$

5 Solve these equations. Use the bar models to guide you.

a



$3y = y + 6$

....

$2y = 6$

....

$y =$ .....

$y = 3$

b

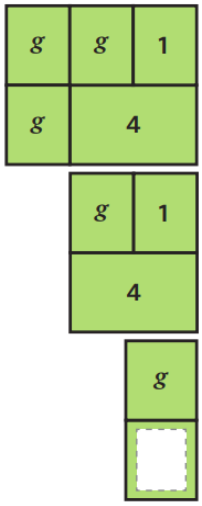
$2g + 1 = g + 4$

....

..... = ...

....

$g =$ .....



$g = 3$

c

$5u + 6 = u + 10$

....

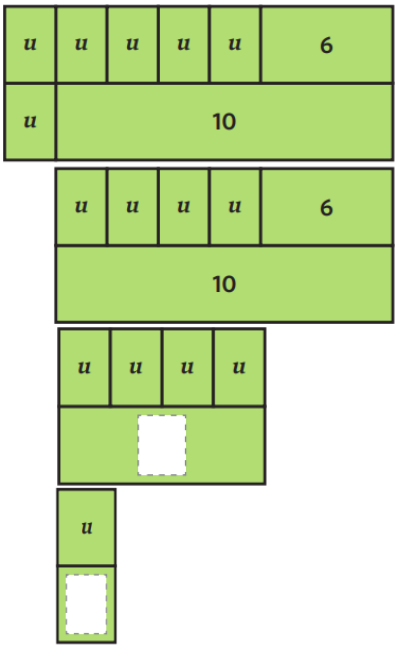
..... = ...

....

..... = ...

....

$u =$ .....



$u = 1$

d

$4m + 8 = 6m + 2$

....

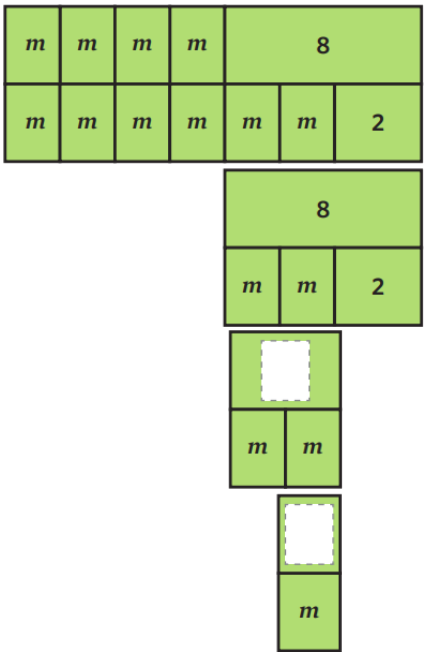
..... = ...

....

..... = ...

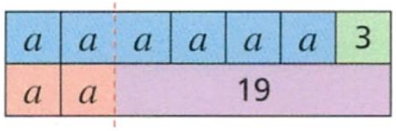
....

$m =$ .....



$m = 4$

6 Complete the solution to the equation $6a + 3 = 2a + 19$. Use the bar model to help you.



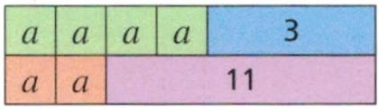
$6a + 3 = 2a + 19$

$-2a$ $-2a$

$4a + 3 = 19$

$a = 4$

7 Solve the equation to find the value of a

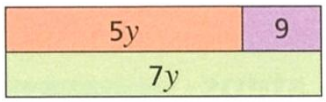


$4a + 3 = 2a + 11$

$a = 2$

8 Solve these equations.

a $7y = 5y + 9$



....

..... = ...

....

..... = ...

$y = 4.5$

b $3k = k + 8$

....

..... = ...

....

..... = ...

$k = 4$

c $3x + 6 = 2x + 9$

....

..... = ...

....

..... = ...

$x = 3$

d $10k = 12 - 8k$

....

..... = ...

....

..... = ...

$k = \frac{2}{3}$

e $3a + 6 = a + 18$

$a = 6$

f $6n + 5 = 2n + 17$

$n = 3$

g $5x - 3 = 2x + 6$

$x = 3$

h $3d - 6 = d - 4$

$d = 1$

i $3m + 5 = -m + 26$

$m = \frac{21}{4}$

j $4x + 3 = -2x + 7$

$x = \frac{2}{3}$

9 Ashley and Adam are solving the equation $8x + 3 = 2x + 21$

I'm going to subtract $2x$ from both sides first

I'm going to subtract $8x$ from both sides first

Solve the equation using both methods.

$6x + 3 = 21$
$6x = 18$
$x = 3$

$3 = -6x + 21$
$-18 = -6x$
$3 = x$

Which method do you prefer?

Ashley's method avoids negative coefficients of x.

10 Emma and Henry are solving the equation $10 - 3t = 2 + 5t$

I'm going to subtract $5t$ from both sides of the equation.

I'm going to add $3t$ to both sides of the equation

Whose strategy is most sensible? Explain why

The second method avoids negative coefficients of x.

Solve the equation using both methods.

$10 - 8t = 2$
$-8t = -8$
$t = 1$

$10 = 2 + 8t$
$8 = 8t$
$t = 1$

11 Solve these equations.

a $x + 5 = 3x + 3$

$x = 1$

b $x - 5 = 3x + 3$

$x = -4$

c $x - 5 = 3x - 3$

$x = -1$

d $x - 5 = -3 + 3x$

$x = -1$

g $-5 + x = -3 + 3x$

$x = -1$

h $5 - x = 3 - 3x$

$x = -1$

i $5 + x = 3 - 3x$

$x = -\frac{1}{2}$

j $5 - x = -3 - 3x$

$x = -4$

j $3 - 3x = 5 - x$

$x = -1$

k $3 - 3x = 5 + x$

$x = -\frac{1}{2}$

l $3 + x = 5 - 3x$

$x = \frac{1}{2}$

m $3 - x = 5 + 3x$

$x = -\frac{1}{2}$

12 Complete the following.

a

$$\begin{array}{rl} & 5x + 12 = 3x + 16 \\ -3x & \square + 12 = 16 \\ -12 & \square = \square \\ \div 2 & x = \square \end{array}$$

$x = 2$

b

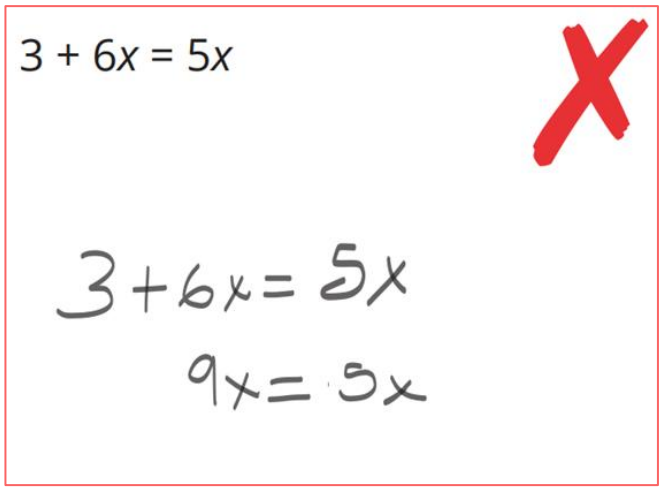
$$\begin{array}{rl} & 5x + 12 = 3x + 16 \\ -12 & 5x = 3x + \square \\ -3x & \square = \square \\ \div 2 & x = \square \end{array}$$

$x = 2$

The two equations above are the same. Which method do you prefer?

13 Read the examples carefully and answer the questions.

Jackson's work:



Which terms did Jackson incorrectly combine to get $9x$?

$3 + 6x$. They are not like terms, so they can't be combined.

Give an example of two terms that would correctly add to $9x$.

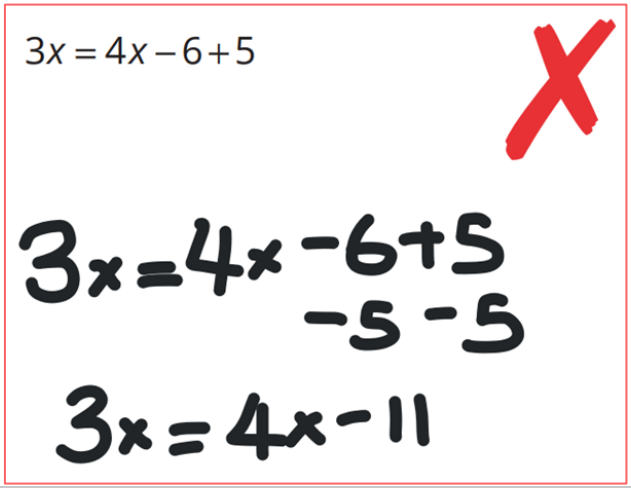
$3x + 6x$

Solve:

$$-6x + 3 = -5x$$

$x = -3$

Umi's work:



What did Umi do wrong in her first step?

Incorrect inverse operation.
Also, you need to subtract from both sides, not from each constant term.

What should Umi have done on the right side of the equation to solve it?

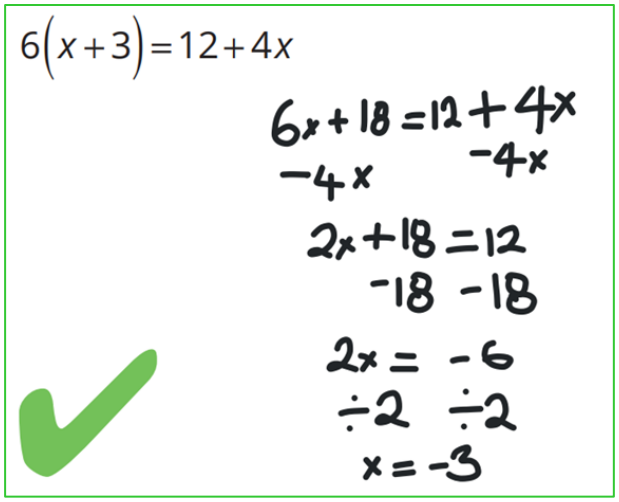
Simplify $-6 + 5$ to -1, then subtract $3x$ or $4x$ from both sides.

Solve:

$$6x = 3x - 5 - 4$$

$x = -3$

George's work:



Where did George get $6x + 18$ from?

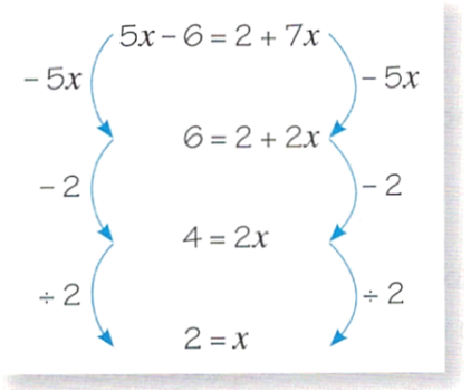
He expanded the brackets

Solve:

$$-3(x + 6) = 4 - 5x$$

$x = 11$

14 Bobbie is solving the equation $5x - 6 = 2 + 7x$



Verify Bobbie's solution by substitution to show it is incorrect.

LHS =

RHS =

LHS = 4 , RHS = 16

LHS ≠ RHS so 2 is not the solution.

Identify Bobbie's error and solve the equation correctly.

He should have kept the negative sign with 6 on the left.

$x = -4$

15 Solve these equations. The answers may be positive or negative integers or fractions,

a $3m + 7 = 8m + 2$

$m = 1$

b $7t - 6 = 4t + 5$

$t = \frac{11}{3}$

c $6h - 8 = 2h - 7$

$h = \frac{1}{4}$

d $12 + 3w = 6w - 4$

$w = \frac{16}{3}$

e $5p = 2p + 8$

$p = \frac{8}{3}$

f $5p = 2p - 8$

$p = -\frac{8}{3}$

g $k - 19 = 6k - 3$

$k = -\frac{16}{5}$

h $6t = 4t + 8 - 3t$

$t = \frac{8}{5}$

FURTHER PROBLEM-SOLVING USING EQUATIONS

- Model scenarios with unknown numbers as **equations**.
    1. Let a pronumeral represent an unknown quantity.
    2. Write an equation describing the problem.
    3. Solve the equation.
    4. Check your answer makes sense and has correct units.

Example Solve problems using equations with pronumeral on both sides.

Purchasing five apples and a \$2.40 mango costs the same as purchasing seven apples and a mandarin that costs 60 cents.

What is the cost of each apple?

1. Let c = cost of an apple.
2. $5c + 2.4 = 7c + 0.6$
3. $2.4 = 2c + 0.6$

   $1.8 = 2c$

   $0.9 = c$
4. An apple costs 90 cents.

Why did we make the pronumeral represent the cost of an apple?

The pronumeral should represent

……

Why is the cost of a mandarin represented by 0.6, not 60?

The …… must be the same.

We chose to have everything in dollars.

Annotate the worked solution, showing the operations applied between each line of working out.

a Purchasing seven pencils and a \$1 ruler is the same as purchasing three pencils and a \$3.80 box of coloured markers. How much does a pencil cost?

1. Let …… be ……
2.
3.
4.

70 cents

b Kathy's age four years ago is the same as is half of her age now plus five. Find Kathy's age now.

1. Let …… be ……
2.
3.
4.

18 years old

1 At a newsagency, Preeta bought four pens and a \$1.50 newspaper, while her husband Levy bought two pens and a \$4.90 magazine. To their surprise the cost was the same.

a Write an equation to describe this, using p for the cost of a pen.

$4p + 1.50 = 2p + 4.90$

b Solve the equation to find the cost of a pen.

$p = \$1.70$

2 Desmond notes that in 4 years' time his age when doubled will give the number 50. Desmond's current age is d.

a Write an expression for Desmond's age in 4 years' time and write an expression for double his age in 4 years' time.

$d + 4,\ 2(d + 4)$

b Write an equation to describe the situation described above.

$2(d\ +\ 4)\ =\ 50$

c Solve the equation to find his current age.

$d\ =\ 21$ years

3 Form an equation to solve the following.

a Eight years ago, Tiff was half her age now. How old is Tiff now?

$t - 8 = \frac{t}{2}$

$t = 16$

Tiff is 16.

b Two years ago, Tiff's father was three times his own age 28 years ago.

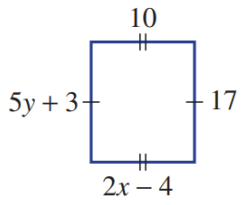
How old is Tiffs father now?

$f - 2 = 3(f - 28)$

Father is 41

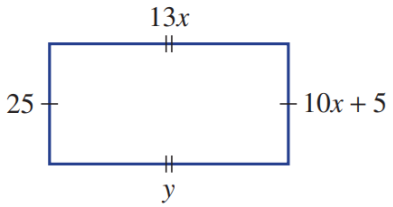
4 The following shapes are rectangles. By solving equations, find the value of the variables. Some of the answers will be fractions.

a



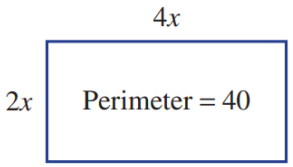
$x = 7, y = \frac{14}{5}$

b



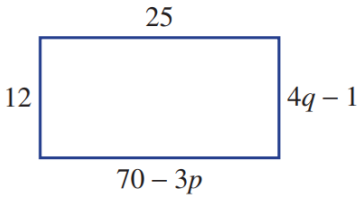
$x = 2, y = 26$

c



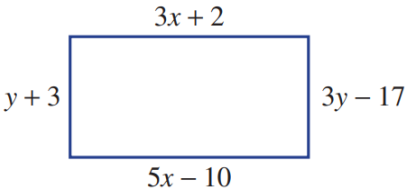
$x = \frac{10}{3}$

d



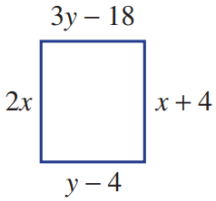
$p = 15, q = \frac{13}{4}$

e



$x = 6, y = 10$

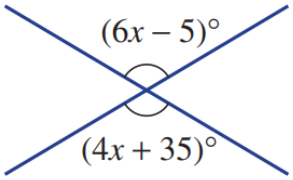
f



$x = 4, y = 7$

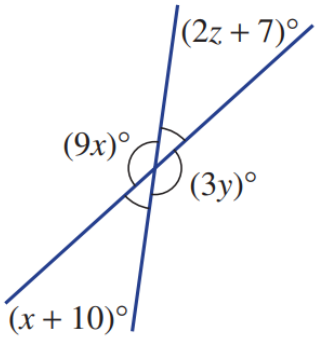
5 Find the values of the pronumerals in the following geometric diagrams.

a



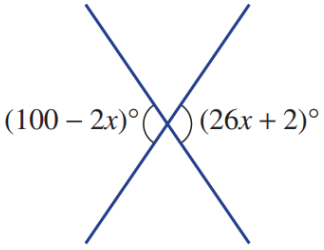
$x = 20$

b



$x = 17, y = 51, z = 10$

c



$x = \frac{7}{2}$

6 I think of a number, double it and add 12. The answer is three times the number I started with.
What was my starting number?

Let x = starting number

2x + 12 = 3x

12 = x

Starting number = 12

7 I think of a number, double it and add 12. The answer is the number I started with.
What was my starting number?

Let x = starting number

2x + 12 = x

x = -12

Starting number = – 12

8 I think of a number, add 12 and then double the result.
The answer is four times the number I started with.
What was my starting number?

Let x = starting number

2(x + 12) = 4x

x = 12

Starting number = 12

9 Sally is 58 and Harry is 10 years old. In how many years will Sally be three times Harry's age?

Let t = years from now

Sally's age in t years: 58 + t

Harry's age in t years: 10 + t

58 + t = 3(10 + t)

t = 14 years

10 If you triple the age Rhys was four years ago, you get 27.
Form and solve an equation to find Rhys' age now.

Let x = Rhys' current age

3(x - 4) = 27

x = 13 years old

11 If you double the age Ali will be in six years' time, you will get 40. How old is Ali now?

Let x = Ali's current age

2(x + 6) = 40

x = 14 years old

12 Kate is three times as old as her son.
If Kate is also 30 years older than her son, what are their ages?

Let x be son's age

Kate's age is $3s$ *and* $s + 30$

$30 + x = 3x$

$x = 15$

Son is 15, Kate is 45

13 Kristen and Daniel have the same amount of money.
Kristen buys 5 kg of cherries and has $2 left over.
Daniel buys 2 kg of cherries and has $20 left over. What is the cost of 1 kg of cherries?

Let x be 1kg of cherries

$5x + 2 = 2x + 20$

$x = 6$

1 kg is $6

14 James and Sue have the same amount of money.
James buys seven sushi rolls and has $1.50 left over.
Sue buys four sushi rolls and has $12 left over. Find the cost of a sushi roll.

Let x be 1 sushi

$7x + 1.5 = 4x + 12$

$x = 3.5$

1 sushi is $3.50

15 Find the unknown number using equations. The answers might not be whole numbers.

a The average of a number and double the number is 25.5.

$$\frac{x + 2x}{2} = 25.5$$
$$\frac{3x}{2} = 25.5$$
$$3x = 51$$
$$x = 17$$

b The average of a number and triple the number is 25.5.

$$\frac{x + 3x}{2} = 25.5$$
$$\frac{4x}{2} = 25.5$$
$$2x = 25.5$$
$$x = 12.75$$

c Adding 3 to twice a number is the same as subtracting 9 from half the number.

$$2x + 3 = \frac{x}{2} - 9$$
$$4x + 6 = x - 18$$
$$3x = -24$$
$$x = -8$$

d Adding 5 to twice a number is the same as subtracting 9 from half the number.

$$2x + 5 = \frac{x}{2} - 9$$
$$4x + 10 = x - 18$$
$$3x = -28$$
$$x = -\frac{28}{3}$$

e The average of a number and double the number gives the same result as adding 1 to the original number and then multiplying by one-third.

$$\frac{x + 2x}{2} = \frac{1}{3}(x + 1)$$
$$\frac{3x}{2} = \frac{x + 1}{3}$$
$$9x = 2(x + 1)$$
$$9x = 2x + 2$$
$$7x = 2$$
$$x = \frac{2}{7}$$

16 Abdullah has 4 packets of mints and 7 more mints.
Beca has 2 packets of mints and 31 more mints.
Each packet contains the same number of mints.
If Abdullah and Beca each have the same number of mints, how many mints do they have altogether?

Let x be number of mints in a packet.

4x + 7 = 2x + 31

x = 12

Together they have 6(12)+38=110

17 Ed collects 5c and 10c coins in a jar. The jar contains three more 5c coins than 10c coins. Altogether there is $1.80 in the jar.
Form and solve an equation to find the number, x, of 10c coins in the jar.

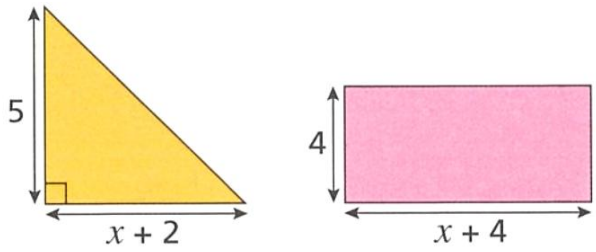
Let x = number of 10c coins

Number of 5c coins = x + 3

5(x + 3) + 10x = 180

x = 11

18 The area of the rectangle is double the area of the triangle. Find both their areas.



Triangle area = $\left(\frac{1}{2}\right)(x + 2)(5) = \frac{5x + 10}{2}$

Rectangle area = $4(x + 4) = 4x + 16$

Rectangle area = 2 × Triangle area:

$4x + 16 = 2 \times \frac{5x + 10}{2}$

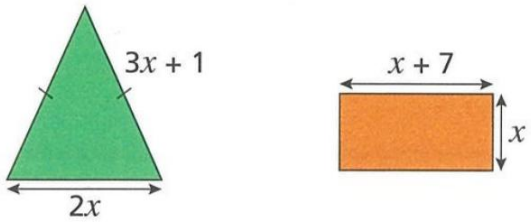
$4x + 16 = 5x + 10$

$6 = x$

Triangle area = 20

Rectangle area = 40

19 The perimeter of the triangle is the same as the perimeter of the rectangle.
Work out the area of the rectangle.



Triangle perimeter = 2x + (3x + 1) + (3x + 1) = 8x + 2

Rectangle perimeter = 2(x + 7) + 2x = 4x + 14

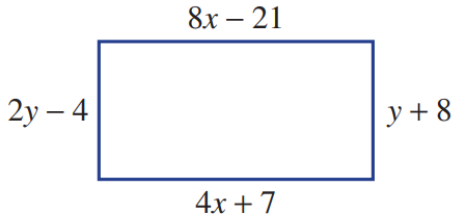
Equal perimeters: 8x + 2 = 4x + 14

4x = 12

x = 3

Rectangle area = 3(3 + 7) = 30

20 Find the area and the perimeter of this rectangle.



Opposite sides equal in rectangle:

8x - 21 = 4x + 7 and 2y - 4 = y + 8

x = 7,

y = 12

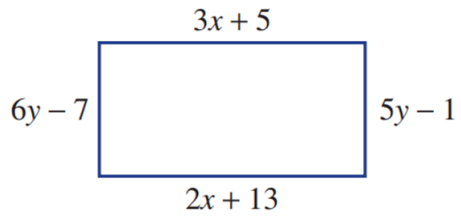
Length = 8(7) - 21 = 35

Width = 12 + 8 = 20

Area = 35 × 20 = 700

Perimeter = 2(35 + 20) = 110

21 Show that the rectangular shape shown must be a square.



Opposite sides equal in rectangle:

3x + 5 = 2x + 13 and 6y - 7 = 5y - 1

x = 8 and y = 6

By substituting and evaluating each side, each side is 29.

A rectangle with all sides equal is a square.

22 A man is currently three times as old as his son.
In 11 years from now he will be twice as old as his son will be then.
How old is his son now?

Let s = son's current age

Man's current age = 3s

In 11 years: (3s + 11) = 2(s + 11)

s = 11

Son is 11 years old now

23 At present Jen is 8 years older than Wesley.
In 3 years from now, Jen's age will be double Wesley's age.
How old is Wesley?

Let w = Wesley's current age

Jen's current age = w + 8

In 3 years: (w + 8 + 3) = 2(w + 3)

5 = w

Wesley is 5 years old

24 The sum of Kelly and Sam's ages is 45 years.
If Kelly's age was doubled, it would be 5 years more than three times Sam's age.
How old is Sam?

Let s = Sam's age, k = Kelly's age

k + s = 45

2k = 3s + 5

use k = 45 - s

Substitute: 2(45 - s) = 3s + 5

s = 17

Sam is 17 years old

25 Flo has two cats, Misty and Smokey. Misty is twice as old as Smokey.
In four years' time, the sum of their ages will be 17. How old is Misty now?

Let s = Smokey's current age, m = Misty's current age

m = 2s

(m + 4) + (s + 4) = 17

2s + s + 8 = 17

s = 3

m = 6

Misty is 6 years old

26 Zach has two dogs, Autumn and Titch. Four years ago, Autumn was three times as old as Titch.
The sum of their ages now is 12. What will be the sum of their ages next year?

Let a = Autumn's current age, t = Titch's current age

a + t = 12

(a - 4) = 3(t - 4)

Use a = 12 – t

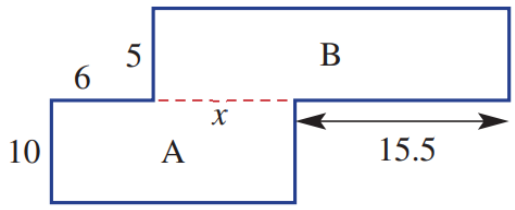
12 – t – 4 = 3t – 12

t = 5, a = 7

Next year their ages will sum to 14

27 Rectangles A and B have the same area.

a What is the value of x?



$10(6 + x) = 5(15.5 + x)$

$x = 3.5$

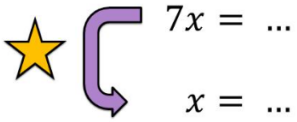
b State the perimeter of the shape.

80

CHECK YOUR UNDERSTANDING

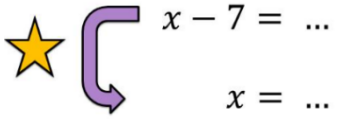
One-step equations

1 What operation should replace the star?



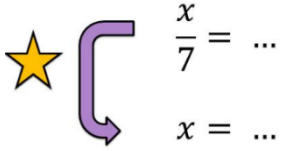
a $+7$ **b** $\times 7$ **c** $\div 7$ **d** -7

2 What operation should replace the star?



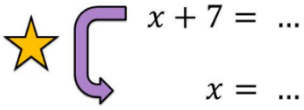
a $+7$ **b** $\times 7$ **c** $\div 7$ **d** -7

3 What operation should replace the star?



a $+7$ **b** $\times 7$ **c** $\div 7$ **d** -7

4 What operation should replace the star?



a $+7$ **b** $\times 7$ **c** $\div 7$ **d** -7

5 Solve $12 = p - 3$

a $p = 9$ **b** $p = 36$ **c** $p = 4$ **d** $p = 15$

6 Solve $12 = \frac{p}{3}$

a $p = 9$ **b** $p = 36$ **c** $p = 4$ **d** $p = 15$

7 Solve $12 = 3p$

a $p = 9$ **b** $p = 36$ **c** $p = 4$ **d** $p = 15$

8 Solve $-3 = p + 12$

a $p = 9$ **b** $p = -15$ **c** $p = -9$ **d** $p = 15$

9 Solve $3p = \frac{1}{12}$

a $p = \frac{1}{4}$ **b** $p = \frac{1}{36}$ **c** $p = -9$ **d** $p = 15$

Two-step equations

1 Solve $9x - 4 = 32$

a $x = 4$ **b** $x = 5$ **c** $x = 6$ **d** $x = 7$

2 Solve $2x + 3 = 14$

a $x = 8.5$ **b** $x = 5.5$ **c** $x = 4$ **d** None of these

3 Solve $4x + 6 = 46$

a $x = 5.5$ **b** $x = 17.5$ **c** $x = 13$ **d** $x = 10$

4 Solve $0 = 20x - 5$

a $x = \frac{1}{4}$ **b** $x = 4$ **c** $x = -4$ **d** $x = -\frac{1}{4}$

5 Tom and Katie are discussing how to solve $4m - 1 = 20$
Tom says to write $4m = 21$
Katie says to write $m - 1 = 5$
Who is correct?

a Only Tom **b** Only Katie **c** Both **d** Neither

6 Tom and Katie are discussing how to solve $\frac{m}{4} - 1 = 20$
Tom says to write $\frac{m}{4} = 21$
Katie says to write $m - 1 = 80$
Who is correct?

a Only Tom **b** Only Katie **c** Both **d** Neither

7 Tom and Katie are discussing how to solve $\frac{8x}{5} = 40$
Tom says to write $8x = 200$
Katie says to write $\frac{x}{5} = 5$
Who is correct?

a Only Tom **b** Only Katie **c** Both **d** Neither

8 Solve $\frac{4}{3}x = 12$

a $x = 1$ **b** $x = 9$ **c** $x = \frac{48}{3}$ **d** $x = 16$

Two-step equations with negative coefficients

1 Solve $-5t = -40$

a $t = 8$ **b** $t = -8$ **c** $t = -45$ **d** $t = -35$

2 Solve $-12 = -\frac{p}{3}$

a $p = -36$ **b** $p = 36$ **c** $p = 4$ **d** $p = -4$

3 Solve $-4x + 1 = 13$

a $x = 3$ **b** $x = -3$ **c** $x = 2$ **d** $x = -4$

4 Solve $4 - x = 6$

a $x = 24$ **b** $x = -24$ **c** $x = -2$ **d** $x = 2$

5 Solve $8 = 24 - d$

a $d = 3$ **b** $d = -16$ **c** $d = 32$ **d** $d = 16$

6 Solve $6 - 3p = 9$

a $p = -1$ **b** $p = 5$ **c** $p = 1$ **d** $p = -5$

7 Solve $5 - 2p = 20$

a $p = -17.5$ **b** $p = -7.5$ **c** $p = 17.5$ **d** $p = 7.5$

Equations with grouping

1 Solve $\frac{x-2}{4} = 10$

a $x = 48$ **b** $x = 42$ **c** $x = 38$ **d** $x = 3$

2 Solve $2(w - 1) = 16$

a $w = 9$ **b** $w = \frac{17}{2}$ **c** $w = 33$ **d** $w = 7$

3 Solve $\frac{x+3}{2} = 10$

a $x = 5$ **b** $x = 8$ **c** $x = 17$ **d** $x = 23$

4 Solve $-3(a - 21) = 12$

a $a = 36$ **b** $a = 17$ **c** $a = -11$ **d** $a = 3$

5 Tom and Katie are discussing how to solve $4(m - 1) = 20$
Tom says to write $4m = 21$
Katie says to write $m - 1 = 5$
Who is correct?

a Only Tom **b** Only Katie **c** Both **d** Neither

6 Tom and Katie are discussing how to solve $\frac{m-1}{4} = 20$
Tom says to write $\frac{m}{4} = 21$
Katie says to write $m - 1 = 80$
Who is correct?

a Only Tom **b** Only Katie **c** Both **d** Neither

Equations with pronumerals on both sides

1 Solve $3x = x + 2$

a $x = 5$ **b** $x = 3$ **c** $x = 2$ **d** $x = 1$

2 Tom and Katie are discussing the first step to solving

$$9v + 1 = 4v - 3$$

Tom says to write $5v + 1 = 4v - 3$

Katie says to write $9v = 4v - 4$

Who is correct?

a Only Tom **b** Only Katie **c** Both **d** Neither

3 Tom and Katie are discussing the first step to solving

$$4v + 1 = 9v - 3$$

Tom says to write $5v + 1 = -3$

Katie says to write $1 = 5v - 3$

Who is correct?

a Only Tom **b** Only Katie **c** Both **d** Neither

4 Tom and Katie are discussing the first step to solving

$$4v + 1 = 3 - 9v$$

Tom says to write $13v + 1 = 3$

Katie says to write $1 = 3 - 13v$

Who is correct?

a Only Tom **b** Only Katie **c** Both **d** Neither

5 An equivalent equation to $5x = 2x + 9$ is:

a $2x = 5$ **b** $3x = 9$ **c** $0 = 7x + 9$ **d** $7x = 9$

6 Solve $x + 6 = 3x + 2$

a $x = 3$ **b** $x = 2$ **c** $x = 4$ **d** $x = 1$

7 Solve $5x + 12 = 2x + 3$

a $x = -6$ **b** $x = \frac{15}{7}$ **c** $x = -3$ **d** $x = 9$