

## Changing the Subject of a Formula

### Starter

1. (Review of last lesson)

Solve: (a)  $2(3x - 4) = 35$

(b)  $5(p + 3) - 7(p - 4) = 53$

(c)  $\frac{4x + 1}{5} - 3 = -10$

(d)  $\frac{15}{x + 4} = \frac{19}{x + 3}$

2. (Review of previous material)

The length of a rectangle is three times its width. Its perimeter is 32 m. Find its area.

3. What is the difference between an equation and a formula?

### Notes

A formula has an = symbol and at least 2 letters in it. One letter is usually on its own on the left hand side. This letter is called the **subject of the formula**. The subject of the formula  $v = u + at$  is  $v$ .

In the same way after solving an equation, we do not write  $-x = 4$  and instead write  $x = -4$ , so the subject of the formula **cannot have a negative symbol in front** of it i.e. write  $x = 2a - 3b$  and not  $-x = 3b - 2a$ .

Changing the subject a formula means **rearranging the formula** so that another letter is on its own on the LHS.

#### Do not copy

For example, consider the formula  $v = u + at$ .

We could rearrange to make  $u$  the subject of the formula  $v = u + at$ .

$v = u + at$        $u$  is positive so we don't want to move it to the other side

$v - at = u$        $(-at)$   $u$  is positive, on its own and at the top but it is not on the LHS

$u = v - at$       Swap the formula over

Or we could rearrange to make  $a$  the subject of the formula.

$v = u + at$        $a$  is positive so we don't want to move it to the other side

$v - u = at$        $(-u)$   $a$  is not on its own so we need to move the  $t$

$\frac{v - u}{t} = a$        $(\div t)$  Divide by  $t$  since division is the opposite to multiplication

$a = \frac{v - u}{t}$       Swap the formula over

#### Please start copying again.

The principles behind solving an equation are exactly the same when you are changing the subject of a formula so we use **SABMIB** to decide which operation to do at each stage.

**Solving an equation**

Solve  $2x + 7 = 15$ .

$$2x + 7 = 15$$

$$2x = 8$$

$$x = 4$$

(-7)

(÷ 2)

**Rearranging a formula**

Rearrange  $ax + b = c$  to make  $x$  the subject.

$$ax + b = c$$

$$ax = c - b$$

$$x = \frac{c - b}{a}$$

(-b)

(÷ a)

When rearranging an equation we need to make sure **PLOT** is in place at the end:

**P**ositive — the new subject must be positive

**L**HS — the new subject must be on the LHS (if you have  $v - at = u$  write  $u = v - at$ )

**O**n its own — no other letters or number must be with the new subject

**T**op — the new subject must not be in the *denominator* of a fraction

**N.B.** LHS  $\equiv$  Left-hand side  
“Don’t lose the **PLOT**.”

**N.B.** Remember to use **SABMIB** to decide which operation to do at each stage

**E.g. 1** Rearrange the formula to make  $x$  the subject:

(a)  $3x - p = q$

(b)  $y = mx + c$

(c)  $s - t = t + kx$

**Working:** (a) *x is positive so we don’t want to move it to the other side*  
*Subtraction before multiplication*  
*Add q to both sides*  
*Divide both sides by 3*

$$\begin{aligned} 3x - p &= q \\ 3x &= q + p \\ x &= \frac{q + p}{3} \end{aligned}$$

**E.g. 2** Rearrange the formula to make  $x$  the subject:

(a)  $\frac{x}{c} = a + b$

(b)  $\frac{x}{s} + 1 = t$

(c)  $a = \frac{x}{m} + n$

**Working:** (a) *x is positive so we don’t want to move it to the other side*  
*Multiply both sides by c*

$$\begin{aligned} \frac{x}{c} &= a + b \\ x &= c(a + b) \end{aligned}$$

**N.B.** *Expand* brackets *before rearranging unless the new subject is in front of the bracket.*

**E.g. 3** Rearrange the formula to make  $x$  the subject of the formula:

(a)  $s(x + a) = b$

(b)  $z = p(3x - y)$

(c)  $x(c + d) = e$

**Working:** (a) *x is positive so we don’t want to move it to the other side*  
*x is not in front of the brackets so expand*  
*Addition before multiplication*  
*Subtract as from both sides*

$$\begin{aligned} s(x + a) &= b \\ sx + as &= b \\ sx &= b - as \end{aligned}$$

*Divide both sides by  $s$*

$$x = \frac{b - as}{s}$$

**N.B.** When the new subject is negative, it is usually a good idea to *prioritise making it positive*

**E.g. 4** Rearrange the formula to make  $y$  the subject of the formula:

(a)  $e = u - gy$

(b)  $w^2 = u^2 - ay$

(c)  $t - 5y = b$

**Working:** (a)  *$y$  is negative so we need to move it to the other side*

*Add  $gy$  to both sides*  
*Addition before multiplication*  
*Subtract  $e$  from both sides*  
*Divide both sides by  $g$*

$$e = u - gy$$
$$e + gy = u$$

$$gy = u - e$$
$$y = \frac{u - e}{g}$$

**Video:** [Changing the subject of a formula](#)

[Solutions to Starter and E.g.s](#)

### Exercise

p23 Ex 12.6 Qu 1ace..., 2-10

### Summary

Changing the subject a formula means *rearranging the formula* so that another letter is on its own on the LHS.

The principles behind solving an equation are exactly the same when you are changing the subject of a formula so we use **SABMIB** to decide which operation to do at each stage.

When rearranging an equation we need to make sure **PLOT** is in place at the end:

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**L**HS — the new subject must be on the LHS (if you have  $v - at = u$  write  $u = v - at$ )

**O**n its own — no other letters or number must be with the new subject

**T**op — the new subject must not be in the denominator of a fraction

[Textbook answers \(only available during a lockdown\)](#)