Worksheet - Formulae and rearranging

Year: Year 8 · 20

Show your working.

Question 1

Question 1 – Expression, equation, formula or identity? *(Section A · Skills practice)*

Maths has some words that look similar but mean different things. For each of the following, write whether it is an expression, an equation, a formula, an identity or an inequality. Give a reason.

a. $3x + 7$
b. $3x + 7 = 22$
c. $A = lw$
d. $2(x + 3) \equiv 2x + 6$
e. $5y - 2 > 13$

Question 2

Question 2 – Substituting into formulae *(Section A · Skills practice)*

Use the formulae to find the value asked for.

a. $P = 2l + 2w$. Find P when $l = 8$ and $w = 5$.
b. $v = u + at$. Find v when $u = 4$, $a = 3$ and $t = 6$.
c. $C = 5n + 20$. Find C when $n = 12$.
d. $A = \frac{1}{2}bh$. Find A when $b = 9$ and $h = 14$.

Question 3

Question 3 – Substitution with squares and negatives *(Section A · Skills practice)*

Take care with the order of operations and negative numbers.

a. $s = ut + \frac{1}{2}at^2$. Find s when $u = 5$, $a = 4$ and $t = 3$.
b. $y = 3x^2 - 2x$. Find y when $x = -2$.
c. $E = mc^2$ is a famous formula. Find E when $m = 2$ and $c = 10$.
d. $V = u^2 - 2as$. Find V when $u = 10$, $a = -3$ and $s = 4$.

Question 4

Question 4 – Changing the subject: one step *(Section A · Skills practice)*

Make x the subject of each formula. Show each step.

a. $y = x + 9$
b. $y = x - 4$
c. $y = 5x$
d. $y = \frac{x}{3}$

Question 5

Question 5 – Changing the subject: two steps *(Section A · Skills practice)*

Make the letter in brackets the subject.

a. $y = 3x + 2$ (x)
b. $P = 2l + 2w$ (l)
c. $C = 5n + 20$ (n)
d. $F = \frac{9C}{5} + 32$ (C)

Question 6

Question 6 – Rearranging with squares and roots *(Section A · Skills practice)*

Make r the subject of each formula. Then use your new formula to find r for the values given. Give answers to 1 decimal place where necessary.

a. $A = \pi r^2$. Find r when $A = 50$.
b. The volume of a cylinder is $V = \pi r^2 h$. Make r the subject. Find r when $V = 300$ and $h = 6$.
c. $s = \sqrt{r}$. Make r the subject. Find r when $s = 7$.
d. $d = \frac{r^2}{4}$. Make r the subject. Find r when $d = 9$.

Question 7

Question 7 – The taxi fare *(Section B · Real-life practice)*

A taxi company in Manchester charges a fixed £3.20 for getting into the cab plus £1.80 for every mile travelled. The formula for the fare is $F = 3.2 + 1.8m$, where m is the number of miles.

a. Find the fare for a 5-mile journey.
b. Find the fare for a 12.5-mile journey.
c. Rearrange the formula to make m the subject.
d. Hamza has only £20. What is the longest journey (in miles, to 1 decimal place) he can afford?
e. The same company offers a fixed price of £25 to the airport, which is 14 miles away. Is that cheaper than the metered fare? By how much?

Question 8

Question 8 – Converting temperatures *(Section B · Real-life practice)*

Holiday brochures in the UK show temperatures in degrees Celsius, but American websites use degrees Fahrenheit. The formula is $F = 1.8C + 32$.

City	Temperature (°C)
Edinburgh	12
Madrid	35
Reykjavik	-5

a. Convert each temperature to °F.
b. Make C the subject of the formula.
c. The temperature in New York is 77°F. What is it in °C?
d. At what Celsius temperature is the Fahrenheit temperature double the Celsius temperature? (Hint: $F = 2C$.)

Question 9

Question 9 – Hiring a room for a party *(Section B · Real-life practice)*

The village hall charges £45 booking fee plus £12 per hour. The cost in pounds is $C = 45 + 12h$, where h is the number of hours.

a. Find the cost of a 4-hour party.
b. Make h the subject.
c. Mia has a budget of £150. For how many hours can she hire the hall?
d. The sports club charges $C = 20h + 15$. For how many hours do the two halls cost the same?

Question 10

Question 10 – Speed, distance and time *(Section B · Real-life practice)*

A train timetable uses the formula $d = st$, where d is distance in miles, s is speed in mph and t is time in hours.

a. The train goes at 80 mph for 2.5 hours. Find the distance.
b. Rearrange the formula to make s the subject.
c. Rearrange the formula to make t the subject.
d. The line from Leeds to London is 190 miles. How long (in hours and minutes) does a train take at an average speed of 95 mph?
e. Another train takes 3 hours to travel 270 miles. Find its average speed.

Question 11

Question 11 – Electricity bill *(Section B · Real-life practice)*

An energy company works out a customer's bill using $B = 0.28u + 0.60d$, where u is the number of units of electricity used, d is the number of days, and B is the bill in pounds.

Month	Units used	Days
March	150	31
June	90	30

a. Calculate the bill for each month.
b. Make u the subject of the formula.
c. In April the bill was £62.40 for 30 days. How many units were used?
d. Is the bill for 200 units over 30 days more than twice the bill for 100 units over 30 days? Explain.

Question 12

Question 12 – Perimeter of the school field *(Section B · Real-life practice)*

The school field is a rectangle. The perimeter is $P = 2l + 2w$. The length is 120 m and the perimeter is 360 m.

a. Rearrange the formula to make w the subject.
b. Find the width of the field.
c. The headteacher wants to put a fence round the field. Fencing costs £14.50 per metre. Find the total cost.
d. A new field has a perimeter of 300 m and a length twice its width. Form an equation and find its dimensions.

Question 13

Question 13 – Bakery pricing *(Section B · Real-life practice)*

A bakery works out the price of a custom cake with $P = 12 + 2.5n$, where n is the number of portions.

a. Find the price of a cake for 16 people.
b. Rearrange the formula to find n.
c. Aaron has £50. How many portions can he get?
d. The bakery adds a charge of £8 for a special design. Write a new formula and find the price for 20 portions.

Question 14

Question 14 – Savings and interest *(Section B · Real-life practice)*

Simple interest on a savings account is given by $I = \dfrac{PRT}{100}$, where P is the money saved in pounds, R is the yearly interest rate in per cent and T is the time in years.

a. Find the interest on £800 at 3% for 4 years.
b. Make P the subject of the formula.
c. Sarah earns £45 interest in 3 years at 2.5%. How much did she save?
d. Make T the subject of the formula and find how long it takes £500 at 4% to earn £100.

Question 15

Question 15 – Spot the mistake *(Section C · Problem solving)*

Four pupils rearranged $y = 4x - 6$ to make x the subject. Their answers are in the table.

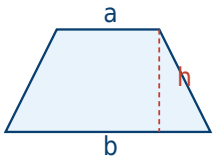
Pupil	Answer
Ali	$x = \dfrac{y - 6}{4}$
Bea	$x = \dfrac{y + 6}{4}$
Cal	$x = \dfrac{y}{4} + 6$
Dev	$x = 4(y + 6)$

a. Which pupil is correct?
b. Explain the mistake made by each of the other pupils.
c. Check the correct answer by substituting $x = 3$.
d. Use the correct formula to find x when $y = 22$.

Question 16

Question 16 – Area of a trapezium *(Section C · Problem solving)*

The area of a trapezium with parallel sides a and b and height h is $A = \frac{1}{2}(a + b)h$.



a. Find the area of a trapezium with $a = 6$ cm, $b = 10$ cm and $h = 5$ cm.
b. Make h the subject of the formula.
c. A trapezium has area 54 cm², $a = 7$ cm and $b = 11$ cm. Find h.
d. Make a the subject of the formula.
e. Use your formula to find a when $A = 40$, $b = 9$ and $h = 5$.

Question 17

Question 17 – Comparing two plumbers *(Section C · Problem solving)*

Two plumbers charge for a repair job as shown.

Plumber	Callout fee	Hourly rate
Ali Plumbing	£40	£30
Beth Repairs	£70	£20

a. Write a formula for each cost, C, after h hours.
b. Find the cost of a 2-hour job for each plumber.
c. For how many hours do they charge the same? Show your working.
d. Which plumber is cheaper for a long job? Explain.
e. Make h the subject in Beth's formula and find the number of hours for a bill of £150.

Question 18

Question 18 – The fuel tank *(Section C · Problem solving)*

A car's fuel economy is given by $d = Gm$ where d is the distance in miles, G is the number of gallons used and m is the miles per gallon. A tank holds 10 gallons.

Car	Miles per gallon
Fiesta	50
Estate	35
Van	28

a. How far can each car go on a full tank?
b. Rearrange the formula to make G the subject.
c. A journey of 245 miles is made in the Estate. How many gallons are used?
d. The Van uses 6.5 gallons for a trip. How far does it go?

Question 19

Question 19 – Gym membership *(Section C · Problem solving)*

A gym offers two plans. Plan A costs £25 a month with no joining fee. Plan B costs £15 a month plus a joining fee of £60.

a. Write a formula for the total cost C of each plan after m months.
b. Find the cost of each plan after 6 months.
c. After how many months are the plans the same price?
d. Aiden wants to join for a year. Which plan is cheaper and by how much?

Question 20

Question 20 – Challenge: rearranging with the subject twice *(Section D ·*

Challenge)

The formula for the total surface area of a cuboid with a square base of side x and height h is $S = 2x^2 + 4xh$.

a. Find S when $x = 3$ and $h = 5$.
b. Make h the subject of the formula.
c. Find h when $S = 150$ and $x = 5$.
d. A square-based box has base side 6 cm and surface area 240 cm². Find its height.
e. Explain why making x the subject is much harder.