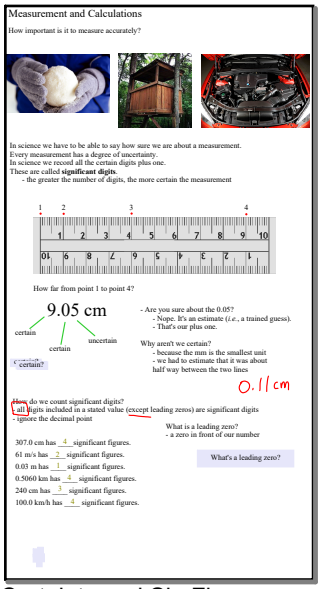



Certainty and Sig Figs

## Let's practice

State the number of significant figures in each of the following:

| | | | |
|---|---|---|---|
| a) 0.0034 | 2 | i) 0.0000100 | 3 |
| b) 1.2300 | 5 | j) 600.021 | 6 |
| c) 0.067 | 2 | k) 102.0 | 4 |
| d) 0.00001 | 1 | l) 102030 | 6 |
| e) 9.3005 | 5 | m) 10200 | 5 |
| f) 1000 | 4 | n) 100 | 3 |
| g) 3006 | 4 | o) 0.1005 | 4 |
| h) 0.0010 | 2 | | |

Practice

How many puppies are in the hammock?

5.000000000 000000000 00000

Are you sure?

Is it exactly 5 or is that an estimate?

Things that you actually count don't have significant digits.

We assume the value to have infinite significant digits.

The number of puppies is 5.0000000000000.....

How many minutes are in one hour?

Are you sure?

Is it exactly 60 or is that an estimate?

Values that are defined don't have significant digits.

We assume the value to have infinite significant digits.

The number of minutes is 60.0000000000000.....

Examples

| Counted Values | Defined Values |
|---|---|
| 29 students | 1000 m/km |
| 3 blue jays | 10 mm/cm |
| 11 Pokeballs | 1 min/60 sec |

Why does this matter?

We don't use counted or defined values when figuring out the number of significant figures to include in the answer of a calculation.

Counted/Defined Values

How many significant digits do I use in a calculation?

multiply and divide
- answer has the same number of significant digits as the measurement with the fewest

*e.g.*, Area of a triangle
A = 1/2 bh
= 1/2 x 3.2 cm x 10.1 cm
(2) (3)
= 16.16 cm²
= 16 cm² (2 significant digits)

0.5

add and subtract
- answer has the same number of decimal places as the measurement with the fewest

*e.g.*, Total distance walked during the lunch break
$d_t$ = 101.2 m + 7 m + 1.12 m
= 109.32 m
= 109 m

*e.g.*,
62.43 cm + 140.2 cm = 202.6 cm 1 decimal places?
100 kg ÷ 6.2 = 16 kg
0.86 m x 100.4 m = 86 m
0.084 + 2800.1 = 2800.1
12.54 s - 3.1 s = 9.4 s

Let's try one more. Total distance travelled by a car
$d_t$ = 104.2 km + 11 km + 0.67 km
1 0 2
= 115.87 km
= 116 km
0 decimal places

Wait a second!
- why is the answer 116 and not 115?

Mult/Div & Add/Subt

How do we round off an answer?

- if the digit after the one you're keeping is 5 or greater - round up

*e.g.*, For a triangle, $A = \frac{1}{2}bh$

b = 6.21 cm
h = 8.0 cm

Decide how many significant digits and round it off.

A = (0.5)(6.21 cm)(8.0 cm)
3 2
= 24.84 cm² → 24.8
= 25 cm²

*e.g.*, Calculate the total distance.
d1 = 5.5 m
d2 = 0.597 m
d3 = 0.1262
Total distance = 5.5 m + 0.597 m + 0.1262 m
1 3 4
= 6.2232
= 6.2 m

Rounding

**Significant Digits and Rounding Off Practice**

1. State the number of significant digits.

| | |
|---|---|
| a) 7.651 mm | 4 |
| b) 20.2 m/s | 3 |
| c) 50.0 cm | 3 |
| d) 0.084 km | 2 |

2. Round the following values to three significant digits.

| | |
|---|---|
| a) 32.674 km | 32.7 km |
| b) 0.003 922 g | 0.00392 g |
| c) 107.51 s | 108 s |

3. Complete the following calculations by providing the correctly rounded answer with units.

| | |
|---|---|
| a) 22.4 h x 0.1 mm/h | a) 2 mm |
| b) 465 km divided by 5.21 h | b) 89.3 km/h |
| c) 18 cm³ x 1.10 g/cm³ | c) 20 g |
| d) 12.3 weeks x 7 days/week | d) 86.1 days |
| e) 17.5 mL + 95 mL + 8.25 mL | e) 121 mL |
| f) 32.1 m + 960 m + 20.02 m | f) 1012 m |
| g) 0.2 cm + 23.91 cm + 0.62 cm | g) 24.7 cm |
| h) 13.63 h - 0.5 h | h) 13.1 h |
| i) 35.1 mm + 67.04 mm | i) 102.1 mm |
| j) 7.52 s + 8.678 s + 0.24 s | j) 16.44 s |

4. Determine the area of the following shapes to the correct number of significant digits.

| | |
|---|---|
| a) A rectangle with a length of 10.0 m and a width of 12 m | 120 m² |
| b) A triangle with a base of 8.23 cm and a height of 0.68 cm | 2.8 cm² |

Practice

Try this one:

A field is 120 m long x 15 m wide.
Calculate the area of the field.

A = l x w
= (120 m)(15 m)
= 1800 m$^2$

How many significant figures are we allowed? 2

Uh-oh!

Scientific notation

We need a way to show the correct number of significant digits.
- use scientific notation

Steps:
1. Move the decimal to give the correct number of significant digits. (Always have one digit in front of the decimal)
2. Add "x10" with an exponent to show how many places you moved it.
   a) Exponent is + if moved to the left.
   b) Exponent is - if moved to the right.

the decimal

exponent

$x10^5$

How do we fix our previous problem?

What do we want? 1800 m$^2$ with 2 significant digits

How do we do that? 1.8

How many places did we move? 3

Left or right? Left

Final answer? $1.8x10^3$ m$^2$

3,457 x10 3

1800

Let's try some.

| Quantity | Scientific Notation | Quantity | Scientific Notation |
|---|---|---|---|
| 2400 km | 2.400 x $10^3$ km | 10101.0 m | 1.01010 x $10^4$ m |
| 0.0000005 s | 5 x $10^{-6}$ s | 0.00035416 m | 3.5416 x $10^{-4}$ m |
| 1234567 kg | 1.234567 x $10^3$ kg | 2340000 5 | 2.34 x $10^6$ s |

Scientific Notation

**Scientific Notation Practice**

1. Change each of the following into correct scientific notation. Round off to one decimal place.

a) 0.00000581
b) 207000
c) 0.03152
d) 40300000
e) 0.00370
(f) 42893
(g) 4105000
(h) 0.0003025
(i) 28750
(j) 213
(k) 200500
(l) 3685000
(m) 30.025
(n) 102.5
(o) 0.356

2. Express each of the following in expanded form.

a) 2.54x$10^5$
b) 1.01x$10^{-3}$
c) 3.05x$10^7$
(d) 2.15x$10^{-6}$
(e) 9.22x$10^2$
(f) 9.22x$10^{-2}$

3. Calculate each of the following using correct significant digits.

a) 7x$10^4$ + 2x$10^5$
b) 8x$10^{-3}$ - 7x$10^{-4}$
c) (3x$10^2$)(2x$10^3$)
d) (1.3x$10^{-3}$)(4x$10^{-5}$)
e) 5x$10^{-2}$ + 3x$10^{-4}$
f) (8x$10^{-5}$)(3x$10^7$)
g) (3x$10^{-3}$)$^3$
h) 6.201 + 7.4 + 0.68 + 12.0
i) 475 - 0.4168
j) (3.2145)(4.23)
k) 3.1416 / 12.4
(l) 6.6x$10^5$ / 3.0x$10^2$
(m) (3800)(0.0054)(0.0000001)
(n) (2x$10^5$)$^2$
(o) (2x$10^4$)$^2$(3x$10^6$)$^3$
(p) 4x$10^5$ - 1x$10^6$
(q) (-9x$10^{17}$)(6x$10^{-18}$)
(r) (-3x$10^{-3}$)$^3$
(s) 10.8 + 8.264
(t) (131)(2.3)
(u) 20.2 / 7.41

Practice

**Scientific Notation Practice**

1. Change each of the following into correct scientific notation. Round off to one decimal place.

a) 0.00000581 5.8x$10^{-6}$
b) 207000 2.1x$10^5$
c) 0.03152 3.2x$10^{-2}$
d) 40300000 4.0x$10^7$
e) 0.00370 3.7x$10^{-3}$
(f) 42893 4.3x$10^4$
(g) 4105000 4.1x$10^6$
(h) 0.0003025 3.0x$10^{-4}$
(i) 28750 2.9x$10^4$
(j) 213 2.1x$10^2$
(k) 200500 2.0x$10^5$
(l) 3685000 3.7x$10^6$
(m) 30.025 3.0x$10^1$
(n) 102.5 1.0x$10^2$
(o) 0.356 3.6x$10^{-1}$

2. Express each of the following in expanded form.

a) 2.54x$10^5$ 254000
b) 1.01x$10^{-3}$ 0.00101
c) 3.05x$10^7$ 30500000
(d) 2.15x$10^{-6}$ 0.00000215
(e) 9.22x$10^2$ 922
(f) 9.22x$10^{-2}$ 0.0922

3. Calculate each of the following using correct significant digits.

a) 7x$10^4$ + 2x$10^5$ 3x$10^5$
b) 8x$10^{-3}$ - 7x$10^{-4}$ 7x$10^{-3}$
c) (3x$10^2$)(2x$10^3$) 6x$10^5$
d) (1.3x$10^{-3}$)(4x$10^{-5}$) 5x$10^{-8}$
e) 5x$10^{-2}$ + 3x$10^{-4}$ 5x$10^{-2}$
f) (8x$10^{-5}$)(3x$10^7$) 2x$10^3$
g) (3.0x$10^{-3}$)$^3$ 2.7x$10^{-8}$
h) 6.201 + 7.4 + 0.68 + 12.0 26.3
i) 475 - 0.4168 475
j) (3.2145)(4.23) 13.6
k) 3.1416 / 12.4 0.253
(l) 6.6x$10^5$ / 3.0x$10^2$ 2.2x$10^3$
(m) (3800)(0.0054)(0.0000001) 9x$10^{-12}$
(430000000)(0.00054) 4x$10^{10}$
(n) (2x$10^5$)$^2$ 1.1x$10^{28}$
(o) (2.0x$10^4$)$^2$(3.0x$10^6$)$^3$ -6x$10^5$
(p) 4x$10^5$ - 1x$10^6$ -5
(q) (-9x$10^{17}$)(6x$10^{-18}$) -9.3x$10^{-6}$
(r) (-2.1x$10^{-2}$)$^3$ 19.1
(s) 10.8 + 8.264 3.0x$10^2$
(t) (131)(2.3) 2.73
(u) 20.2 / 7.41

Answers

You're planning on going to Moncton which is 135 km away and you don't want to speed so you won't get faster than 110 km/h. How can you figure out how long it would take you?

d = vt

What does t = ?

To find t, we have to rearrange the formula.

Steps:
1. What am I looking for?
2. What's happening to it?
3. "Undo" (i.e., do the opposite) what's happening to it using BEDMAS backward. Brackets, Exponents, Divide/Multiply, Add/Subtract
4. Do the same on both sides of the equation. — cancel what you can
5. Repeat these steps until you have the variable you want all by itself.

Rule 1: Always do the same thing to both sides.

Rule 2: There is no Rule 2. Wait. What?

Let's do it!

$d = vt$ - we want t by itself so we have to get rid of everything else
- t is multiplied by v so to get rid of v we have to divide by it

$\frac{d}{v} = \frac{vt}{v}$ - do the same to both sides — Whatever was done to the variable, do the opposite.

$\frac{d}{v} = t$ - simplify by crossing out what you can

Basically, we just get rid of everything we don't want.

Solve for r

$C = 2\pi r$ - we want r by itself so we have to get rid of everything else
- r is multiplied by $2\pi$ so to get rid of $2\pi$ we have to divide by them

$\frac{C}{2\pi} = \frac{2\pi r}{2\pi}$ - do the same to both sides

$r = \frac{C}{2\pi}$ - simplify by crossing out what you can

Solve for m

$D = \frac{m}{V}$ - we want m by itself so we have to get rid of everything else
- m is divided by V so to get rid of V we have to multiple by it

$DV = \frac{mV}{V}$ - do the same to both sides

$m = DV$ - simplify by crossing out what you can

Solve for x

$y = mx + b$ - we want x by itself so we have to get rid of everything else
- x is added to b so to get rid of b we have to subtract it

$y - b = mx$ - do the same to both sides

$\frac{y-b}{m} = \frac{mx}{m}$ - x is multiplied by m so to get rid of m we have to divide by it

$x = \frac{y-b}{m}$ - simplify by crossing out what you can

Rearranging equations

Let's Practice!

Rearrange the following equations for the (variable):

1. A = B + C (B)
2. R = A - X (X)
3. M + L = n - R (M)
4. y = x - 2 (x)
5. a = b - 3 (b)
6. y = 2x (x)
7. y = 2/x (x)
8. E = 0.5 mv$^2$ (m)
9. y = mx (m)
10. PV = nRT (P)
11. a = 2b - 3 (b)
12. p = 2q - 2r (q)
13. 9m = 3x - 6y (y)
14. v - wa - wc = 0 (c)
15. (2m - n)/3 = m + n + 3 (m)

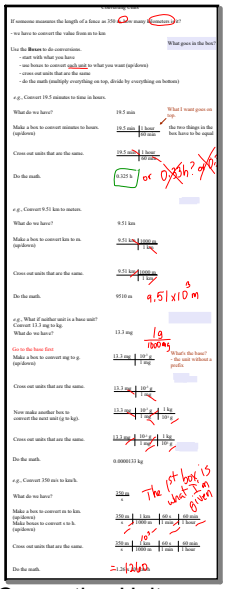
Rearranging Prac.

Let's Practice!

Rearrange the following equations for the (variable):

1. $A = B + C$ (B) $B = A - C$
2. $R = A - X$ (X) $X = A - R$
3. $M + L = n - R$ (M) $M = n - R - L$
4. $y = x - 2$ (x) $x = y + 2$
5. $a = b - 3$ (b) $b = a + 3$
6. $y = 2x$ (x) $x = \frac{y}{2}$
7. $y = 2/x$ (x) $x = \frac{2}{y}$
8. $E = 0.5\ mv^2$ (m) $m = \frac{2E}{v^2}$
9. $y = mx$ (m) $m = \frac{y}{x}$
10. $PV = nRT$ (P) $P = \frac{nRT}{V}$
11. $a = 2b - 3$ (b) $b = \frac{a + 3}{2}$
12. $p = 2q - 2r$ (q) $q = \frac{p + 2r}{2}$
13. $9m = 3x - 6y$ (y) $y = \frac{3x - 9m}{6}$
14. $v - wa - wc = 0$ (c) $c = \frac{v - wa}{w}$
15. $(2m - n)/3 = m + n + 3$ (m) $m = -4n - 9$

Rearranging Prac.



Converting Units

## Metric Prefixes and Symbols

| MULTIPLICATION FACTOR | PREFIX | SYMBOL |
|---|---|---|
| 1 000 000 000 000 000 000 = $10^{18}$ | exa | E |
| 1 000 000 000 000 000 = $10^{15}$ | peta | P |
| 1 000 000 000 000 = $10^{12}$ | tera | T |
| 1 000 000 000 = $10^{9}$ | giga | G |
| 1 000 000 = $10^{6}$ | mega | M |
| 1 000 = $10^{3}$ | kilo | k |
| 100 = $10^{2}$ | hecto | h |
| 10 = $10^{1}$ | deka | da |
| e.g., m, g, s — Base | | |
| 0.1 = $10^{-1}$ | deci | d |
| 0.01 = $10^{-2}$ | centi | c |
| 0.001 = $10^{-3}$ | milli | m |
| 0.000 001 = $10^{-6}$ | micro | µ |
| 0.000 000 001 = $10^{-9}$ | nano | n |
| 0.000 000 000 001 = $10^{-12}$ | pico | p |
| 0.000 000 000 000 001 = $10^{-15}$ | femto | f |
| 0.000 000 000 000 000 001 = $10^{-18}$ | atto | a |

How do I use this table?

It always answers the question:
"How many base in a prefix?"

$\frac{10^{-2}\ m}{1\ cm}$

*e.g.*, Convert centimeters to meters.
How many meters in a centimeter? $10^{-3}$ millimeter

*e.g.*, Convert grams to kilograms.
How many grams in a kilogram? $10^{3}$

Metric Prefixes

## Converting Units Practice

Perform each of the following conversions.

a) 0.785 kg → mg
b) 0.0775 g → mg
c) 12 cm/s → km/h
d) 7.56 mm → cm
e) 81.4 nm → cm
f) 3.21 Gm → km
g) 5 km/h → m/s
h) 27.1 µm → nm
i) 675 nm → µm
j) 3.70 cs → ms
k) 5 km/h → m/s
l) 27.3 µm → nm
m) 0.307 mg → g
n) 0.667 m → cm
o) 0.384 m → dm
p) 60 cm/s → km/h
q) 0.0300 h → s
r) 60 m/s → km/h
s) 427 Mm → Tm
t) 36.8 nm → pm
u) 0.0278 Gm → km
v) 300 cm → µm
w) 629 mm → m
x) 52.1 L → mL

Converting Practice

## Converting Units Practice

Perform each of the following conversions.

a) 0.785 kg → mg — $7.85 \times 10^{5}$ mg
b) 0.0775 g → mg — 77.5 mg
c) 12 cm/s → km/h — 0.432 km/h
d) 7.56 mm → cm — 0.756 cm
e) 81.4 nm → cm — $8.14 \times 10^{-6}$ cm
f) 3.21 Gm → km — $3.21 \times 10^{6}$ km
g) 5.0 km/h → m/s — 1.4 m/s
h) 27.1 µm → nm — $2.71 \times 10^{4}$ nm
i) 675 nm → µm — 0.675 µm
j) 3.70 cs → ms — 37.0 ms
k) 52.1 L → mL — $5.21 \times 10^{3}$ mL
l) 27.3 µm → nm — $2.73 \times 10^{4}$ nm
m) 0.307 mg → g — $3.07 \times 10^{-4}$ g
n) 0.667 m → cm — 66.7 cm
o) 0.384 m → dm — 3.84 dm
p) 60 cm/s → km/h — 2.16 km/h
q) 0.0300 h → s — 108 s
r) 60 m/s → km/h — 216 km/h
s) 427 Mm → Tm — $4.27 \times 10^{-4}$ Tm
t) 36.8 nm → pm — $3.68 \times 10^{4}$ pm
u) 0.0278 Gm → km — $2.78 \times 10^{4}$ km
v) 300 cm → µm — $3.00 \times 10^{6}$ µm
w) 629 mm → m — 0.629 m

Answers

a) $0.785\ kg \rightarrow mg$

$$\frac{0.785\ kg}{1} \left| \frac{10^{3}\ g}{1\ kg} \right| \frac{1\ mg}{10^{-3}\ g} =$$

$785\,000 = 7.85 \times 10^{5}$

Nov 22-10:21 AM

c) 12 cm/s → km/h

$$\frac{12\ \text{cm}}{\text{s}} \left| \frac{10^{-2}\ \text{m}}{1\ \text{cm}} \right| \frac{1\ \text{km}}{10^{3}\ \text{m}} \left| \frac{60\ \text{s}}{1\ \text{min}} \right| \frac{60\ \text{min}}{1\ \text{h}}$$

$$= 0.432\ \text{km/h}$$

$$= 0.43\ \text{km/h}$$

Nov 22-10:30 AM

k) 52.1 L → mL

$$52.1\ \text{L} \left| \frac{1\ \text{mL}}{10^{-3}\ \text{L}} \right. = 52100\ \text{mL}$$

$$= 5.21 \times 10^{4}\ \text{mL}$$

Nov 22-10:36 AM