# Dimensional Analysis

3 Dozen eggs equals how many eggs?

Equality   1 dozen items = 12 items

## Road map

Given: Dozen —equality→ Desired: eggs

$$3 \text{ Dozen eggs} \times \frac{12 \text{ eggs}}{1 \text{ Dozen}} = 36 \text{ eggs}$$

Conversion factor expressed as a ratio of 2 units

$$\frac{1 \text{ dozen}}{12 \text{ eggs}} \text{ or } \frac{12 \text{ eggs}}{1 \text{ dozen}}$$

Equality expressed as a mathematical equality   1 dozen = 12 eggs

Desired                                   Given

How many **second** are there in **3.7 hours**?

Equalities

1 min = 60 seconds

~~1 hour = 60 min~~

## Road Map

Given hours —(1 hour = 60 min)→ min —(1 min = 60 sec)→ Desired seconds

$$3.7\ \text{hours} \times \frac{60\ \text{min}}{1\ \text{hours}} \times \frac{60\ \text{seconds}}{1\ \text{min}} = 13{,}320\ \text{seconds}$$

$$\frac{3.7 \times 60 \times 60}{1 \times 1} = 13{,}320\ \text{seconds}$$

## Sig figs

2SF, def, def, 2 SF

$$3.7\ \text{hours} \times \frac{60\ \text{min}}{1\ \text{hours}} \times \frac{60\ \text{seconds}}{1\ \text{min}} = 13|320\ \text{seconds}$$

>5 ↑

<5 ↓

= **13,000 seconds** or **$1.3 \times 10^4$ seconds**

# Steps for problem Solving

① Parse the problem
- identify Given
  Desired
  equalities

② Develope a road map

Given ⟶ ⟶ ⟶ ⟶ Desired

Some equalities must be memorized

SI system

| | |
|---|---|
| Kilo | 1 Km = 1000 m |
| Centi | 1 m = 100 cm |
| milli | 1 m = 1000 mm |
| Micro | $1 \times 10^{-6}$ m = 1 μm |
| | 1,000,000 μm = 1 m |

**3 Key Conversion factors (equalities)**

| | Eng ⟶ SI | |
|---|---|---|
| Length | 1 in = 2.54 cm | *Exact |
| mass | 1 lb = 453.6 g | 4 SF |
| Volume | 1 gal = 3.785 L | 4 SF |

③ Write out the problem in dimensional analysis format

Given × ——— × ——— × ——— = Desired

④ Analyse Sig figs

⑤ Round & Box in answer

Desired / Given

How many **seconds** are in **57.7 years**?

## Road Map

years $\xrightarrow{1}$ days $\xrightarrow{2}$ hours $\xrightarrow{3}$ min $\xrightarrow{4}$ seconds

## Equalities

~~1 year = 12 months~~

1. 1 year = 365 days
2. 1 days = 24 hours
3. 1 hour = 60 min
4. 1 min = 60 sec

3 — def — def — def — def

$$57.7\ \text{years} \times \frac{365\ \text{days}}{1\ \text{years}} \times \frac{24\ \text{hours}}{1\ \text{days}} \times \frac{60\ \text{min}}{1\ \text{hours}} \times \frac{60\ \text{sec}}{1\ \text{min}}$$

$$\frac{57.7 \times 365 \times 24 \times 60 \times 60}{1 \times 1 \times 1 \times 1} = 1,630,411,200\ \text{seconds}$$

1630000000 second

$1.63 \times 10^{9}$ seconds

The volume of blood plasma in adults is 3.1 L. (Given)

The density of plasma is $1.03\ g/cm^3$. (Equality) How many pounds (desired) of plasma are in the average adult body?

Equality

① $1.03\ g = 1\ cm^3$ Density (mass to volume Conversion factor)

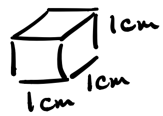
memorized

② $453.6\ g = 1\ lb$

③ $1\ mL = 1\ cm^3$

④ $1\ L = 1000\ mL$

or $1\times10^{-3}\ L = 1\ mL$




$= 1\ cm \times 1\ cm \times 1\ cm = 1\ cm^3$

$= 1\ mL = 1\ cm^3$

Road Map

L (Volume in SI units) →④ mL →③ $cm^3$ →① g →② lbs (mass in Eng)

vol | mass

2SF, def, def, measured 3 SF, measured 4SF

$$3.1\ \cancel{L} \times \frac{1000\ \cancel{mL}}{1\ \cancel{L}} \times \frac{1\ \cancel{cm^3}}{1\ \cancel{mL}} \times \frac{1.03\ \cancel{g}}{1\ \cancel{cm^3}} \times \frac{1\ lbs}{453.6\ \cancel{g}} = \quad lbs$$

$$\frac{3.1 \times 1000 \times \cancel{1} \times 1.03 \times \cancel{1}}{\cancel{1} \times \cancel{1} \times \cancel{1} \times 453.6}$$

$$\frac{3.1 \times 1000 \times 1.03}{453.6} = 3.1 \times 1000 \times 1.03 \times \frac{1}{453.6}$$

$$= 3.1 \times 1000 \times 1.03 \div 453.6 = 7.039241622 57\ lbs$$

**7.0 lbs**

# Rounding

Round each of the following to 3 sig figs

Start at 1st non zero value
& move to right

57.0297 L    57.0 L

103.592 mm    104 mm

2,399,673 sec    2,400,000 sec or $2.40 \times 10^6$ sec

0.00067029 m    0.000670 m or $6.70 \times 10^{-4}$ m

## Rules for × ÷

Round to smallest number of SF in problem

Rounding answer to match the piece of data with largest uncertainty
⇒ smallest # of sig figs

## Rules for ±

Rounding is done by place value.

Rounding answer to match the piece of data with the bigest uncertainty
⇒ gratest uncertainty by place value

$\times \div$

$$\overset{4}{6.732\,s} \times \overset{\text{def}}{\frac{1\,\text{min}}{60\,s}} \times \overset{2\,\text{sf}}{\frac{3.7\,\text{km}}{1\,\text{min}}} = \quad 2\,\text{SF}$$

$\pm$

| | | | |
|---|---|---|---|
| | 3.62 m | 3 | ± 0.01 |
| | 102.0 m | 4 | ± 0.1 ⟸ |
| | 0.006 m | 1 | ± 0.001 |
| + | 50.32 m | 4 | ± 0.01 |
| | 155.946 m | | |

**155.9 m** 4 SF