2-2 Measurement and Calculations

Section 2-2 Measurements

Quantity – has magnitude, size, or amount
(volume, mass, length, etc)

Unit – predefined quantity represented by a specific type of measurement
(feet, meter, gram, mile, etc.)

- A measurement will consist of a number and a unit
- Units of measure have been standardized on natural values that never change.
- World uses SI system as a standard system.
- Numbers do not use commas
  - 2,100 can mean 2.100 in some countries

Section 2-2 Measurements

7 Major unit types (p34)

SI units use standard prefixes (p35)

Mass is not weight!! Mass is amount of material. Weight is a measure of gravitational pull

Derived units are measurable properties that are based on SI units multiplying or dividing each other. (p36)

Some units with their own name are derived → Pascal = $\frac{kg}{m\ s^2}$

Density = $\frac{\text{Mass}}{\text{Volume}} = \frac{g}{cm^3} = \frac{g}{mL}$

Conversion Factors are ratios of equal amounts between different units

Section 2-2 Measurements

Comparisons of Units

Length
1 km ~ 2½ laps on the track
1 m ~ Height of a desk
1 cm ~ Width of a finger
1 mm ~ Credit card thickness

Volume
1 L ~ About 1 Quart
1 mL ~ a few drops of water (cm^3)

Mass
1 g ~ Weight of a paper clip
1 kg ~ 1 liter of water
1 ton ~ small car

Section 2-2 Dimensional Analysis

Math with Units
Units will follow the same rules as variables and numbers.

Going back to math…

Anything multiplied by 1 remains the same.

$A \cdot 1 = A$

Anything divided by itself equals 1

$\frac{A}{A} = 1$

If B = A
→ $\frac{B}{A} = 1$ Division of equal things → 1

Section 2-2 Dimensional Analysis

Applying rules to units:

Begin with a statement of equality.
3 ft = 1 yd

This means:

$\frac{3\text{ ft}}{1\text{ yd}} = 1 = \frac{1\text{ yd}}{3\text{ ft}}$

These are conversion factors!!
Multiplying by either one does not change a value…

Section 2-2 Dimensional Analysis

How many feet are in 10 yards?

Begin with writing all statements of equality needed.
3 ft = 1 yd

Next, write the quantity to be converted.
10 yards

We want to cancel yards and be left with feet. What factor to use?
$\frac{3\text{ ft}}{1\text{ yd}}$ or $\frac{1\text{ yd}}{3\text{ ft}}$

Finally, put it all together:
Cancel units, multiply top numbers, divide by bottom numbers
10 yd $\left[\frac{3\text{ ft}}{1\text{ yd}}\right]$ **=** **10** ~~**yd**~~ $\left[\frac{3\text{ ft}}{1\ \not{\text{yd}}}\right]$ **= 30 ft**

Section 2-2 Dimensional Analysis

Quality Expectations

How many grams are in 3.25 kg?

1 kg = 1000 g ← Statement of Equality

$$3.25\,\cancel{kg}\left[\frac{1000\,(g)}{1\,\cancel{kg}}\right] = \boxed{3250\text{ g}}$$

Units are canceled

Answer is marked

The "cross-hatch" method is also acceptable:

1 kg = 1000 g

$$\frac{3.25\,\cancel{kg}}{}\Big|\frac{1000\,(g)}{1\,\cancel{kg}} = \boxed{3250\text{ g}}$$

Section 2-2 Dimensional Analysis

Handling Time

A separate conversion factor must be used for each step needed.

s → min → hr → day → year

Convert 5 040 s into hrs.

1 min = 60 sec

1 hr = 60 min

$$5040\,\cancel{s}\underbrace{\left[\frac{1\text{ min}}{60\,\cancel{s}}\right]}_{\text{Factor 1}}\underbrace{\left[\frac{1\,(hr)}{60\,\cancel{min}}\right]}_{\text{Factor 2}} = \boxed{1.4\text{ hrs}}$$

Section 2-2 Dimensional Analysis

Derived Units

A separate conversion factor is needed for each unit change. For each power of a unit, you will also need an extra conversion factor.

Convert 10 km / hr to m / min.

1 km = 1000 m

1 hr = 60 min

$$\frac{12\,\cancel{km}}{\cancel{hr}}\underbrace{\left[\frac{1000\,(m)}{1\,\cancel{km}}\right]}_{\text{Factor 1}}\underbrace{\left[\frac{1\,\cancel{hr}}{60\,(min)}\right]}_{\text{Factor 2}} = \boxed{200\ \frac{m}{min}}$$

Section 2-2 Dimensional Analysis

Area and Volume

Area and volume require a separate conversion factor for each power

Convert 5 m^2 to cm^2.

1 m = 100 cm

$$5\,\cancel{m^2}\underbrace{\left[\frac{100\,(cm)}{1\,\cancel{m}}\right]}_{\text{Factor 1}}\underbrace{\left[\frac{100\,(cm)}{1\,\cancel{m}}\right]}_{\text{Factor 2}} = \boxed{50\ 000\ cm^2}$$