

Significant Figures

Rules for Counting Sig. Fig.

1. **All** non-zero digits are significant

2. Zeros

a) zeros between non-zero digits are significant

Ex. 507

b) leading zeros are not significant

Ex. 0.00004

c) Trailing zeros to the right of a number are significant **if the number has a decimal point**. If the number ends in zero and has no decimal point, we assume that the trailing zeros are not significant.

Ex. 480.0 (4 sig figs)

Ex. 4800 (2 sig figs)

How many significant figures in the following?

a) 38.4703 mL - ____ sig. figs

b) 0.0052 g - ____ sig. figs

c) 0.05700 s - ____ sig. figs

d) 6.19×10^8 years - ____ sig. figs

Significant Figures and Calculations

1. Multiplication and Division

The result of the operation is reported as having **as many significant figures as the measurement with the fewest significant figures**

Ex. $(6.221 \text{ cm}) \times (5.2 \text{ cm}) =$

2. Addition and Subtraction

The result of the operation is reported to the **same number of decimal places as that of the term with the least number of decimal places**

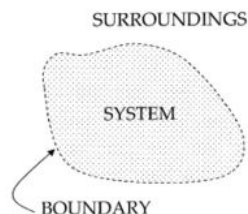
Ex.
$$\begin{array}{r} 20.4 \\ 1.322 \\ + 83 \end{array}$$

Energy Changes

Energy - is the ability to do work.

A chemical substance or **system** is a group of chemicals being studied, separated from the surroundings by a boundary.

The **surroundings** are defined as the environment around the chemical system.



When a system loses thermal energy, the surroundings will gain that energy.

When a system gains thermal energy, it usually gets it from the surroundings.

Temperature (T) - is a measure of the average kinetic energy of the particles in a system.

Kinetic energy - energy of motion

Heat (q) - is a measure of the total kinetic energy of the particles in a system. (measured in Joules)

~~Heat will always flow from a warm object to a cooler object.~~

Heat Capacity (C) - is the heat required to change the temperature of a quantity of the substance.

There are two kinds of heat capacity:

1. **Specific Heat Capacity (J/g °C)** - is the quantity of heat required to raise the temperature of a unit mass (1 gram) of a substance by a temperature of one degree Celsius.

2. **Volumetric Heat Capacity (MJ/m³ °C)** - is the quantity of heat required to raise the temperature of a unit volume of a substance by one degree Celsius.

$$\text{kJ/L} \cdot ^\circ\text{C} \quad 4.19 \frac{\text{MJ}}{\text{m}^3 \cdot ^\circ\text{C}} = 4.19 \frac{\text{kJ}}{\text{L} \cdot ^\circ\text{C}}$$

Volumetric heat capacity is used mainly with liquids and gases.

Note: 1 (MJ/(m³ °C) = 1 (kJ/(L °C))

The quantity of heat (q) that flows varies directly with the quantity of substance (mass or volume), the specific or volumetric heat capacity (C) and the temperature change (ΔT).

FORMULA: $q = m C \Delta T$ or $q = v C \Delta T$

In calculating q, the heat capacity constant (C) must correspond to the state of matter of the substance.

$$4.19 \frac{\text{J}}{\text{g} \cdot ^\circ\text{C}}$$

HEAT

$$q = m C \Delta T$$

↑ heat (J) ↑ mass (g) ↑ spec. heat capacity ($\frac{J}{g^{\circ}C}$) ↑ change in temp. ($^{\circ}C$)

$$q = V C \Delta T$$

↑ volume (L) ↑ vol. heat capacity ($\frac{kJ}{L^{\circ}C}$)

Example

How much energy does it take to raise the temperature of 50.0 g of copper from 18.0°C to 30.0°C?

$$m = 50.0 \text{ g}$$

$$C = 0.385 \frac{\text{J}}{\text{g} \cdot ^\circ\text{C}}$$

$$\Delta T = 12.0^\circ\text{C}$$

$$q = ?$$

$$q = mC\Delta T$$

$$q = (50.0 \text{ g}) (0.385 \frac{\text{J}}{\text{g} \cdot ^\circ\text{C}}) (12.0^\circ\text{C})$$

$$q = 231 \text{ J}$$

Determine the amount of energy required to heat 15.00 g of ice from -25.00°C to -8.000°C .