CH 221 Chapter One Concept Guide

Much scientific work depends on physical measurements, and much of the progress of science depends on communication. Throughout time, a system of standardized units of measurement has evolved. The system utilizes the metric system and a standard set of units, called *Système International d'Unités* (International System of Units), abbreviated SI units.

1. Common Units

SI System: Most measurements in chemistry are made in terms of powers of ten of these standard units.

Units of Measurement

Measurement	Name of Unit	Abbreviation
Mass	kilogram *	kg
Length	meter *	m
Time	second *	s
Temperature	Kelvin *	K
Amount of substance	mole *	mol
Charge	coulomb	C
Electric current	ampere *	A
Force	Newton	N
Work and energy	joule	J
Frequency	hertz	Hz
Pressure	Pascal	Pa
Volume	cubic meter *	m^3
Volume	liter	L

* indicates SI Base Unit

Selected Prefixes Used in the Metric System

mega-	M	10^6
kilo-	k	10^3
deci-	d	10^{-1}
centi-	c	10^{-2}
milli-	m	10^{-3}
micro-	μ	10^{-6}
nano-	n	10^{-9}
pico-	p	10^{-12}

2. Mass

Mass is a physical property that represents the quantity of matter in an object. Weight, on the other hand, is the force exerted on the object by the pull of gravity on the mass of that object and is expressed in units of force.

- 1 lb = 0.4536 kg
- 1 g = 0.0353 oz
- 1 metric ton = 10^3 kg

Problem

Make the following conversion: 16.0 pounds to grams.

Solution

We need the following conversion factor to convert pounds to grams:

0.4536 kg = 1 lb.

(16.0 lbs)(0.4536 kg/1 lb)(1000 g/1 kg) = 7260 g

3. Energy

In the SI system, the unit for energy of all types is the joule (J). One J = 1 kg * m^2 /s^2, where m is meters and s is seconds. Both joules and kilojoules (kJ), as well as the older metric units of calorie and kilocalorie, are used, where 1 cal = 4.184 J, exactly.

4. Temperature

Heat is a form of energy that arises from the motions of atoms and molecules in a substance. Temperature, on the other hand, is a measurement that determines whether heat can transfer from one object to another, and it indicates the direction of that transfer. Three temperature scales are in common use today: Fahrenheit (F), Celsius (C), and Kelvin (K). When these scales measure the same temperature, they give different numbers. For example, 212 °F, 100 °C, and 373.15 K represent identical temperatures. The conversions between different scales are:

K = °C + 273.15 = (°F + 495.67)/1.8

°C = (°F - 32)/1.8 = K - 273.15

°F = (°C * 1.8) + 32 = (K * 1.8) - 459.67

Problem

Convert 70.0 °F to (a) Celsius and (b) Kelvin.

Solution

(a) We will need to substitute given information, T(°F) = 70.0 °F, into the following equation:

°C = (70.0°F - 32)/1.8 = 21.1 °C

(b) Now, use the following equation to convert from Celsius to Kelvin.

°C = K - 273.15

21.1°C = K - 273.15 = 294. 25 K which gives **294.3 K** with correct significant figures.

5. Density

When mass and volume are combined in a ratio, they yield density: mass per unit volume of substance. The most common SI unit for this property is g/cm^3, which is equivalent to g/mL. The density of solids and liquids generally has these dimensions, whereas it is common to use g/L for gases.

When we know a substance's density, we can convert between its mass and volume. For this reason, density is a common conversion factor.

Problem
Vinegar has a density of 1.0056 g/cm^3. What is the mass of 1.5000 L of vinegar?

Solution
(1.5000 L vinegar)(1000 mL/1 L)(1 cm^3/1 mL)(1.0056 g/1 cm^3)
= 1.5084×10^3 g