Unit Equations:

Practice: Please set up unit equations for each of the following metric relationships

a) Scoville (Sc) and kiloScoville (kSc) → 1 k = $1x10^3$, so **1 kSc = $1x10^3$Sc**
b) mole (mol) and millimole (mmol) → 1 m = $1x10^{-3}$, so **1 mmol = $1x10^{-3}$mol**
c) megacalorie (Mcal) and calorie (cal) → 1 M = $1x10^6$, so **1 Mcal = $1x10^6$cal**
d) farad (f) and picofarad (pf) → 1 p = $1x10^{-12}$, so **1 pf = $1x10^{-12}$f**
e) gigawatt (GW) and watt (W) → 1 G = $1x10^9$, so **1 GW = $1x10^9$W**
f) nanotesla (nT) and tesla (T) → 1 n = $1x10^{-9}$, so **1 nT = $1x10^{-9}$T**

Conversion Factors:

Practice: Please give the 2 possible conversion factors for each of the following (the first 6 are from above)

a) Scoville (Sc) and kiloScoville (kSc) $\frac{1\times10^{3}\,\text{Sc}}{1\,\text{kSc}}$ **OR** $\frac{1\,\text{kSc}}{1\times10^{3}\,\text{Sc}}$

b) mole (mol) and millimole (mmol) $\frac{1\times10^{-3}\,\text{mol}}{1\,\text{mmol}}$ **OR** $\frac{1\,\text{mmol}}{1\times10^{-3}\,\text{mol}}$

c) megacalorie (Mcal) and calorie (cal) $\frac{1\times10^{-3}\,\text{mol}}{1\,\text{mmol}}$ **OR** $\frac{1\,\text{mmol}}{1\times10^{-3}\,\text{mol}}$

d) farad (f) and picofarad (pf) $\frac{1\times10^{-12}\,\text{f}}{1\,\text{pf}}$ **OR** $\frac{1\,\text{pf}}{1\times10^{-12}\,\text{f}}$

e) gigawatt (GW) and watt (W) $\frac{1\times10^{9}\,\text{W}}{1\,\text{GW}}$ **OR** $\frac{1\,\text{GW}}{1\times10^{9}\,\text{W}}$

f) nanotesla (nT) and tesla (T) $\frac{1\times10^{-9}\,\text{T}}{1\,\text{nT}}$ **OR** $\frac{1\,\text{nT}}{1\times10^{-9}\,\text{T}}$

g) 4.184 J = 1 g•1 °C $\frac{4.184\,\text{J}}{1\,\text{g}\cdot1\,^{\circ}\text{C}}$ **OR** $\frac{1\,\text{g}\cdot1\,^{\circ}\text{C}}{4.184\,\text{J}}$

h) 0.789 g = 1 mL $\frac{0.789\,\text{g}}{1\,\text{mL}}$ **OR** $\frac{1\,\text{mL}}{0.789\,\text{g}}$

i) 1 mol•1 K = 8.314 J $\frac{8.314\,\text{J}}{1\,\text{mol}\cdot1\,\text{K}}$ **OR** $\frac{1\,\text{mol}\cdot1\,\text{K}}{8.314\,\text{J}}$

j) 83 miles = 1 hour $\frac{83\,\text{mi}}{1\,\text{hr}}$ **OR** $\frac{1\,\text{hr}}{83\,\text{mi}}$

Sig Figs and Conversion Factors:

Practice: For each of the following, state the system of measure for each unit, the quality measured by each unit, and then give the number of sig figs in the conversion factor. (green) = match, (red) and (yellow) = no match

a) 1 J = 0.2390 cal **J = metric energy, cal = standard energy, 4 s.f. (different systems)**
b) 1 km = $1.09x10^3$ yards **kM = metric distance, yd = standard distance, 3 s.f. (different systems)**
c) 1 L = $1x10^{-3}$ m^3 **L = metric volume, m^3 = metric volume, infinite s.f.**
d) 1 mL = 1.13 g **mL = metric volume, g = metric mass, 3 s.f. (different qualities)**
e) 5280 ft = 1 mile **ft = standard distance, mile = standard distance, infinite s.f.**
f) 1 kg = 2.20 lb **kg = metric mass, lb = standard mass, 3 s.f. (different systems)**
g) 65 miles = 1 hr **miles = standard distance, hr = standard time, 2 s.f. (different qualities)**
h) 0.26420 L = 1 gal **L = metric volume, gal = standard volume, 5 s.f. (different systems)**
i) 196.97 g Au = 1 mole Au **g AU = metric mass, hr = metric count, 5 s.f. (different qualities)**
j) 1 ML = $1x10^6$ L **ML = metric volume, L = metric volume, infinite s.f.**

Using Conversion Factors:

Practice: Perform the following conversions

a) 28.0 cm → m   1 **c** = 1x10^{-2} → 1 **cm** = 1x10^{-2}**m** → $\frac{1\ cm}{1\times10^{-2}\ m}$ **or** $\frac{1\times10^{-2}\ m}{1\ cm}$ → $28.0\ cm\times\frac{1\times10^{-2}\ m}{1\ cm}=0.280\ m$

b) 1000. m → km   1 **k** = 1x10^{3} → 1 **km** = 1x10^{3}**m** → $\frac{1\ km}{1\times10^{3}\ m}$ **or** $\frac{1\times10^{3}\ m}{1\ km}$ → $1000.\ m\times\frac{1\ km}{1\times10^{3}\ m}=1.000\ km$

c) 9.28 m → mm   1 **m** = 1x10^{-3} → 1 **mm** = 1x10^{-3}**m** → $\frac{1\ mm}{1\times10^{-3}\ m}$ **or** $\frac{1\times10^{-3}\ m}{1\ mm}$ → $9.28\ m\times\frac{1\ mm}{1\times10^{-3}\ m}=9280\ mm$

d) 10.68 g →mg   1 **m** = 1x10^{-3} → 1 **mg** = 1x10^{-3}**g** → $\frac{1\ mg}{1\times10^{-3}\ g}$ **or** $\frac{1\times10^{-3}\ g}{1\ mg}$ → $10.68\ g\times\frac{1\ mg}{1\times10^{-3}\ g}=10680\ mg$

e) 4.5 m → dm   1 **d** = 1x10^{-1} → 1 **dm** = 1x10^{-1}**m** → $\frac{1\ dm}{1\times10^{-1}\ m}$ **or** $\frac{1\times10^{-1}\ m}{1\ dm}$ → $4.5\ m\times\frac{1\ dm}{1\times10^{-1}\ m}=45\ dm$

f) 12 m → Mm   1 **M** = 1x10^{6} → 1 **Mm** = 1x10^{6}**m** → $\frac{1\ Mm}{1\times10^{6}\ m}$ **or** $\frac{1\times10^{6}\ m}{1\ Mm}$ → $12\ m\times\frac{1\ Mm}{1\times10^{6}\ m}=1.2\times10^{-5}\ Mm$

g) 23.6 kJ to J   1 **k** = 1x10^{3} → 1 **kJ** = 1x10^{3}**J** → $\frac{1\ kJ}{1\times10^{3}\ J}$ **or** $\frac{1\times10^{3}\ J}{1\ kJ}$ → $23.6\ kJ\times\frac{1\times10^{3}\ J}{1\ kJ}=23600\ J$

h) 1.6411x10^{7} pg → g   1 **p** = 1x10^{-12} → 1 **pg** = 1x10^{-12}**g** → $\frac{1\ pg}{1\times10^{-12}\ g}$ **or** $\frac{1\times10^{-12}\ g}{1\ pg}$ → $1.6411\times10^{7}\ pg\times\frac{1\times10^{-12}\ g}{1\ pg}=1.6411\times10^{-5}\ g$

i) 6.8x10^{4} ng → g   1 **n** = 1x10^{-9} → 1 **ng** = 1x10^{-9}**g** → $\frac{1\ ng}{1\times10^{-9}\ g}$ **or** $\frac{1\times10^{-9}\ g}{1\ ng}$ → $6.8\times10^{4}ng\times\frac{1\times10^{-9}\ g}{1\ ng}=6.8\times10^{-5}\ g$

j) 8.54 g → cg   1 **c** = 1x10^{-2} → 1 **cg** = 1x10^{-2}**g** → $\frac{1\ cg}{1\times10^{-2}\ g}$ **or** $\frac{1\times10^{-2}\ g}{1\ cg}$ → $8.54\ g\times\frac{1\ cg}{1\times10^{-2}\ g}=854\ cg$

k) 25.0 mL → L   1 **m** = 1x10^{-3} → 1 **mL** = 1x10^{-3}**L** → $\frac{1\ mL}{1\times10^{-3}\ L}$ **or** $\frac{1\times10^{-3}\ L}{1\ mL}$ → $25.0\ mL\times\frac{1\times10^{-3}\ L}{1\ mL}=0.0250\ L$

l) 22.4 L → µL   1 **µ** = 1x10^{-6} → 1 **µL** = 1x10^{-6}**L** → $\frac{1\ \mu L}{1\times10^{-6}\ L}$ **or** $\frac{1\times10^{-6}\ L}{1\ \mu L}$ → $22.4\ L\times\frac{1\ \mu L}{1\times10^{-6}\ L}=2.24\times10^{7}\ \mu L$

m) 0.65 Gs → s   1 **G** = 1x10^{9} → 1 **Gs** = 1x10^{9}**s** → $\frac{1\ Gs}{1\times10^{9}\ s}$ **or** $\frac{1\times10^{9}\ s}{1\ Gs}$ → $0.65\ Gs\times\frac{1\times10^{9}\ s}{1\ Gs}=6.5\times10^{8}\ s$

n) 5.5 kg → g   1 **k** = 1x10^{3} → 1 **kg** = 1x10^{3}**g** → $\frac{1\ kg}{1\times10^{3}\ g}$ **or** $\frac{1\times10^{3}\ g}{1\ kg}$ → $5.5\ kg\times\frac{1\times10^{3}\ g}{1\ kg}=5500\ g$

o) 0.468 TL → L   1 **T** = 1x10^{12} → 1 **TL** = 1x10^{12}**L** → $\frac{1\ TL}{1\times10^{12}\ L}$ **or** $\frac{1\times10^{12}\ L}{1\ TL}$ → $0.468\ TL\times\frac{1\times10^{12}\ L}{1\ TL}=4.68\times10^{11}\ L$

p) 9.0x10^{5} µL → L   1 **µ** = 1x10^{-6} → 1 **µL** = 1x10^{-6}**L** → $\frac{1\ \mu L}{1\times10^{-6}\ L}$ **or** $\frac{1\times10^{-6}\ L}{1\ \mu L}$ → $9.0\times10^{5}\ \mu L\times\frac{1\times10^{-6}\ L}{1\ \mu L}=0.90\ L$

Okay, here are some for you to try:

1) 58216 microliters to dekaliters $58216\ \mu L\times\frac{1\times10^{-6}\ L}{1\ \mu L}\times\frac{1\ daL}{1\times10^{1}\ L}=5.8216\times10^{-3}daL$

2) 46.875 terabytes to kilobytes $46.875\ TB\times\frac{1\times10^{12}\ B}{1\ TB}\times\frac{1\ kB}{1\times10^{3}\ B}=4.6875\times10^{10}\ kB$

3) How many femtoseconds in 22.16 milliseconds $22.16\ ms\times\frac{1\times10^{-3}\ s}{1\ ms}\times\frac{1\ fs}{1\times10^{-15}\ s}=2.216\times10^{13}\ fs$

4) 3.78×10^{-2} megagrams to centigrams? $$3.78\times10^{-2}\,Mg\times\frac{1\times10^{6}\,g}{1\,Mg}\times\frac{1\,cg}{1\times10^{-2}\,g}=3.78\times10^{6}\,cg$$

5) 650.89 Gm → pm $$650.89\,Gm\times\frac{1\times10^{9}\,m}{1\,Gm}\times\frac{1\,pm}{1\times10^{-12}\,m}=6.5089\times10^{23}\,pm$$

6) 249 cm → km $$249\,cm\times\frac{1\times10^{-2}\,m}{1\,cm}\times\frac{1\,km}{1\times10^{3}\,m}=2.49\times10^{-3}\,km$$

7) 45.14 dm → Mm $$45.14\,dm\times\frac{1\times10^{-1}\,m}{1\,dm}\times\frac{1\,Mm}{1\times10^{6}\,m}=4.514\times10^{-6}\,Mm$$

8) 570 kg → µg $$570\,kg\times\frac{1\times10^{3}\,g}{1\,kg}\times\frac{1\,\mu g}{1\times10^{-6}\,g}=5.7\times10^{11}\,\mu g$$

9) 2383.7 Mg → mg $$2383.7\,Mg\times\frac{1\times10^{6}\,g}{1\,Mg}\times\frac{1\,mg}{1\times10^{-3}\,g}=2.3837\times10^{6}\,mg$$

10) 39.46 µg → cg $$39.46\,\mu g\times\frac{1\times10^{-6}\,g}{1\,\mu g}\times\frac{1\,cg}{1\times10^{-2}\,g}=3.946\times10^{-3}\,cg$$

11) 139.42 pL → nL $$139.42\,pL\times\frac{1\times10^{-12}\,L}{1\,pL}\times\frac{1\,nL}{1\times10^{-9}\,L}=0.13942\,nL$$

12) 5.23×10^{-4} TL → kL $$5.23\times10^{-4}\,TL\times\frac{1\times10^{12}\,L}{1\,TL}\times\frac{1\,kL}{1\times10^{3}\,L}=5.23\times10^{5}\,kL$$

<u>Conversion between systems of measure</u>:

Practice: (use the “SI Units and Conversion Factors” table in your book, or the conversion table I gave you, to do these)

1) Convert 103 kg to ounces $$103\,kg\times\frac{1\times10^{3}\,g}{1\,kg}\times\frac{1\,oz}{28.3\,g}=3.64\times10^{4}\,oz$$

2) What is the equivalent of 653 nm in angstroms? $$653\,nm\times\frac{1\times10^{-9}\,m}{1\,nm}\times\frac{1\,\mathring{A}}{1\times10^{-10}\,m}=6530\,\mathring{A}$$

3) How many liters are there in 6.375 pints $$6.375\,pt\times\frac{1\,gal}{8\,pt}\times\frac{3.785\,L}{1\,gal}=3.02\,L$$

4) 0.75 tons is equal to how many kg? $$0.75\,ton\times\frac{907.185\,kg}{1\,ton}=6.8\times10^{2}\,kg$$

5) How many amu are in 3.89266×10^{-17} pounds? $$3.89266\times10^{-17}\,lb\times\frac{0.45359\,kg}{1\,lb}\times\frac{1\times10^{-3}\,g}{1\,kg}\times\frac{1\,amu}{1.6606\times10^{-24}\,g}=10633\,amu$$

6) What is the distance in µm of 8.00 ft? $$8.00\,ft\times\frac{1\,m}{3.281\,ft}\times\frac{1\,\mu m}{1\times10^{-6}\,m}=2.44\times10^{6}\,\mu m$$

7) How many millimeters in a marathon (26.22 miles) $$26.22\,mi\times\frac{5280\,ft}{1\,mi}\times\frac{1\,m}{3.281\,ft}\times\frac{1\,mm}{1\times10^{-3}\,m}=4.219\times10^{7}\,mm$$

8) What is the volume in nL of 2.336 gallons? $$2.336\,gal\times\frac{3.785\,L}{1\,gal}\times\frac{1\,nL}{1\times10^{-9}\,L}=8.842\times10^{9}\,nL$$

9) Given that 1 mL = 0.789 g (for ethanol), convert 7.39×10^{7} m^3 of ethanol to tons of ethanol

$$7.39\times10^{7}\,m^{3}\times\frac{1\,L}{1\times10^{-3}\,m^{3}}\times\frac{1\,mL}{1\times10^{-3}\,L}\times\frac{0.789\,g}{1\,mL}\times\frac{1\,kg}{1\times10^{3}\,g}\times\frac{1\,ton}{907.158\,kg}=6.43\times10^{7}\,ton$$

Percents:

Practice: Give it a try. I want you to try to identify the "part" and the "whole sample" in each of the following.

a) Selenium makes up 28.17% of the compound barium selenate. **Selenium is PART of barium selenate**
b) Water is 11.2% hydrogen. **Hydrogen is PART of water**
c) A certain solution is 95% isopropyl alcohol. **Isopropyl alcohol is PART of a solution**
d) The other 5% of the above solution is water. **Water is PART of a solution**
e) Seawater is about 3.5% sodium chloride. **Sodium chloride is PART of seawater**
f) Silicon makes up about 25.7% of the Earth's mass. **Silicon is PART of the Earth**
g) The average human body is 2.9x10^{-4} % gold. **Gold is PART of the human body**

Percents as conversion factors:

Practice: Write the 2 possible conversion factors for each of the following. Be sure to include proper units.

a) Selenium makes up 28.17% of the compound barium selenate. $\frac{\textbf{28.17 g selenium}}{\textbf{100 g barium selenate}}$ **OR** $\frac{\textbf{100 g barium selenate}}{\textbf{28.17 g selenium}}$

b) Water is 11.2% hydrogen $\frac{\textbf{11.2 kg hydrogen}}{\textbf{100 kg water}}$ **OR** $\frac{\textbf{100 kg water}}{\textbf{11.2 kg hydrogen}}$

c) A certain solution is 95% isopropyl alcohol $\frac{\textbf{95 mL isopropyl alcohol}}{\textbf{100 mL solution}}$ **OR** $\frac{\textbf{100 mL solution}}{\textbf{95 mL isopropyl alcohol}}$

d) The other 5% of the above solution is water $\frac{\textbf{5 mL water}}{\textbf{100 mL solution}}$ **OR** $\frac{\textbf{100 mL solution}}{\textbf{5 mL water}}$

e) Seawater is about 3.5% sodium chloride $\frac{\textbf{3.5 m}^3\textbf{ sodium chloride}}{\textbf{100 m}^3\textbf{ seawater}}$ **OR** $\frac{\textbf{100 m}^3\textbf{ seawater}}{\textbf{3.5 m}^3\textbf{ sodium chloride}}$

f) Silicon makes up about 25.7% of the Earth's mass $\frac{\textbf{25.7 kg silicon}}{\textbf{100 kg Earth}}$ **OR** $\frac{\textbf{100 kg Earth}}{\textbf{25.7 kg silicon}}$

g) The average human body is 2.9x10^{-4} % gold $\frac{\textbf{2.9}\times\textbf{10}^{-4}\textbf{ troy-oz gold}}{\textbf{100 troy-oz human body}}$ **OR** $\frac{\textbf{100 troy-oz human body}}{\textbf{2.9}\times\textbf{10}^{-4}\textbf{ troy-oz gold}}$

Practice: Solve each of the following:

a) A sample of barium selenate weighs 56.113 grams. If selenium makes up 28.17% of the compound barium selenate, how many grams of selenium are in the sample?

$$56.113\ g\ \textbf{barium selenate} \times \frac{28.17\ g\ \textbf{selenium}}{100\ g\ \textbf{barium selenate}} = 15.81\ g\ \textbf{selenium}$$

b) Water is 11.2% hydrogen. If a bowl of water contains 1.44 kg of hydrogen, how many kg of water are there?

$$1.44\ kg\ \textbf{hydrogen} \times \frac{100\ kg\ \textbf{water}}{11.2\ kg\ \textbf{hydrogen}} = 12.9\ kg\ \textbf{water}$$

c) 750 mL of a certain solution is 95% isopropyl alcohol. How many mL of isopropyl alcohol does the solution contain?

$$750\ mL\ \textbf{solution} \times \frac{95\ mL\ \textbf{isopropyl alcohol}}{100\ mL\ \textbf{solution}} = 710\ mL\ \textbf{isopropyl alcohol}$$

d) Seawater is about 3.5% sodium chloride. How many m^3 of seawater contains 500.0 m^3 of sodium chloride?

$$500.0\ m^3\ \textbf{sodium chloride} \times \frac{100\ m^3\ \textbf{seawater}}{3.5\ m^3\ \textbf{sodium chloride}} = 1.4 \times 10^4\ m^3\ \textbf{seawater}$$

e) Silicon makes up about 25.7% of the Earth's mass. If the Earth weighs about 5.9752x10^{24} kg, what is the mass of silicon available for making stuff?

$$5.9752 \times 10^{24}\ kg\ \textbf{Earth} \times \frac{25.7\ kg\ \textbf{silicon}}{100\ kg\ \textbf{Earth}} = 1.54 \times 10^{24}\ kg\ \textbf{silicon}$$

f) The average human body is 2.9x10^{-4} % gold. If the average human weighs 2250 troy-ounces, how many troy-ounces of gold are in the human body? If the price of gold is \$1257 per troy-ounce, how much is that gold worth?

$$2250\ troy\text{-}oz\ \textbf{human body} \times \frac{2.9 \times 10^{-4}\ troy\text{-}oz\ \textbf{gold}}{100\ troy\text{-}oz\ \textbf{human body}} \times \frac{\$1257}{1\ troy\text{-}oz\ \textbf{gold}} = \$8.2$$