

SCH3U

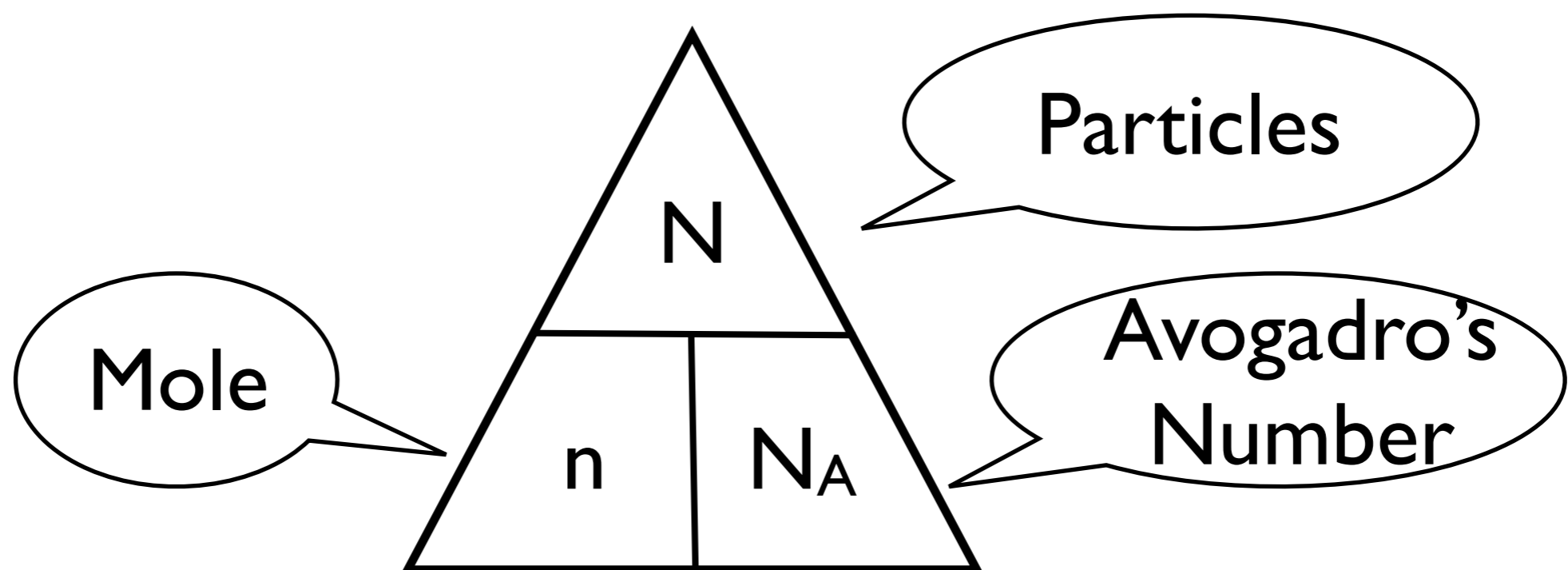


**Relating molar mass,
the mole and mass**



So far...

- We have learned that the mole is a unit chemists use because the atom is so tiny
- 1 mole = 6.02×10^{23} particles or atoms
- $N = n \times N_A$ $n = N / N_A$



Molar Mass

- But we can't measure moles directly! There is no "scale" that we can use.
- So we need some way to convert moles into mass, which we can measure.
- The mass of 1 mole of a substance is called the **molar mass**
- Unit is g/mol

Molar Mass of Molecules and Compounds

Mass in grams of 1 mole equal numerically to the sum of the atomic masses

ie) CaCl_2

1 mole Ca x 40.1 g/mol

+ 2 moles Cl x 35.5 g/mol = 111.1 g/mol CaCl_2

1 mole of CaCl_2 = 111.1 g

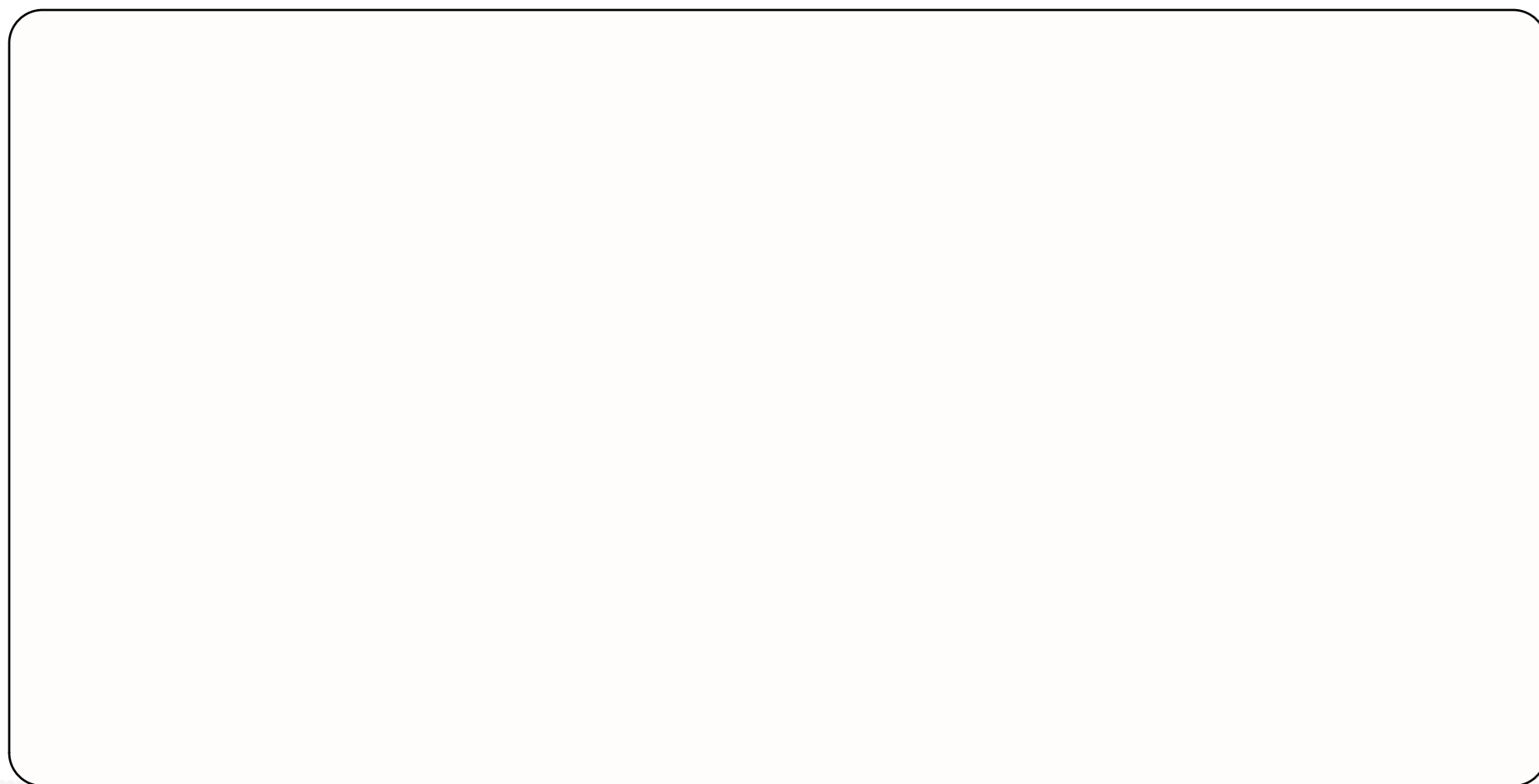
Learning Check!

Determine the relative molecular mass of the following molecules.

a Water (H_2O)

b Methane (CH_4)

c Sulfuric acid (H_2SO_4)

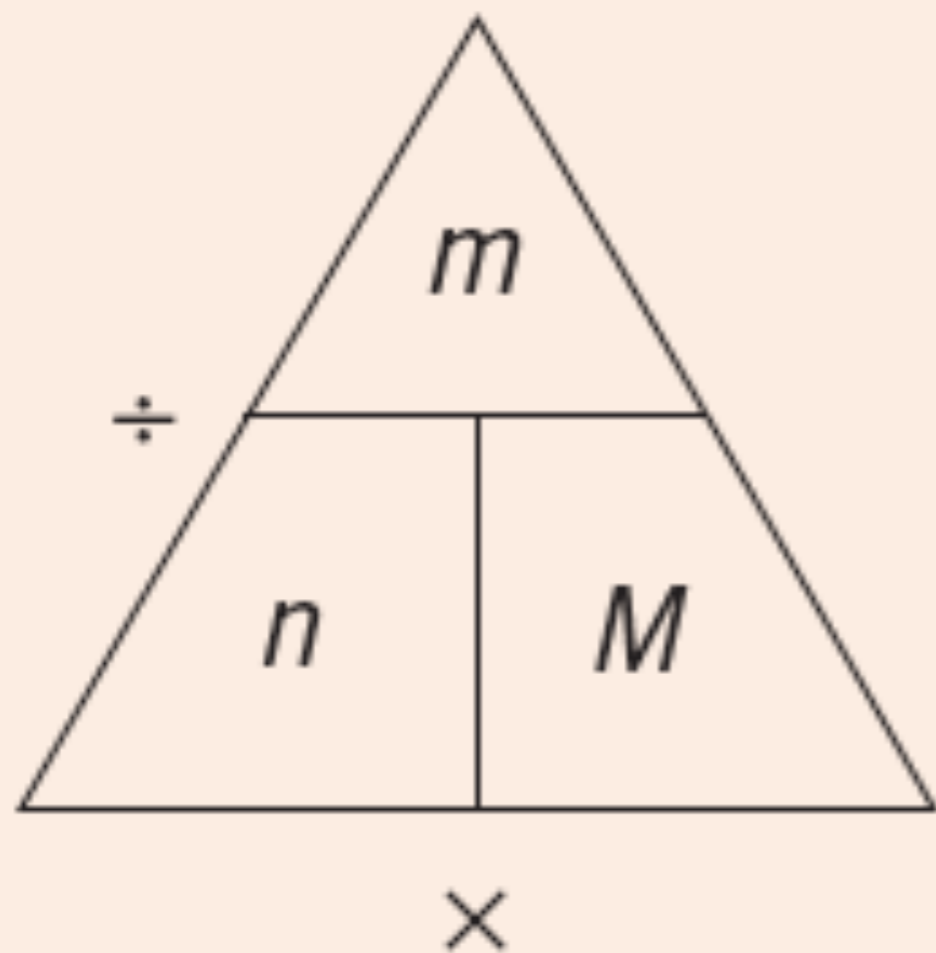


Learning Check

Prozac, $C_{17}H_{18}F_3NO$, is a widely used antidepressant that inhibits the uptake of serotonin by the brain. Find its molar mass.

309.18 g/mol

Relating mass, moles & molar mass



where n = number of mole (mol)
 m = mass (g)
 M = molar mass (g mol^{-1})

$$n = m / M$$

$$m = n M$$

$$M = m / n$$

Figure 4.2.1 A formula triangle can be used to make it easier to rearrange this formula.

Converting Moles and Grams



Aluminum is often used for the structure of light-weight bicycle frames. How many grams of Al are in 3.00 moles of Al?

1. Unknown: $m=???$

2. Given: $n=3.00$ mol; $M=27.0$ g/mol

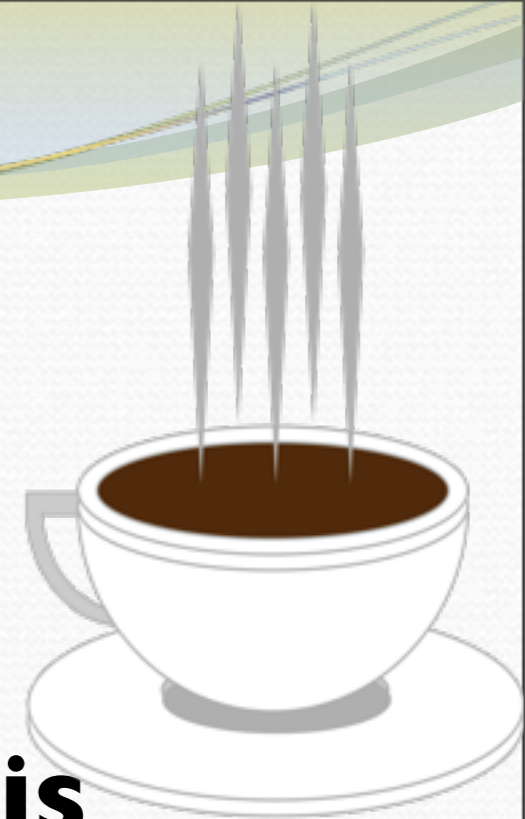
3. Solve: $m = n * M$

$$m = 3.00 \text{ mol} * 27.0 \text{ g/mol}$$

$$m = 81.0 \text{ g Al}$$

Learning Check!

The artificial sweetener aspartame (Nutra-Sweet) formula $C_{14}H_{18}N_2O_5$ is used to sweeten diet foods, coffee and soft drinks. How many moles of aspartame are present in 225 g of aspartame?



$$n = m / M$$

$$n = 225 \text{ g} / 294 \text{ g/mol}$$

$$n = 0.76 \text{ mol}$$

p. 237 in MHR

Practice Problems

- 41.** Calculate the mass of 3.57 mol of vanadium.
- 42.** Calculate the mass of 0.24 mol of carbon dioxide.
- 43.** Calculate the mass of 1.28×10^{-3} mol of glucose, $C_6H_{12}O_6(s)$.
- 44.** Calculate the mass of 0.0029 mol of magnesium bromide, $MgBr_2(s)$, in milligrams.
- 45.** Name each compound, and then calculate its mass. Express this value in scientific notation.
- 4.5×10^{-3} mol of $Co(NO_3)_2(s)$
 - 29.6 mol of $Pb(S_2O_3)_2(s)$
- 46.** Determine the chemical formula for each compound, and then calculate its mass.
- 4.9 mol of ammonium nitrate
 - 16.2 mol of iron(III) oxide
- 47.** What is the mass of 1.6×10^{-3} mol of calcium chloride dihydrate, $CaCl_2 \cdot 2H_2O(s)$, in milligrams?
- 48.** A litre of water contains 55.56 mol of water molecules. What is the mass of a litre of water, in kilograms?
- 49.** For each group of three samples, determine the sample with the largest mass.
- 2.34 mol of bromine, $Br_2(l)$; 9.80 mol of hydrogen sulfide, $H_2S(g)$; 0.568 mol of potassium permanganate, $KMnO_4(s)$
 - 13.7 mol of strontium iodate, $Sr(IO_3)_2(s)$; 15.9 mol of gold(III) chloride, $AuCl_3(s)$; 8.61 mol of bismuth silicate, $Bi_2(SiO_3)_3(s)$
- 50.** Which has the smallest mass: 0.215 mol of potassium hydrogen sulfite, $KHSO_3(s)$; 1.62 mol of sodium hydrogen sulfite, $NaHSO_3(s)$; or 0.0182 mol of aluminum iodate, $Al(IO_3)_3(s)$?

p. 239 in MHR

Practice Problems

- 51.** Convert 29.5 g of ammonia to the amount in moles.
- 52.** Determine the amount in moles of potassium thiocyanate, $\text{KSCN}(s)$, in 13.5 kg.
- 53.** Determine the amount in moles of sodium dihydrogen phosphate, $\text{NaH}_2\text{PO}_4(s)$, in 105 mg.
- 54.** Determine the amount in moles of xenon tetrafluoride, $\text{XeF}_4(s)$, in 22 mg.
- 55.** Write the chemical formula for each compound, and then calculate the amount in moles in each sample.
- 3.7×10^{-3} g of silicon dioxide
 - 25.38 g of titanium(IV) nitrate
 - 19.2 mg of indium carbonate
 - 78.1 kg of copper(II) sulfate pentahydrate
- 56.** The characteristic odour of garlic comes from allyl sulfide, $(\text{C}_3\text{H}_5)_2\text{S}(\ell)$. Determine the amount in moles of allyl sulfide in 168 g.
- 57.** Road salt, $\text{CaCl}_2(s)$, is often used on roads in the winter to prevent the build-up of ice. What amount in moles of calcium chloride is in a 20.0 kg bag of road salt?
- 58.** Calculate the amount in moles of trinitrotoluene, $\text{C}_7\text{H}_5(\text{NO}_2)_3(s)$, an explosive, in 3.45×10^{-3} g.
- 59.** Arrange the following substances in order from largest to smallest amount in moles:
- 865 mg of $\text{Ni}(\text{NO}_3)_2(s)$
 - 9.82 g of $\text{Al}(\text{OH})_3(s)$
 - 10.4 g of $\text{AgCl}(s)$
- 60.** Place the following substances in order from smallest to largest amount in moles, given 20.0 g of each:
- glucose, $\text{C}_6\text{H}_{12}\text{O}_6(s)$
 - barium perchlorate, $\text{Ba}(\text{ClO}_4)_2(s)$
 - tin(IV) oxide, $\text{SnO}_2(s)$

What about converting Particles into MASS?

$$n = N / N_A \quad n = m / M$$

We must go through MOLES!



What is the mass of 4.72×10^{23} formula units of chromium(III) iodide, $\text{CrI}_3(\text{s})$?

Given: $N = 4.72 \times 10^{23}$

Required: $m = ?$

Solve: $n = N / N_A$

$$n = 4.72 \times 10^{23} / 6.02 \times 10^{23}$$

$$n = 0.784 \text{ mol}$$

$$m = n \times M$$

$$m = 0.784 \times 432.70$$

$$m = 339$$

The mass is 339 g.

Phosphoryl chloride, $\text{POCl}_3(\ell)$, is an important compound in the production of flame retardants. How many molecules of phosphoryl chloride are in a 25.2 g sample?

9.9×10^{22} molecules

| Plan Your Strategy | Act on Your Strategy |
|---|-----------------------------|
| Calculate the amount of phosphoryl chloride from the given mass, using the molar mass. | |
| Calculate the number of molecules of phosphoryl chloride from the amount in moles, using the Avogadro constant. | |

QUIZ

NEXT CLASS!!!

To prepare:

**Try Chapter 5 Self
Assessment (p. 254)**

Practice Problems

- 61.** Calculate the mass of each sample.
- 1.05×10^{26} atoms of neon, $\text{Ne}(\text{g})$
 - 2.7×10^{24} molecules of phosphorus trichloride, $\text{PCl}_3(\ell)$
 - 8.72×10^{21} molecules of karakin, $\text{C}_{15}\text{H}_{21}\text{N}_3\text{O}_{15}(\text{s})$
 - 6.7×10^{27} formula units of sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3(\text{s})$
- 62.** Determine the number of molecules or formula units in each sample.
- 2.4 g of lead(II) phosphate, $\text{Pb}_3(\text{PO}_4)_2(\text{s})$
 - 1.62×10^{-3} g of dinitrogen pentoxide, $\text{N}_2\text{O}_5(\text{s})$
 - 48 kg of molybdenum(VI) oxide, $\text{MoO}_3(\text{s})$
 - 567 g of tin(IV) fluoride, $\text{SnF}_4(\text{s})$
- 63.** Sodium hydrogen carbonate, $\text{NaHCO}_3(\text{s})$, is the principal ingredient in many stomach-relief medicines.
- A teaspoon of a particular brand of stomach-relief medicine contains 6.82×10^{22} formula units of sodium hydrogen carbonate. What mass of sodium hydrogen carbonate is in the teaspoon?
 - The bottle of this stomach-relief medicine contains 350 g of sodium hydrogen carbonate. How many formula units of sodium hydrogen carbonate are in the bottle?
- 64.** Riboflavin, $\text{C}_{17}\text{H}_{20}\text{N}_4\text{O}_6(\text{s})$, is an important vitamin in the metabolism of fats, carbohydrates, and proteins in your body.
- The current recommended dietary allowance (RDA) of riboflavin for adult men is 1.3 mg/day. How many riboflavin molecules are in this RDA?
 - The RDA of riboflavin for adult women contains 1.8×10^{18} molecules of riboflavin. What is the RDA for adult women, in milligrams?
- 65.** What is the mass, in grams, of a single atom of platinum?
- 66.** Rubbing alcohol often contains propanol, $\text{C}_3\text{H}_7\text{OH}(\ell)$. Suppose that you have an 85.9 g sample of propanol.
- How many carbon atoms are in the sample?
 - How many hydrogen atoms are in the sample?
 - How many oxygen atoms are in the sample?
- 67.**
- How many formula units are in a 3.14 g sample of aluminum sulfide, $\text{Al}_2\text{S}_3(\text{s})$?
 - How many ions (aluminum and sulfide), in total, are in this sample?
- 68.** Which of the following two substances contains the greater mass?
- 6.91×10^{22} molecules of nitrogen dioxide, $\text{NO}_2(\text{g})$
 - 6.91×10^{22} formula units of gallium arsenide, $\text{GaAs}(\text{s})$
- 69.** Many common dry-chemical fire extinguishers contain ammonium phosphate, $(\text{NH}_4)_3\text{PO}_4(\text{s})$, as their principal ingredient. If a sample of ammonium phosphate contains 4.5×10^{21} atoms of nitrogen, what is the mass of the sample?
- 70.** Place the following three substances in order, from greatest to smallest number of hydrogen atoms:
- 268 mg of sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}(\text{s})$
 - 15.2 g of hydrogen cyanide, $\text{HCN}(\ell)$
 - 0.0889 mol of acetic acid, $\text{CH}_3\text{COOH}(\ell)$