

# Counting Atoms

“If the average American has 2.3 children,  
there are no average Americans.”

— Unknown



Name: \_\_\_\_\_

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Date: \_\_\_\_\_

1. One penny weighs 2.50 grams a second weighs 3.11 grams, what is the average weight of the two pennies?
2. Eight pennies weigh 2.50 grams and two more weigh 3.11 grams, what is the average weight of those ten pennies?
3. In 1982 we changed how we made pennies. No one knows how many pennies are in circulation, but banks estimate 13.4% have the pre-1982 weight of 3.11 grams. The rest weigh 2.50 grams.
  - a. What is the average weight of all the pennies in circulation?
  - b. How many pennies are in 3,790 kg of pennies?

4. There are two isotopes of copper (Cu). Copper-65 atoms weigh 64.9278 amu and has a natural abundance of 30.91%, the rest are copper-63 and weigh 62.9298 amu.
- a. What is the average weight of all copper atoms (in amu)?

- b. A pure copper propeller for a nano-machine weighs 20.6 million amu, how many copper atoms are in that microscopic propeller?

5. A proton and a neutron each weigh about 1 amu (about  $1.66 \times 10^{-24}$  grams). Electrons weigh 1/2000 of that, to three digits their weight is not significant to the weight of an atom.

- a. Copper-65 weighs about 65 amu (that's why we call it copper-65). How many protons, electrons, and neutrons are in a copper-65 atom? Write the complete isotopic symbol for this neutral particle.

Symbol	# of protons	# of electrons	# neutrons	mass (in amu)

- b. Copper can form ions. Consider a +2 ion of Copper-63. How many protons, electrons, and neutrons are in this one copper-65 ion? Write the complete isotopic symbol for this charged particle.

Symbol	# of protons	# of electrons	# neutrons	mass (in amu)

6. One amu measures  $1.66054 \times 10^{-24}$  grams. What does 1.000 g weigh in amu?  
(Considered another way: how many 1 amu things (like protons) are in 1.000 g?)
7. About 30 isotopes of Zinc (Zn) have been observed, but only 5 of them exist in any significant quantity. One is zinc-64 ( $^{64}\text{Zn}$ ), which weighs 63.9291422 amu and has a natural abundance of 49.17%. What is the weight of  $6.022 \times 10^{23}$  zinc-64 atoms in grams?
8. The average mass of all zinc atoms measures 65.39 amu. What is the weight of  $6.022 \times 10^{23}$  zinc (Zn) atoms in grams?
9. The average mass of all neon (Ne) atoms measures 20.18 amu. What is the weight of  $6.022 \times 10^{23}$  neon atoms in grams?
10. A cat weighs X amu, what is the weight of  $6.022 \times 10^{23}$  cats in grams?

**11.** Pencils are bought and sold by the gross. A gross is 144 of something (a dozen dozen singles). A gross of pencils weighs 816 g.

**a.** If you want 1,512 pencils, how many gross should you order?

**b.** If you measure 509 kg of pencils, how many gross do you have?

**c.** If you find 2.5 gross of pencils, how many single pencils are there?

**12.** Atoms are counted by the mole. A mole (mol) is  $6.022 \times 10^{23}$  of something (measured to 4 significant figures). A mole of iron atoms weighs 55.93 g.

**a.** If you want  $2.83 \times 10^{24}$  iron atoms, how many moles of iron do you need?

**b.** If you measure 95.0 g of iron, how many moles do you have?

**c.** If you find 3.7 mol of iron, how many single iron atoms are there?

13. A proton and a neutron each weigh about 1 amu (about  $1.66 \times 10^{-24}$  grams). Electrons weigh 1/2000 of that, to three figures the electrons weight is not significant to the weight of an atom. The periodic table shows the the weight of chlorine is 35.45 (periodic tables generally do not write units for this weight).

a. What is the average weight of a mole of chlorine atoms (in grams)?

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b. What is the average weight of a single chlorine atom (in amu)?

\_\_\_\_\_

c. How many 1.00 amu sized particles (protons and neutrons) would there be in a single chlorine atom of average weight (35.45)? (this is a trick question)

d. How many chlorine atoms in the universe have the weight of chlorine shown on the periodic table? Justify your answer.

e. How many moles of chlorine atoms are in 3.75 grams of chlorine?

f. How many single chlorine atoms are in 3.75 grams of chlorine?

**14.** You have a reaction that requires 2.45 mols of sodium (Na).

**a.** How many grams of sodium should you measure out to equal that many atoms?

**b.** How many single sodium atoms are in 2.45 mols of sodium?

**15.** If I had  $2.7 \times 10^{24}$  singles of any particle, how many moles would I have?

**16.** You have a beaker with 10.3 grams of cobalt (Co) powder in it.

**a.** How many mols of atoms are in 10.3 grams of cobalt powder?

**b.** How many single cobalt atoms are in 10.3 grams of cobalt?

17. How many moles of magnesium (Mg) are in 5.72 kg of iron?

18. How many single lithium (Li) atoms are in 31.2 mg Li? (hint: mg  $\rightarrow$  g  $\rightarrow$  mol  $\rightarrow$  atoms)

19. Gold (Au) sells for \$50.80 a gram. How many gold atoms can you buy for \$1.00?

20. What is the average weight of 12 silver (Ag) atoms?

a. In amu?

b. In grams? (hint: atoms  $\rightarrow$  mol  $\rightarrow$  g)