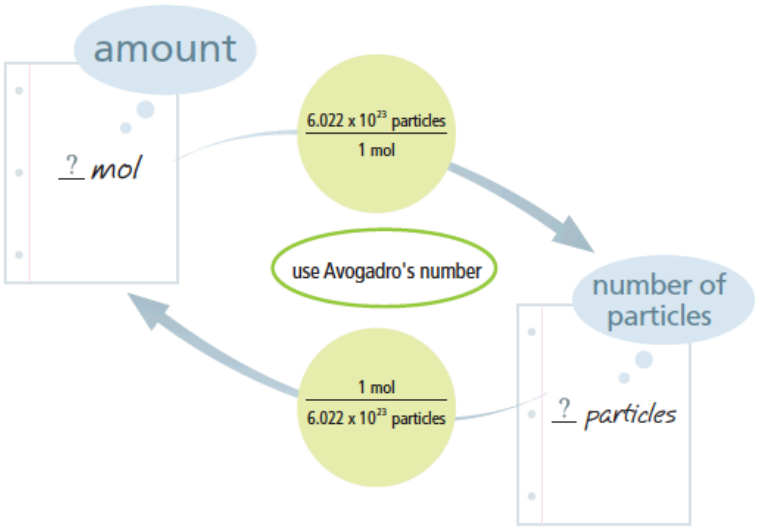
SKILLS Toolkit 1

Converting Between Amount in Moles and Number of Particles

1. Decide which quantity you are given: amount (in moles) or number of particles (in atoms, molecules, formula units, or ions).
2. If you are converting from amount to number of particles (going left to right), use the top conversion factor.
3. If you are converting from number of particles to amount (going right to left), use the bottom conversion factor.



Amount in Moles Can Be Converted to Number of Particles

A conversion factor begins with a definition of a relationship. The definition of one mole is

$$6.022 \times 10^{23} \text{ particles} = 1 \text{ mol}$$

If two quantities are equal and you divide one by the other, the factor you get is equal to 1. The following equation shows how this relationship is true for the definition of the mole.

$$\frac{6.022 \times 10^{23} \text{ particles}}{1 \text{ mol}} = 1$$

The factor on the left side of the equation is a conversion factor. The reciprocal of a conversion factor is also a conversion factor and is also equal to one, so the following is true.

$$\frac{6.022 \times 10^{23} \text{ particles}}{1 \text{ mol}} = \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ particles}} = 1$$

Because a conversion factor is equal to 1, it can multiply any quantity without changing the quantity's value. Only the units are changed.

These conversion factors can be used to convert between a number of moles of substance and a corresponding number of molecules. For example, imagine that you want to convert 2.66 mol of a compound into the corresponding number of molecules. How do you know which conversion factor to use? **Skills Toolkit 1** can help.

SAMPLE PROBLEM A

Converting Amount in Moles to Number of Particles

Find the number of molecules in 2.5 mol of sulfur dioxide.

1 Gather information.

- amount of SO_2 = 2.5 mol
- 1 mol of any substance = 6.022×10^{23} particles
- number of molecules of SO_2 = ? molecules

2 Plan your work.

The setup is: 2.5 mol SO_2 × ? = ? molecules SO_2

3 Calculate.

You are converting from the unit *mol* to the unit *molecules*. The conversion factor must have the units of *molecules/mol*. **Skills Toolkit 1** shows that this means you use 6.022×10^{23} molecules/1 mol.

$$2.5 \text{ mol } SO_2 \times \frac{6.022 \times 10^{23} \text{ molecules } SO_2}{1 \text{ mol } SO_2} = 1.5 \times 10^{24} \text{ molecules } SO_2$$

4 Verify your result.

The units cancel correctly. The answer is greater than Avogadro's number, as expected, and has two significant figures.

PRACTICE HINT

Take your time, and be systematic. Focus on units; if they are not correct, you must rethink your preliminary equation. In this way, you can prevent mistakes.

PROBLEM SOLVING SKILL

PRACTICE

1. How many ions are there in 0.187 mol of Na^+ ions?
2. How many atoms are there in 1.45×10^{-17} mol of arsenic?
3. How many molecules are there in 4.224 mol of acetic acid, $C_2H_4O_2$?
4. How many formula units are there in 5.9 mol of NaOH?

Number of Particles Can Be Converted to Amount in Moles

Notice in **Skills Toolkit 1** that the reverse calculation is similar but that the conversion factor is inverted to get the correct units in the answer. Look at the following problem. How many moles are 2.54×10^{22} iron(III) ions, Fe^{3+}?

$$2.54 \times 10^{22} \text{ ions } Fe^{3+} \times ? = ? \text{ mol } Fe^{3+}$$

Multiply by the conversion factor that cancels the unit of *ions* and leaves the unit of *mol*. (That is, you use the conversion factor that has the units that you want to get on top and the units that you want to get rid of on the bottom.)

$$2.54 \times 10^{22} \text{ ions } Fe^{3+} \times \frac{1 \text{ mol } Fe^{3+}}{6.022 \times 10^{23} \text{ ions } Fe^{3+}} = 0.0422 \text{ mol } Fe^{3+}$$

This answer makes sense, because you started with fewer than Avogadro's number of ions, so you have less than one mole of ions.

Answers to Practice Problems A

1. 1.13×10^{23} ions Na^+
2. 8.73×10^6 atoms As
3. 2.544×10^{24} molecules $C_2H_4O_2$
4. 3.6×10^{24} formula units NaOH

Homework

GENERAL

Additional Practice How many representative particles are present in each of the following?

1. 4.3 mol of tungsten **Ans.** 2.6×10^{24} atoms W
2. 2.45×10^{-6} mol of nickel(II) selenide **Ans.** 1.48×10^{18} formula units NiSe
3. 0.923 mol of selenium tetrabromide **Ans.** 5.56×10^{23} molecules $SeBr_4$

LS Logical