Skill Sheet 19-E   Calculating Formula Mass

A chemical formula gives you useful information about a compound. First, it tells you which types of atoms and how many of each are present in a compound. Second, it lets you know which types of ions are present in a compound. Finally, it allows you to determine the mass of one molecule of a compound, relative to the mass of other compounds. We call this the formula mass. This skill sheet will show you how to calculate the formula mass of a compound.

1. Calculating formula mass: a step-by-step approach

A common ingredient in most toothpastes is a compound called sodium phosphate. If you examine a tube of toothpaste, you will find that it is usually listed as trisodium phosphate.
What is the formula mass of sodium phosphate?

Step 1: Determine the formulas and oxidation numbers of the ions in the compound.

Sodium phosphate is made up of the *sodium ion* and the *phosphate ion*. The oxidation number for the sodium ion can be determined from the periodic table. Since sodium, Na, is located in group 1 of the periodic table, it has an oxidation number of 1+ like all of the elements in group 1.

    The chemical formula and oxidation number for sodium is: Na^+

To find the formula and oxidation number for the phosphate ion, use the ion chart in chapter 19 of your textbook.

    The chemical formula and oxidation number for the phosphate ion is: PO_4^{3-}

Step 2: Write the chemical formula of the compound.

Remember that compounds must be neutral that is, the oxidation numbers of the elements and ions must be equal to zero. Since sodium = $\mathbf{Na^+}$ and phosphate = $\mathbf{PO_4^{3-}}$ how many of each do you need to make a neutral compound? You need three sodium ions for each phosphate ion to make a neutral compound.

    The chemical formula of sodium phosphate is: Na_3PO_4.

Step 3: List the atoms, number of each atom, atomic mass of each atom, and total mass of each atom.

Atom	number	atomic mass (from the periodic table)	total mass (number × atomic mass)
Na	3	22.99 amu	3 × 22.99 = 68.97 amu
P	1	30.97 amu	1 × 30.97 = 30.97 amu
O	4	16.00 amu	4 × 16.00 = 64.00 amu

Step 4: Add up the values and calculate the formula mass of the compound.

    68.97 amu + 30.97 amu + 64.00 amu = 163.94 amu

    The formula mass of sodium phosphate is 163.94 amu

2. Practice

Now try one on your own:

Eggshells are made mostly of a brittle compound called calcium phosphate. What is the formula mass of this compound?

1. Write the chemical formula and oxidation number of each ion in the compound:

   First ion: Second ion:

2. Write the chemical formula of the compound:

3. List the atoms, number of each atom, atomic mass of each atom, and total mass of each atom.

Atom	number	atomic mass (from the periodic table)	total mass (number × atomic mass)

4. Add up the values to calculate the formula mass of the compound.

3. More practice on your own

Write the chemical formula and the formula mass for each of the compounds below. Use separate paper and show all of your work.

1. barium chloride
2. sodium hydrogen carbonate
3. magnesium hydroxide
4. ammonium nitrate
5. strontium phosphate
6. **Challenge!**
   What is the formula mass of $CoCl_2 \cdot 6H_2O$?
   Hint: Read about hydrates in chapter 19 of your textbook.