1. Salt lowers the freezing point of water by _____.

(A) increasing the kinetic energy of water molecules
(B) interfering with the formation of six-sided ice crystals
(C) releasing ionization energy as sodium chloride is ionized
(D) preventing six-sided ice crystals from hydrogen bonding to other six-sided ice crystals

Hint: Because of hydrogen bonding, ice freezes into flat six-sided crystals.
Any molecule that happens to be in the way of water molecules slipping into the forming ice crystal will inhibit freezing.
Lowering the temperature will overcome this interference by lowering water's kinetic energy and allowing water molecules to gradually insert themselves into the forming ice crystal.
Any intermolecular attraction between formed six-sided ice crystals has little bearing on the formation of the ice crystal in the first place, so any molecules between ice crystals will not affect the formation of the ice crystals.

2. How many molecules are in 1 mole of molecules?

(A) 6.02×10^{23}
(B) 12.02×10^{23}
(C) 1.00×10^{23}
(D) 1.15×10^{23}

Hint: Like the term "dozen," a mole is simply a number, 6.01×10^{23}.

3. Calculating the weighted average molecular weight for an element requires all of the following except _____.

(A) the atomic number for each isotope
(B) the molecular weight of each isotope for that element
(C) the percentage of each isotope in nature
(D) the atomic mass of each isotope for that element

Hint: The weighted average takes into account that some isotopes of an element are more abundant in nature than others.

Multiplying the percentage occurrence for each isotope times the isotope's atomic mass indicates how much mass each isotope contributes to that element's average atomic mass.

4. If the atomic number of a sodium atom is 11, and its atomic weight is 23, how much does 1 mole of sodium atoms weigh?

(A) 11g
(B) 23g
(C) 6.02×10^{23}g
(D) 33g

Hint: Atomic number is the number of protons in the nucleus of an element.

The atom's weight, though, is made up of protons and neutrons (and a tiny bit from electrons), which is what the atomic weight measures.
1 mole of an atom is its atomic weight in grams.

5. If you have 1 mole of oxygen molecules, and the molecular weight of oxygen is 16.0, which of the following can you calculate in the oxygen sample?

(A) the total weight
(B) the total pressure
(C) the total volume
(D) the kinetic energy

Hint: In order to calculate the energy, pressure, and volume of 1 mole of any molecule, you must know it temperature, because PV = nRT (pressure x volume equals the number of molecules x their temperature in Kelvins x the constant R).

6. What is the mass number of an atom which contains 28 protons, 28 electrons, and 34 neutrons?

(A) 28
(B) 56
(C) 62
(D) 90

Hint: Atomic weight is the weight of all its protons and neutrons with a minimal contribution from the weight of its electrons.

7. The atomic number of cobalt is 27 and its atomic weight is 59. How many neutrons does an atom of cobalt have?

(A) 86
(B) 27
(C) 32
(D) 59

Hint: Since atomic weight (or atomic mass) is protons plus neutrons, and atomic number is protons alone, atomic weight minus atomic number is the weight in atomic mass units of the neutrons alone.

And since each proton and neutron is 1.01 atomic mass units, the atomic weight is also a good measure of the number of protons and neutrons.

8. Table sugar has the formula $C_{12}H_{22}O_{11}$. The atomic weight of carbon is 12.0, hydrogen 1.0, and oxygen 16.0. How many grams of carbon are in 454 grams (1.00 lb) of sugar?

(A) 121 g
(B) 42 g
(C) 144 g
(D) 192 g

Hint: First determine the percentage weight of carbon in a molecule of sugar.

The total weight of a sugar molecule in atomic mass units is 12 carbons x 12 amu per carbon atom, plus 22 hydrogen x 1 amu per hydrogen atom, plus 11 oxygens x 16 amu per oxygen atom.

This totals to 144 + 22 + 176 amu, or 342 amu.

Carbon represents 144/342, or 0.42 of the weight of sucrose. 0.42 x 454 grams = 191 grams

9. If the molecular weight of an ammonia molecule is (NH_3) 17.03 and the molecular weight of nitrogen is 14.01, what is the percent weight of nitrogen in the ammonia molecule?

(A) 72.27%
(B) 82.27%
(C) 86.27%
(D) 92.27%

Hint: Since there is only 1 molecule of nitrogen in a molecule of ammonia, nitrogen represents 14.01/17.03, or 82.27% of the weight of an ammonia molecule.

10. If 13.2% of a compound is boron and 86.8% is chlorine, what is the empirical formula for the compound? Boron's atomic weight is 10.8 and chlorine's 35.5.

(A) BCl_2
(B) B_2Cl
(C) BCl
(D) B_2Cl_2

Hint: The empirical formula is the ratio of atoms in a molecule, but not necessarily the exact formula.

The easiest way to solve this problem is to assume the answer and see if it fits the facts. If, for example, BCl_2 were correct, would boron represent 13.2% of the weight of the molecule?

A single boron atom weighing 10.8 amu in a molecule with two chlorine atoms, each weighing 35.5 amu, or 71.0 amu total, would represent only 10.8 amu divided by the total weight of the molecule, 71.0 + 10.8, or 81.8 amu.

10.8/81.8 = 13.2%, which matches the facts of the question.

11. If the molar mass of the compound is 164 g, what is the molecular formula for the compound?

(A) BCl_2
(B) B_2Cl_4
(C) B_3Cl_6
(D) B_4Cl_8

Hint: The empirical formula only provides the ratio of atoms in a molecule.

In order to determine whether BCl_2 **i**s the actual formula, or whether the actual formula is some multiple of BCl_2, we need to know the mass of a mole of the molecule, that is, its molar mass.

The molar mass is 164g. If BCl_2 were the actual formula, its molar mass would be 81.8.

The actual molar mass, however, is twice this, 164 g, so the actual formula must be twice the empirical formula, or B_2Cl_4.