Measurements are part and parcel of science approach. As a matter of fact and as one is aware that sciences give lot of importance to observations made in lab or in nature. These observations are given a firm footing when they are quantified. In other words a number must be associated with that inference obtained from observation. In fact all the definitions look like English statements which can take mathematical form.

In Chemistry computations are important. We often use the term atomic weights/ Molecular weights. We shall try to understand the meaning of these two weights. Atom is extremely small in dimension. To understand this small dimension, let us take an illustration. We shall consider a one centimeter line. We shall divide it into ten parts. So each part is only 0.1 cm in dimension. We can express it as exponential form also. It is 10^{-1}cm. We can thus have a population of ten objects with that dimension accommodated on one cm line.

We shall again take the one cm line and now divide it into 100 parts. Hence each part has the size of .01 cm. Unlike earlier instance to imagine such a small dimension is not easy. Normal habit is to think any familiar object with that size and get some appreciation of such a small size. We may recollect a small creature or some object with which we are all familiar. So on one cm line we have 100 such objects accommodated. The size of the object now is 10^{-2} cm.

We shall again take the one cm line and divide into thousand parts. To divide it into so many parts itself is difficult. Suppose we do it by some sophisticated tools. We now have particles with the dimension of .001. Even though we cannot see with naked eye such particles, we cannot rule out the possibility of the existence of particles of such dimension. So we can accommodate 1000 such particles. Dimension of each particle is 10^{-3}cm.

If we divide the one cm line further we can expect particles which are still smaller and probably we do not have objects with which we are familiar to have such objects. So after some time small numbers remain abstract for us and we cannot visualize them.

Atom has the radius of 10^{-8} cm, which means it is just outside human imagination . Now we are trying to use an atom which is the fundamental unit and we are attempting to quantify it. Again going back to our one cm line we can place hundred million atoms on that line. Such a small sized entity is beyond the imagination of a human being.

If this is the reality of an atom, the expression atomic weight may not indicate weight of a single atom. The modern estimates tell us that the weight of one single atom is around 1.66×10^{-24} gms or 1.66×10^{-27}kgs. It means that we cannot weigh the weight of a single atom. So the expression atomic weight can never be weight of one single atom.

To overcome this practical problem, people thought in terms of relative weights, instead of absolute weights. They took H as the reference and it was assigned the mass of 1, and rest of the elements were given weights taking H as the reference. later on the reference was changed to Oxygen and now we have taken C-12 isotope as the reference. They took 1/12 part of mass of C--12 and called it as one amu (atomic mass unit). Suppose oxygen atom is 16 amu, it means an atom of oxygen is 16 times heavier than the reference unit. In a similar way molecular weight were assigned based on C-12 convention. For example O_2 is the molecule of oxygen and it is 32 times heavier than C--12 scale or in other words oxygen atom is 16 amu, while oxygen molecule is 32 amu. Glucose with the molecular formula $C_6H_{12}O_6$ and one single molecule shall weigh 180 amu. Earlier we have seen one amu = 1.66×10^{-24}grams.

We nor require an approach by which we can generate weights that can easily be weighed. Suppose we take more than one atom, then there will be increase in weight. Imagine we take 10^6 atoms, and we know weight of one amu and we know that each oxygen atom is 16, so weight of one million atoms of oxygen will be $16 \times 1.66 \times 10^{-24} \times 10^6 = 26.56 \times 10^{-18}$gms. even though we have taken one million atoms still it does not give appreciable weight. So we need to take EXTREMELY LARGE NUMBER of atoms to get a number which can be measured and secondly the number chosen must be same for all types of atoms and molecules. So that chosen number must be constant. It is Avogadro's number, which has a constant value of 6.02×10^{23}.

Let us discuss taking some examples to understand clearly to get the meaning of expressions like atomic or molecular weights. As per the relative atomic masse which we discussed earlier, Oxygen has the mass of 16 amu. This is the weight of each atom of oxygen. One atomic mass unit (amu) in terms of grams will weigh approximately 1.66×10^{-24}grams. So each oxygen atom has the weight in grams will be $16 \times !.66 \times 10^{-24} = 2.656 \times 10^{-23}$ grams. Now we have to consider the weight of Avogadro number of oxygen atoms, so it will be 15.989 grams, or 16 grams. This figure corresponds to the weight of Avogadro number of Oxygen atoms. It is also called as gram atomic weight or mole of Oxygen atoms. Briefly in the number 16 amu, which is equal to relative atomic weight of one oxygen atom, we retain that number of 16 but replace amu with grams then it corresponds to the mole weight or gram molecular weight. When we say atomic weight we normally refer to mole weight or gram atomic or molecular weight. In fact atomic weight of any atom or molecular weight of any substance is the weight of Avogadro number of those species. Let us take one more example to clarify the concept of mole further. We now consider a molecule of glucose, $C_6H_{12}O_6$. The relative molecular mass is nothing but summation of relative atomic masses. C= 12 amu, H = 1amu and O= 16 amu. So when we add these weights of all the atoms in the given formula we get 180 amu. This is the weight of one molecule of glucose. Since we have the correlation between amu and grams, the weight of glucose in terms of grams will be 2.988×10^{-22} grams. So for Avogadro number of glucose molecules will be 179.87 grams or 180 grams. This is the weight of a mole of glucose molecules. Also called as gram molecular weight. The weights so obtained can be measured comfortably. So mole is the weight of Avogadro number of species. Thus we have equation between NUMBER AND WEIGHT in grams or kgs.

Suppose we have a balanced equation involving HCl and NaOH, We need to understand such a balanced equation by correctly interpreting the coefficients before a formula in a balanced chemical equation.

HCl + NaOH = NaCl + H_2O. This is a balance equation. Since there is no mention of any coefficient before any formula it means it is one before each of the formulas So we have one mole of HCl or 36.5grams of HCl, One mole of NaOH or 40 grams of it, and on the product side we obtained one mole of NaCl or 58.5 grams and one mole of water or 18 grams. This is the interpretation of the balanced equation. Since we know the proportion in which the reactants are reacting, we can extend further, if we take 20 grams of NaOH, which is half its mole weight, it means we have taken less than one mole, or to be more precise half mole, so we expect all other species will also react in the proportion indicated in the balance equation. Suppose imagine we have taken 36.5grams of HCl in the earlier case where we have taken 20 grams of NaOH, we expect only half a mole of HCl is utilized and the remaining amount will remain un reacted. Later we expand this idea of limiting reagent. In the above illustration NaOH shall function as limiting regent and it limits the amount of products formed. So we can identify the excess reagent as HCl. On the product side also we now get half mole each of NaCl and H_2O. So we can have an estimate of any product which is obtained in a chemical process using the mole concept.

In fact we can correlate the concept of mole in terms of volume also. But this relation has a limitation, it can be equated only at STP condition. At those conditions one mole of the compound shall occupy 22.4 liters. These conditions indicate 0 degrees centigrade and one atmosphere pressure. So Avogadro number of molecules or atoms shall occupy 22.4 liters. So proportionately we can find the volume of a given quantity will occupy, provided we have converted that quantity into moles. We can find the volume of the gas at different conditions by making use of ideal gas equation PV = nRT and equations derived from it.

To summarize till this stage we can correlate Avogadro number with the either weight or volume in the computations of any chemical reaction. So now we need to take up some numerical problems.

Q1) Calculate the weight of 6.02×10^{23} molecules of $CaCO_3$.

Q2) Calculate the weight of $12.04 \times 10^{23} atoms\ of\ carbon$

Q3) What will be number of Oxygen atoms in one mole of oxygen gas

Q4) A piece of copper weighs 0.635 grams. calculate number of Cu atoms in that piece.

Q5) Calculate the number of molecules in 11.2 liters of SO_2 at STP

Q5) one atom of an element X weighs 6.644×10^{-23} grams. Calculate the number of gram atoms in 40 kgs of it

Q6)From 200 mgs of CO_2, 10^{21} molecules are removed. How many moles of CO_2 are left behind

Q7) Calculate the volume of 20 grams of hydrogen gas at STP

Q8) What volume shall be occupied by 6.02×10^{23} molecules of any gas at STP

Q9) How many atoms are present in 100 amu of He

Q10) The density of O_2 at STP is 1.429 grams /liter. Calculate standard molar volume of the gas

Q11) The measured density of He at STP is 0.1784 gms/liter. What is the weight of 1 mole of it

Q12) Calculate the number of moles and number of atoms of H, S and O in 5 moles of H_2SO_4