Think It Over

This section of* Resonance *is meant to raise thought-provoking, interesting, or just plain brain-teasing questions every month, and discuss answers a few months later. Readers are welcome to send in suggestions for such questions, solutions to questions already posed, comments on the solutions discussed in the journal, etc. to* Resonance *Indian Academy of Sciences, Bangalore 560 080, with "Think It Over" written on the cover or card to help us sort the correspondence. Due to limitations of space, it may not be possible to use all the material received. However, the coordinators of this section (currently A Sitaram and R Nityananda) will try and select items which best illustrate various ideas and concepts, for inclusion in this section.

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Counting Molecules in a Spoonful of Water

What do 18 g of water, 27 g of aluminium, 197 g of gold and 342 g of sugar have in common? The quantities correspond to the atomic weight of the metals and the molecular weight of the molecular substances in grams. These measures represent one mole of each material. They all contain the same number of atoms or molecules. To be precise, 602,205,000,000,000,000,000,000 of them, give or take a few trillion-millions. This astronomical figure is the famous *Avogadro Number*.

The number appears in text books during the discussion of gas laws. It is the number of molecules in 22.4 litres of a gas at 25° C and 1 atmosphere pressure. As mentioned earlier, it is also the number of molecules in a gram molecular weight of any substance. The magical figure shows up in electrochemistry too. An Avogadro number of electric charge (called a Faraday) is needed to deposit a mole of a metal from a solution containing its monocation. Thus,

6.02×10^{20} electrons would be needed to electroplate a surface with 0.197 g of gold.

The concept of mole is very important in chemistry. Atoms and molecules usually combine in simple molar ratios. Therefore, the optimum way to understand chemical reactions and equilibria is by determining the number of moles of each of the species involved. The proportions in terms of weight or volume are more complex, but can be calculated from the molar ratios.

In recent times, October twenty third (written 10/23 by Americans) of each year is celebrated as the International Mole Day (no, not the Zoology variety). The festivities begin at two minutes past six (AM or PM, as per convenience). This specific time in a thoroughly unimportant date in history has been chosen to create greater awareness for arguably the most important number in chemistry: 6.02×10^{23}.

It is all very well, but how can the value of Avogadro number be determined experimentally?

Smallest Possible Magic Square of Consecutive Odd Prime Numbers

1	823	821	809	811	797	19	29	313	31	23	37
89	83	211	79	641	631	619	709	617	53	43	739
97	227	103	107	193	557	719	727	607	139	757	281
223	653	499	197	109	113	563	479	173	761	587	157
367	379	521	383	241	467	257	263	269	167	601	599
349	359	353	647	389	331	317	311	409	307	293	449
503	523	233	337	547	397	421	17	401	271	431	433
229	491	373	487	461	251	443	463	137	439	457	283
509	199	73	541	347	191	181	569	577	571	163	593
661	101	643	239	691	701	127	131	179	613	277	151
659	673	677	683	71	67	61	47	59	743	733	41
827	3	7	5	13	11	787	769	773	419	149	751

In a magic square the sum of all the elements of a row or a column or a diagonal will be the same. In the present case this is 4514.