The atomic weight of an element is determined by

NFL-YET ACADEMY CHEMISTRY-I: atoms.htm FALL, 1999 DR. GERALD A. ROSENTHAL THE CHEMICAL NATURE OF ATOMS THE mass of an atom is concentrated in a very small central portion of the atom which is called the atomic nucleus. The atomic nucleus is made up of electrically positive protons and electrically neutral neutrons. Surrounding the atomic nucleus are the electrically negative electrons. The masses and charges of these three fundamental constituents of atoms are given below: Particle Charge Mass Electron -1 0 Proton +1 1 Neutron 0 1 The chemical nature of an atom, that is , the chemical properties of a specific element, is determined by the number of protons in the nucleus. This number of protons is called the atomic number. The mass of the atom, its atomic mass, depends upon both the number of protons and upon the number of neutrons present in the nucleus (remember that the mass of an electron is so small that it is simply ignored for the purpose of establishing the atomic mass). Before moving further into this unit, link to:atoms02.htm. ISOTOPES AND ATOMIC MASSES This is a complex unit that requires attention to detail and careful thought. This is not easy. For many of the chemical elements there are several known isotopes. Isotopes are atoms with different atomic masses which have the same atomic number. The atoms of different isotopes are atoms of the same chemical element; they differ in the number of neutrons in the nucleus. REMEMBER: Atoms of the same chemical element do not always have the same mass because, although the number of protons in the nucleus is the same for all atoms of the same element, the number of neutrons is not. Most elements as they occur naturally on earth are mixtures of several isotopes. For example, the element hydrogen has atoms that have one proton in the nucleus. This is the most common form of hydrogen. Most of the atoms of hydrogen found in the Universe are 1H. That is, they have an atomic number of one due to the presence of single proton in the nucleus, and a mass of one due to the presence of a single proton. Occasionally, one finds and atom of hydrogen in which a neutron has been incorporated into the nucleus. This isotope of hydrogen is characterized by an atomic number of one (only one proton; hydrogen can only have one proton in the nucleus), but an atomic mass of two (one proton plus one neutron). This isotope of hydrogen is known as "deuterium" or heavy hydrogen. Finally, even rarer is the third isotope of hydrogen [3H]. It has a mass of three which can only occur from the presence of two neutrons in the nucleus. Remember, that if there was another proton in hydrogen-3-it would not be hydrogen. This final isotope of hydrogen is known as "tritium" and it is radioactive. Later, we shall consider isotopes again when we consider the important question of atomic mass Moles of Atoms Historical background. The atomic mass of an element is a relative quantity. Originally the atomic mass of hydrogen, the lightest of the elements, was taken to be one and the atomic masses of all other elements were measured in relation to the atomic mass of hydrogen. This later proved to have been a poor choice. Not only does hydrogen naturally consist of more than one isotope, but there was the additional question (particularly among early chemists) as to whether monatomic hydrogen or diatomic hydrogen should be taken as having atomic mass one. Can you see the problem? If all hydrogen existed as a single atom (which it does not) it would have been possible to use hydrogen as a basis for comparing its mass to the mass of any other element. Hydrogen could have been taken as one mass unit and everything else compared relative to hydrogen. However, hydrogen has three isotopes and it occurs as diatomic hydrogen (two atoms in a single molecule). After some effort, and one major false start with oxygen, chemists and physicists agreed on a common scale of relative atomic mass. Carbon of isotopic mass twelve was assigned an atomic mass of exactly twelve, and all other atomic masses whether of isotopes or of elements were specified relative to carbon of atomic mass twelve. This had the effect of making the relative atomic mass of hydrogen 1.0079...rather than exactly 1.0000.... The difference of less than 1% is too small to matter in many approximate chemical calculations, but it is large enough to be significant when accurate work must be done. Do you understand? Carbon-12 was taken as the standard and now everything is taken relative to this single isotope of carbon. That is why hydrogen has an atomic mass greater than unity. Scientists needed a single unit to enable them to compare the exact same number of atoms or molecules of one element or compound to another. Eventually, they agreed upon using the concept of the mole (mol) for this purpose. By definition, one mole of atoms is that number of atoms which exist in exactly twelve grams of carbon of isotopic mass twelve (12C). Remember, scientists have agreed on the isotope carbon-12 for determining all relative atomic masses. The number of atoms in a mol of any element or compound is called the Avogadro number; the best current determination of its value is 6.0221 x 1023. YOU MUST MEMORIZE AVOGADRO'S NUMBER AND HAVE AN ABSOLUTELY CLEAR UNDERSTANDING OF EXACTLY WHAT IT MEANS AND WHY IT IS SO IMPORTANT IN MODERN CHEMISTRY Molar Atomic Masses of Elements The molar mass of an atom is simply the mass of one mole of its identical atoms. However, most of the chemical elements are found on earth not as one isotope but as a mixture of isotopes, so the atoms of one element do not all have the same mass. Chemists therefore distinguish the molar atomic mass of an isotope, which is the mass of one mole of the identical atoms which form that isotope, from the molar atomic mass of an element, which is the mass of one mole of the atoms of the various isotopes of that element having the natural abundance as they are found on earth. I know that this is very difficult, but if you truly understand this concept, then the following is clear to you: Chemists deal with elements as they are naturally found, and so the atomic mass of a particular isotope is of less interest than the weighted mean molar atomic mass of the individual isotopes which is the molar atomic mass of the naturally occurring element. This property has open been called the atomic weight or chemical atomic weight of the element. The weighted mean molar atomic mass of an element as it naturally occurs will be referred to simply as the atomic mass of the element from now on. Example. The relative abundance's of the isotopes 6Li and 7Li in naturally occurring lithium can be computed as follows. Their atomic masses are 6.0151214 and 7.0160030, respectively. The atomic mass of naturally occurring lithium given in the table of atomic mass or weight is 6.941. If the relative abundance of 6Li is 7.5% and the relative abundance of 7Li is 92.5%, then the atomic weight of Lithium (for the entire population of lithium atoms) is: (.075 x 6.0151214) + (.925 x 7.0160030) = 0.451 + 6.49 or 6.941 Remember that this is a weighted average in which the contribution of each isotope is taken into account. The final atomic mass of Li is very close to the atomic mass of the 7Li isotope because so much of this isotope (as compared to 6Li) makes up the natural population of lithium atoms. Thus, the atomic mass of Li is taken to be 6.941 because this value takes into account the natural abundance of the isotopes of Lithium. Special thanks to James A. Plambeck of the University of Alberta in Canada who authored some of this material. Page ID8789 Contributed by BoundlessGeneral Microbiology at Boundless The average atomic mass of an element is the sum of the masses of its isotopes, each multiplied by its natural abundance. An element can have differing numbers of neutrons in its nucleus, but it always has the same number of protons. The versions of an element with different neutrons have different masses and are called isotopes. The average atomic mass for an element is calculated by summing the masses of the element's isotopes, each multiplied by its natural abundance on Earth. When doing any mass calculations involving elements or compounds, always use average atomic mass, which can be found on the periodic table. mass number: The total number of protons and neutrons in an atomic nucleus. natural abundance: The abundance of a particular isotope naturally found on the planet. average atomic mass: The mass calculated by summing the masses of an element's isotopes, each multiplied by its natural abundance on Earth. The atomic number of an element defines the element's identity and signifies the number of protons in the nucleus of one atom. For example, the element hydrogen (the lightest element) will always have one proton in its nucleus. The element helium will always have two protons in its nucleus. Atoms of the same element can, however, have differing numbers of neutrons in their nucleus. For example, stable helium atoms exist that contain either one or two neutrons, but both atoms have two protons. These different types of helium atoms have different masses (3 or 4 atomic mass units), and they are called isotopes. For any given isotope, the sum of the numbers of protons and neutrons in the nucleus is called the mass number. This is because each proton and each neutron weigh one atomic mass unit (amu). By adding together the number of protons and neutrons and multiplying by 1 amu, you can calculate the mass of the atom. All elements exist as a collection of isotopes. The word 'isotope' comes from the Greek 'isos' (meaning 'same') and 'topes' (meaning 'place') because the elements can occupy the same place on the periodic table while being different in subatomic construction. Figure: Lithium Atom: Stylized lithium-7 atom: 3 protons (red), 4 neutrons (black), and 3 electrons (blue). (Lithium also has another, rarer isotope with only 2 neutrons.) the atomic weight of an element is determined by the number of. the atomic weight of an element is determined by john. the atomic weight of an element is approximately determined by. an element's atomic weight is determined by adding the number of. atomic weight is determined by the number of protons in an atom of a given element. how to find atomic weight of an element