I'm not robot

reCAPTCHA

Continue

How to calculate percent abundance from amu

Atomic massA atomic weight (relative atomic mass) of an element from a given source is the ratio of the average mass per atom of the element to 1/12 of the mass of 12C in its nuclear and electronic ground state. A sample of any element consists of one or more isotopes of that element. Each isotope has a different weight. The relative sets of each isotope for any element represent the isotope distribution for that element. Atomic weight is the average of isotope weights, weighted for isotope distribution and expressed on the 12C scale as mentioned above. Atomic Mass CalculationsAtomic Mass = [(Mass of Isotope) (%Abundance)] + [(Mass of Isotope) (%abundance)] + [....] 100%The equation continues[....] based on the number of isotopes in the problem. Example 1 The natural frequency for Borisotope is: 19.9% 10B (10,013 amu) and 80.1% 11B (11.009amu). Calculate the atomic weight of boron. Atomic mass =[19.9)(10.013)] + [(80.1)(11.009)] 100%atomic mass =atomic mass = 10.81amu, the atomic weight of B = 10.81amuIf you look in the period table, you can check if our answer is correct! 3Make sure that the atomic mass of magnesium is 24.31, considering that :24Mg= 23.985042amu, 78.99%25Mg= 24.985837 amu, 10.00% 26Mg= 25.982593, 11.01% Atomic Mass= [(0.7899)(23 .985042)] + [(0.1)(24.985837)] + [(0.110) 1)(25.982593)]Atomic mass = 18.946 + 2,499 + 2,861 AP Chemistry Example 1Determination of the percentage frequency of each isotope from the atomic mass. Copper exists as two isotopes: 63Cu (62.9298 amu) and 65Cu (64.9278 amu). What are the percentage excesses of the isotopes? Because the total atomic weight for copper is not specified in the problem, you must look it up in the period table to work this solution. Atomic mass for Cu = 63.54663Cu % = 1-x 65Cu % = x63.546 = [(1-x)(62.9298)] + [(x)(64.9278)]63.546 = 62.9298 - 62.9298x + 64.9278x1.3818 = 1.9 8xX = 0.6916 63Cu = 0.6916 x 100% = 69.16%65Cu = 1 - x = 1 - 0.6916 = 0.3084 x 100% = 30.84%AP Example 2The atomic mass of lithium is 6.94, the naturally occurring isotopes are 6Li = 6.015121 amu, and 7Li = 7.016003 amu. Determine the percentage frequency of each isotope. Aw = [(%Abundance of the isotope) (mass of the isotope)] + [(%Abundance of the isotope) (mass of the isotope)] + [....] 6.94 =[(% 6Li)(6.015121)] + [(%7Li)(7.016003)] Since I do not know what the percentage is, I have to use variables. 100% lithium is determined by these two naturally occurring isotopes. We leave 6Li = x and 7 Li = 1-x; we use 1 - x instead of 100 - x because the small number is easier to use. (in other words, we have reduced 100% to decimal form 1.00) Now we include our variables: 6.94 =[(% 6Li)(6.015121)] + [(%7Li)(7.016003)] 6.94 = [(x)(6.015121)] [(x)(6.015121)] = 6.015121x + 7.016003 - 7.016003xCombine as terms: 6.94 -7.016003 = (6.015121x - 7.016003x) -0.076003 = -1.0008 8 2 xSolve for x: -0.076003= x-1.000882X = 0.075936, therefore 6Li = 0.075936 x 100% = 7.59% 1-X = 1 -0.075936 = 0.924064, therefore 7Li = 0.924064 x 100% = 92.41%Atomic Structure LinksChemical Demonstration Videos You have a bunch of rocks to move and must decide what equipment you want to rent to move them. If the rocks are quite small, you can get a shovel to pick them up. Larger rocks could be moved by hand, but large boulders require some kind of mechanical shovel. The amount of each type of rock also determines how much time you need to get the job done. Knowing the relative amounts of large, medium and small rocks can be very useful in deciding how to approach the job. Most elements occur naturally as a mixture of two or more isotopes. The following table shows the natural isotopes of several elements, along with the percentage natural abundance of each element. Element Isotopes (symbol) Percent Natural frequency atomic mass ()(,left ('text'amu'{1}'es hydrogen ()99,985 1.0078 1.0079 ,(ce_1-2H) 0.015 2.0141 H) negligible bar 3.0160 Carbon '('ce'_6'{12}C') 98.89 12.000 12.011 '('_6'{13}C') 1.11 13.003 {14} Trace 14.003 Oxygen '"_8'{16}O') 99.759 15.995 15.999 '('ce'_8'{17}O') 0.037 16.995 '('ce'_8'{18}O') 0.204 17.999 Chlorine '('_{17}'{35}Cl') 75.77 34,969 35,453 '('_{17}'{38}Cl') 24.2 36,966 Copper {63}{29} ()69.17 62.930 63.546 ,(){29}-{65}Cu) 30.83 64.928 For some elements, a particular isotope outweighs the other isotope. Naturally occurring hydrogen is almost all hydrogen-1 and naturally occurring oxygen is almost the entire oxygen-16. However, many other elements may have more than one isotope in larger quantities. Chlorine (atomic number 17) is a yellowish-green poison gas. About three-quarters of all chlorine atoms have 18 neutrons, giving these atoms a mass of 35. About a quarter of all chlorine atoms have 20 neutrons, giving these atoms a mass of 37. If you simply calculated the arithmetic average of the precise atomic masses, you would get 36. 34,969 + 36,966 ,right){2} = 35,968 (text) and amu significantly lower. Why? We need to take into account the percentagenatural excesses of each isotope to calculate the weighted average. The atomic mass of an element is the weighted average of the atomic masses of the naturally occurring isotopes of this element. The following example problem shows how the atomic mass of Example: PageIndex{1}) Use the atomic masses of each of the two isotopes of chlorine along with their percentage natural abundance to calculate the average atomic mass of chlorine. Solution Step 1: List known and unknown quantities and plan the problem. Known chlorine-35: atomic mass (= 34,969) and percentage abundance (= 75.77 %) Chlorine-37: Atomic mass (= 36,966) and percentage abundance (= 24.23 %) Unknown average atomic mass of chlorine change each percentage excess quantity in decimal form by dividing by 100. Multiply this value by the atomic mass of this isotope. Add for each isotope to get the average atomic mass. Step 2: Calculate the number of text chlorine-35-35-35-,0,969 times from 34,969 = 26.50 , and , and , text-amu and text and chlorine-37 & 0.2423 ,-times 36,966 = 8,957 € Note: Applying significantly Number rules result in a result without excessive rounding errors: In one step: ['links(0.7577 'by 34,969 'right) + 'left(0.2423 'times 36.966 'right) = 35.45 ': 'text'amu'] Step 3: Think about your result. The calculated average atomic mass is closer to 35 than 37, since a larger percentage of naturally occurring chlorine atoms have the mass number of 35. It matches the value from the table above. Summary The atomic mass of an element is the weighted average of the atomic masses of the naturally occurring isotopes of this element. Atomic mass calculations use the percentage frequency of each isotope. Contributors and Attributions CK-12 Foundation by Sharon Bewick, Richard Parsons, Therese Forsythe, Shonna Robinson and Jean Dupon. Defining Atomic Weight Learning Objectives Calculate the atomic weight from percentage frequency Calculate the atomic weight equation to calculate different unknown variables Distinguish between atomic weight, atomic number, and mass number As mentioned in the previous section, atoms that have the same atomic number (number of protons) but different mass numbers (number of protons and neutrons) are called isotopes (nuclides). There are naturally occurring isotopes and isotopes that are produced artificially. Of all the elements on the periodic table, only 21 are pure elements. Pure or monotopic elements are elements with only one naturally occurring isotope. The following are the 21 pure elements:Table of the 2.3.1 Monotopic Elements isotopes of a particular element do not all exist in the same ratios. Mercury, for example, has seven naturally occurring isotopes: {196}Hg), {198}Hg), {199}Hg, {200}Hg, {201}Hg, {202}Hg, ({204}Hg); these have the percentage natural abundance of 0.146%, 10.02%, 16.84%, 23.13%, 13.22%, 29.80% and 6.85% respectively. It is clear that the {202}Hg) of the greatest abundance, and is the next most common, but the other isotopes occur only in small traces. Note: The sum of the percentage natural frequency of all isotopes of a given element must be 100%. Some naturally occurring and artificially produced isotopes are radioactive. All atoms that are heavier than bismuth {83} {209} ()) are radioactive. However, there are many lighter nuclides that are radioactive. Hydrogen has e.B. two naturally occurring stable isotopes, e.B. {1}H) and {2}H) (deuterium), and a third naturally occurring radioactive isotope, the (tritium) {3} (tritium). It should not be surprising, but isotope abundance (% of each isotope) may vary between samples. Here is an interesting IUPAC technique report, Isotope-Abundance Variations of Selected Elements, which describes this, How do we know what the percentage frequency is for each of the isotopes of a particular element? Isotopes are separated by mass spectrometry; MS tracks show the relative frequency of isotopes vs. mass count (mass: charge ratio). Although we cannot directly measure the mass of atoms, we can use the mass spectrometer, an instrument with which we can measure the ratio of mass to charge. In Figure 2.3.2 you can see chlorine gas entering a mass spectrometer. The chlorine has several isotopes and is hit by a stream of ionizing electrons that break the bond of Cl2 and remove electrons from chlorine, creating ions. These are then accelerated in the chamber until they reach a magnetic field that deflects the particles. The deflection angle depends on both the mass of the particle and the magnetic field strength, with the lighter particles being more distracted (the lighter 35Cl+ ions are more distracted than the heavier 37Cl+ ions).) At the end of the chamber there is an outlet hole with a detector, and with the increase in magnetic field intensity, the deflection angle that separates the particles changes. Note that the mass spectrum in Figure 2.3.2 (b) shows the relative frequency of each isotope, normalizing the peak to the isotope with the highest abundance. So if this ratio was 3:1, which means that there are 3 particles of 35Cl for each particle of 37Cl, and the percentage frequency would be 75% 35Cl and 25% 37Cl. Figure 2.3.2 Determination of relative atomic masses with a mass spectrometer below is a video from YouTube that describes the mass spectrometer Here is a bar chart showing the relative frequency of 4 isotopes of strontium example: The mass spectrum of strontium has four different peaks, different in intensity. The four peaks indicate that there are four isotopes of strontium. The four of strontium have isotope-sized masses of 84, 86, 87 and 88 and relative excess essays of 0.56%, 9.86%, 7.00% and 82.58% respectively. The intensity of the summit corresponds to the abundance. {84} The smallest peak has the smallest peak, which is of 0.56%, while the {88}Sr) has the highest peak, which corresponds to its relative frequency of 82.58%. This indicates {88} that the isotope is the isotope found in the highest amounts. Once we collect the relative masses of each isotope from the data of mass spectrometry, we can use this information to calculate the average atomic mass (weight) of all atoms of each element, taking into account the mass of each existing isotope and the percentage frequency for each isotope. This can be done by the following formula: Average atomic mass = (mass of the isotope 1 x fracture frequency of the isotope 1) + (mass of the isotope 2 x fracture frequency of the isotope 2) + ... The average atomic mass was calculated in this way and can be found under any symbol in the period table. Let's look at an example of how we can calculate this information. Calculation of average atomic mass Problem 1 Average atomic mass: What is the average atomic mass of neon, since it has 3 isotopes with the following percent abundance; 20Ne = 19,992 amu (90.51%), 21Ne = 20.993 amu (0.27%), 22Ne = 21,991 amu. What we know: Since you know what the element is, you can solve this without doing maths by using the period table, but you need to be able to do the math because it could be an unknown, and that's the only way to figure out the right significant numbers. Since Ne-20 has the largest percentage of abundance, it should have the greatest effect on your average. Therefore, we expect the average atomic mass to be closer to the mass of Ne-20 (approx. 19,992 amu). Click on the video tutor below to see if we have appreciated correctly. Video Tutor: Answer: According to the correct number of significant numbers, we came up with 20.18 amu, since the average atomic weight even thought the average atomic weight from the periodic table is 20,179 amu. However, it's still a good test to make sure you're on the right track. Check for yourself: We predicted that our response should be closer to the mass of Ne-20 (19,992 amu) instead of Ne-21 or Ne-22, because it has the greatest natural fullness and thus affects the average more. We can see that mathematics is consistent with our logic! Problem 2: Chlorine has two isotopes, where 75.53% is 35Cl with an isotope mass of 34,969 amu, what is the mass of the other isotope? What we do know: In this case, you have the average atomic mass (from the periodic table). You try to find the mass of each isotope. You also know that the individual isotopes must add up to 100%. Video Tutor: Answer: The Answer is 36.9 amu. {1} A fictitious element has two isotopes and an atomic mass of 131,244 amu. If the first isotope (isotope 1) has a mass of 129.588amu and the second isotope (isotope 2) has a mass of 131,912 amu, which isotope has the greatest natural abundance? A) Isotope 1 B) Isotope 2 C) C) are equal amounts. D) Insufficient information provided. (E) none of the above-mentioned answer B) isotopes 2. Although it is algebraically possible to calculate the special percentage excesses for both isotopes, there is no need to spend so much time on this problem if you know the principle behind it. The average is 131,244 amu. It looks as if the mass of isotope 2 (131.912amu) is closer to the average than the mass of isotope 1 (129,588 amu). This suggests that isotope 2 has a much more influenced average than isotope 1 and has a higher percentage frequency. {2} The atomic weight of Chorin e_______________and the atomic number of chlorine-35 is_________________. A) 35, 17 B) 17, 35 C) 35,4527; 17 D) 35,4527; 35 Answer C) the atomic weight is the average of the mass of all isotopes of chlorine atoms and is located below the symbol on the periodic table. The ordinal number is the number of protons in all chlorine atoms and is located on the top of the symbol in the period table. You should create the following worksheets that are designed for the preparation course as in The Course Activities, and therefore provide more step-by-step instructions than we use. Isotope Abundance Worksheets: Isotope Abundance Worksheet Key to Isotope Abundance Worksheet Petrucci, Ralph H., William S. Harwood, F. Geoffrey Herring, and Jeffry D. Madura. General chemistry: principles and modern application. Ninth Ed. Pearson Prentice Hall, New Jersey. Catherine E. and Alan G. Sharpe. Inorganic chemistry. England: Pearson Prentice Hall, 2008. Hoefs, Jochen. Stable isotope geochemistry. Sixth ed. Germany: Springer, 2009 Anonymous Modified by Joshua Halpern, Scott Sinex and Scott Johnson Bob Belford and November Palmer Ronia Kattoum (UALR) (UALR)