Name_____ Per_____

AVERAGE ATOMIC MASS

The number of protons, neutrons, and electrons an atom contains determines its mass. The mass of the electrons is usually omitted since electrons are so much smaller than protons and neutrons. A proton has a mass of about 1.0073 atomic mass units (abbreviated "u"). The neutron's mass is approximately 1.0087 u. By comparison, the electron's mass is only 0.00055 u. So, ignoring the electrons, a nitrogen-14 atom has a mass of about 14.1120 u (7 protons x 1.0073 u/proton + 7 neutrons x 1.0087 u/neutron = 14.1120 u).

The average atomic mass of an element is determined by calculating the mass of the individual isotopes of the element and then multiplying these masses by the relative abundance of each isotope as it is found in nature. Consider hydrogen as an example. Although three isotopes of hydrogen are known, only two of these occur in measurable quantities in nature, hydrogen-1 and hydrogen-2. Hydrogen-1 has one proton and no neutrons, so its mass is 1 proton x 1.0073 u/proton + 0 x 1.0087 u/neutron = 1.0073 u. Similarly, hydrogen-2 has a mass of 2.0160 u (1 proton x 1.0073 u/proton + 1 neutron x 1.0087 u/neutron). 99.985% of hydrogen found in nature is hydrogen-1. Only 0.015% is hydrogen-2. The calculation for average atomic mass for these data is:

$$\frac{(1.0073\text{ u} \times 99.985\%) + (2.0160\text{ u} \times 0.015\%)}{100.000\%} = 1.0074\text{ u}$$

Care must be exercised in rounding the above calculation to the correct number of significant figures. Notice first of all that this is a mixed operation calculation involving both addition and multiplication. Before the addition can be computed, the two multiplication components will have to be completed and rounded to the correct number of significant figures. The addition is then computed and rounded to the fewest number of decimal places featured in the multiplication products. The individual steps look like this:

step 1.	1.0073 x 99.985 = 100.71	(product rounded to 5 sig figs)
	2.0160 x 0.015 = 0.030	(product rounded to 2 sig figs)
step 2.	100.71 + 0.030 = 100.74	(sum rounded to 2 decimal places)
step 3.	100.74 / 100.000% = 1.0074	(result rounded to 5 sig figs)

I. Procedure

1. Use the data in the table below to calculate the average atomic mass of carbon.

Isotope	Number of protons	Number of neutrons	Mass	Relative abundance
C^{12}	6	6	12.0960 u	98.89%
C^{13}	6	7	13.1047 u	1.11%

2. Use the data in the table below to calculate the average atomic mass of nitrogen.

Isotope	Number of protons	Number of neutrons	Mass	Relative abundance
N^{14}	7	7	14.1120 u	99.64%
N^{15}	7	8	15.1207 u	0.36%

3. Use the data in the table below to calculate the average atomic mass of helium.

Isotope	Number of protons	Number of neutrons	Mass	Relative abundance
He^{3}	2	1	3.0233 u	0.00013%
He^{4}	2	2	4.0320 u	99.99987%

4. Use the data in the table below to calculate the average atomic mass of lithium.

Isotope	Number of protons	Number of neutrons	Mass	Relative abundance
Li^{6}	3	3	6.0480 u	7.5%
Li^{7}	3	4	7.0567 u	92.5%

5. Use the data in the table below to calculate the average atomic mass of boron.

Isotope	Number of protons	Number of neutrons	Mass	Relative abundance
B^{10}	5	5	10.0800 u	20.0%
B^{11}	5	6	11.0887 u	80.0%

6. Use the data in the table below to calculate the average atomic mass of oxygen.

Isotope	Number of protons	Number of neutrons	Mass	Relative abundance
O^{16}	8	8	16.1280 u	99.76%
O^{17}	8	9	17.1367 u	0.040%
O^{18}	8	10	18.1454 u	0.20%

7. Use the data in the table below to calculate the average atomic mass of neon.

Isotope	Number of protons	Number of neutrons	Mass	Relative abundance
Ne^{20}	10	10	20.1600 u	90.51%
Ne^{21}	10	11	21.1687 u	0.27%
Ne^{22}	10	12	22.1774 u	9.22%

II. Data table

1. Average atomic mass of carbon _____ u
2. Average atomic mass of nitrogen _____ u
3. Average atomic mass of helium _____ u
4. Average atomic mass of lithium _____ u
5. Average atomic mass of boron _____ u
6. Average atomic mass of oxygen _____ u
7. Average atomic mass of neon _____ u