Calculating Isotopic Abundances

① Nitrogen has two isotopes, N-14 and N-15. If the relative atomic mass of nitrogen is 14.007 what is the percentage abundance of each isotope.

$$(14 \times x) + (15 \times (1-x)) = 14.007 \qquad 14x + 15 - 15x = 14.007$$

$$14x - 15x = 14.007 - 15 \qquad -1x = -0.993 \qquad x = 0.993$$

$$\therefore \quad N_{14} = 0.993 \text{ or } 99.3\% \qquad N_{15} = 0.007 \text{ or } 0.7\%$$

② Copper has two isotopes Cu-63 and Cu-65. Given that copper has an atomic weight of 63.546, what is the percentage abundance of each isotope?

$$(63 \times x) + (65 \times (1-x)) = 63.546 \qquad 63x + 65 - 65x = 63.546$$

$$63x - 65x = 63.546 - 65 \qquad -2x = -1.454 \qquad 2x = 1.454$$

$$x = \frac{1.454}{2} \qquad x = 0.727 \qquad \therefore \quad Cu_{63} = 0.727 \text{ or } 72.7\%$$
$$Cu_{65} = 0.273 \text{ or } 27.3\%$$

③ A sample of naturally occurring silicon consists of Si-28, Si-29 and Si-30. If the relative atomic mass of silicon is 28.0855 and the abundance of Si-29 is 4.67%, what are the abundances of Si-28 and Si-30?

$$(28 \times x) + (29 \times 0.0467) + (30 \times (1 - 0.0467 - x)) = 28.0855$$

$$28x + 1.3543 + 30 - 1.401 - 30x = 28.0855$$

$$28x - 30x = 28.0855 - 1.3543 - 30 + 1.401$$

$$-2x = -1.8678 \qquad 2x = 1.8678 \qquad x = \frac{1.8678}{2} \qquad x = 0.9339$$

$$\therefore \quad Si_{28} = 0.9339 \text{ or } 93.39\% \qquad Si_{30} = 0.0194 \text{ or } 1.94\%$$

④ Determine the percentage abundance of Fe-57 and Fe-58.

Isotope	% abundance
Fe-54	8.536
Fe-56	90.007
Fe-57	
Fe-58	

Relative atomic mass of Fe = 55.845

$(54 \times 0.08536) + (56 \times 0.9007) + (57 \times x) + (58 \times (1 - 0.08536 - 0.9007 - x))$
$= 55.845$

$4.60944 + 50.4392 + 57x + 0.01394 - 58x = 55.845$

$57x - 58x = 55.845 - 4.60944 - 50.4392 - 0.80852$

$-1x = -0.01216 \qquad x = 0.01216$

∴ Fe-57 = 0.01216 or 1.216 %   Fe58 = 0.00241 or 0.241%

⑤ Lead has three isotopes, Pb-206, Pb-207 and Pb-208. If Pb-207 and Pb-208 are present in equal amounts, calculate their percentage abundances if it's relative atomic mass is 207.19.

$(206 \times 1 - 2x) + (207 \times x) + (208 \times x) = 207.19$

$206 - 412x + 207x + 208x = 207.19$

$-412x + 207x + 208x = 1.19$

$3x = 1.19$

$x = 0.396$

∴ Pb-207 = 0.396 or 39.66 %   Pb206 = 0.206 or 20.66%.
Pb⁺208