# Atomic Structure and Properties
# 1.2 Mass Spectroscopy of Elements
# Worksheet Key

1) What is an isotope?

Isotopes are elements that have the same atomic number but different atomic masses. This means that they contain the same number of protons, but different numbers of neutrons.

Questions 2 – 5 refer to the $^{238}_{92}U$ isotope.

2) How many protons are contained within the nucleus?

92 protons

3) How many neutrons are contained within the nucleus?

238 – 92 = 146 neutrons

4) How many electrons are contained within a single neutral isotope of this element?

92 electrons in a neutral uranium atom.

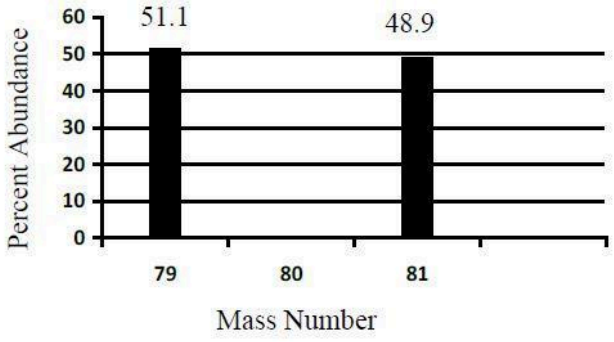
5) What is the mass of this isotope in amu?

The mass is ~238 amu.

6) Which isotope is more likely to bond with oxygen, $^{12}C$ or $^{14}C$? Explain.

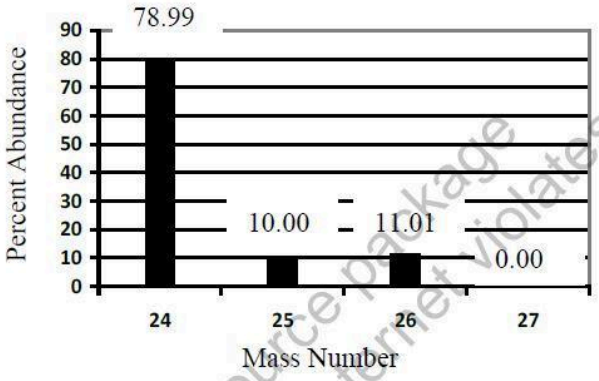
Both isotopes are equally likely to bond with oxygen. Having more or less neutrons in an isotope does not change its chemical reactivity.

7) A pure sample of bromine was vaporized and injected into a mass spectrometer and the data was plotted on the graph below. The mass value for Br-79 is 78.918 amu. Find the mass of Br-81.



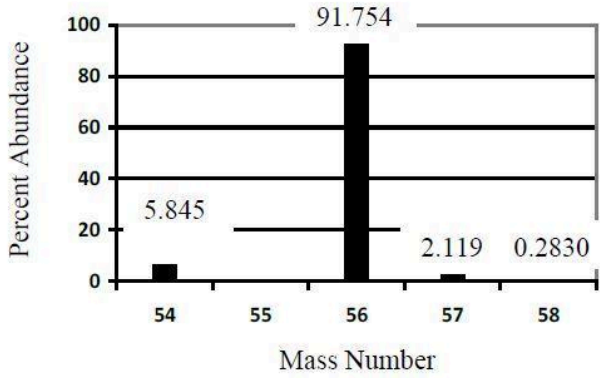
$$(78.918 \times 0.511) + ({}^{81}\text{Br} \times 0.489) = 79.90 \text{ amu}$$
$$40.3 + ({}^{81}\text{Br} \times 0.489) = 79.90 \text{ amu}$$
$$({}^{81}\text{Br} \times 0.489) = 39.6 \text{ amu}$$
$${}^{81}\text{Br} = \frac{39.6 \text{ amu}}{0.489}$$
$${}^{81}\text{Br} = 81.0 \text{ amu}$$

8) A pure sample of an element was vaporized and injected into a mass spectrometer and the data was plotted on the graph below. The mass values for the isotopes were found to be: A-24 (23.985 amu), A-25 (24.986 amu), and A-26 (25.983). Find the average atomic mass and identify the element.



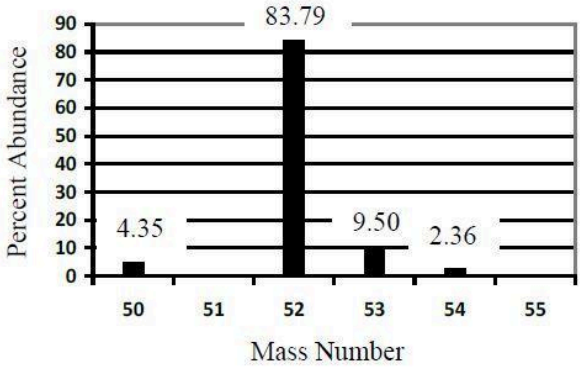

(23.985 amu x 0.7899) + (24.986 amu x 0.1000) + (25.983 amu x 0.1101) = **24.31 amu**
The element is magnesium.

9) A pure sample of an element was vaporized and injected into a mass spectrometer and the data was plotted on the graph below. The mass values for the isotopes were found to be: A–56 (55.935 amu), A–54 (53.940 amu), A–57 (56.935 amu), and A–58 (57.933 amu). Find the average atomic mass and identify the element.



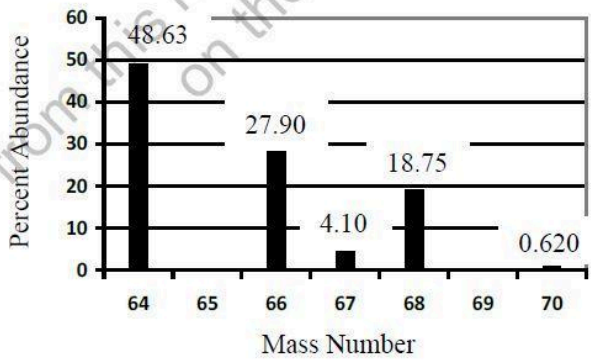

(55.935 amu x 0.91754) + (53.940 amu x 0.05845) + (56.935 amu x 0.02119)
+ (57.933 amu x 0.002830) = **55.846 amu** The element is iron.

10) A pure sample of an element was vaporized and injected into a mass spectrometer and the data was plotted on the graph below. The mass values for the isotopes were found to be: A–50 (49.946 amu), A–52 (51.941 amu), A–53 (52.941 amu), and A–54 (53.939 amu). Find the average atomic mass and identify the element.




(49.946 amu x 0.0435) + (51.941 amu x 0.8379) + (52.941 amu x 0.0950) + (53.939 x 0.0236) = **52.00 amu** The element is chromium.

11) A pure sample of an element was vaporized and injected into a mass spectrometer and the data was plotted on the graph below. The mass values for the isotopes were found to be: A–64 (63.929 amu), A–66 (65.926 amu), A–68 (67.925 amu), A–70 (69.925 amu), and A–67 (66.927 amu). Find the average atomic mass and identify the element.




(63.929 amu x 0.4863) + (65.926 amu x 0.2790) + (67.925 amu x 0.1875) + (69.925 amu x 0.00620) + (66.927 amu x 0.0410) = **65.40 amu**
The element is zinc.