Monopoly Problems

Andrew Ye and Diva Shah

May 2024

Contents

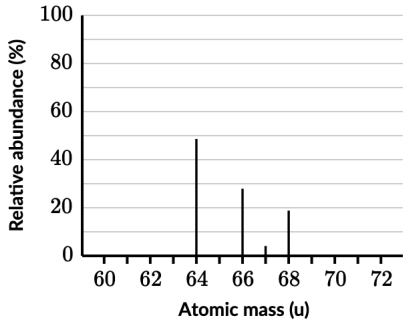
1 Unit 1: Atomic Structure and Properties

Problem 1

Calculate the number of moles in a $7.89kg$ sample of $C_9H_8O_4$

Problem 2

Given this graph, what is true about the element depicted



(a) In an average sample of the element, less than 20% of the atoms have an atomic mass of $66u$.
(b) The most abundant isotope of the element has an atomic mass of $64u$.
(c) The element has an average atomic mass of $64u$.
(d) The element has an average atomic mass between 66 and $68u$.

Problem 3

What is the percent composition of Carbon in $C_{13}H_{18}O_2$?

Problem 4

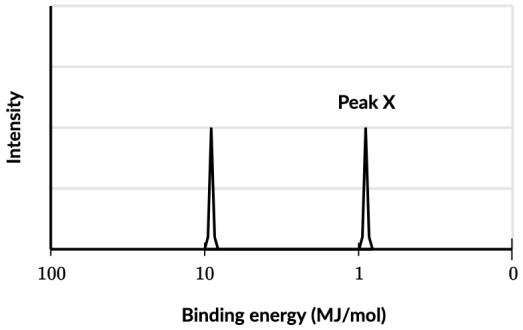
A compound contains 32.38% sodium, 22.65% sulfur, and 44.99% oxygen. What is the emperical forumula.

Problem 5

What is the full electron configuration of mercury?

Problem 6

Below, the photoelectron spectra of the $2s$ electrons of Be and Mg are shown.



Is peak X the peak associated with Be or Mg?

Problem 7

What are the periodic trends of ionization energy, atomic radius, and electronegativity? Why?

Problem 8

Which of the following bonds is likely to have the most ionic character?
(a) H —— F
(b) C —— O
(c) Na —— F
(d) Mg —— O

Problem 9

Based on the information in the table, which of the following arranges the bonds in order of decreasing polarity?

Element	Electronegativity
H	2.2
N	3.0
F	4.0
Cl	3.2
Se	2.6
I	2.7

(a) Se —— N > H —— I > Cl —— F
(b) H —— I > Se —— N > Cl —— F

(c) Cl —— F > H —— I > Se —— N
(d) Cl —— F > Se —— N > H —— I

2 Answers

2.1 Unit 1

Problem 1

The molar mass of $C_9H_8O_4$ is $1.008 * 8 + 12.01 * 9 + 16.00 * 4 = 180.2 \frac{g}{mol}$

$$7.89kg \times \frac{1g}{10^{-3}kg} \times \frac{1mol}{180.2g} = 43.8mol \tag{1}$$

Problem 2

(b), the tallest peak of the graph is the one at $64u$.

Problem 3

In one mole of $C_{13}H_{18}O_2$ is $206.31g$.

$$1mol\,C_{13}H_{18}O_2 \times \frac{13mol\,C}{1mol C_{13}H_{18}O_2} \times \frac{12.01g}{1mol\,C} = 156.31g \tag{2}$$

Thus, the percent composition by weight is $\frac{156.31}{206.31} = 75.764\%$

Problem 4

Take $100g$ of the substance such that there are $32.38g$ sodium, $22.65g$ sulfur, and $44.99g$ oxygen.

$$\begin{aligned} 32.38g\,\mathrm{Na} \times \frac{1mol\,\mathrm{Na}}{22.99g} &= 1.408mol\,\mathrm{Na} \\ 22.65\,g\mathrm{S} * \frac{1\,mol\mathrm{S}}{32.07g} &= 0.7063\,mol\mathrm{S} \\ 44.99\,g\mathrm{O} * \frac{1\,mol\mathrm{O}}{16g} &= 2.812\,mol\mathrm{O} \end{aligned} \tag{3}$$

Take the ratio of each compound with the smallest quantity.

$$\begin{aligned} S: \frac{0.7063}{0.7063} &= 1 \\ Na: \frac{1.408}{0.7063} &= 2 \\ O: \frac{2.812}{0.7063} &= 4 \end{aligned} \tag{4}$$

Therefore, the empirical formula is Na_2SO_4

Problem 5

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10}$

Problem 6

Be. The peak location of the peak on the x-axis means that there is less binding energy for the electrons in element X. Be has fewer protons and both electrons are in the same shell, so it peak must belong to Be.

Problem 7

- The electronegativity increases from left to right across a period. This is because if a valence shell of electrons is less than half full than it requires less energy to lose an electron than gain one. If if the valence shell of electrons is more than half full, it is easier to pull and electron into the valence shell. The electronegativity decreases from the top to the bottom of a group. This is beause there is a greater atomic radius lower on the group.
- The ionization energy increases from left to right in a period. This is because of greater valence shell stability also because of smaller atomic radius. The ionization energy also decreases from top to bottom of a group. This is because of greater electron shielding and greater atomic radius.
- Atomic radius decreases from left to right within a period. This is because there are more protons to the right of the period. Atomic radius increases from top to bottom within a group. This is because of electron shielding and there are more electron shells in the atom.

Problem 8

The ionic character increase the greater the electronegativity difference. In this case, Na and O had the greatest electronegativity difference.

Problem 9

(c) Cl —— F > H —— I > Se —— N