Answers to Exercises and Problems

for

CHEMISTRY

A Guided Inquiry

Sixth Edition, 2014

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Answers to Exercises and Problems

These answers may be given to students.

ChemActivity 1

1. A = 31, no. of e^- = 15. Z = 8, A = 18. $^{39}K^+$. Z = 28, no. of e^- = 26.
2. 1.674×10^{-24} g. 1.993×10^{-23} g.
3. 8.67×10^{-17} g.
4. 12.00 g.
5. 7.305×10^{-23} g.
6. a) sum of protons and neutrons in the nucleus. b) number of protons in the nucleus.
7. False. ^{18}O has 8 protons and 10 neutrons.
8. 12, 12, 12. 10, 11, 12. 17, 17, 18. 18, 17, 18. 23, 26, 30. 7, 7, 8. 10, 8, 8. 10, 13, 14.
9. $^{59}Co^{2+}$. Z = 7, A = 14, no. of e^- = 7. ^7Li . Z = 30, A = 58, no. of e^- = 28. Z = 9, A = 19, no. of e^- = 10.
10. All isotopes of an element have the same number of protons in the nucleus. One isotope of an element is differentiated from another isotope of the same element by the number of neutrons in the nucleus.

Problems

1. Using carbon-13 and carbon-12, approx mass of neutron = 13.0034 – 12 = 1.0034 amu. approx mass of ^{14}C = 13.0034 + 1.0034 = 14.0068 amu.
2. a) Using ^{14}C and $^{14}C^-$, mass of electron is approximately 13.0039 amu – 13.0034 amu = 0.0005 amu

   b) Using ^1H, mass of proton is approximately 1.0078 amu – 0.0005 amu = 1.0073 amu

   c) Using ^1H and ^2H, mass of neutron is approximately 2.0140 amu – 1.0078 amu = 1.0062 amu

   (Note that slightly different values for the masses of protons and neutrons will be obtained if different elements/isotopes are used to calculate these masses.)
3. The calculated mass of ^{12}C based on the masses of the constituent particles is 12.099 amu; and the actual mass of ^{12}C is exactly 12 amu.

ChemActivity 2

1. a) 1.008 g. b) 39.10 g.
2. a) 45.98 g. b) 57.27 g.
4. ^{37}Cl has two more neutrons in its nucleus.
5. average mass of a marble $= \dfrac{1 \infty 5.00\text{ g} + 3 \infty 7.00\text{ g}}{4} = \dfrac{1}{4} \times 5.00\text{ g} + \dfrac{3}{4} \times 7.00\text{ g} =$

   $0.2500 \times 5.00\text{ g} + 0.7500 \times 7.00\text{ g} = 6.50\text{ g}$ (this is eqn (2))
6. 10.44 amu
7. ^{35}Cl, 75.76%. ^{37}Cl, 24.24%.
8. a) 4.003 g b) 39.10 g

9. a) 1 He atom $\times \frac{1 mole\ He\ atoms}{6.022 x 10^{23}\ He\ atoms} \times 4.003$ g He/mole He atoms
   $= 6.647 \times 10^{-24}$ g of He.
   b) 1 K atom $\times \frac{1 mole\ K\ atoms}{6.022 x 10^{23}\ K\ atoms} \times 39.098$ g K/mole K atoms =
   6.493×10^{-23} g. of K
10. 60.06 g
11. 3.613×10^{24} atoms.
12. 2.619×10^{24} atoms.
13. a) 3.029×10^{25} atoms. b) 1.022×10^{19} atoms. c) 1.878×10^{25} atoms. d) 9.782×10^{27} atoms.
14. Phosphorus
15. 89.5 g I

Problems

1. Assume that mass of ^{22}Ne is 22 amu. Calculated avg mass of Ne is 20.18—close to the experimental value of 20.179.
2. a) False. 6.941 g per mole of Li atoms. b) False. No H atoms weighs 1.008 amu. c) True. Na atoms are more massive.
3. 17: protons in nucleus and electrons in the neutral atom. 35.453: avg amu of a Cl atom and grams of one mole of Cl atoms.
4. Re-187

ChemActivity 3

1. 5.47×10^{-18} J.
2. a) $IE_a = -(2)(-1)/d_1 = 2/d_1$ b) $IE_b = -(1)(-1)/2d_1 = 1/2d_1$ $IE_a > IE_b$
3. The ionization energy of case (a) is larger, 1.20 k/d_1, than that of case (b), 1.17 k/d_1.

Problems

1. large and negative
2. $V = \frac{(+2)(-1)k}{300pm} + \frac{(+2)(-1)k}{400pm} + \frac{(-1)(-1)k}{700pm}$
3. Each of the six electrons is at some distance, r_i, from the +6 nucleus and has a Coulombic Potential Energy term (six terms; all of these are attractive). Let r_{ij} be the distance between electron i and electron j; for example, r_{25} is the distance between electron 2 and electron 5. Each electron has a Coulombic Energy Term (a repulsion in this case) with every other electron as follows: 1-2, 1-3, 1-4, 1-5, 1-6, 2-3, 2-4,2-5, 2-6, 3-4, 3-5, 3-6, 4-5- 4-6, 5-6 (a total of 15 repulsion terms. Thus, the total number of Coulombic Potential Energy terms is 21.

ChemActivity 4

1. No. The ionization energy of He would be about 4× (twice the charge and half the distance) the ionization energy of H if this were the case.
2. Open ended. All three electrons at a farther distance (than in H) from the nucleus.

Problem

1. a) $V = \frac{(+2)(-1)k}{d} + \frac{(+2)(-1)k}{d} + \frac{(-1)(-1)k}{2d}$

   b) The IE of He is slightly less than twice the IE of H because the electron-electron repulsion makes the potential energy more positive. Note that the first two terms in 1a) are negative and the third term is positive.

ChemActivity 5

1. a) 4. b) 6. c) 5. d) 8.
2. a) +4. b) +6. c) +5. d) +8.
3. The IE of Br should be less than the IE of Cl. There is about a 0.4 MJ/mole difference between the IEs of F and Cl. Prediction: Br, 0.8 MJ/mole.
4. The IE of Li+ should be larger than the IE of He because both atoms have 2 electrons in the 1st shell and Li^+ has a core charge of +3 whereas He only has a core charge of +2.
5. The IE of F^- should be less than the IE of Ne because both atoms have eight electrons in the 2nd shell and F^- has a core charge of +7 whereas Ne has a core charge of +8.
6. IE of Kr > IE of Br because they are in the same valence shell and Kr has the higher core charge (+8 vs. +7). IE of Rb is the lowest because core charge is +1 and its valence shell (n = 5) is larger than the valence shell (n = 4) of Kr and Br.
7. One of the inner shell electrons is harder to remove because it is closer to the nucleus.

Problems

1. a) TRUE. Br is a group VII element. The number of valence electrons is seven.
   b) TRUE. The ionization energies increase as one moves from left to right across a period and as one moves up a group.
2. If the fourth electron in Be were added to a third shell, it would be easier to remove and the IE would be less than the IE of Li.

ChemActivity 6

1. Ar: predict r = 150 pm (larger than K^+ but smaller than Cl^-). N: predict r = 71 pm (larger than O but smaller than C). F^-: predict r = 90 pm (considerably smaller than Cl^-, but *probably* larger than other 2nd period neutral atoms. Ne: predict r = 50 pm (smaller than O).
2. a) False. Both have a core charge of +2 and the valence electrons of Ba are much farther away. b) False. Both have 10 electrons and sodium has more protons. c) True. Both have 18 electrons and chlorine has fewer protons. d) True. A whole shell has been added for Ar. e) False. Ar and Ca^{2+} are isoelectronic and Ca^{2+} has more protons.
3. a) N b) K^+ c) Cl d) H e) Mg^{2+}
4. Fe^{2+}
5. a) Pb b) Na c) Ba^{2+} d) H^- e) Rb f) P^{3-}

Answers to Critical Thinking Questions

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Please do not give these answers to students.

Quite often, the answers given here are less detailed than what is expected for a student's answer.

ChemActivity 1

1. 6, 6, 6
2. 6, 7, 7
3. 6, 6, 7
4. All carbon atoms and ions have six protons in the nucleus.
5. All hydrogen atoms and ions have one proton in the nucleus.
6. Z is the number of protons in the nucleus of that atom.
7. Twenty-eight protons in the nucleus.
8. a) Because there are six protons and 7 electrons. b) In an ion the number of protons and electrons are not equal. c) The charge on an ion = # of protons – # of electrons.
9. The left-hand-superscript, 1, is the value of the mass number (A), the sum of the number of protons and the number of neutrons in the nucleus. Because every H atom must have one proton, the number of protons is 1 and the number of neutrons is zero. Also, the number of electrons is zero because the charge is 1+ and there has to be one proton.
10. Different isotopes on a particular element have a different number of neutrons in the nucleus (but the same number of protons).
11. The left-hand-superscript is the value of the mass number (A); it is the sum of the number of protons and the number of neutrons in the nucleus.
12. The O atom has 8 protons and 8 neutrons in its nucleus; hence, the mass number is 16. The O atom has 8 protons and 10 electrons; hence the charge on the ion is 2–. The Na atom has 11 protons and 12 neutrons; hence, the mass number is 23. The Na atom has 11 protons and 10 electrons; hence the charge on the ion is 1+.
13. Most of the mass is in the nucleus—where the protons and neutrons are. Note that the difference in mass between a ^{13}C and a $^{13}C^-$ atom (which differ by only one electron) is only 0.0005 amu.

ChemActivity 2

1. 3
2. All isotopes of magnesium have twelve protons in the nucleus. The three isotopes of magnesium have 12, 13, and 14 neutrons in the nucleus.
3. 12.0000 amu
4. a) 1200.00 amu; b) 1300.34 amu
5. Slightly more than 1200.00 amu because 1200 amu would be the minimum and there is a 1.11 % change that a ^{13}C would be among the 100 atoms.

6. None
7. You must know the total number of marbles to use the first method. The second method must be used in this case.
8. a) 0.7577×34.9689 amu + 0.2423×36.9659 amu = 35.45 amu. b) Zero.
9. a) 35.45 amu. b) 5.887×10^{-23} g
10. 35.45 g
11. a) 24.31 amu. b) 4.037×10^{23} g
12. 24.31 g
13. a) It is the same number. b) It is the same number.
14. a) It is the same number. b) It is the same number.
15. 12.001 is a) the average mass in amu of one C atom and b) the mass in grams of 6.022×10^{23} C atoms.
16. Zero %.
17. a) 12. b) They have the same number—12. c) 6.022×10^{23}. d) They have the same number, 6.022×10^{23}. e) They have the same number, 12. f) They have the same number, 6.022×10^{23}.
18. a) Two dozen elephants. b) One mole of sodium atoms.
19. There is one mole of H atoms and one mole of argon atoms; they both have the same number of atoms.

ChemActivity 3

1. The magnitude of V decreases.
2. $V = 0$.
3. V must be positive. That is, $V > 0$
4. a) $q = +1$ for a proton. b) $q = 0$ for a neutron. c) $q = +6$ for the nucleus of a carbon atom.
5. V is a negative number because $k(1)(-1)/d$ is negative.
6. V is negative because the electron is negative and the proton is positive.
7. I would expect V to be become more negative as d becomes smaller.
8. $V\ (10^{-18}\ \text{J}) = 0, -.0462, -0.231, -0.462, -1.16, -2.31$.
9. $V = -\text{IE}$
10. The electron that is closer to the nucleus would have the larger ionization energy because it is at a lower (more negative) potential energy according to Coulomb's potential energy equation.
11. The electron that is at d_1 from the +2 nucleus would have the larger ionization energy because it is at a lower (more negative) potential energy according to Coulomb's potential energy equation.
12. The ionization energy is larger by a factor of 2.
13. He^+ would have a larger ionization energy than H because $q = +2$ for He and it would have a lower (more negative) potential energy according to Coulomb's potential energy equation.

ChemActivity 4

1. 1.31 MJ/mole
2. The electron that is farthest from the nucleus will have the least negative potential energy (d is larger) and the lowest ionization energy.