Dr. Zellmer | Chemistry 1210 | All Sections
Time: 7 PM Sun. | Autumn Semester 2022 | October 30, 2022
30 min | Quiz VIII

Name KEY Rec. TA/time _____

1. (6 pts) Al_2O_3 reacts with hydrochloric acid. Complete and balance the reaction (include state symbols).

   Not on Carmen quiz! Just for practice for section 7.5.

   $$Al_2O_3\,(s) + 6\,HCl\,(aq) \rightarrow 2\,AlCl_3\,(aq) + 3\,H_2O\,(\ell)$$

   Metal oxides are also referred to as basic oxides. Group 1A and 2A metal (except Be) oxides react with water and acids. Other metal oxides don't react with water but will react with acids to form a salt and water, just like acid-base reactions we learned about in Ch. 4.

2. (6 pts) Potassium reacts with water. Complete and balance the reaction (include state symbols).

   Not on Carmen quiz! Just for practice for section 7.5.

   $$2\,K\,(s) + 2\,H_2O\,(\ell) \rightarrow 2\,KOH\,(aq) + H_2\,(g)$$

   Group 1A and 2A (except Be) react with water to form the metal hydroxide and H_2 gas. Group 1A are more reactive than group 2A and reactivity increases going down the group (become more metallic, lower IE, so they are more easily oxidized.

3. (3 pts) Consider the valence electron configuration of ns^2np^5 and the following statements. Which of the statements are **true**?

   1. Elements with this electron configuration form -1 anions.
   2. Elements with this electron configuration are expected to have large positive electron affinities.
   3. Elements with this electron configuration are nonmetals.
   4. Elements with this configuration form acidic oxides.

Consider the valence electron configuration of ns^2np^5. This is the e^-configuration for group 7A.

The **Correct** statements are:

1) Elements with this electron configuration from -1 anions.
3) Elements with this electron configuration are nonmetals.
4) Elements with this configuration form acidic oxides (nonmetal oxides form acids in water and are thus often referred to as acidic oxides).

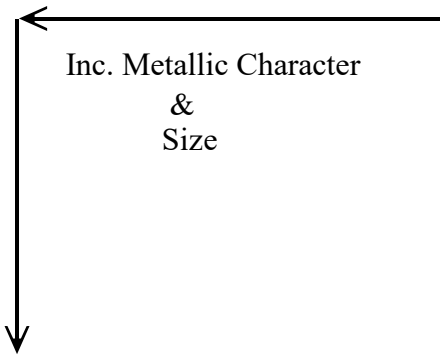
#2 is incorrect. The corrected answer for 2 is:

2) Elements with this electron configuration are expected to have large **negative** electron affinities. This is group 7 A (F, Cl, Br, I, At) which attract electrons easily.

4. (3 pts) Which of the following has the **intermediate** (middle) value when the five elements listed are arranged in order of **increasing nonmetallic** character?

a) Pb(82) b)* As(33) c) Br(35) d) Sb(51) e) Se(34)

Pb Sb As Se Br



5. (3 pts) Which of the following statements is **INCORRECT**?

a) $_{37}$Rb is **more metallic** than $_{19}$K .

b) The **electron affinity** of $_{56}$Ba is **less negative** than that for $_{52}$Te.

c) The **radius** of $_{33}$As is **smaller** than that of $_{31}$Ga.

d)* The ionic **radius** of P^{3-} is **smaller** than that of Ca^{2+}.

e) $_{55}$Cs forms a **cation more easily** than $_{56}$Ba does.

For d) The ionic radius of P^{3-} is **larger** than Ca^{2+} NOT smaller.

P^{3-} & Ca^{2+} are isoelectronic *(they have the same number of e− and look like Ar, same electron configuration). In an isoelectronic series, anions are bigger than cations. The cations have more protons and the same # e− as the anions so "extra" protons pull the e− in closer. The more positive the ion (the less negative) the smaller the ion for an isoelectronic series.

6. (2 pts) Which of the following are basic oxides or acidic oxides? Why?

SO_3 CaO Al_2O_3 CO_2

Metal oxides are often referred to as basic oxides.

Group 1A and 2A metal oxides react with water to form hydroxides.

$Na_2O(s) + H_2O(\ell) \rightarrow 2\ NaOH(aq)$ combination rxn

Other metal oxides don't react with water but react with acids to give a salt plus water.

$NiO(s) + 2\ HCl(aq) \rightarrow NiCl_2(aq) + H_2O(\ell)$ acid-base rxn

Nonmetal oxides are referred to as acidic oxides since they react with water to form acids.

$SO_3(g) + H_2O(\ell) \rightarrow H_2SO_4(aq)$ combination rxn
$CO_2(g) + H_2O(\ell) \rightarrow H_2CO_3(aq)$ combination rxn

Acidic oxides can react with bases to form a salt and water.

$CO_2(g) + 2\ NaOH(aq) \rightarrow Na_2CO_3(aq) + H_2O(\ell)$

This is discussed in section 17.6. I discussed some of these reactions back in Chapter 3.

7. (2 pts) Identify the following as ionic or molecular.

$PbCl_2$	TeH_2	Fe_2O_3	SO_2
ionic	molecular	ionic	molecular

Generally:

metal & nonmeal ==> Ionic

nonmetal & nonmetal or nonmetal & semimetal ==> molecular (covalent)

8. (5 pts) Show the relationship between lattice energy (LE), charge and distance between the charges and use it to explain which compound in each pair should have the greater LE.

a) show the equation for lattice energy, LE.

$$LE \propto \frac{Q_1 Q_2}{d}$$

Q = charges on ions d = distance between cation and anion (sum of ionic radii)

This eqn. shows the **LE** is **proportional** to the **charges** on the ions. The bigger the charges the greater the LE. (Use the magnitude, absolute value, of the charges).

The eqn also shows the **LE** is **<u>inversely</u> proportional** to the **distance between** the **charges**. The smaller the distance (the smaller the ions) the greater the LE.

b) $FeBr_3$ or $FeBr_2$

$FeBr_2$ +2 on Fe^{2+} and −1 on Br^-
$FeBr_3$ +3 on Fe^{3+} and −1 on Br^-

Fe^{3+} is smaller than Fe^{2+} so the FeBr distance is smaller in $FeBr_3$ than in $FeBr_2$.

The numerator for $FeBr_3$ is greater than that for $FeBr_2$ (3 to 2) and the distance between the ions in $FeBr_3$ is smaller than that in $FeBr_2$. Thus the expected result would be,

$$LE_{FeBr3} > LE_{FeBr2}$$

c) CaO or MgO

CaO +2 on Ca^{2+} and −2 on O^{2-}
MgO +2 on Mg^{2+} and −2 on O^{2-}

Mg^{2+} is smaller than Ca^{2+} so the MgO distance is smaller than the CaO distance

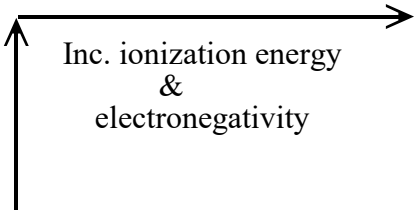
The numerators for CaO and MgO are the same (4). Since the distance between the Mg^{2+} and O^{2-} ions is smaller than that between Ca^{2+} and O^{2-} the denominator for LE is smaller and thus,

$$LE_{MgO} > LE_{CaO}$$

9. (3 pts) Which of the following substances has the largest dipole moment?

a) H—C **b) H—O** c) H—Cl d) H—N e) O—F

Simply look at the electronegativities of the atoms. Remember, **EN <u>increases</u> bottom** to **top** and **left** to **right** in the periodic table. EN is a not an experimentally determined property but is a calculated property from a combination of ionization energy and electron affinity.



Also, remember the ordering of a number of the most used atoms and the fact there is a big drop in EN going from the 2nd row to the 3rd row and then from the 3rd row down the EN decreases but not by much.

The EN of some of the most common elements inc. in the following order:

B, As < H, P < C, S, I < Br < N, Cl < O < F

Based on this the H-O bond would be the most polar (largest dipole moment) of those listed. You SHOULD know this ordering and the general trend for EN in the PT, especially for the representative elements.

10. (3 pts) Which of the following compounds would you expect to be ionic?

1) SF_6 2) H_2O_2 3) FeF_3 4) PbF_2 5) SO_3

Once again, compounds composed of metal with nonmetal will generally be ionic, with some exceptions. You don't really even need to look at the EN differences in most cases.

Based on this, FeF_3 and PbF_2 would both be ionic.

Compounds composed of all nonmetals or nonmetals & metalloids are generally molecular, with some exceptions (think ammonium compounds such as NH_4Cl, which is ionic).

Based on this, SF_6, H_2O_2 and SO_3 would both be molecular.

11. If the electronegativity difference between elements A and X is **1.0**, the bond in AX will most likely be

Polar covalent (△EN is the difference in the electronegativity of the elements in the compound)

△EN ≥ 2.0	ionic	
2.0 > △EN > 0	**polar covalent**	(△EN = **1.0** falls in this range)
△EN = 0	pure nonpolar covalent	

12. (3 pts) The dipole moment of ClF(g) is 0.88 D. The bond length is 1.63 Å. (**Show work and explain!**) What magnitude of the effective charge (i.e. the partial charge), in units of *e*, on the Cl and F atoms leads to this dipole moment?

A dipole occurs when you have two opposite charge separated by some distance. The quantative measurement of the magnitude of the dipole is the dipole moment, μ, when there are two equal and opposite charges is given by,

$$\mu = Q \bullet r \qquad Q = \text{charge} \quad r = \text{distance between charges}$$

For this problem you are after Q, the charge on the atoms which gives the experimental dipole moment.

$$Q = \frac{\mu}{r} = \frac{0.88\ \text{D}}{1.63\text{Å}} = 0.5\underline{3}98\ \text{D/Å}$$

Need to covert this to units of *e* (electron charge):

$$\text{charge in } e = \frac{0.5\underline{3}98\ \text{D}}{\text{Å}} \times \frac{3.34 \times 10^{-30}\ \text{C}\bullet\text{m}}{\text{D}} \times \frac{1\ \text{Å}}{10^{-10}\ \text{m}} \times \frac{1\ e}{1.602 \times 10^{-19}\ \text{C}}$$

$$= 0.1\underline{1}25\ e = 0.11\ e$$

The more electronegative atom will have the partial negative charge, with a few exceptions (like in CO). Since **F** is **more electronegative** than Cl it will pull the electrons in the bond toward it and the partial negative chg will be on F and the partial positive chg on Cl.

$$\overset{\delta+}{\text{Cl}} - \overset{\delta-}{\text{F}}$$