Objective 0: 1A review skills

Quiz Practice problems:

Key ideas: Periodic Table gives you information about elements and compounds.
Valence electrons are responsible for bonding atoms together to form compounds.
Lewis structure describes how atoms are connected together in a molecule.
Valence Shell Electron Pair Repulsion (VSEPR) theory is used to describe the shape at a central atom in a molecule.
Shape determines whether a molecule is polar or non-polar.
Molecular polarity determines the intermolecular forces between molecules.
A chemical reaction occurs when bonds break in reactants and new bonds form to make products.
Every chemical reaction involves energy (exothermic or endothermic).
Substances are sources of light.

Skills: Use Periodic Table to identify element as metal or non-metal.
Use chemical formula to identify compound as ionic or molecular.
Draw Lewis structure of a compound.
Determine shape using VSEPR theory.
Determine molecular polarity.
Determine intermolecular forces.
Balance chemical equations.
Do chemical calculations involving mass, concentration, volume, moles.

1. a. Salt is sodium chloride, NaCl. What type of element is sodium? What type of element is chlorine?
b. What type of compound is salt (NaCl)? What type of compound is sugar ($C_{12}H_{22}O_{11}$)?
c. You need an electrolyte for a battery. Would you use sugar or salt? Draw a picture to support your answer.
Answers:
a. Sodium is a metal. Chlorine is a non-metal.
b. NaCl is an ionic compound. Sugar is a molecular compound.
c. Use salt - ionic compound dissolves to form electrolyte solution.

2. One way to make sodium ion is to add sodium metal to water. In other words, sodium metal reacts with water to form sodium hydroxide and hydrogen gas.
a. Write a balanced chemical equation and net ionic equation that represents this reaction.
b. Why do chemical equations need to be balanced?
Answers:
a. This is a single replacement reaction: A + BC --> B + AC
2 Na + 2 H_2O --> H_2 + 2 NaOH
NaOH is soluble in water.
Net ionic equation: 2 Na + 2 H_2O --> H_2 + 2 Na^+ + 2 OH^-
b. A balanced chemical equation represents the law of conservation of mass – matter is neither created nor destroyed.

3. You can test the amount of salt in water by adding silver nitrate ($AgNO_3$). Silver chloride precipitate forms. In other words, silver nitrate reacts with salt to form silver chloride and sodium nitrate.
a. Write a balanced chemical equation and net ionic equation that represents this reaction.
b. You measure the mass of silver chloride precipitate that forms. How can you separate the silver chloride precipitate from the other substances?
c. How can you determine the mass of NaCl from the mass of AgCl? Set up a calculation to support your answer.
Answers:
a. This is a double replacement reaction: AB+ CD --> AD + CB
NaCl + $AgNO_3$ ---> $NaNO_3$ + AgCl
Precipitate = AgCl (see Table of solubility of ionic compounds)
Ionic equation: Na^+ + Cl^- + Ag^+ + NO_3^- ---> Na^+ + NO_3^- + AgCl (s)
Net ionic equation: Cl^- + Ag^+ ---> AgCl (s)
Spectator ions: Na^+ + NO_3^-
b. Separate a solid from a liquid by filtration.
c. mass of AgCl --> moles of AgCl --> moles of NaCl --> mass of NaCl
mass of NaCl = mass in g $AgNO_3$ (1 mole $AgNO_3$/170 g $AgNO_3$) (1 mole NaCl)/1 mole $AgNO_3$)(58.5 g NaCl/1 mole NaCl)

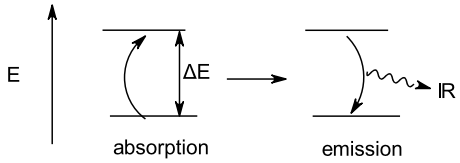
4. You are making pancakes and you used 0.5 tsp of salt (3 g of NaCl) and 1 Tbsp of sugar (36 g of $C_{12}H_{22}O_{11}$) in your recipe. Are there more particles (atoms or ions or molecules) of salt or sugar? Support your answer with a calculation.
Answers:

Convert g --> moles --> molecules
3 g of NaCl (1 mole NaCl/58.5 g NaCl)(2 moles of ions/mole NaCl)(6.02×10^{23} ions/mole) = 6.17×10^{22} ions
36 g of $C_{12}H_{22}O_{11}$ (1 mole $C_{12}H_{22}O_{11}$/342 g $C_{12}H_{22}O_{11}$)(6.02×10^{23} molecules $C_{12}H_{22}O_{11}$/mole $C_{12}H_{22}O_{11}$) = 6.34×10^{22} molecules

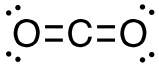
5. Approximately 200 billion tons of carbon from CO_2 enter the earth's atmosphere each year from all sources (1/2 from oceans, ½ from volancoes and decaying plants). About 6 billion tons of carbon from CO_2 come from human activity. The CO_2 that enters the atmosphere is recycled by terrestrial plant life and oceans. What is the mass in tons of carbon that enter the earth's atmosphere each year from all sources?
Answers:
1 ton = 2000 lbs or 1 ton = 1000 kg
Convert billion tons CO_2 --> tons CO_2 --> g CO_2 --> moles CO_2 --> moles C --> tons C
200 billion tons CO_2 (1×10^9 tons/1 billion tons)(1000 kg/1 ton)(1000 g /1 kg)(1 mole CO_2 /44 g CO_2)(1 mole C/1 mole CO_2)(12 g C/1 mole C)(1 kg/1000 g)((1 ton/1000 kg) = 5.45×10^{10} tons C

6. a. Write a chemical equation that represents the combustion of gasoline (octane (C_8H_{18})). How much CO_2 in g is produced when 1 gallon (3800 liters) of octane (C_8H_{18}) burns?
b. Calculate the theoretical yield of CO_2.
c. Most reactions do not produce the theoretical yield of product. One reason is because other (side) reactions occur. For example when gasoline combusts, one side reaction is the formation of poisonous CO.
The % yield of CO_2 is 80%. What is the actual yield of CO_2?
Answers:
a. 2 C_8H_{18} + 25 O2 --> 16 CO_2 + 18 H_2O
Convert liters C_8H_{18} --> ml C_8H_{18} --> g C_8H_{18} --> moles C_8H_{18} --> moles CO_2 --> g CO_2
3800 liters (1000 ml/1 liter)(0.7 g C_8H_{18} /ml C_8H_{18})(1 mole C_8H_{18} /114 g C_8H_{18})(16 moles CO_2/2 moles C_8H_{18})(44 g CO_2/1 mole CO_2) = 8200 g CO_2
b. Theoretical yield of CO_2 = 8200 g CO_2
c. % yield = (actual yield/ Theoretical yield) x 100
Rearrange and solve for actual yield = % yield x Theoretical yield/ 100 = 6600 g CO_2

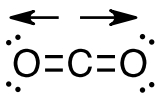
7. a. CO_2 absorbs IR radiation and re-emits IR, which makes it a greenhouse gas. Draw an energy level diagram that shows how CO_2 produces IR radiation.
b. Draw the Lewis structure of CO_2. Is polar or non-polar?
c. Is CO_2 soluble in water? Are the oceans a good CO_2 sink?
Answers:
a. Remember $\Delta E = hc/\lambda$.
CO_2 absorbs the amount of energy, ΔE, that corresponds to an IR wavelength.



b.



CO_2 is non-polar.
Structure --> shape --> polarity.
The central atom, C, has a linear shape.
Each C=O bond is polar. O is more electronegative than C.



Each O "pulls" on C but C does not move because of shape ==> CO_2 is non-polar.
c. CO_2 is not soluble in water.
Although CO_2 is not soluble in water, CO_2 does dissolve slightly in water and it reacts with water to form carbonic acid, H_2CO_3. So it turns out the oceans are good CO_2 sink.