Things to Know For the Chemistry Final *Answer Key

20. ***Binary compounds*** are substances made up of only *two* kinds of atoms.
"Ternary" compounds contain three (or more) kinds of atoms.
Which substance is a binary compound?
Ammonia (NH_3) *magnesium* (Mg) *potassium nitrate* (KNO_3) *sucrose* ($C_{12}H_{22}O_{11}$)

21. ***Diatomic molecules*** are elements that form two atom molecules in their natural form at STP.
What are the 7 diatomic elements? H_2 N_2 O_2 F_2 Cl_2 Br_2 I_2
Which element is a diatomic liquid at STP? *chlorine* *fluorine* *bromine* *iodine*

24. ***Solutions*** are the best examples of ***homogeneous mixtures***. They have **two** sets of properties.

25. ***Heterogeneous mixtures*** have discernible components and ***are not*** uniform throughout.
Air is classified chemically as a(n)
Substance *compound* *element* *solution*

26. A ***solute*** is the substance being dissolved; the ***solvent*** is the substance that dissolves the solute.
NaCl (s) is added to water.
The solute is ..NaCl *the solvent is* ..H_2O *the solution is* ..aqueous

30. Calculations bases on quantitative relationships and balanced chemical equations are called ***stoichiometry.***
Stoichiometric calculations are bases on the **mole ratios** between any two substances in the reaction.
What is the mole ratio between oxygen and water in the following reaction? $2H_2 + O_2 \rightarrow 2H_2O$
1:2

31. Use the **mole *map*** to help you solve conversions (don't forget mole ratios!)
between moles, grams, numbers of molecules/atoms, and liters of gases at STP.
Given the reaction $CH_4 + 2O_2 \dashrightarrow CO_2 + 2H_2O$,
what amount of carbon dioxide is produced by the reaction of 1 mole of CH_4*?*
1 gram *1 liter* *1 mole* *22 grams*

32. An **empirical formula** is the simplest mole ratio among the elements in a compound.
Use the mole map to convert percent (mass) to moles.
Find the empirical formula of a compound composed of 75% carbon and 25% hydrogen.
$\frac{75\text{g C}}{12.0\text{g}} \frac{1\text{mol}}{} = \frac{6.24}{6.24} = 1$ (CH_4)
$\frac{25\text{g}}{1.0\text{g}} \frac{1\text{mol}}{} = \frac{24.8}{6.24} = 4$

32.5 A **molecular formula** is the true formula of a molecular compound. Use the molecular (molar) mass of the compound and its empirical formula mass to find the true molecular formula.
Find the molecular formula of the compound from problem 32, if its molecular mass is 48.15 g/mol
EF = CH_4 = 16.05g/mol X = 48.15g/mol

33. ***Lewis Electron dot structures*** represent covalently bonded molecules formed through the sharing of valence electrons between atoms. It also shows the lone-pair(s) of electrons that may affect the shape and polarity of the molecules.
Draw the Lewis structures for these common molecules H_2 H_2O NH_3 CH_4
2e⁻ 2+6=8e⁻ 5+3=8e⁻ 4+4=8e⁻
H-H H-O-H H-N-H H-C-H

36. ***Coefficients*** are written in front of the formulas of reactants and products to balance chemical equations. They give the ratios of reactants and products in a balanced chemical equation.
..2..Na + ..2..Cl_2 → ..2..NaCl

37. **Chemical formulas** are written so that the charges of **cations** and **anions** neutralize (cancel) one another.
calcium phosphate: Ca^{2+} PO_4^{3-} = $Ca_3(PO_4)_2$ (criss-cross)

38. When naming **binary ionic compounds**, write the name of the positive ion (cation) first, followed by the name of the negative ion (anion) with the name ending in "-ide."
$CaCl_2$ calcium chloride *MgS* magnesium sulfide

39. When naming compounds containing **polyatomic ions**, keep the name of the polyatomic ion the same as it is written on your reference sheet.

NH_4Cl ammonium chloride *copper (I) nitrate* copper(I) nitrate $CuNO_3$

40. **Roman numerals** are used to show the positive oxidation number of the cation if it has more than one positive oxidation number

FeO: iron(II) oxide *Nickel (III) sulfate:* $Ni_2(SO_4)_3$

41. When naming a **binary molecular compound,** the first element is named using the name of the element. The second element always end in "–ide." Indicate the number of atoms using the prefix…

1 mono 2 di 3 tri 4 tetra 5 penta 6 hexa 7 hepta 8 octa 9 nona 10 deca

If the first element has only one atom, don't use the mono. *What is the name of the following molecular compounds?* CO_2 carbon dioxide N_2O dinitrogen monoxide

41. ***Physical changes*** do not form new substances.

They merely change the appearance of the original material. (The melting of ice) H_2O (s) → H_2O (l)

42. ***Chemical changes*** result in the formation of new substances or the product(s) of a ***chemical reaction***.

Which process is an example of a chemical change?

the melting of ice *the electrolysis of water* ★ *the boiling of water*

43. ***Reactants*** are on the left side of the reaction arrow and ***products*** are on the right.

What are the names of the reactants in this neutralization reaction? hydrochloric acid sodium hydroxide

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

44. ***Temperature*** is a measure of average kinetic.

Which sample has the highest average kinetic energy?

H_2O (l) at 0°C 273K *H_2O (s) at 0°C* 273K *CO_2 (g) at STP* 273K *Mg (s) at 298K*

45. ***Exothermic reactions*** release energy (energy is a product of the reaction) while ***Endothermic reactions*** absorb energy and the *energy is a reactant* in the reaction.

Given the reaction: $CH_4(g) + 2\,O_2(g) \rightarrow 2\,H_2O(g) + CO_2(g) + heat$

What is the overall result when CH_4 (g) burns according to this reaction?

Energy is absorbed *Energy is released* ★

46. *Only* **coefficients** can be changed when balancing chemical equations!

Given the unbalanced equation: $4Al + O_2 = 2Al_2O_3$

When this equation is balanced using the smallest whole numbers, what is the coefficient of Al?

1 *2* *3* *4*

47. ***Synthesis reactions*** occur when two or more reactants combine to form a single product.

Finish and balance the following synthesis reaction

$2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$

48. ***Decomposition reactions*** occur when a single reactant forms two or more products

Finish and balance the following decomposition reaction

$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

49. ***Single replacement reactions*** occur when one element replaces another element in a compound.

Which equation below represents a reaction classified as a "single replacement" reaction?

$2\,H_2 + O_2 \text{ --> } 2\,H_2O$

$Pb(NO_3)_2 + K_2CrO_4 \text{ --> } 2\,KNO_3 + PbCrO_4$

$HCl + NaOH \text{ --> } H2O + NaCl$

★ $Cu + Zn(NO_3)_2 \text{ --> } Zn + Cu(NO_3)_2$ ★

$CaCO_3 \text{ --> } CO_2 + CaO$

50. ***Double replacement (displacement) reactions*** occur when two compounds react to form two new compounds.

Potassium sulfide (K_2S) is mixed with lead acetate($Pb(C_2H_3O_2)_2$). Which of the following products is expected? $PbSO_4$ K_2S K_3PO_4 (PbS) $K_2S + Pb(C_2H_3O_2)_2 \rightarrow PbS + 2KC_2H_3O_2$

50.5 ***Combustion reactions*** occur when a hydrocarbon burns in the presence of oxygen gas to produce carbon dioxide gas and water vapor. Write the combustion reaction for the combustion of methane gas (CH_4)

$CH_{4\,(g)} + 2O_2 \rightarrow CO_2 + 2H_2O$ **balance*

51. The masses (and energy) of the reactants in a chemical equation is always equal to the masses (and energy) of the products. "***Law of Conservation of Mass (and Energy)***."

For the reaction: $CaCO_3 \rightarrow CO_2 + CaO$

If 20.0g of $CaCO_3$ decomposes to for 19.5 g of CaO, how many grams of CO_2 gas is formed? 0.5g

52. The gram formula mass (**molar mass**) of a substance is the sum of the atomic masses of all the atoms in it.

H_2SO_4 = 98.09 g/mole

2 x H = 2 x 1.01 g = 2.02 g
1 x S = 1 x 32.07 g = 32.01 g
4 x O = 4 x 16.00 g = 64.00 g

53. Know how to calculate the **percentage composition** of a compound. (Formula is on the last pages.)

Find the percent by mass of oxygen in $CaCO_3$. $40.08 + 12.01 + 3(16.00) = 100.09$

$\%O = \left(\frac{48}{100.09}\right) \times 100 = 48.0\%$

54. ***6.02 x 10^{23}*** is called ***Avogadro's number*** and is the number of particles in ***1 mole*** of a substance.

Equal volumes of gases contain an equal number of molecules.

Under similar conditions, which sample contains the same number of moles of particles as 1 liter of O_2 (g)? (1 L Ne(g)) 0.5 L SO_2 (g) 2 L N_2 (g) 1 L H_2O(l)

55. Know how to convert an **empirical formula** into a **molecular formula**.

A compound has the empirical formula NO_2. Find its molecular formula if the molar mass = 92g.

N_2O NO_2 (N_2O_4) N_2O $NO_2 = 14 + 32 = 46 \quad x = 92 \quad x = 2$

56. The **kinetic molecular theory** explains the behavior of matter as particles with energy and motion.

57. The particles in a ***solid*** are rigidly held together, closely packed in a **lattice** arrangement.

Which of the following has a regular geometric arrangement at 298 K and 1.0 atm?

Br_2 (l) CO_2 (g) (Mg (s)) H_2O (l)

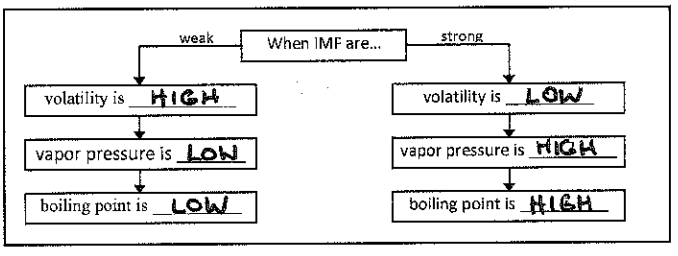
58. ***Solids*** have a definite shape and volume. GRAPH on NEXT PAGE

In what region of the graph ~~below~~ would you only find molecules with definite shape and volume? A→B

59. ***Liquids*** have closely-spaced particles that easily slide past one another; they have no definite shape, but have a definite volume.

60. ***Gases*** have widely-spaced particles that are in random motion (collide with container to create pressure).

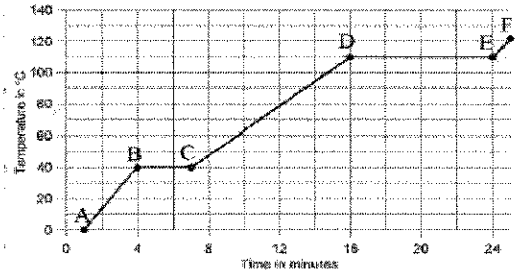
60.5 Fill in the diagram (with high or low) to show how intermolecular forces influence the **volatility**, **vapor pressure**, and **boiling point** of a substance



61. ***Gases*** are easily compressed and have no definite shape or volume.
In what region of the graph below would you only find a sample with no definite shape or volume?
E→F

62. Be able to read and interpret heating/cooling curves as pictured below.

*During which **interval** on the graph are solid and liquid in equilibrium?* B→C



63. Substances that ***sublime*** turn from a solid directly into a gas.
They have very weak attractive or intermolecular forces. (examples include CO_2 & I_2)
What type of intermolecular forces exist between molecules of CO_2 or I_2? London-Dispersion

65. "***STP***" means "***S***tandard ***T***emperature and ***P***ressure."
These conditions define STP $P =$ 1.00 *atm* = 101.3 *kPa* $T =$ 273 *K*

66. Degrees Kelvin = C + 273 ***Temperature*** is a measure of the **kinetic energy** of the particles in matter.
Room temperature = 25°C = 298 *K* *Boiling point of helium = 4 K =* -269 *°C*

71. *Always use Kelvins* for temperature when using the ***combined gas law***. $P_1V_1T_2 = P_2V_2T_1$
Set up the equation to calculate the volume of 50. mL of methane gas collected at STP when the pressure rises to 2.4 atm and the temperature drops to 240 K. $V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{(1.00\,atm)(50.\,mL)(240\,K)}{(2.4\,atm)(273\,K)}$ $V_2 = 18\,mL$

72. As the ***pressure*** exerted on a gas increases, the ***volume*** decreases proportionally.
25 L of a gas is held at 1.2 atm pressure. Find the new volume if pressure drops to 0.80 atm at constant temperature. $V_2 = \frac{P_1V_1}{P_2} = \frac{(1.2\,atm)(25\,L)}{(0.80\,atm)} = 38\,mL$ Boyle's Law

73. As the ***pressure*** on a gas increases, ***temperature*** increases.
A sample of gas exerts a pressure of 220. kPa at 373 K. Find the pressure at 273 K at constant volume.
$P_2 = P_1T_2 / T_1 = (220\,kPa)(273\,K) \div (373\,K)$

74. As the ***temperature*** of a gas increases, ***volume*** increases.
15 mL of oxygen gas is collected at 0°C. Find the volume at 50°C at constant pressure. 273K 323K $V_2 = \frac{V_1T_2}{T_1} = \frac{(15\,mL)(323\,K)}{273\,K} = 18\,mL$

75. ***Real gas*** particles have volume and are attracted to one another. They don"t always behave like ***ideal gases***.
Lighter gases (with weaker attractive forces) are often most ideal.
Which of the following is the most ideal gas?
He *Ne* *Ar* *Kr*

76. Real gases behave more like ideal gases at *low pressures and high temperatures.*

77. According to ***Avogadro's law*** at constant temperature and pressure, the volume of a gas is directly proportional to the number of moles. This is true for any gas.
At STP 22.4 L of any gas = 1 mole, what is this equality called? Molar volume of a gas

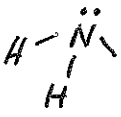
78. The ***Ideal Gas Law*** relates the pressure (atm), volume (L), temperature (K), and amount of gas particles (moles) of a gas. The formula is PV = nRT where R is 0.0821 L•atm/mol•K
What is the volume occupied by 36.0g of water vapor at 125°C and 0.999atm?
18.0 g/mol = 2.00 mol 398 K
$V = \frac{nRT}{P} = \frac{(2.00\,mol)\left(0.0821\,\frac{L \cdot atm}{mol \cdot K}\right)(398\,K)}{(0.999\,atm)} = 65.4\,L$

94. The last digit of an element's group number is equal to its ***number of valence electrons***.
Which contains the greatest number of valence electrons?

Ca	*Ge*	*Se*	*Kr*
2	4	6	8

105. **London Dispersion** attractive forces are the attractive force between nonpolar molecules.
Nonpolar molecules are molecules that have structural symmetry.

106. **Dipole-dipole** attractions occur between all polar moleucles.
Which of the following samples has the dipole-dipole forces of attraction?
F_2 CH_4 (circled) NH_3 I_2



* polar molecule so dipole-dipole forces of attraction between molecules

107. **Polar molecules** have stronger forces of attraction. The lack structural symmetry.
Which of the following is a polar molecule?
CO_2 (circled) H_2O C_4H_{10} N_2

108. ***Hydrogen bonds*** are attractive forces that form when hydrogen bonds to the elements N, O, or F and gives the compound unexpectedly high melting and boiling points.
The strongest forces of attraction occur between molecules of
HCl *HBr* (circled) *HF* *HI*

109. Substances containing mostly ionic bonds are called ***ionic compounds***.
They are made of metal and nonmetallic ions. They are held together by electrostatic (ionic) forces.

110. Complete and memorize this table.

Substance Type	Properties
Ionic	Hard *(Low (circled) high) melting and boiling points* Conduct electricity when molten or aqueous
Covalent (Molecular)	Soft *(Low (circled) high) melting and boiling points* Do not conduct electricity (insulators)

111. Remember: substances tend to be soluble in solvents with similar molecular properties.
"Like dissolves like"
Pentane does not dissolve in water because pentane is nonpolar *and water is* polar

112. As temperature increases, solubility increases for most solids.
For which substance does increasing temperature have the least effect on solubility?
Sodium chloride *calcium carbonate* *oxygen* (circled) *sodium bicarbonate*

113. At low temperatures and high pressures solubility *increases* for most gases.
*Carbon dioxide gas is **least** soluble in water at conditions of* high *temperature and* low *pressure.*

116. ***Molarity*** is a way to measure the *concentration* of a solution.
Molarity is equal to the number of moles of solute divided by the number of liters of solution.
What is the molarity of an NaCl solution if 2.0 mol NaCl is present in 0.50 L solution? $\frac{2.0\ mol}{0.50\ L} = 4.0\ M$

117. ***Molality*** = (moles of solute/ kg of sovent)
A solution of glucose is prepared by added 10. g glucose ($C_6H_{12}O_6$) to 40. g water.
What is its molality? $\frac{10.\ g / 1\ mol / 180\ g}{} = 0.0556\ mol$ $180\ g/mol$ $\frac{40.\ g / 1\ kg / 1000\ g}{} = 0.040\ kg$ $m = \frac{0.0556\ mol}{0.040\ kg} = 1.4\ m$

118. ***Dilutions*** → $M_1V_1 = M_2V_2$ is the way to determine how to make a less concentrated solution.
A student needs 250 mL of a 1.0 M HCl solution, how many mL of 6.0M HCl do they need to make this solution? $V_1 = \frac{M_2V_2}{M_1} = \frac{(1.0\ M)(250\ mL)}{(6.0\ M)} = 42\ mL$

119. Solutes **raise** the boiling points and **lower** the melting points of solvents. ***Colligative Properties***
Which of the following will have the highest boiling point?
1 mol NaCl in 100 g water $i = 2$ *1 mole CH_3OH in 100 g water* $i = 1$ *1mol $CaCl_2$ in 100 g water* (circled) $i = 3$

95. Draw one dot for each valence electron when drawing an element's or ion's ***Lewis electron dot diagram***.
Which dot model would contain the fewest dots as valence electrons? Ca → Metal

Ca · *·Ge·* *·Se:* *:Kr:*

96. **Metallic bonds** can be thought of as a crystalline lattice of kernels surrounded by a "sea" of mobile valence electrons. *Metallic bonding occurs between atoms of*

sulfur *sodium fluoride* *sodium* *carbon*

97. Atoms are most stable when they have 8 valence electrons (an ***octet***) and tend to form ions to obtain such a configuration of electrons.
*Which of the following atoms forms a stable ion that does **not** have an octet structure?*

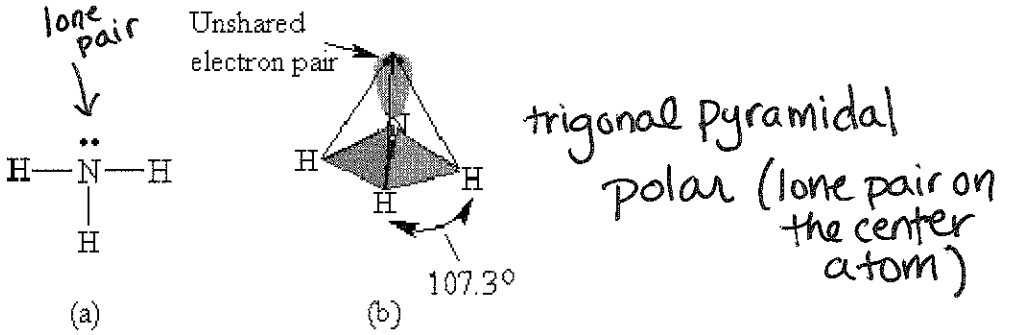
Li *F* *Na* *Cl*

98. ***Covalent bonds*** form when two atoms ***share*** a pair of electrons.
How many covalent bonds are found in a nitrogen (N_2) molecule? :N≡N: 3 covelent bonds = 1 triple bond
5+5=10e⁻

99. ***Ionic bonds*** form when one atom ***transfers*** an electron to another atom when forming a bond with it.
Which substance exhibits ionic bonding rather than covalent bonding?

CO_2 *N_2O_4* *SiO_2* *$CaBr_2$* *$C_6H_{12}O_6$*

100. **Lewis Dot models** may be used to represent the formation of ions or covalent molecules and help determine their shape using VSEPR theory and their polarity.



trigonal pyramidal
polar (lone pair on the center atom)

Given the Lewis structure in figure (a) and the diagram figure (b), what is the shape of the ammonia molecule? Is this molecule polar or nonpolar?

101. ***Nonpolar covalent bonds*** form when two atoms of the *same element* bond together.

102. ***Polar covalent bonds*** form when the electronegativity difference between two bonding atoms is between 0.4 and 1.7.
Which of the following combinations would form a polar covalent bond?

H and H *Na and N* *H and N* *Na and Br*

103. ***Ionic bonds*** form when the electronegativity difference between two bonding atoms is *greater than* 1.7.
Which of the following combinations would form an ionic bond?

H and H *Na and N* *H and N* *Na and Br*

104. Substances containing mostly covalent bonds are called ***molecular substances***.
They are attracted to each other by weak van der Waals or stronger hydrogen attractions
Which of the following is a molecular substance?

Lithium chloride *carbon monoxide* *sodium nitrate* *aluminum oxide*

120. The ***freezing-point depression*** is the change in the lowering of the freezing point of a substance when a solute is added to it. The ***boiling-point elevation*** is the change is the substance's boiling point under the same conditions. *What is the freezing-point depression of a 0.020 m aqueous $CaCl_2$ solution?*

$\Delta T = m i K_f = (0.020m)(3)(1.86°C) = 0.11°C$

0.0°C − .11°C = −0.11°C

123. Covalently bonded substances form **molecules**. Molecular compounds are made up of nonmetals only.
Which of the following are molecular compounds? H_2O CH_4 *NaCl* *CuSO* CO_2

123.5 The formula of a **molecular compound** represents one molecule of the substance, also one mole of molecules and the number of atoms for each nonmetal element making up the molecule.
The formula for methane gas, CH_4, tells us the make-up of one molecule of methane is 1 carbon atom and 4 hydrogen atoms covalently bonded together. We can also figure out the molar mass or the mass in one mole of methane. What is the molar mass of CH_4? 47 g/mol 24 g/mol 16 g/mol 10 g/mol

124. Increasing the **concentration** of reactants will increase ***reaction rate***.
Which sample of HCl (aq) will react most rapidly with magnesium metal?
0.50 M HCl *1.0 M HCl* *3.0 M HCl* *6.0 M HCl*

125. ***Reaction rate*** increases with an increase in temperature (and pressure for gases).

126. ***Catalysts*** speed up reactions by lowering their ***activation energies***.
They are not changed themselves and can be reused many times over.

153. ***Acids*** and ***bases*** are both ***good electrolytes***. Their solutions conduct electricity well.
Which of the following is a nonelectrolyte?
LiOH *HBr* $HC_2H_3O_2$ C_2H_5OH

154. **Weak acids** taste *sour* and *react with metals*.

155. **Weak bases** taste *bitter* and *feel slippery*.

156. Acids and bases turn ***indicators*** different colors.
* Bases change litmus to blue
Which solution will change red litmus to blue?
HCl(aq) *NaCl(aq)* $CH_3OH(aq)$ *NaOH(aq)*
acid salt alcohol base

157. **pH** is the negative log (exponent) of the hydronium $[H^+]$ ion concentration.
What is the pH of a 1.0×10^{-5} molar HCl solution?
1 *9* *5* *4*

158. **Acids** have a pH < 7. **Bases** have a pH > 7.

159. Every 1 pH number **decrease** represents a ten-fold $[H^+]$ **increase**.

162. ***Arrhenius*** model of acids and bases states:
"Acids give off H^+ to form H_3O^+ ions in aqueous solution as their only (+) ion."
"Bases give off OH^- ions in aqueous solution as their only (-)."
Which of the following is neither an Arrhenius acid nor an Arrhenius base?
KOH CH_3COOH CH_3OH HNO_3

163. ***Brønsted*** model of acids and bases states:
"Acids *donate* protons." "Bases *accept* protons."
Identify one Bronsted acid and one Bronsted base in the reaction below:
$H_2O + NH_3 \Leftrightarrow NH_4^- + OH$
A B CA CB

164. Bronsted acids become Bronsted bases; Bronsted bases become Bronsted acids; forming conjugate pairs.
Identify one conjugate acid-base pair from question #163
H_2O and OH^- or NH_3 and NH_4^+

165. Acids and bases react in ***neutralization*** reactions to make ***water*** and a ***salt***.

Name the salt produced when sulfuric acid is neutralized by potassium hydroxide.

$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(\ell)$

166. Acids are ionic formulas in which the positive ion is H+. Use as many H+ ions as the charge on the negative anion.

Three rules for naming: if the **anion** ends with: the acid is named:

–ite ********ous acid –ate ********ic acid –ide hydro********ic acid

Which of the following acids would be called sulfuric acid?

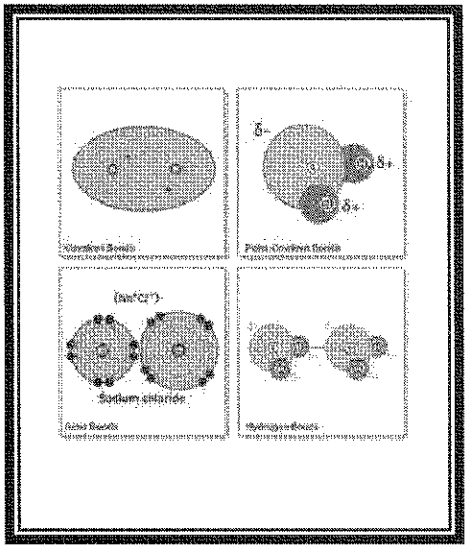
H_2S H_2SO_3 H_2SO_4 H_2CO_3

167. A ***buffer*** is a solution that stabilizes the pH of a solution when small amounts of acids or bases are added. A buffer is a solution of a weak acid and one of its salts, or a solution of a weak base and one of its salts.

Some Helpful Stuff to Look Over

Rate of Solution

Factor	Effect on Solid Solute	Effect on Gaseous Solute
Particle Size	Reducing particles size by crushing increases the rate by increasing **surface area**	Not applicable
Stirring	Increases the rate by exposing fresh solvent to solute and increasing **kinetic energy**	Decreases the rate by increasing **kinetic energy**, thereby reducing solubility
Amount of dissolved solute	As the amount of dissolved solute increases, the rate decreases	As the amount of dissolved solute increases, the rate decreases
Temperature	As the temperature increases, the kinetic energy increases, and the rate increases	As the temperature increases, the rate decreases



Common Acids

Formula	Name
HCl(aq)	hydrochloric acid
HNO_2(aq)	nitrous acid
HNO_3(aq)	nitric acid
H_2SO_3(aq)	sulfurous acid
H_2SO_4(aq)	sulfuric acid
H_3PO_4(aq)	phosphoric acid
H_2CO_3(aq) or CO_2(aq)	carbonic acid
CH_3COOH(aq) or $HC_2H_3O_2$(aq)	ethanoic acid (acetic acid)

$$Molarity = M = \frac{mol}{L} = \frac{\text{(no.of moles solute)}}{\text{(no. of liters of solution)}}$$

$$M_{concentrated} \times V_{concentrated} = M_{dilute} \times V_{dilute}$$

$$M_{initial} \times V_{initial} = M_{final} \times V_{final}$$

Common Bases

Formula	Name
NaOH(aq)	sodium hydroxide
KOH(aq)	potassium hydroxide
$Ca(OH)_2$(aq)	calcium hydroxide
NH_3(aq)	aqueous ammonia

Ideal Gas Problems

Gases at low pressures obey the ideal gas law,

$$p\,V = n\,R\,T \qquad (1)$$

where R is a constant (known as the *gas constant*) that has the value

$$R = 0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1} \qquad (2)$$

Appropriate units to use for p, V, n, and T in the ideal gas equation are those used for R above. Thus the pressure (p) should be in atm, the volume (V) in L, the temperature (T) in degrees K, and the amount of gas (n) should be in moles. Useful conversion factors are

Pressure: 1 atm = 760 Torr = 760 mmHg = 101.3 kPa = 1.013 bar
Temperature: K = 273 + °C
Volume: 1 L = 1000 mL = 1000 cm^3

Since $\frac{pV}{nT} = R$, and R is a constant, it follows that

$$\frac{p_1V_1}{n_1T_1} = \frac{p_2V_2}{n_2T_2} \qquad (3)$$

where the subscript "1" represents one set of conditions, and the subscript "2" represents another set of conditions. More specialized equations may be derived from Eq(3) when one or more of the variables is held constant. For example, you can easily derive the familiar equations given below in this manner (convince yourself that this works!):

Boyle's law: $p_1V_1 = p_2V_2$ (obtained when $n_1 = n_2$ and $T_1 = T_2$)

Charles's law: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (obtained when $n_1 = n_2$ and $p_1 = p_2$)

Avogadro's Principle: $\frac{V_1}{n_1} = \frac{V_2}{n_2}$ (obtained when $T_1 = T_2$ and $p_1 = p_2$)

STP

Often you will see gas volumes reported at STP (*standard temperature and pressure*). STP is defined as T = 273 K (0°C) and p = 1 atm. Substitution of these values into Eq(1) shows that the *volume of 1 mol of any gas is approximately 22.4 L at STP*. (You should verify this for yourself using Eq(1)!).

Molecular Crystals	
Examples:	One or more of the following:
(a) Need H bonded to O, N or F: H_2O, HF, NH_3.	(a) *Hydrogen bonding*: Hydrogen bonds are weaker than covalent bonds, but stronger than (b) or (c) below.
(b) C_6H_6 (benzene), polyethylene, I_2, F_2, and all the compounds from (a) above.	(b) *Dispersion forces* (induced dipole – induced dipole or London dispersion forces): universal force of attraction between instantaneous dipoles. These forces are weak for small, low-molecular weight molecules, but large for heavy, long, and/or highly *polarizable* molecules. They usually dominate over (c) below.
(c) CHF_3, CH_3COCH_3 (acetone) and H_2O, HF, NH_3.	(c) *Dipole-dipole forces*: these forces act between *polar* molecules. They are much weaker than hydrogen bonding.
Note: ***Van der Waals Forces*** is a category which includes *both* categories (b) and (c) above.	