

# Honors Chemistry Fourth Marking Period Review Sheet

Spring, Mr. Wicks

## Chapter 10: Physical Characteristics of Gases

- I can describe the characteristics of ideal gases and how real gases are different from them. Ideal gas molecules are assumed to have no volume and to not interact with one another by intermolecular forces. Deviations from ideal behavior are greatest at high pressure and low temperature.
- Ideal gas characteristics:
  1. Gases are composed of very tiny molecules with lots of empty space between them.
  2. Gas molecules move rapidly, move in straight lines, and travel in random directions.
  3. Gas molecules do not attract each other.
  4. Gas molecules have elastic collisions. In other words, the total kinetic energy of the molecules before and after a collision is the same.
  5. The average kinetic energy of gas molecules is proportional to the absolute (Kelvin) temperature.
- I can apply the kinetic-molecular theory of gas behavior at the molecular level.
- In kinetic theory, the molecules of a gas are imagined to be a large number of points bouncing off the walls of a container. Gas pressure is related to the number of collisions that occur with the walls per unit time.
- I understand how pressure measurements are made.
- I can convert between various pressure units: 1 atm = 760 mm Hg = 760 torr = 101.3 kPa = 14.7 psi
- I know and can use the standard conditions of temperature and pressure (STP): 0°C (273 K) and 1 atm.
- I recall that all temperature-related gas laws use Kelvin rather than Celsius temperature, and I can convert between Kelvin and Celsius temperatures.
- I know that absolute zero on the Kelvin scale is the temperature at which all atomic and molecular motion stops. It can be determined by extrapolating a line to zero volume on a V-T diagram (Charles' law) or by extrapolating a line to zero pressure on a P-T diagram (Gay-Lussac's law).
- I can compare and contrast Boyle's law, Charles' law, Gay-Lussac's law, Avogadro's law, the combined gas law, the ideal gas law, Dalton's law, and Graham's law, which are presented in Table 1 along with values for the gas law constant,  $R$ .

## Chapter 11: Molecular Composition of Gases

- I can use the standard molar volume of a gas at STP to solve problems. The volume occupied by one mole of an ideal gas at standard conditions of temperature and pressure (STP, 0°C and 1 atm) is 22.4 L/mole.
- I can calculate gas densities and molar masses by substituting  $n = \frac{m}{MM}$  into the ideal gas law,  $PV = nRT$ , to get  $d = \frac{m}{V} = \frac{PMM}{RT}$  and  $MM = \frac{mRT}{PV} = \frac{dRT}{P}$ .
- I can apply the gas laws when solving stoichiometry problems involving gaseous materials.

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<b>Table 1: Gas Laws</b>		
<i>Gas Law Name</i>	<i>Equation</i>	<i>Quantities Held Constant</i>
<b>Boyle's Law:</b>	$P_1V_1 = P_2V_2$	Temperature and moles
<b>Charles' Law:</b> (Absolute zero, 0 K, can be determined by extrapolating a line to zero volume on a V-T diagram.)	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$	Pressure and moles
<b>Gay-Lussac's Law:</b> (Absolute zero, 0 K, can be determined by extrapolating a line to zero pressure on a P-T diagram.)	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$	Volume and moles
<b>Avogadro's Law:</b> (Stoichiometric coefficients can be used to compare volumes of different gases in a chemical equation,)	$\frac{V_1}{n_1} = \frac{V_2}{n_2}$	Temperature and pressure
<b>Combined Gas Law:</b> (Combines Boyle's, Charles', and Gay-Lussac's Laws)	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$	Moles
<b>Ideal Gas Law:</b> (Combines Boyle's, Charles', and Avogadro's Laws)	$PV = nRT$ where $R = 0.0821 \text{ L}\cdot\text{atm}/(\text{mole}\cdot\text{K})$ $= 8.314 \text{ J}/(\text{mole}\cdot\text{K})$ $= \text{Gas Law Constant}$	None
<b>Dalton's Law:</b> Total pressure is equal to the sum of the partial pressures.	$P_{\text{Total}} = P_1 + P_2 + P_3 + \dots$	Not applicable

### Chapter 12: Liquids and Solids

- I can compare and contrast the properties of gases, liquids, and solids.
- I can apply the Kinetic Molecular Theory of Matter to explain the physical properties of gases, liquids, and solids. Focus on volume, shape, compressibility, relative density, and molecular motion.
- I can compare and contrast the intermolecular forces of attraction (IFA or IMF; sometimes called "van der Waals forces") for molecular compounds. See Table 2.
- I can use intermolecular forces of attraction to explain relative melting points, boiling points, surface tensions, viscosities, specific heats, and vapor pressures for a given series of molecular compounds.

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<b>Table 2: Intermolecular Forces of Attraction (“van der Waals forces”)</b>			
<i>Type</i>	<i>Strength</i>	<i>Attraction</i>	<i>Examples</i>
Hydrogen bonding	Strongest	“H” on one molecule is attracted to “F,” “O,” or “N” on an adjacent molecule.	H <sub>2</sub> O, NH <sub>3</sub> , HF, base pairs in DNA
Dipole-dipole forces	Intermediate	Polar molecules attract each other like tiny magnets. (Larger dipole moments result in greater interactions.)	HCl, H <sub>2</sub> S
London dispersion forces	Weakest	Induced dipoles attract each other for a fraction of a second; works best with atoms and molecules having lots of electrons, which makes them more polarizable. All covalent compounds have London dispersion forces.	CH <sub>4</sub> , CCl <sub>4</sub>

- I can compare and contrast intramolecular forces of attraction for ionic, covalent, molecular, and metallic materials. See Table 3.

<b>Table 3: Comparing Intramolecular Forces of Attraction</b>	
<i>Intramolecular Force</i>	<i>Examples</i>
Ionic Bond	NaCl, BaF <sub>2</sub>
Covalent Bonds forming a Network Solid	C(diamond), SiO <sub>2</sub>
Covalent Bond	See examples in previous table.
Metallic Bond	Ag, Na

- I can explain why water has “surprising” physical properties
  - Water is polar because it has polar bonds and bent geometry. It is also capable of hydrogen bonding, which results in several unusual properties.
    - Water has a higher melting point and boiling point than expected.
    - Water has considerable surface tension.
    - Water has a high capacity to absorb heat.
    - Ice is less dense than liquid water and will therefore float.
  - In addition to these properties, polar and ionic substances will dissolve in water.

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### Chapter 13: Solutions and Their Behavior

- I can compare and contrast solutions, colloids, and suspensions. See Table 4.
- I can give examples of colloids from everyday life.
  - Emulsions—cheese, butter
  - Foams—whipped cream, shaving cream
  - Gels—gelatin
  - Aerosols—smoke, fog, mist
- I can describe the Tyndall effect—when a beam of light is passed through a substance, light scattering occurs. Ex. The beam of light from auto headlights is visible during a fog but not during other conditions.

<b>Table 4: Contrasting Solutions, Colloids, and Suspensions</b>			
	<i>Solution</i>	<i>Colloid</i>	<i>Suspension</i>
Example:	NaCl dissolved in water	Milk	Sand mixed with water
Settles out?	No	No	Yes
Can be separated by filtration?	No	No	Yes
Shows the Tyndall effect?	No	Yes	Yes

- I can distinguish between solute, solvent, solution, and solubility.
- I remember that solubility is defined as the maximum amount of a solute that will dissolve in a given quantity of solvent at a specific temperature.
- I can describe general solubility trends:
  - As temperature increases, the solubility of a solid in water increases.
  - As temperature increases, the solubility of a gas in water decreases.
  - As pressure increases, the solubility of a gas in water increases. Ex. Soda pop effervescence.
- I can use both words and graphs to compare and contrast saturated, unsaturated, and supersaturated solutions.
- I can distinguish between miscible and immiscible liquids.
- I can clearly explain and apply the solubility rule “like dissolves like,” which means that the solute and solvent are alike in polarity:
  - Nonpolar solutes will dissolve in nonpolar solvents.
  - Polar and ionic solutes will dissolve in polar solvents.
- I can explain how soap works. Soap molecules have ionic “heads” that dissolve in water and nonpolar “tails” that dissolve in grease. Thus, soap and water can remove grease despite the fact that water and grease, which are polar and nonpolar compounds, respectively, will not dissolve in each other.
- I can calculate the molar concentration of ionic substances dissolved in water using
$$\text{Molarity} = \left( \frac{\text{Moles of Solute}}{\text{Liters of Solution}} \right)$$
- I can safely prepare solutions of various molar concentrations:
  1. from solids.
  2. by diluting liquids. (Recall  $C_1V_1 = C_2V_2$  where  $C$  = concentration and  $V$  = volume.)

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### Chapter 14: Ions in Aqueous Solutions and Colligative Properties

- I can use the solubility rules given in Table 5 to predict the solubility of ionic compounds in water.
- I can write the ions formed when an ionic compound dissolves in water.
- I can predict products for precipitation reactions (double replacement reactions).
- I can write molecular, ionic, and net ionic equations, and I can identify spectator ions.
- I can explain the difference between a strong electrolyte, a weak electrolyte, and a nonelectrolyte.
- I can compare and contrast the four colligative properties vapor-pressure lowering, boiling-point elevation, freezing-point depression, and osmotic pressure. Recall that colligative properties depend only on the number of solute particles in solution and not on the nature of the solute particles.
- I can compare and contrast volatile and nonvolatile solutes. As you will recall, nonvolatile solutes have no measurable vapor pressure and they are generally used when discussing colligative properties.

<b>Table 5: Solubility Rules for Common Ionic Compounds in Water at 25°C</b>	
<b><i>General Rule</i></b>	<b><i>Exceptions to the Rule</i></b>
Almost all compounds containing alkali metal ions ( $\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , etc.) and $\text{NH}_4^+$ are soluble	
Almost all compounds containing nitrates ( $\text{NO}_3^-$ ), bicarbonates ( $\text{HCO}_3^-$ ), and chlorates ( $\text{ClO}_3^-$ ) are soluble	
Most compounds containing halides ( $\text{Cl}^-$ , $\text{Br}^-$ , and $\text{I}^-$ ) are soluble	Halides of $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , and $\text{Pb}^{2+}$
Most sulfates ( $\text{SO}_4^{2-}$ ) are soluble	Sulfates of $\text{Ag}^+$ , $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Hg}_2^{2+}$ , and $\text{Pb}^{2+}$
Carbonates ( $\text{CO}_3^{2-}$ ), phosphates ( $\text{PO}_4^{3-}$ ), chromates ( $\text{CrO}_4^{2-}$ ), and sulfides ( $\text{S}^{2-}$ ) are usually insoluble	Compounds containing alkali metal ions ( $\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , etc.) and $\text{NH}_4^+$
Hydroxides ( $\text{OH}^-$ ) are usually insoluble	Hydroxides containing alkali metal ions ( $\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , etc.) and $\text{Ba}^{2+}$

### Chapter 15: Acids and Bases

- I can compare and contrast the properties and general characteristics of acids and bases.
- I can give examples of common acids and bases.
- I can write equations for acid ionization and base dissociation.
- I can write molecular, ionic, and net ionic equations for acid-base neutralizations (double replacement reactions).
- I know that when acid-base reactions form “salts,” this does NOT mean that they all form table salt, NaCl. The word “salt” in this context refers to an inorganic compound whose cation comes from a base and whose anion comes from an acid.

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- I can compare and contrast Arrhenius, Bronsted-Lowry, and Lewis acids and bases. See Table 6.

<b>Table 6: Acid-Base Definitions</b>		
<i>Definition</i>	<i>Acid</i>	<i>Base</i>
Arrhenius	Produces H <sup>+</sup> ions Ex. HCl, H <sub>2</sub> SO <sub>4</sub>	Produces OH <sup>-</sup> ions Ex. NaOH, Ca(OH) <sub>2</sub>
Bronsted	Proton (H <sup>+</sup> ) donor Ex. NH <sub>4</sub> <sup>+</sup>	Proton (H <sup>+</sup> ) acceptor Ex. NH <sub>3</sub>
Lewis	Electron-pair acceptor Ex. BF <sub>3</sub> , AlCl <sub>3</sub>	Electron-pair donor Ex. NH <sub>3</sub>

- I can explain the difference between strong and weak acids and strong and weak bases. See Table 7.

<b>Table 7: Comparing Strengths of Acids and Bases</b>		
<i>Type of Acid or Base</i>	<i>Characteristic</i>	<i>Classic Examples</i>
Strong Acid	Completely Ionized	HCl → H <sup>+</sup> + Cl <sup>-</sup> HNO <sub>3</sub> → H <sup>+</sup> + NO <sub>3</sub> <sup>-</sup>
Weak Acid	Incompletely Ionized (equilibrium exists)	HC <sub>2</sub> H <sub>3</sub> O <sub>2</sub> + H <sub>2</sub> O ⇌ H <sub>3</sub> O <sup>+</sup> + C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> <sup>-</sup> CH <sub>3</sub> COOH + H <sub>2</sub> O ⇌ H <sub>3</sub> O <sup>+</sup> + CH <sub>3</sub> COO <sup>-</sup>
Strong Base	Completely Dissociated	NaOH → Na <sup>+</sup> + OH <sup>-</sup> KOH → K <sup>+</sup> + OH <sup>-</sup>
Weak Base	Incompletely Dissociated (equilibrium exists)	NH <sub>3</sub> + H <sub>2</sub> O ⇌ NH <sub>4</sub> <sup>+</sup> + OH <sup>-</sup>

### Chapter 16: Acid-Base Titration and pH

- I can write the autoionization of water and explain its significance.
  - The autoionization of water,  $2 \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$ , can also be written  $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$ .
  - Water can act as either an acid or a base depending on the accompanying reactant present. With this in mind, water is said to be “amphoteric.”
  - The equilibrium expression for the autoionization of water is  $K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14}$ .  
It can also be written  $K_w = [\text{H}^+][\text{OH}^-] = 10^{-14}$ .
  - In acidic solution,  $[\text{H}^+] > [\text{OH}^-]$ ; in neutral solution,  $[\text{H}^+] \cong [\text{OH}^-]$ ; and in basic solution,  $[\text{H}^+] < [\text{OH}^-]$ .

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- I can relate acidity to pH and  $[H^+]$ , and I can relate basicity to pOH and  $[OH^-]$ 
  - In acidic solution,  $pH < 7$ ; in neutral solution,  $pH \cong 7$ ; and in basic solution,  $pH > 7$ .
  - I can perform calculations involving pH and pOH. See Table 8.

<b>Table 8: pH- and pOH-Related Calculations</b>		
<b><i>Quantity</i></b>	<b><i>Exponent-Oriented Calculation</i></b>	<b><i>Concentration-Oriented Calculation</i></b>
pH	$pH = -\log[H^+]$	$[H^+] = 10^{-pH}$
pOH	$pOH = -\log[OH^-]$	$[OH^-] = 10^{-pOH}$
Combination of pH and pOH	$pH + pOH = 14.00$	$K_w = [H^+][OH^-] = 10^{-14}$

- I can solve acid-base stoichiometry problems involving concentrations.
- I can properly perform a “titration” and a “standardization” experimentally.
- I can calculate concentrations of reactants and products from titration data.