**Harold’s High School Chemistry**

**Cheat Sheet**

25 August 2025

**Chapter 1: Measuring Up**

|  |  |  |
| --- | --- | --- |
| **Term** | **Description** | **Equation** |
| **Rulers** | When using a ruler that is marked off in 16ths of an inch, report your answers to a hundredth of an inch. | |
| **Units** | The unit of measurement is just as important as the number.  You must always list the units, followed by the compound!  Example: 6.28 mL H2O | |
| **Significant Figures** | 1. All non-zero figures (1, 2, 3, 4, 5, 6, 7, 8, and 9) are significant. 2. A zero (0) is significant if it is between two significant digits. 3. A zero (0) is also significant if it’s at the end of the number *and* to the right of the decimal point. | |
| **Using SigFigs** | 1. When **adding** and **subtracting** measurements, you must report your answer to the same precision as the least precise number in the problem. 2. When **multiplying** and **dividing** measurements, you must report your answer with the same number of significant figures as the measurement that has the fewest significant figures. 3. There is always some **error** in the last significant figure of a measurement. | |
| **Precision vs. Accuracy** | * **Precision:** The consistency and reproducibility of measurements (e.g., 10 decimal places). * **Accuracy:** How close a measurement is to the true or accepted value. | |
| **Prefixes** | |  |  |  |  | | --- | --- | --- | --- | | **Prefix** | **Abbreviation** | **Meaning** | **Scientific** | | giga | G | 1,000,000,000 | 109 | | mega | M | 1,000,000 | 106 | | **kilo** | **k** | **1,000** | **103** | | hector | H | 100 | 102 | | deca | Da | 10 | 101 | | **centi** | **c** | **0.01** | **10-2** | | **milli** | **m** | **0.001** | **10-3** | | micro | μ | 0.000001 | 10-6 | | nano | n | 0.000000001 | 10-9 | | |
| **Scientific Notation** | 14,000,000 = 1.4 ⨯ 107 = 1.4E7 | 0.00000014 = 1.4 ⨯ 10-7 = 1.4E–7 |
| **Measuring** | Volume () | 1 cm3 = 1 mL |
| Mass () | weight = mass ⨯ gravity |
| Density (*ρ*) |  |
| **Unit Conversion** (Train Track Method) | 0.1436 mL = ? m3   |  |  |  |  |  | | --- | --- | --- | --- | --- | | 143.6 L | 1000 ~~mL~~ | 1 cm3 | (1 m)3 | **0.1436 m3** | |  | 1 L | 1 ~~mL~~ | (100 cm)3 |  | | |

**Chapter 2: What’s The Matter**

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**Chapter 3: Making Sense of Atoms and Elements**

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**Chapter 4: The Modern View of Atoms and Their Chemistry**

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**Chapter 5: Covalent Compounds and Their Molecular Geometry**

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**Chapter 6: Physical and Chemical Changes**

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**Chapter 7: Stoichiometry**

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**Chapter 8: Still More on Stoichiometry**

**Common Polyatomic Ions** (Memorize)

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| **#** | **Name** | **Ion** |
| 1 | Ammonium |  |
| 2 | Hydronium |  |
| 3 | Acetate |  |
| 4 | Cyanide |  |
| 5 | Bicarbonate |  |
| 6 | Carbonate |  |
| 7 | Hydroxide |  |
| 8 | Nitrite |  |
| 9 | Nitrate |  |
| 10 | Sulfite |  |
| 11 | Sulfate |  |
| 12 | Phosphate |  |
| 13 | Chlorite |  |
| 14 | Manganate |  |

**Chapter 9: Chemists Have Solutions**

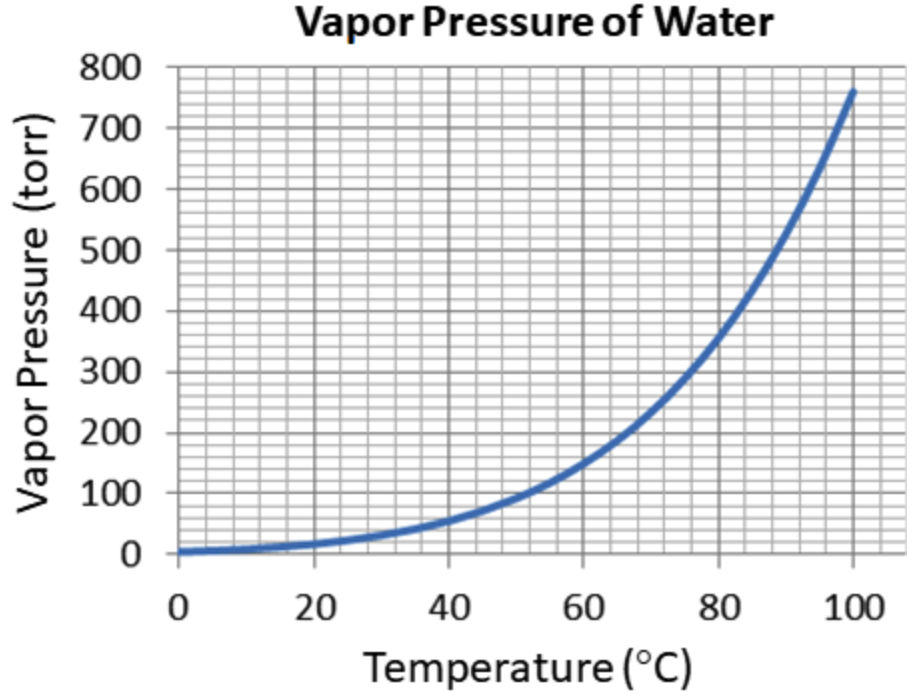
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| **Term** | **Description** | **Equation** |
| **Dissolving Compounds** | * When ionic compounds dissolve, they split up into their individual atoms. * When polar covalent compounds dissolve, they split up into their individual molecules. | |
| **Solubility of Solutes** | |  |  |  | | --- | --- | --- | | **State** | **Temperature** | **Pressure** | | Solid | ⬆ | - | | Liquid | - | - | | Gas | ⬇ | ⬆ |   . | |
| **Concentration** | The behavior of a chemical often depends on concentration. | |
| **Molarity** |  | Liters |
| **Molality** |  | Kilograms |
| **Freezing Point Depression** |  |  |
| **Boiling Point Elevation** |  |  |

**Chapter 10: It’s a Gas!**

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| --- | --- | --- |
| **Term** | **Equation** | **Note** |
| **Ideal Gas Law** |  | Ideal Gas Constant (R): |
| **Boyle’s Law** |  | Assumes |
| **Charle’s Law** |  | Assumes |
| **Combined Gas Law** |  | Since |
| **Avagadro’s Law** |  | Same number of molecules or atoms |
| **Volumes of Gases** |  | Relationship between volumes of those gases |
| **Kelvin (T)** |  |  |
| **Pressure (P)** |  |  |
|  | Units can be torr, atm, or Pa |
| **Ideal Gas** | 1. The molecules or atoms that make up the gas occupy no volume. 2. The molecules or atoms that make up the gas are not attracted to each other. 3. The collisions that occur between the molecules or atoms that make up the gas are elastic, which means no energy is lost in such a collision. This is also true for any collisions between the molecules or atoms that make up the gas and the walls of the container in which the gas is held. | |
| **STP** | A gas is at STP if its pressure is 1 atm and its temperature is . | **S**tandard **T**emperature and **P**ressure |
| **Dalton’s Law** |  | Partial pressures |
| **Mole Fraction** |  |  |
| **Vapor Pressure** | Boiling point = The temperature at which a liquid’s vapor pressure is equal to the external air pressure. | |
| **Extrapolation** | Extending a trend in data to situations for which no measurements have been made. Usually linear approximations. | |

**Vapor Pressure of Water**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Temperature**  **(°C)** | **Vapor Pressure (torr)** |  | **Temperature**  **(°C)** | **Vapor Pressure (torr)** |
| **0** | 4.6 |  | 39 | 52.4 |
| **2** | 5.3 |  | 40 | 55.3 |
| **4** | 6.1 |  | 42 | 61.5 |
| **6** | 7.0 |  | 44 | 68.3 |
| **8** | 8.0 |  | 46 | 75.5 |
| **10** | 9.2 |  | 48 | 83.7 |
| **12** | 10.5 |  | 50 | 92.5 |
| **14** | 12.0 |  | 52 | 102.1 |
| **15** | 12.8 |  | 54 | 112.5 |
| **16** | 13.6 |  | 56 | 123.8 |
| **17** | 14.5 |  | 58 | 136.1 |
| **18** | 15.5 |  | 60 | 149.4 |
| **19** | 16.5 |  | 62 | 163.8 |
| **20** | 17.5 |  | 64 | 179.3 |
| **21** | 18.7 |  | 66 | 196.1 |
| **22** | 19.8 |  | 68 | 214.2 |
| **23** | 21.1 |  | 70 | 233.7 |
| **24** | 22.4 |  | 72 | 254.6 |
| **25** | 23.8 |  | 74 | 277.2 |
| **26** | 25.2 |  | 76 | 301.4 |
| **27** | 26.7 |  | 78 | 327.3 |
| **28** | 28.3 |  | 80 | 355.1 |
| **29** | 30.0 |  | 82 | 384.9 |
| **30** | 31.8 |  | 84 | 416.8 |
| **31** | 33.7 |  | 86 | 450.9 |
| **32** | 35.7 |  | 88 | 487.1 |
| **33** | 37.7 |  | 90 | 525.8 |
| **34** | 39.9 |  | 92 | 567.0 |
| **35** | 42.2 |  | 94 | 610.9 |
| **36** | 44.6 |  | 96 | 657.6 |
| **37** | 47.1 |  | 98 | 707.3 |
|  | 49.7 |  | 100 | 760.0 |



**Chapter 11: Some Pretty Basic (and Acidic) Chemicals**

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| --- | --- | --- |
| **Term** | **Equation / Definition** | **Note** |
| **Acids**  **(Acidic)** | A chemical that donates an H+.  Have more H+ ions. | 1. Tend to taste sour 2. Are covalent electrolytes 3. Turn blue litmus paper red |
| **Bases**  **(Alkaline)** | A chemical that accepts an H+.  Have more OH– ions. | 1. Tend to taste bitter 2. Tend to feel slippery when mixed with water 3. Turn red litmus paper blue |
| **Litmus** | An acid/base indicator that is usually on a strip of paper | |
| **Amphoteric**  (Amphiprotic) | Capable of reacting as either an acid or a base (, metal oxides) | |
| **Covalent Electrolytes** | hydrofluoric acid + water ⟶ fluoride ion + hydronium ion  acid base . | |
| ammonium hydroxide (ammonia) + water 🡪 ammonium ion + hydroxide ion  base acid . | |
| **Ionic Electrolytes** | hydrochloric acid + sodium hydroxide (lye) 🡪 water + salt  acid base . | |
| **Acid/Base Identification Rules** | * Ammonia () is a covalent base. * If a covalent compound starts with an , it can usually act like an acid. * Ionic compounds that contain the hydroxide ion can act as bases. * An acid reacts with an ionic base to make water () and salt (). | |
| **pH Scale** | Potential hydrogen (pH).  Amount of hydronium ion () in the solution. |  |
| pH of 0: highly acidic  pH of 7: neutral .  pH of 14: highly alkaline |
| **Polyprotic Acid** | An acid that can donate two or more H+ ions. Examples:  hydrogen sulfate (), carbonic acid ( | |
| **Titration** | The process by which an acid of known concentration is added to a base of unknown concentration (or vice versa) until a neutral pH is reached to determine the unknown concentration. | |

A diagram of different types of objects

AI-generated content may be incorrect.

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| |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **pH of Acids** | | | |  |  | **pH of Bases** | | | |  | | **Acid** | **Name** | **1 mM** | **10 mM** | **100 mM** |  | **Base** | **Name** | **1 mM** | **10 mM** | **100 mM** | | H2SeO4 | selenic acid | 2.74 | 1.83 | 1 |  | Ba(OH)2 | barium hydroxide | 11.27 | 12.22 | 13.08 | | H2SO4 | sulfuric acid  (oil of vitriol) | 2.75 | 1.87 | 1 |  | Sr(OH)2 | strontium hydroxide (caustic alkali) | 11.27 | 12.22 | 13.09 | | HI | hydroiodic acid (muriatic acid) | 3.01 | 2.04 | 1.1 |  | NaOH | sodium hydroxide  (lye) | 10.98 | 11.95 | 12.88 | | HBr | hydrobromic acid | 3.01 | 2.04 | 1.1 |  | KOH | potassium hydroxide (caustic potash) | 10.98 | 11.95 | 12.88 | | HCl | hydrochloric acid  (gastric acid) | 3.01 | 2.04 | 1.1 |  | Na2SiO3 | sodium metasilicate | 11 | 11.91 | 12.62 | | HNO3 | nitric acid | 3.01 | 2.04 | 1.1 |  | Ca(OH)2  (CaO:H2O) | calcium hydroxide  (lime) | 11.27 | 12.2 | 12.46 | | H3PO4 | orthophosphoric acid | 3.06 | 2.26 | 1.6 |  | Na3PO4 | trisodium phosphate  (food additive) | 10.95 | 11.71 | 12.12 | | H3AsO4 | arsenic acid | 3.08 | 2.31 | 1.7 |  | K2CO3 | potassium carbonate (potash or pearl ash) | 10.52 | 11 | 11.36 | | H2SeO3 | selenous acid | 3.15 | 2.47 | 1.9 |  | Na2CO3 | sodium carbonate  (soda ash) | 10.52 | 10.97 | 11.26 | | H2CrO4 | chromic acid | 3.03 | 2.33 | 2.1 |  | NH4OH  (NH3:H2O) | ammonium hydroxide (Windex) | 10.09 | 10.61 | 11.12 | | C6H8O7 | citric acid (lemon juice) | 3.24 | 2.62 | 2.1 |  | Mg(OH)2  (MgO:H2O) | magnesium hydroxide | 10.4 | 10.4 | 10.4 | | HF | hydrofluoric acid | 3.27 | 2.65 | 2.1 |  | CaCO3 | calcium carbonate (limestone or calcite) | 9.91 | 9.91 | 9.91 | | HNO2 | nitrous acid | 3.28 | 2.67 | 2.1 |  | Fe(OH)2 | iron(II) hydroxide  (ferrous hydroxide) | 9.45 | 9.45 | 9.45 | | HOCN | isocyanic acid | 3.35 | 2.76 | 2.2 |  | Cd(OH)2 | cadmium hydroxide | 9.36 | 9.36 | 9.36 | | CH2O2 | formic acid, (formic or methanoic acid) | 3.47 | 2.91 | 2.4 |  | Na2B4O7 | sodium borate  (Borax) | 9.21 | 9.17 | 9.05 | | H2Se | hydrogen selenide | 3.49 | 2.93 | 2.4 |  | Co(OH)2 | cobalt(II) hydroxide | 9.15 | 9.15 | 9.15 | | H2MoO4 | molybdic acid | 3.46 | 2.94 | 2.4 |  | Zn(OH)2 | zinc hydroxide | 8.88 | 8.88 | 8.88 | | C3H6O3 | lactic acid  (milk acid) | 3.51 | 2.96 | 2.4 |  | Ni(OH)2 | nickel(II) hydroxide | 8.37 | 8.37 | 8.37 | | C2H4O2 | acetic acid  (vinegar) | 3.91 | 3.39 | 2.9 |  | CH3COOK | potassium acetate  (diuretic salt) | 7.87 | 8.33 | 8.75 | | H2CO3 | carbonic acid | 4.68 | 4.18 | 3.7 |  | CH3COONa | sodium acetate  (acetic acid) | 7.87 | 8.33 | 8.75 | | H2S | hydrogen sulfide | 4.97 | 4.47 | 4 |  | KHCO3 | potassium hydrogen carbonate | 8.27 | 8.25 | 8.13 | | H3AsO3 | arsenious acid | 6.07 | 5.58 | 5.1 |  | NaHCO3 | sodium hydrogen carbonate  (baking soda) | 8.27 | 8.22 | 8.02 | | HCN | hydrocyanic acid | 6.11 | 5.62 | 5.1 |  | Be(OH)2 | beryllium hydroxide | 7.9 | 7.9 | 7.9 | | H3BO3 | boric acid | 6.12 | 5.62 | 5.1 |  | Cu(OH)2 | copper(II) hydroxide | 7.69 | 7.69 | 7.69 | | H4SiO4 | silicic acid | 6.4 | 5.91 | 5.4 |  | Pb(OH)2 | lead(II) hydroxide | 7.54 | 7.54 | 7.54 | | H4SiO4 | silicic acid | 6.4 | 6.26 | 6.3 |  | Cr(OH)3 | chromium(III) hydroxide | 7.04 | 7.04 | 7.04 | | H2O | pure water | 7.0 | 7.0 | 7.0 |  | Hg(OH)2 | mercury(II) hydroxide | 7.03 | 7.03 | 7.03 | |

Source: aqion (27 Oct 2024), [pH of Common Acids and Bases](https://www.aqion.de/site/ph-of-common-acids), <https://www.aqion.de/>

**Chapter 12: Reduction and Oxidation**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Term** | **Description** | | **Equation** | | |
| **Chemical Reaction Types** | 1. Synthesis (Formation) 2. Decomposition 3. Single Displacement 4. Double Displacement 5. Combustion 6. Acid-Base 7. Reduction-Oxidation | | 1. A + B ⟶ AB 2. AB ⟶ A + B 3. A + BC ⟶ AC + B 4. AB + CD ⟶ AD + CB 5. C3H8 + 5O2 ⟶ 3CO2 + 4H2O + heat (propane) 6. HA + BOH ⟶ BA + H2O | | |
| **Oxidation State** | The charge on an ion, or for a molecule, the charge that an atom would have, if the shared electrons in a bond were always given to the more **electronegative** atom. | | | | |
| Covalent | | | Ionic | |
| CF4 ⟶ C4+ + 4F– |  | | Al2O3 ⟶ 2Al3+ + 3O2– |  |
| **Oxidation State Rules** | These rules are **always** true:   1. For ions composed of only one atom, the oxidation state is equal to the charge on the ion. 2. For all elements and homonuclear molecules, the oxidation state of each atom is 0. 3. For molecules and polyatomic ions, the sum of the oxidation states must equal the total charge. 4. The oxidation state of F in any compound is 1-. 5. In covalent compounds and polyatomic ions, H has an oxidation state of 1+.   These rules are **usually** true:   1. In most compounds, O has an oxidation state of 2-. 2. Group 7A elements (especially Cl) usually have an oxidation state of 1-. | | | | |

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| --- | --- | --- |
| **Reduction-Oxidation (Redox)** | Redox Reactions - Examples, Types, Applications, Balancing  Reactions that transfer electrons from one set of atoms to another.  LEO says GER. | |
| **Oxidized** | Atom **loses** an electron | “Lose Electrons Oxidation” (LEO) |
| **Reduced** | Atom **gains** an electron | “Gain Electrons Reduction” (GER) |
|  |  | |
| **Oxidizing Agent** | If a reactant is reduced, it is called the **oxidizing agent**, because it oxidizes another reactant. | |
| **Reducing Agent** | If a reactant is oxidized, it is called the **reducing agent**, because it reduces another reactant. | |
| **Batteries** | Galvanic Cell (battery) | A system that uses a redox reaction to produce electrical energy. |
| Anode | The **negative** electrode in a Galvanic cell. |
| Cathode | The **positive** electrode in a Galvanic cell. |
| Draw a Galvanic cell made up of Cu and Zn. Be sure to label the anode,  cathode, charge on electrodes, and direction of electron and ion flow. |  Homework.Study.com | |
| **Balancing Charge** | For a chemical equation to be balanced, the total charge on each side of the equation must be the same. | |
| **Electroplating** | Using reduction (usually powered by electricity) to coat an object with a metal. | |
| **Corrosion** | The chemical deterioration of a substance, usually by oxidation. (rust) | |

**Chapter 13: The Heat Is On**

|  |  |  |
| --- | --- | --- |
| **Term** | **Equation** | **Note** |
| **Energy** |  | The ability to do work.  Units are energy are always in Joules ().  Conservation of energy . |
| **Work** |  | The application of a force to move an object over a distance. |
| **Heat** |  | Energy that is exchanged because of a difference in temperature or a phase change. |
| **Kinetic Energy** |  | Energy that is in motion. |
| **Potential Energy** |  | Energy that is stored. |
| **calorie** |  | The amount of heat required to raise 1 gram of water 1 degree Celsius. |
| **Calorie** | 1 Food **C**alorie = 1,000 chemist **c**alories | Big ‘C’ vs. little ‘c’. |
| **Specific Heat Capacity (c)** |  | The amount of heat it takes to raise a specific mass of a substance 1 °C. |
| **Heat Capacity (C)** |  | The amount of heat it takes to raise an entire object 1 °C.  Takes the mass of the object into account. |
| **Measuring Heat** | ***.***  *where:* | |
| **Calorimeter** | Calorimetry ( Read ) | Chemistry | CK-12 Foundation | |
|  | In a calorimeter experiment, the temperature of the liquid and the calorimeter are always the same.  In addition, the *final* temperature of the liquid, calorimeter, and object are all the same. |
| **Latent Heat** | *where:* | The amount of heat absorbed or released by a substance during a phase change. |
|  | | |
| **Exothermic Reaction** |  | A chemical reaction that releases energy.  e.g., Dilution of sulfuric acid in water. |
| **Endothermic Reaction** |  | A chemical reaction that absorbs energy.  e.g., Dissolving ammonium nitrate in water. |

**Specific Heat Capacities of Different Substances**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Substance** | **Specific Heat J/gC** |  | **Substance** | **Specific Heat J/gC** |
| **Water (l)** | **4.184** |  | Nickel (s) | 0.440 |
| Water (s) | 2.093 |  | Zinc (s) | 0.387 |
| Vegetable Oil | 2.000 |  | Copper (s) | 0.386 |
| Air | 1.020 |  | Brass (s) | 0.380 |
| Magnesium (s) | 1.020 |  | Sand | 0.290 |
| Aluminum (s) | 0.900 |  | Silver (s) | 0.240 |
| Glass | 0.840 |  | Tin (s) | 0.210 |
| Potassium (s) | 0.757 |  | Lead(s) | 0.160 |
| Calcium (s) | 0.650 |  | Mercury (l) | 0.140 |
| Iron (s) | 0.444 |  | Gold (s) | 0.126 |

**Chapter 14: Thermodynamics**

|  |  |  |
| --- | --- | --- |
| **Term** | **Description** | **Equation** |
| **Enthalpy ()** | The energy change that accompanies a chemical or physical change. | |
| **Enthalpy Observations** | * For exothermic reactions, is negative (–). * For endothermic reactions, is positive (+). | |
| **Enthalpy** | *= (Energy for breaking bonds) – (Energy from making bonds)* | |
| **Bond Energy** | The energy required to break a mole of a given type of bond. | |
| **State Function** | A property that is independent of the path. | |
| **Default Enthalpy** | The of any element in its natural phase is zero. | |
| **Hess’s Law** | Chemical reaction: | |
| **Activation Energy** | The energy required to initiate a chemical reaction.  Reaction Coordinate Diagrams - College Chemistry | |
| **Thermodynamics** | The study of the relationships and conversions between different forms of energy.   * 1st Law: Energy cannot be created or destroyed. It can only change form. * 2nd Law: The entropy of the universe can never decrease. It must always stay the same or increase. | |

|  |  |
| --- | --- |
| **Entropy (S)** | A measure of the amount of thermal energy in a system that is not available to do useful work.  Because work is obtained from ordered molecular motion, entropy is also a measure of the molecular disorder, or randomness, of a system. |
| **Change in Entropy** |  |
| **Entropy Observations** | * The solid phase is the lowest-entropy phase. * The gas phase is the highest-entropy phase. * The larger the number of molecules, the higher the entropy. |
| **Entropy Reactions** | Chemical reaction: |
| **Gibbs Free Energy (G)** |  |
| undefined |
| **Efficiency** | can predict chemical reaction efficiency. |
| **Gibbs Observations** | * When is negative (–), the reaction is spontaneous. * When is positive (+), the reaction is not spontaneous. * The of any element in its natural phase is zero. |
| **Gibbs Reactions** | Chemical reaction: |

**Bond Energies**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Bond** | **Energy**  **( kJ/mole)** |  | **Bond** | **Energy**  **( kJ/mole)** |  | **Bond** | **Energy**  **( kJ/mole)** |
|  | 436 |  |  | 350 |  |  | 159 |
|  | 410 |  |  | 450 |  |  | 243 |
|  | 460 |  |  | 330 |  |  | 340 |
|  | 432 |  |  | 350 |  |  | 310 |
|  | 390 |  |  | 300 |  |  | 200 |
|  | 611 |  |  | 732 |  |  | 945 |
|  | 607 |  |  | 498 |  |  | 1072 |

**Standard Enthalpies of Formation**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Compound** | **( kJ/mole)** |  | **Compound** | **( kJ/mole)** |  | **Compound** | **( kJ/mole)** |
|  | -74.9 |  |  | -277.7 |  |  | -191.2 |
|  | -84.7 |  |  | -393.5 |  |  | -92.3 |
|  | 82.6 |  |  | -110.5 |  |  | -167.2 |
|  | 49.0 |  |  | 116.9 |  |  | -45.9 |
|  | -200.7 |  |  | 89.7 |  |  | -80.3 |
|  | -238.7 |  |  | -241.8 |  |  | -314.6 |
|  | -235.1 |  |  | -285.8 |  |  | -425.9 |

**Absolute Entropies**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Substance** | **( J/mole·K)** |  | **Substance** | **( J/mole·K)** |  | **Substance** | **( J/mole·K)** |
|  | 186.1 |  |  | 160.7 |  |  | 143.9 |
|  | 229.5 |  |  | 213.7 |  |  | 186.8 |
|  | 269.2 |  |  | 197.5 |  |  | 56.5 |
|  | 173.4 |  |  | 237.9 |  |  | 192.7 |
|  | 239.7 |  |  | 153.1 |  |  | 111.3 |
|  | 126.8 |  |  | 188.7 |  |  | 94.9 |
|  | 282.6 |  |  | 70.0 |  |  | 64.4 |
|  | 5.7 |  |  | 130.6 |  |  | 223.0 |
|  | 158.0 |  |  | 205.0 |  |  | 191.6 |

**Standard Gibbs Free Energy of Formation**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Compound** | **( kJ/mole)** |  | **Compound** | **( kJ/mole)** |  | **Compound** | **( kJ/mole)** |
|  | -50.8 |  |  | -174.9 |  |  | -134.1 |
|  | -32.9 |  |  | -394.4 |  |  | -95.3 |
|  | 129.7 |  |  | -137.2 |  |  | -131.3 |
|  | 124.4 |  |  | 66.9 |  |  | -16.4 |
|  | -162.0 |  |  | 65.3 |  |  | -26.6 |
|  | -166.4 |  |  | -228.6 |  |  | -203.1 |
|  | -168.8 |  |  | -237.1 |  |  | -379.7 |

**Chapter 15: Kinetics**

|  |  |  |
| --- | --- | --- |
| **Term** | **Equation** | **Note** |
| **Kinetics** | The study of chemical reaction rates. | |
| **Rate** |  | Chemical reaction:  [ ] = “The concentration of” |
| **Reaction Rate Observations** | The reaction rate is usually proportional to the:   * Concentration of reactants * Surface area over which the reaction can occur * Temperature | |
| **Rate Equation** |  | Chemical reaction:  The Rate Equation (A-Level) | ChemistryStudent |
| **Rate Constant** | * The units for the rate constant depend on the overall order of the reaction. * The rate constant increases exponentially with increasing temperature. * The rate constant decreases with increasing activation energy. | |
| IB Colourful Solutions in ChemistryRates of Reactions | CK-12 Foundation | | |
| **Catalyst** | A chemical that increases the rate of a chemical reaction without being used up in the process.  i.e., It lowers the activation energy of the reaction by pulling the molecules closer to one another than they would normally be.  Catalyst Regulating Reactions — Overview & Examples - Expii | |
| **Catalase** | A common enzyme found in nearly all living organisms exposed to oxygen which catalyzes the decomposition of to and . | |
| **Heterogeneous Catalyst** | A catalyst in a phase that is different from that of the reactants.  e.g., Catalytic converter (g) + (s). | |
| **Catalytic Converter**  aFe Power Direct Fit Catalytic Converter 07-13 Mini Cooper S (R56) L4- |  Black Ops Auto Works | A device attached to the exhaust of a car that speeds up the following reaction:  The catalyst is the platinum-coated (**solid**) mesh that lowers the activation energy. | |
| **Homogeneous Catalyst** | A catalyst in a phase that is the same as that of the reactants. | |
| **Reaction Mechanism** | A detailed, step-by-step process that tells you exactly how a reaction occurs.  Step 1:  Step 2: due to UV light  Step 3: | |

**Chapter 16: Chemical Equilibrium**

|  |  |  |  |
| --- | --- | --- | --- |
| **Term** | **Description** | **Equation** | |
| **Chemical Equilibrium** | The state that occurs in a chemical reaction when the rate of the forward reaction equals the rate of the reverse reaction. | | |
| **Example** | 8.2: Chemical Equilibrium - Chemistry LibreTexts | | |
| **Equilibrium Constant** |  | Chemical reaction: | |
| The value of the equilibrium constant for a given reaction changes with temperature. | | |
| **Interpreting the Constant** | :   * When the equilibrium constant is small, the reaction makes fewer products and has lots of reactants. * The smaller it is, the more reactants there are and the fewer products there are at equilibrium.   **= 1**:   * When the equilibrium constant is 1, the reaction is balanced between reactants and products.   :   * When the equilibrium constant is large, the reaction makes lots of products and has few reactants. * The larger it is, the more products there are and the fewer reactants there are at equilibrium. | | |
|  | |  |
| **Focus on Gas** | Do not include solid or liquid reactants or products in the equation for the equilibrium constant. | | |
| **Interpreting Results** |  | | |
| For the above equation:   * **>**: If the result is greater than the equilibrium constant, the reaction will shift towards the reactants. * **=**: If the result is equal to the equilibrium constant, the reaction is at equilibrium. * **<**: If the result is less than the equilibrium constant, the reaction will shift towards the products. | | |
| **Le Chatelier’s Principle** | When a system at equilibrium is stressed, it will shift in a way that relieves the stress and reestablishes equilibrium. | | |
|  |  | | |
| **Shifting: Concentration** | A system in equilibrium will:   * ⬆: shift away from the side that experiences an increase in concentration. * ⬇: shift towards the side that experiences a decrease in concentration. | | |
| **Shifting: Temperature** | * ⬆: When temperature is raised, an equilibrium will shift away from the side that contains energy. * ⬇: When temperature is lowered, it will shift towards the side that contains energy. | | |
| **Shifting: Pressure** | * ⬆: When pressure is raised, an equilibrium will shift away from the side that has the most gas molecules. * ⬇: When pressure is lowered, it will shift towards the side that has the most gas molecules * **↔**: If there are no gas molecules, the equilibrium doesn’t shift when pressure is changed. | | |
| **Acid Ionization Constant ()** | The equilibrium constant for the reaction between an acid and water. | | |
| **Base Ionization Constant ()** | The equilibrium constant for the reaction between a base and water. | | |

**Sources**

These chapters and content are from the textbook:

* Dr. Jay L. Wile (2015). [Discovering Design with Chemistry](https://www.amazon.com/Discovering-Design-Chemistry-Textbook-Wile/dp/099627846X/ref=sr_1_1), 1st Edition.