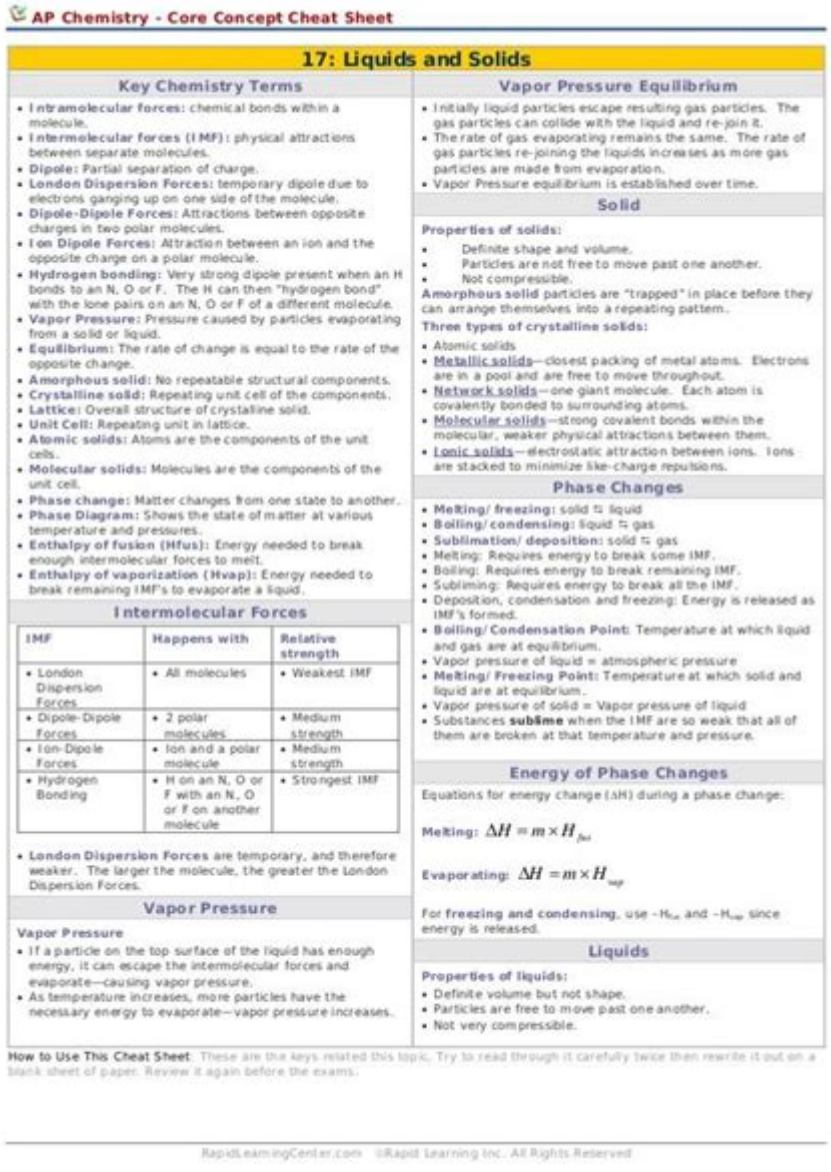
Environmental Chemistry Science Olympiad Cheat Sheet



AP Chemistry - Core Concept Cheat Sheet

17: Liquids and Solids

Key Chemistry Terms

- **Intramolecular forces:** chemical bonds within a molecule.
- **Intermolecular forces (IMF):** physical attractions between separate molecules.
- **Dipole:** Partial separation of charge.
- **London Dispersion Forces:** temporary dipole due to electrons ganging up on one side of the molecule.
- **Dipole-Dipole Forces:** Attractions between opposite charges in two polar molecules.
- **Ion Dipole Forces:** Attraction between an ion and the opposite charge on a polar molecule.
- **Hydrogen bonding:** Very strong dipole present when an H bonds to an N, O or F. The H can then "hydrogen bond" with the lone pairs on an N, O or F of a different molecule.
- **Vapor Pressure:** Pressure caused by particles evaporating from a solid or liquid.
- **Equilibrium:** The rate of change is equal to the rate of the opposite change.
- **Amorphous solid:** No repeatable structural components.
- **Crystalline solid:** Repeating unit cell of the components.
- **Lattice:** Overall structure of crystalline solid.
- **Unit Cell:** Repeating unit in lattice.
- **Atomic solids:** Atoms are the components of the unit cells.
- **Molecular solids:** Molecules are the components of the unit cell.
- **Phase change:** Matter changes from one state to another.
- **Phase Diagram:** Shows the state of matter at various temperature and pressures.
- **Enthalpy of fusion (Hfus):** Energy needed to break enough intermolecular forces to melt.
- **Enthalpy of vaporization (Hvap):** Energy needed to break remaining IMF's to evaporate a liquid.

Intermolecular Forces

IMF	Happens with	Relative strength
• London Dispersion Forces	• All molecules	• Weakest IMF
• Dipole-Dipole Forces	• 2 polar molecules	• Medium strength
• Ion-Dipole Forces	• Ion and a polar molecule	• Medium strength
• Hydrogen Bonding	• H on an N, O or F with an N, O or F on another molecule	• Strongest IMF

- **London Dispersion Forces** are temporary, and therefore weaker. The larger the molecule, the greater the London Dispersion Forces.

Vapor Pressure

Vapor Pressure

- If a particle on the top surface of the liquid has enough energy, it can escape the intermolecular forces and evaporate—causing vapor pressure.
- As temperature increases, more particles have the necessary energy to evaporate—vapor pressure increases.

Vapor Pressure Equilibrium

- Initially liquid particles escape resulting gas particles. The gas particles can collide with the liquid and re-join it.
- The rate of gas evaporating remains the same. The rate of gas particles re-joining the liquids increases as more gas particles are made from evaporation.
- Vapor Pressure equilibrium is established over time.

Solid

Properties of solids:

- Definite shape and volume.
- Particles are not free to move past one another.
- Not compressible.

Amorphous solid particles are "trapped" in place before they can arrange themselves into a repeating pattern.

Three types of crystalline solids:

- Atomic solids
- Metallic solids—closest packing of metal atoms. Electrons are in a pool and are free to move throughout.
- Network solids—one giant molecule. Each atom is covalently bonded to surrounding atoms.
- Molecular solids—strong covalent bonds within the molecular, weaker physical attractions between them.
- Ionic solids—electrostatic attraction between ions. Ions are stacked to minimize like-charge repulsions.

Phase Changes

- **Melting/ freezing:** solid ⇅ liquid
- **Boiling/ condensing:** liquid ⇅ gas
- **Sublimation/ deposition:** solid ⇅ gas
- Melting: Requires energy to break some IMF.
- Boiling: Requires energy to break remaining IMF.
- Subliming: Requires energy to break all the IMF.
- Deposition, condensation and freezing: Energy is released as IMF's formed.
- **Boiling/ Condensation Point:** Temperature at which liquid and gas are at equilibrium.
- Vapor pressure of liquid = atmospheric pressure
- **Melting/ Freezing Point:** Temperature at which solid and liquid are at equilibrium.
- Vapor pressure of solid = Vapor pressure of liquid
- Substances **sublime** when the IMF are so weak that all of them are broken at that temperature and pressure.

Energy of Phase Changes

Equations for energy change (ΔH) during a phase change:

Melting: $\Delta H = m \times H_{fus}$

Evaporating: $\Delta H = m \times H_{vap}$

For **freezing and condensing**, use $-H_{fus}$ and $-H_{vap}$ since energy is released.

Liquids

Properties of liquids:

- Definite volume but not shape.
- Particles are free to move past one another.
- Not very compressible.

How to Use This Cheat Sheet: These are the keys related this topic. Try to read through it carefully twice then rewrite it out on a blank sheet of paper. Review it again before the exams.

Environmental chemistry science olympiad cheat sheet is a valuable resource for students preparing for competitions focused on the intersection of chemistry and environmental science. This area of study is crucial for understanding the impact of chemical substances on the natural world and human health. The Science Olympiad often requires participants to have a solid grasp of various concepts, principles, and applications of environmental chemistry. This cheat sheet will provide an overview of key topics, essential formulas, and practical applications that will help competitors excel in their events.

Key Concepts in Environmental Chemistry

Environmental chemistry focuses on the chemical processes that occur in the environment and the effects of human activities on these processes. Here are some foundational concepts:

1. Chemical Reactions and Environmental Impact

Understanding how chemicals interact in the environment is essential. Key types of reactions include:

- Combustion: The burning of fossil fuels releases carbon dioxide (CO_2), nitrogen oxides (NO_x), and sulfur dioxide (SO_2), leading to air pollution and climate change.
- Photosynthesis and Respiration: These processes are vital for understanding carbon cycling. Photosynthesis converts CO_2 into organic matter, while respiration returns CO_2 to the atmosphere.
- Decomposition: The breakdown of organic matter by microorganisms releases nutrients back into the soil but can also lead to methane (CH_4) emissions.

2. Environmental Pollutants

Pollutants can be categorized into several types:

- Heavy Metals: Lead (Pb), mercury (Hg), and cadmium (Cd) are toxic even at low concentrations and can bioaccumulate in organisms.
- Nutrients: Excess nitrogen and phosphorus from fertilizers can lead to eutrophication in water bodies, causing algal blooms and hypoxia.
- Persistent Organic Pollutants (POPs): Chemicals like DDT and PCBs are resistant to environmental degradation and can accumulate in the food chain.

Essential Principles and Theories

Understanding key theories and principles is crucial for any environmental chemistry competition.

1. The Law of Conservation of Mass

This principle states that mass cannot be created or destroyed in a closed system. In environmental chemistry, this means that chemicals in the environment can change forms (e.g., from solid to gas) but their total mass remains constant.

2. The Greenhouse Effect

The greenhouse effect is a natural process where certain gases in the atmosphere trap heat, keeping

the Earth warm. Key points include:

- Greenhouse Gases: CO_2, CH_4, nitrous oxide (N_2O), and water vapor.
- Human Impact: Increased emissions from industrial activities, agriculture, and transportation enhance this effect, leading to climate change.

3. Acid-Base Chemistry

Acidic and basic substances play significant roles in environmental chemistry. Understanding pH and its implications is important:

- pH Scale: Ranges from 0 (acidic) to 14 (basic), with 7 being neutral.
- Acid Rain: Formed when sulfur and nitrogen oxides react with water in the atmosphere, lowering surface water pH and harming aquatic life.

Analytical Techniques in Environmental Chemistry

Analytical chemistry techniques are essential for detecting and quantifying pollutants.

1. Chromatography

A technique used to separate mixtures. Common types include:

- Gas Chromatography (GC): Used for volatile compounds.
- High-Performance Liquid Chromatography (HPLC): Effective for non-volatile compounds.

2. Spectroscopy

Spectroscopic methods help identify substances based on their interaction with light:

- UV-Vis Spectroscopy: Measures absorbance of UV or visible light.
- Infrared Spectroscopy (IR): Identifies molecular structures based on vibrational transitions.

3. Mass Spectrometry

This technique determines the mass-to-charge ratio of ions, allowing for the identification and quantification of chemical species in environmental samples.

Environmental Chemistry Applications

The principles of environmental chemistry are applied in various fields, including:

1. Pollution Monitoring

Regular monitoring of air, water, and soil quality is essential for assessing pollution levels and implementing regulations. Key methods include:

- Sampling: Collecting samples from various environments.
- Analysis: Using techniques like chromatography and spectroscopy to analyze samples.

2. Waste Management

Effective waste management strategies minimize environmental impact. Key practices include:

- Recycling: The process of converting waste into reusable material.
- Composting: Organic waste is decomposed naturally, reducing landfill use and creating nutrient-rich soil.

3. Remediation Techniques

Techniques used to clean up contaminated sites include:

- Bioremediation: Using microorganisms to degrade pollutants.
- Phytoremediation: Utilizing plants to absorb and detoxify contaminants.

Study Tips for the Science Olympiad

Preparing for the Environmental Chemistry portion of the Science Olympiad can be challenging. Here are some effective study tips:

1. Create a Study Schedule

Organize your study time to cover all topics systematically. Break down the syllabus into manageable sections and allocate specific time slots for each.

2. Use Visual Aids

Diagrams, charts, and flashcards can help reinforce complex concepts. Consider creating:

- Mind Maps: To visualize connections between different topics.
- Flashcards: For definitions and key formulas.

3. Practice with Past Olympiad Questions

Familiarize yourself with the format and types of questions that may be asked. This practice helps build confidence and identify areas needing more focus.

4. Group Study Sessions

Collaborating with peers can enhance understanding. Discussing topics and quizzing each other can reinforce learning and expose you to different perspectives.

5. Stay Updated on Current Environmental Issues

Being informed about current events in environmental science can provide context for your studies. Follow reputable environmental news sources and scientific journals.

Conclusion

An environmental chemistry science olympiad cheat sheet serves as a valuable tool for students preparing for competitions. By mastering key concepts, principles, and analytical techniques, participants can enhance their understanding of how chemistry interacts with environmental processes. Additionally, employing effective study strategies will allow competitors to approach their preparation with confidence and clarity. As students engage with this interdisciplinary field, they not only prepare for their Olympiad but also gain insights into the critical environmental challenges facing our world today.

Frequently Asked Questions

What topics should I focus on for the Environmental Chemistry Science Olympiad?

Focus on key topics such as chemical cycles (carbon, nitrogen, sulfur), pollution types and sources, environmental regulations, and the impact of chemicals on ecosystems.

How can I effectively use a cheat sheet for the Environmental Chemistry Science Olympiad?

Organize your cheat sheet by categories such as definitions, formulas, and key concepts. Use bullet points for clarity and include diagrams for complex processes.

What are some important chemical reactions relevant to environmental chemistry?

Key reactions include photosynthesis, respiration, combustion, and the formation of acid rain through the reaction of sulfur dioxide with water.

What role do greenhouse gases play in environmental chemistry?

Greenhouse gases trap heat in the atmosphere, leading to global warming. Understanding their sources, such as CO2 from fossil fuels and CH4 from agriculture, is crucial.

How can I prepare for the practical component of the Environmental Chemistry Science Olympiad?

Practice laboratory techniques like titration, chromatography, and spectrophotometry. Familiarize yourself with safety protocols and data analysis methods.

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