4-2-2009

Gases, Liquids, and Solids [9th-12th grade]

Dustin Demoin
Trinity University, Dustin.Demoin@yahoo.com

Unit: Gases, Liquids, and Solids
Grade: High School Chemistry (Pre-AP)

Stage 1: Desired Results

Content Standards (TEKS)

4. The student knows the characteristics of matter.
   The student is expected to:
   B. Analyze examples of solids, liquids, and gases to determine their compressibility, structure, and motion of particles, shape, and volume.
5. The student knows that energy transformations occur during physical or chemical changes in matter.
   The student is expected to:
   A. Identify changes in matter, determine the nature of the change, and examine the forms of energy involved.
   C. Measure the effects of the gain or loss of heat energy on the properties of solids, liquids, and gases.
7. The student knows the variables that influence the behavior of gases.
   The student is expected to:
   A. Describe interrelationships among temperature, particle number, pressure, and volume of gases contained within a closed system.
   B. Illustrate the data obtained from investigations with gases in a closed system and determine if the data are consistent with the Combined (Universal) Gas Law.

Understandings

Students will understand that…

- The kinetic energy (energy of motion) of the particles that make up a substance determines the state of the material.
- During phase changes, energy increases, but the temperature does not increase, until all of the material has changed phase.
- Energy and stresses cause changes in physical properties of all materials—solids, liquids, and gases.

Essential Questions

- How is it possible that all matter is in constant motion?
- How are energy and phases related?
- How do forces affect matter?
- When are laws meant to be broken?
  - All matter at any temperature is in constant motion (potential energy). Energy is consumed when changing phases, but the temperature does not increase. Intramolecular and intermolecular forces cause gases, solids, and liquids to behave differently depending on the types of forces acting on the molecules, as well as the points and lines on the phase diagrams. Laws break down at different places and students should have a basic understanding of where those points are, if they understand the laws.

Knowledge

Students will know:

- Boyle's, Charles', Combined Gas, Ideal Gas, and Graham's Laws (and their limitations)
- The Kinetic Molecular Theory
- Properties of solids (lowest KE; defined volume, shape, and structure; relatively incompressible; diffuse millions times slower)
- Properties of liquids (middle range of KE; defined volume, but undefined shape and structure; relatively incompressible; easily diffuses; surface tension)
  - Water and Ice behave differently
- Properties of gases (highest KE; no defined shape, structure, or volume; easily compressed; easily diffuses)
- Molar volume of 22.4L of an ideal gas at STP
- Conversions for Pressure units
- The Ideal Gas Constant R (units and value) [0.0821 Latm/molK]
- Use of the Kelvin Temperature Scale and the importance of absolute zero

Skills

Students will be able to:

- Use the gas laws to answer questions about changes in Pressure, Volume, Temperature, and the number of particles
- Balance and discuss gas phase reactions
  - Stoichiometry included
- Discuss the difference between solids, liquids, and gases in terms of the relative kinetic energy of the particles that make up the substance, volume, compressibility, structure, and shape
- Label the points on a phase diagram and discuss their relevance
- Define the terms used to describe phase changes
- Determine the amount of a certain phase left, if some amount of heat energy is lost or gained
  - Using specific heat, ΔH_{vap} and ΔH_{fusion}
- Determine if data is consistent with the combined gas law

Stage 2: Assessment Evidence

Performance Task:

Phases of Matter

Each group will investigate one compound (ionic or covalent) to determine the main points of its phase diagram and then use this to answer specific questions relative to the class. The questions will ask students to

1. determine, summarize, and write about the usage, transportation, storage, and precautions for their respective compound;
2. construct (from data or find) a phase diagram with at least the triple point, solid region, liquid region, gaseous region, and critical point labeled and colored;
3. choose one pressure at which all three phases can be attained and calculate the amount of energy necessary to convert one kilogram of material from the solid to the liquid to the gaseous phase at that pressure,
4. use an example of a change in pressure and volume of the gaseous compound with Boyle's Law; volume and temperature with Charles' Law; temperature and pressure with Gay-Lussac's Law; and pressure, volume, and temperature with Combined Gas Law;
5. and calculate the number of moles in a given volume, temperature, and pressure using the Ideal Gas Law.

Other evidence:

(quizzes, tests, academic prompts, etc. note – these are usually included where appropriate in Stage 3 as well)

Tested or Quizzed Vocabulary:

a. Degrees Celsius, Kelvin, gases, liquids, solids, compressibility, volume, temperature, surface tension of liquids, viscosity, buoyancy, crystal structure, Kinetic energy
b. Phase change, sublimation, deposition, melting, fusion, vaporization, condensation, equilibrium vapor pressure, boiling point, triple point
c. Kinetic Molecular Theory, effusion, barometers/manometers, atm/torr/pascal, Dalton's law of partial pressures, combined gas law, diffusion, pressure, ideal gas law, Standard Temperature and Pressure (STP)

Mini-Assessments: Students will take the last five minutes of classes to prepare a short statement about what was covered during that class and answer one question

Tests: 1 test covering phase changes and the energy involved (short answer with one problem and two essays); 1 test over gases (multiple choice with short answer and one essay)

Homework: A few problems each night, checked for completion, graded if it was needed to reinforce what was going right and what was going wrong.

Stage 3: Learning Activities

(Steps taken to get students to answer Stage 1 questions and complete performance task)

Day 1A&B

- Created Warm-Up Page (did a warm-up like the test question from Stoichiometry)
- Wrapped up Stoichiometry
- Fold paper in notebook to separate sections; write "States of Matter"
- Worked in lab groups to brainstorm what the students already knew about Solids, Liquids and Gases
    - One side of the paper was what they knew
    - The other side was questions they had
- Pasted in the Venn Diagram and filled in the bullet points (left the arrows blank)
- Cut out vocabulary foldable
- Homework: write down an example of each one of the phases (solid, liquid, and gas)

Day 2A&B

- Ask what people found for their homework (in notebook and will be graded later)
- Introduce Unit and Essential Questions
    - How is it possible that all matter is in constant motion?
    - How are energy and phases related?
    - How do forces affect matter?
    - When are laws meant to be broken?
- Phases:
    - Vocabulary Foldable
    - KMT notes
- Discuss units: Volume, Temperature (both Celsius and Kelvin), Pressure, and Energy
    - Recap conversions/dimensional analysis as warm-up assessment
    - Discuss volume units and conversions
    - Discuss the temperature scales, their bases and their uses (conversion to Fahrenheit).
    - Discuss the pressure scales, their bases and their conversions
    - Discuss energy (Joules and calories, and their conversion)
- Start Solids and Liquids
    - Demonstration with diffusion of food coloring onto a solid vs. "stagnant" liquid
    - Had students get into groups to learn from booklets (made from the cartoon guide to chemistry) the following information:
        - Solids
            - Crystal Structures
            - Diffusion
            - Specific Heat
        - Liquids
            - Pure vs. solutions
            - Surface tension
                - Mosquito sits on top of water and drinks
                - Add soap, destroy surface tension, and he falls through
                - "Bubble" that prevents spilling in a liquid, how you get a bead of on your car
                - Can you find a liquid that doesn't bead up? AKA no surface tension?
                - What causes surface tension? Intermolecular forces

- Capillary Action
- Diffusion
- Vapor Pressure
    - Boiling
        - Normal Boiling Point
    - Evaporation
- Specific heat

➢ Homework: Fill-in the answers from your booklet on the Summary Questions worksheet for tomorrow's class.

Day 3A&B

➢ Vocabulary Quiz over the first 13 terms
    - Check homework during quiz for completion
➢ Teaching booklets (groups)
➢ Completed Summary Questions as a class
➢ Started next vocabulary foldable
➢ Homework: both sides of the Homework worksheet.

Day 4A&B

➢ Check for homework
➢ Vocabulary foldable for changes of state
➢ Filled-in arrows on Venn Diagram
➢ Lab: Freezing and Melting of H_2O
➢ Homework: Finish Lab if not done, and do the homework page that has specific heat problems and the heating curve from the homework book.

Day 5A&B

➢ Partner quiz covering states of matter and one specific heat problem.
➢ Start notes.
    - Phase Diagram
        - Typical placement of phases
        - Triple Point
        - Critical Pressure and Temperature
        - Fusion line, vapor line, and sublimation line
        - How water's phase diagram is different and how that affects life on earth
    - Enthalpy of fusion and vaporization
➢ Homework: Finish combination practice problems, fusion/vaporization problems and if you have time start the review.

Day 6A&B

➢ Warm-Up/Check Homework
➢ Notes/Practice Problems
➢ Review – numbered heads together
➢ Homework: Review and Phase change problems
➢ Test next time

Day 7A&B

➢ Phase Changes Test: Vocabulary and Problems
➢ Boyle's Law Lab
➢ Homework: Finish lab and questions.

Day 8A&B

➢ Passed back Tests
➢ Introduced Project

- Gas Law Notes for Boyle's, Charles', Gay-Lussac's, and Combined Gas Laws
- Homework: Boyle's and Charles' Laws and Combined Gas Law; Gas Laws Problems I

Day 9A&B

- Turn-in homework
- Dalton's law and Ideal Gas Law Notes
- Molar Mass of Butane Lab
- Homework: Ideal Gas Problems 1-8

Day 10A&B

- Turn-in Ideal gas law homework
- Graham's Law notes
- Gas law problems II; More ideal gas problems; effusion
- Homework: work on worksheets and project

Day 11A&B

- Handed out Review
- Worked on Project
- Worked on a few practice problems
- Homework: If not finished with practice problems or review, then they should be completed

Day 12A&B

- Gases Test

Day 13A&B

- Present Projects
  - Students fill out an evaluation of group members
  - Students fill out an evaluation of each group's presentation
  - Turn-in their written reports
  - Max of 5 minutes on each presentation
- Wrap-up the unit

Unit Schedule

Monday	Tuesday	Wednesday	Thursday	Friday
29	30 Start Unit Venn Diagram *SWBAT define the three phases of matter with respect to the KMT* *SWBAT define the first section of the vocab terms*	31 Start Unit Venn Diagram	1 Units: V, T (C&K), P, and E KMT Notes Vocab Cartoon Booklets *SWBAT use the units outlined and convert between the different units for V, T, P, and E* *SWBAT discuss the properties of solids and liquids with respect to each other*	2 Units: V, T (C&K), P, and E KMT Notes Vocab Cartoon Booklets
5 Vocab Quiz 1 Teach Booklets Phase Changes Vocab *SWBAT discuss the properties of solids and liquids with respect to each other* *SWBAT define the first section of the vocab terms*	6 Vocab Quiz 1 Teach Booklets Phase Changes Vocab	7 Phase Change Vocab Melting and Freezing of water lab *SWBAT define the second section of the vocab terms* *SWBAT draw and discuss the heating curve of water*	8 Phase Change Vocab Melting and Freezing of water lab	9 Partner quiz Phase change notes *SWBAT identify properties of solids, liquids, and gases* *SWBAT label and use the phase diagram* *SWBAT calculate the amount of E needed to change phases from one to another*
12 Partner quiz Phase change notes	13 Finish Notes Review Game *SWBAT calculate the amount of E needed to change phases from one to another* *SWBAT discuss properties of solids, liquids, and gases*	14 Finish Notes Review Game	15 Phase change Test Boyle's Law Lab *SWBAT calculate the amount of E needed to change phases from one to another* *SWBAT discuss properties of solids, liquids, and gases* *SWBAT discuss the relationship between volume and pressure for gases*	16 Phase change Test Boyle's Law Lab

Monday	Tuesday	Wednesday	Thursday	Friday
19 Passed back Tests Intro Project Gas Law Notes *SWBAT discuss the relationship between volume, pressure, and temperature for gases*	20 Passed back tests Intro Project (TAKS TEST)	21 Dalton's Law Ideal Gas Law Molar mass of Butane *SWBAT discuss the relationship between volume, pressure, temperature, and number of moles for gases* *SWBAT calculate the partial pressure of gases*	22 Gas Law Notes Work on worksheets	23(B) Dalton's Law Ideal Gas Law Molar mass of Butane
26 **School's Out**	27 Graham's Law Practice Problems for all laws *SWBAT discuss the effects of temperature on the relative rates of effusion and diffusion for gases of different masses* *SWBAT solve gas law problems using the correct formulas*	28 Graham's Law Practice Problems for all laws	1 Review handed out Work on project *SWBAT answer questions regarding gases properties, gas laws, and the effects of gases on their containers* *SWBAT work gas law and specific heat problems* *SWBAT construct an accurate phase diagram for their compound* *SWBAT construct an accurate model showing both the molecular geometry and intermolecular forces*	2 Review handed out Work on project
5 Test: Gases *SWBAT answer questions regarding gases properties, gas laws, and the effects of gases on their containers*	6 Test: Gases	7 Present Projects Wrap-Up Unit *SWBAT present the researched material for their respective compounds* *SWBAT answer the essential questions*	8 Present Projects Wrap-Up Unit	9