# Richmond Public Schools

## Department of Curriculum and Instruction

## Curriculum Pacing and Resource Guide – Unit Plan

**Course Title/ Course #: EOC Chemistry/2802 or EOC Pre AP Chemistry/ 2804**

**Unit Title/ Marking Period # (MP):1**

**Start day: Day 13**

**Meetings (Length of Unit): 3 Weeks**

## *Desired Results ~ What will students be learning?*

### Standards of Learning/ Standards

**CH.5a-g**

CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include
a) pressure, temperature, and volume;
b) partial pressure and gas laws;
c) vapor pressure;
d) phase changes;
e) molar heats of fusion and vaporization;
f) specific heat capacity; and
g) colligative properties.

### Essential Understandings/ Big Ideas

The concepts developed in this standard include the following:
- Atoms and molecules are in constant motion.
- The phase of a substance depends on temperature and pressure.
- Temperature is a measurement of the average kinetic energy in a sample. There is a direct relationship between temperature and average kinetic energy.
- The kinetic molecular theory is a model for predicting and explaining gas behavior.
- Gases have mass and occupy space. Gas particles are in constant, rapid, random motion and exert pressure as they collide with the walls of their containers. Gas molecules with the lightest mass travel fastest. Relatively large distances separate gas particles from each other.
- Equal volumes of gases at the same temperature and pressure contain an equal number of particles. Pressure units include atm, kPa, and mm Hg.
- An ideal gas does not exist, but this concept is used to model gas behavior. A real gas exists, has intermolecular forces and particle volume, and can change states. The Ideal Gas Law states that PV = nRT.
- The pressure and volume of a sample of a gas at constant temperature are inversely proportional to each other (Boyle's Law: P1V1 = P2V2).
- At constant pressure, the volume of a fixed amount of gas is directly proportional to its absolute temperature (Charles' Law: V1/T1 = V2/T2).
- The Combined Gas Law (P1V1/T1 = P2V2/T2) relates pressure, volume, and temperature of a gas.
- The sum of the partial pressures of all the components in a gas mixture is equal to the total pressure of a gas mixture (Dalton's law of partial pressures).

 Forces of attraction (intermolecular forces) between molecules determine their state of matter at a given temperature. Forces of attraction include hydrogen bonding, dipole-dipole attraction, and London dispersion (van der Waals) forces.
 Vapor pressure is the pressure of the vapor found directly above a liquid in a closed container. When the vapor pressure equals the atmospheric pressure, a liquid boils. Volatile liquids have high vapor pressures, weak intermolecular forces, and low boiling points. Nonvolatile liquids have low vapor pressures, strong intermolecular forces, and high boiling points.
 Solid, liquid, and gas phases of a substance have different energy content. Pressure, temperature, and volume changes can cause a change in physical state. Specific amounts of energy are absorbed or released during phase changes.
 A fourth phase of matter is plasma. Plasma is formed when a gas is heated to a temperature at which its electrons dissociate from the nuclei.
 A heating curve graphically describes the relationship between temperature and energy (heat). It can be used to identify a substance's phase of matter at a given temperature as well as the temperature(s) at which it changes phase. It also shows the strength of the intermolecular forces present in a substance.
 Molar heat of fusion is a property that describes the amount of energy needed to convert one mole of a substance between its solid and liquid states. Molar heat of vaporization is a property that describes the amount of energy needed to convert one mole of a substance between its liquid and gas states. Specific heat capacity is a property of a substance that tells the amount of energy needed to raise one gram of a substance by one degree Celsius. The values of these properties are related to the strength of their intermolecular forces.
 Solutions can be a variety of solute/solvent combinations: gas/gas, gas/liquid, liquid/liquid, solid/liquid, gas/solid, liquid/solid, or solid/solid.
 Polar substances dissolve ionic or polar substances; nonpolar substances dissolve nonpolar substances. The number of solute particles changes the freezing point and boiling point of a pure substance.
 A liquid's boiling point and freezing point are affected by changes in atmospheric pressure. A liquid's boiling point and freezing point are affected by the presence of certain solutes.

## Key Essential Skills and Knowledge

In order to meet this standard, it is expected that students will
 explain the behavior of gases and the relationship between pressure and volume (Boyle's Law), and volume and temperature (Charles' Law).
 solve problems and interpret graphs involving the gas laws.
 identify how hydrogen bonding in water plays an important role in many physical, chemical, and biological phenomena.
 interpret vapor pressure graphs.
 graph and interpret a heating curve (temperature vs. time).
 interpret a phase diagram of water.
 calculate energy changes, using molar heat of fusion and molar heat of vaporization.
 calculate energy changes, using specific heat capacity.
 examine the polarity of various solutes and solvents in solution formation.

## Vocabulary

| | | | |
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| kinetic energy | condensation | ideal gas law | Molar heat of vaporization |
| liquid | melting point | joule | activation energy |
| gas | boiling point | partial pressure | diffusion |
| solid | freezing point | Dalton's Law of Partial Pressure | molar boiling point |
| phase diagram | specific heat of solid | Boyle's Law | molar heat of fusion |
| Vapor pressure diagram | specific heat of gas | Charles' Law | enthalpy |
| vaporization | Temperature | combined gas law | manometer |
| vapor pressure | Pressure | Volume | solubility |
| Celsius | collision | Direct | colligative properties |
| Kelvin | evaporation | Inverse | entropy |

## *Assessment Evidence ~ What is evidence of mastery? What did the students master & what are they missing?*

### Assessment/ Evidence

**Evidence of Mastery:** Students will display mastery by consistently scoring at a "C" or above range on all assessments. Success and mastery will also be shown by increasing scores from the beginning of the unit to the end of the unit. Overall mastery of the content and successful learning of the Targeted Objectives will be measured by assessing the Lab Journal for the "Determining the Heat of Ice Lab" or Alka Seltzer and Ideal Gas Lab and the final unit assessment. Mastery will result in score 90 out of 100 points on the Determining the Heat of Ice Lab Rubric or Alka Seltzer and Ideal Gas Lab and the final assessment scores at or above "C".

**Other Assessment Methods**

- Group Discussions
- Student Reports
- Teacher-Created IA Test/Quiz
- Writing Assignment

**Possible Learning Gaps**

- When water boils and bubbles, the bubbles are air, oxygen or hydrogen, or heat.
- Steam is hot air.
- When steam is no longer visible it becomes air.
- Water in an open container is absorbed by the container, disappears, changes into air, or dries up and goes into the air. .
- Ice molecules are colder than water molecules.
- Condensation is when air turns into a liquid.
- Condensation on the outside of a container is water that seeped (or sweated) through the walls of the container.
- Expansion of matter is due to the expansion of the particles rather than increased space between the particles.
- Conservation of matter applies to solids and liquids, but may be ignored for gaseous reactants and products.
- Molecules increase in size with change of state from solid to liquid to gas.
- Gases have no mass.
- The decrease in volume as a gas cools is due to increased attractive forces between particles, rather than decreased molecular motion.
- The energy gradually dies, so the gas motion stops and balloon deflates.
- Matter exists between gas atoms.
- Collisions may result in a change of atomic size.
- The particles in a gas are unevenly scattered in any enclosed space.
- Heated air weighs more than cold air.
- Hot air weighs less than cold air.
- Air neither has mass nor can it occupy space.
- An evacuated can or deflated balloon has less pressure inside than out.
- Pressure acts downward only.
- In compressed air the particles are compacted like a solid and do not move.
- When heated the molecules expand, when cooled they shrink.
- When the air is compressed, the particles stick together.
- When the air is compressed, the air particles are all pushed to the end of the syringe.
- Gas behavior is similar to liquid behavior.

# Learning Plan ~ What are the strategies and activities you plan to use

## Learning Experiences/ Best Practice

- Have a group of students model the behavior of particles in solids by standing in a box outlined on the floor and vibrating in place but not moving within the square. Have other students model the movement of particles in liquids (a little place-to-place movement of their bodies) and another group model the behavior of particles in gases (great place-to-place movement). During this process, reinforce how the motion and orientation of particles relates to the physical description of each state of matter.
- Have students visit an ice skating rink and discuss the melting of ice that makes gliding on ice possible.
- Have students design an investigation into a phase change, perhaps including colligative properties. Encourage them to keep it simple and small in focus. The idea is for students to identify variables and constants and to test out a hypothesis. Some examples are listed below. Remember, it is not that important that they get an answer to their question or that the question is based in valid science; it can be useful to let them test some common myths. This should be about the process and being able to explain why things work or do not work. Possible investigations might include the following:
    - Does salt water freeze and/or boil faster than pure water?
    - Does cold water freeze faster than hot water?
    - Does the amount/type of solute affect the boiling point?
    - Does alcohol boil at the same temperature as water?
    - Does the rate of melting depend more on mass or more on surface area?

**POGIL Activities**
Kinetic Molecular Theory
Calorimetry
Vapor Pressure
Phase Changes
Distillation

**Labs**
Liquid Air Demonstration – See how gases can become liquids with this demonstration.
Boyle's Law – This interactive page helps to demonstrate the famous Boyle's Law.
The Cat's Meow – This simple and safe experiment shows how different molecules react at the surface of a liquid.
Smell the Difference – This experiment shows how different molecules have different properties, even with their smells.
Production of Oxygen – This experiment demonstrates to students how to generate oxygen and test its properties.

## Technology Integrations

**Review Power Point**
Phases of Matter
Phase Changes
Measurement of Pressure and Temperature
Gas Laws
The Ideal Gas Law
Kinetic Molecular Theory

**PhET Simulations:**
States of Matter: Basics
States of Matter
Energy Forms & Changes
Gas Properties
Balloons & Buoyancy

**Gizmos**
Diffusion

## Resources

**VDOE Lesson Plans**

Vapor Pressure and Colligative Properties (PDF) / (Word)
States of Matter (PDF) / (Word)
Thermochemistry: Heat and Chemical Changes (PDF) / (Word)
Heat Transfer and Heat Capacity (PDF) / (Word)
Molar Volume of a Gas (PDF) / (Word)
Molar Heat of Fusion for Water (PDF) / (Word)
The Colligative Properties of Solutions (PDF) / (Word)
Charles' Law (PDF) / (Word)
Partial Pressure (PDF) / (Word)

Mr. Christopherson's Website

**Videos**

Collecting & Identifying Gases
Calculating Gas Volumes
Diffusion of Gases

## Cross Curricular Connection

**English**: Journalists often write about "scientific proof" and some scientists talk about it, but in fact, the concept of proof — real, absolute proof — is not particularly scientific. Science is based on the principle that any idea, no matter how widely accepted today, could be overturned tomorrow if the evidence warranted it. Science accepts or rejects ideas based on the evidence; it does not prove or disprove them. To learn more about this, visit our page describing how science aims to build knowledge.

**Math**: Calculating mean, median & mode.

**Real World:** Use everyday ideas to introduce the terms and promote discussion:
– Accuracy and precision are required to succeed at darts and archery.
– A cookery book must contain recipes that are repeatable and reproducible, otherwise no one would want to buy it.