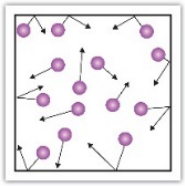
PhET-Investigation of Gas Laws Name_____
(Using PhET-"Gas Properties" & Particle Diagrams) Partner_____ Date_____

Kinetic Molecular Theory of Gases (KMT of Gases):



- All gases consist of particles (atoms and molecules) that are in constant random motion.
- Gas particles are constantly colliding with each other and the walls of a container.
- The average kinetic energy of molecules is proportional to temperature.
- Gas particles exert pressure on a container wall by colliding with the wall.

Pressure: Pressure is defined as the force (or "push") per unit area. **Pressure** $= \frac{Force}{area}$

Directions: *Watch demonstration/video of each scenario. Download the PhET simulation called, "Gas Properties" and click on "Ideal." Use the PhET to visualize each scenario below. Draw representations of gas particles by using a "●" for each particle.* ***If temperature changes****, draw* ***shorter arrows when colder (●→)*** *and* ***longer arrows when hotter (●⟶)****. Explanations must use concepts of KMT and pressure.* ***Key terms to use are particles, collisions, frequent, and forceful.*** *(When done each scenario, hit* ***orange "reset"*** *button.)*

1) **Pressure vs. moles (constant volume and temperature): Air is pumped into a ball.**
   - Demo: Observe how pressure changes when air is pumped into a soccer/basketball. *(Assume the volume of the ball stays completely constant even though in reality it increases slightly.)*
   - PhET: Pump in 100 particles and let pressure stabilize. Under "Hold Constant" click on "volume". Now, pump in more particles and observe pressure.

Ball with some particles (Draw 4 particles)	Ball with more particles (Draw 8 particles)	When moles of air increases, the pressure inside ball _____ because….

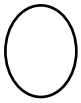
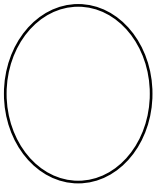
2) **Pressure vs. Temperature (constant moles and volume): Rigid, sealed bulb placed in hot water.**
   - Demo: Observe how the pressure changes when a rigid, sealed bulb connected to a pressure gauge is immersed into boiling water.
   - PhET: Pump in 100 particles. Under "Hold Constant", click "volume". Add heat. Observe pressure.

Rigid bulb with air. (Draw 4 particles)	Temperature is increased.	When temperature increased, the pressure inside bulb_____ because….

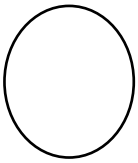
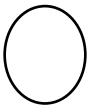
3) **Pressure vs. Volume (constant moles and temp): Plunger of syringe filled with air is pushed in.**
   - Demo: Remove cap of syringe and fill syringe with air to 60 mL mark. Put cap back on. Push down on plunger of syringe so that the volume of air inside the syringe decreases.
   - PhET: Pump in 100 particles. Wait for pressure to stabilize. Under "Hold Constant," click on temp. Slide beige "handle" to right to decrease volume. Observe the pressure.

Syringe filled with air (Draw 4 particles.)	Volume is decreased.	When volume decreased, the pressure inside the syringe _____ because….

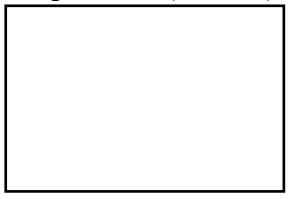
4) **Volume vs. moles (constant pressure and temperature): Air is blown into a balloon.**
   - Think: When air is blown into a balloon, the balloon expands (when under constant atmospheric pressure).
   - PhET: First slide beige "handle" to right to decrease volume, then pump in 100 particles and let pressure stabilize. Under "Hold Constant", click Pressure ↕V. *(This keeps pressure constant by changing volume.)* Add one "pump" of gas. Observe volume.

Balloon with "4" particles inside and "4" particles outside.	Balloon with "8" particles inside and still "4" particles outside.	When moles increased inside balloon, the volume of the balloon increased because...
		*The balloon will expand until the pressure inside the balloon is _____ the pressure outside the balloon.*

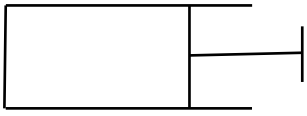
5) **Volume vs. temperature (constant pressure and moles): Liquid nitrogen is poured onto balloon**
   - Video Clip: Watch the 45 sec video clip called, "Liquid Nitrogen on a balloon." Observe how the volume of a balloon changes when liquid nitrogen is poured onto the sealed balloon.
   - PhET: Pump in 100 particles and let the pressure stabilize. Under "Hold Constant," click Pressure↕V. *(This keeps pressure constant by changing Vol)*. Use slider to cool the container. Observe Vol.

Balloon with "4" particles inside and "4" particles outside.	For the same sealed balloon, the temperature is decreased.	When temperature decreased, the volume of the balloon _____ because….
		*The balloon will contract until the pressure inside the balloon is _____ the pressure outside the balloon.*

6) **Moles vs. Temperature (constant volume and pressure): Air pumped into rigid bulb, keeping P constant**
   - Imagine: Suppose air is pumped into a rigid bulb connected to a pressure gauge. How would the temperature need to be changed to keep the pressure constant? _____
   - PhET: Pump in 100 particles and let pressure stabilize. Pressure↕T. *(This keeps pressure constant by changing Tempeature)*. Pump in more particles. Observe change in temperature.

Rigid bulb with "4" particles of air at room temperature (same P)	Rigid bulb with "8" particles and _____ temperature (same P)	When moles of particles increased, the temperature needed to be _____ to keep the pressure constant. This is because….
		

7) **Apply your understanding:** Obtain a syringe, remove the cap and push the plunger all the way in so that all air is removed. Put cap back on. Pull the plunger part way out. Draw particles to represent what is inside and outside the syringe when the plunger is part way out. (Assume the cap has a perfect seal.)

	Why is it so difficult to pull out the plunger?