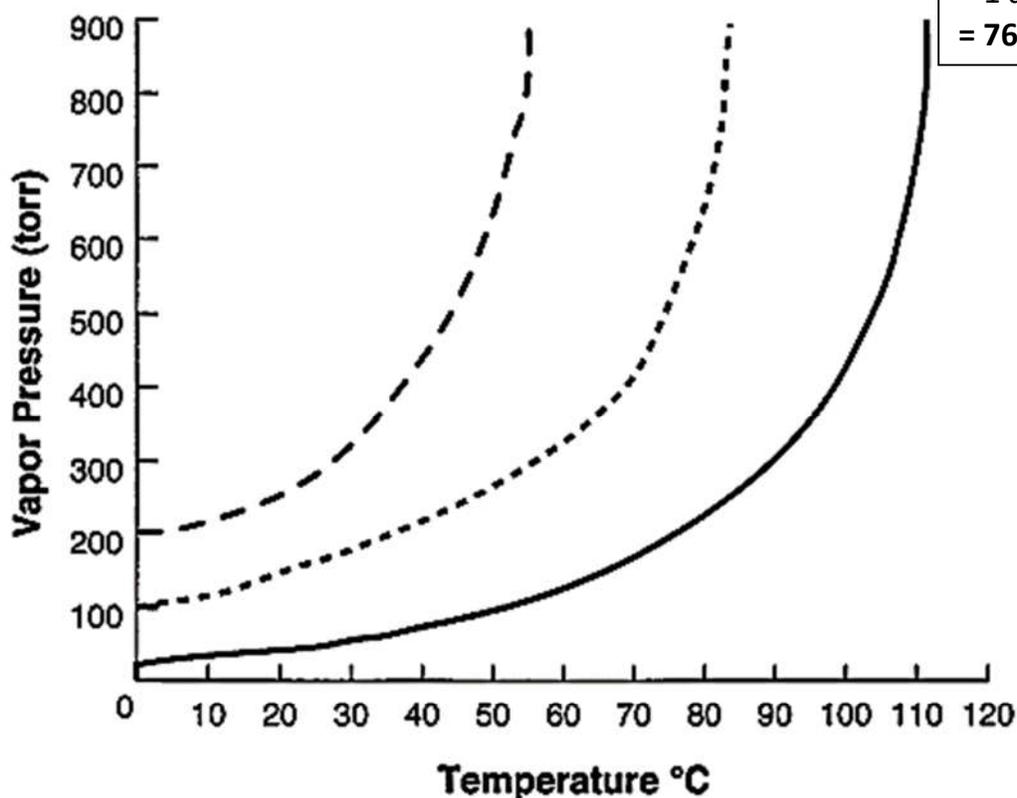


**Do Now: Vapor Pressure Review**

A liquid will boil when its vapor pressure equals atmospheric pressure. Answer the questions following the graph.



1. At what temperature would Liquid A boil at an atmospheric pressure of 400 torr? \_\_\_\_\_
2. Liquid B? \_\_\_\_\_
3. Liquid C? \_\_\_\_\_
4. How low must the atmospheric pressure be for Liquid A to boil at 35° C? \_\_\_\_\_
5. Liquid B? \_\_\_\_\_
6. Liquid C? \_\_\_\_\_
7. What is the normal boiling point of Liquid A? \_\_\_\_\_
8. Liquid B? \_\_\_\_\_
9. Liquid C? \_\_\_\_\_
10. Which liquid has the strongest intermolecular forces? \_\_\_\_\_

## Intermolecular Forces Review

1. What are intermolecular forces?
2. Provide an explanation as to why the following phenomena occur:
  - a. Water beads up on your windshield, but acetone doesn't. (Relate IMFs and Surface Tension)
  - b. Water is less viscous than molasses (Relate IMFs and Viscosity)
  - c. Molecular nitrogen boils at 77 K, while nitric oxide boils at 110 K. (Relate IMFs and Boiling Point)
  - d. A test tube was filled halfway with acetone and another was filled halfway with water. Both test tubes are left at room temperature. A few hours later, much of the acetone had evaporated while most of the water was still in the test tube. (Relate IMFs and Volatility).
  - e. Butane is a gas at standard temperature and pressure while pentane is a liquid. (Relate IMFs and state of matter)
3. Explain how the demo worked by relating IMFs, vapor pressure, and boiling point.

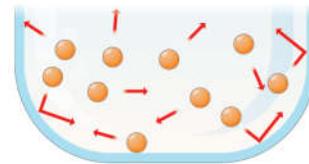
### **Demo: IMFs and Boiling Point**

1. What is boiling point?
2. The temperature water boils at is \_\_\_\_\_°C.
3. The temperature of the room is \_\_\_\_\_°C.
4. Water does does not boil at room temperature
5. Predict: Do you think liquid butane will boil in room temperature? Explain your choice.
6. Liquid butane was placed into a ziplock bag. Record your observations.
7. Compared to water, liquid butane has more less attractive forces. Explain.
8. Describe the relationship between boiling point and intermolecular forces. (include direct or inverse relationship in description)

### Demo: IMFs and Vapor Pressure

**Pressure** is caused by the collisions of gaseous molecules to the surface of a container

**Vapor Pressure** is the pressure caused by the liquid particles that turn into gaseous particles and collide with the surface of the closed container



1. Which has more vapor pressure? Acetone or Alcohol  
Explain your answer using your observations.

2. From last class, we learned that acetone had more less attractive forces between its molecules than alcohol.
3. Describe the relationship between vapor pressure and intermolecular forces. (include direct or inverse relationship in description)

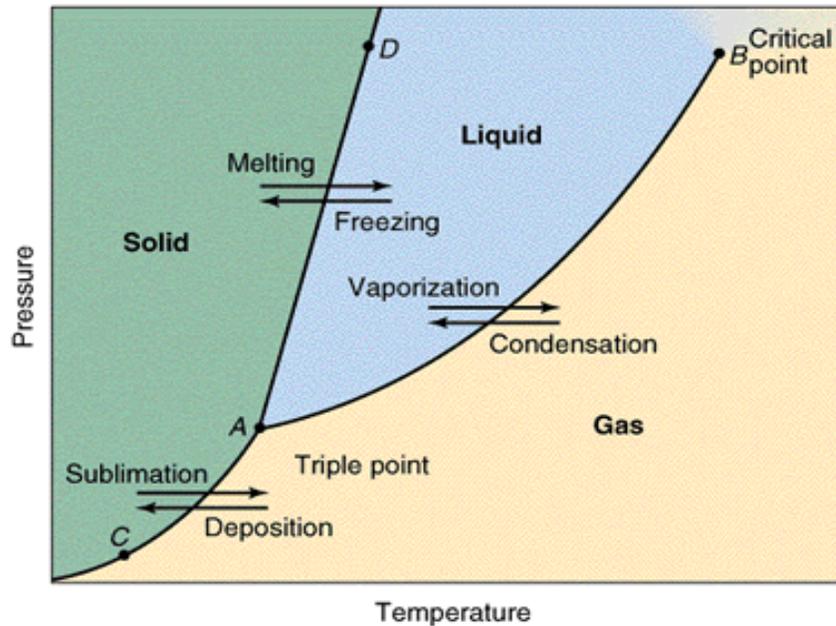
### Demo: Vapor Pressure & Temperature

1. The vapor pressure increased decreased when the flask with liquid was heated.  
Explain your answer using your observations.

2. When you increase the heat, describe what is happening to the attractive forces between the liquid molecules in the flask. How does this impact vapor pressure?
3. Describe the relationship between vapor pressure and temperature. (include direct or inverse relationship in description)

## Phase Diagram WS

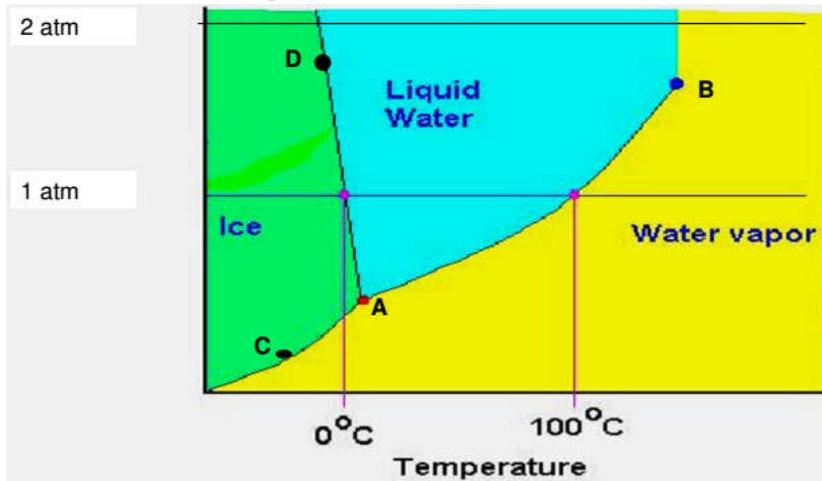
A **phase diagram** is a graphical way to summarize the conditions under which equilibria exist between the different states of matter. It also allows us to predict the phase of a substance that is stable at any given temperature and pressure.



**Part 1:** Use the phase diagram above to answer the following questions.

1. What label is on the x-axis? What label is on the y-axis?
2. List the three phases of matter that are on the diagram.
3. At which point do **all three** phases on the diagram meet?
4. In your own words, define what you think the **triple point** is. Make sure to include the following terms in your response: solid, liquid, gas, pressure, temperature.
5. Look at the arrows labeled with a specific phase change (i.e. melting, freezing, vaporization, etc.). In general, describe how a phase change is represented on this graph.
6. The line extending from the triple point to the critical point stops. What do you think this mean in terms of phase change?
7. In your own words, define what you think the critical point is.

## Part 2: Phase Diagram of Water



1. Identify the following points on the graph:

- A C  
B D

2. If the line AD represents the melting/freezing line for water,  
a. What would the AB line represent?

b. What would the AC line represent?

3. Even though a phase change could occur along any of the solid lines, the two points labeled at 0°C and 100°C are known as the “normal melting point” and “normal boiling point”, respectively. **Based on the pressure that these occur at**, what do you think is meant by “normal” melting or boiling point?

4. Given the phase diagram above, what phase would water be in if it had the following properties:

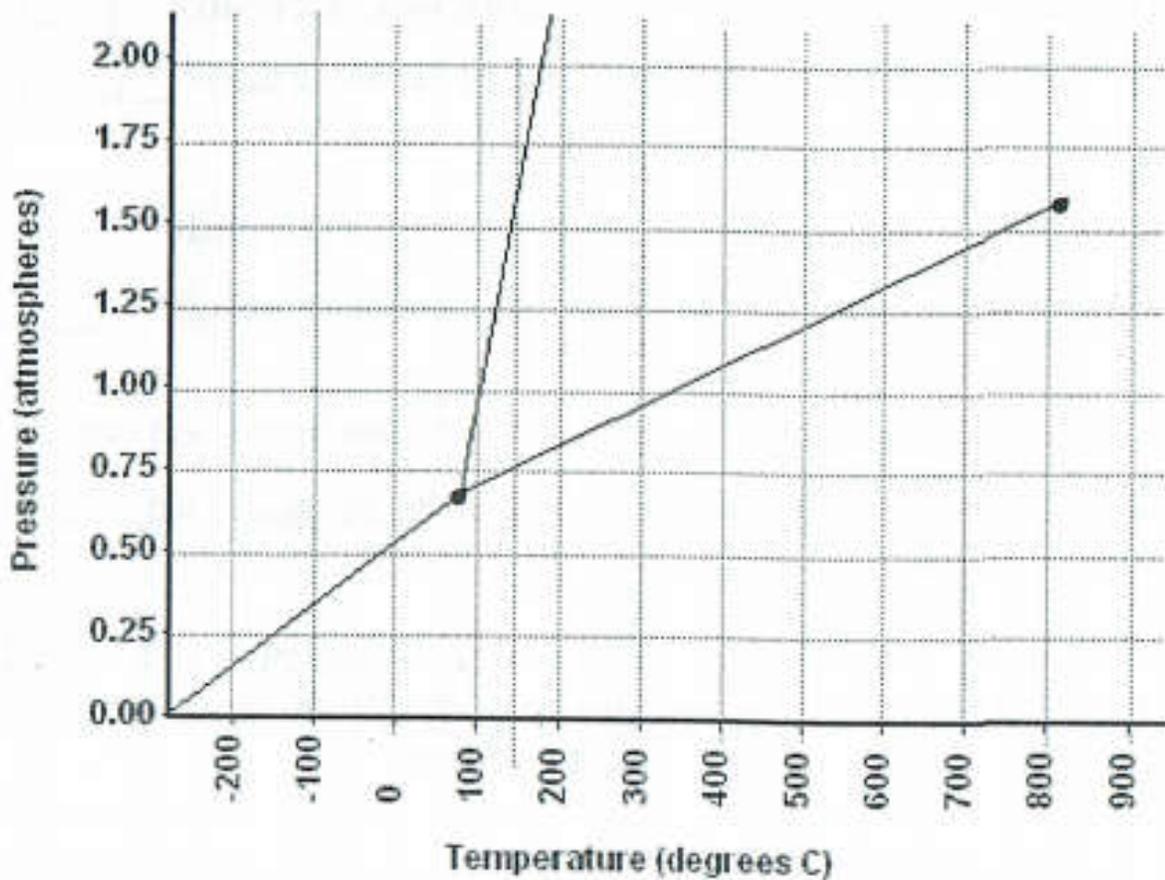
a. 50 °C and 0.5 atm

b. -50°C and 0.5 atm

c. 125 °C and 1.0 atm

### Part 3: Practice

1. Use the phase diagram to answer the following questions:



- What is the normal freezing point of this substance?
- What is the normal boiling point of this substance?
- What is the normal melting point of this substance?
- At what temperature and pressure does the triple point occur for this substance?
- What is the phase (solid, liquid, gas) of this substance at 2.0 atm and 100°C?
- What is the phase of this substance at 0.75 atm and 100°C?
- What is the phase of this substance at 0.5 atm and 100°C?

- h. What is the phase of this substance at 1.5 atm and 50°C?
- i. What is the phase of this substance at 1.5 atm and 200°C?
- j. What is the phase of this substance at 1.5 atm and 800°C?
- k. If I had a quantity of this substance at a pressure of 1.25 atm and a temperature of 300°C and lowered the pressure to 0.25 atm, what phase changes would occur?
- l. If I had a quantity of this substance at an initial pressure of 1.25 atm and a temperature of 0°C and then lowered the pressure to 0.25 atm, what phase changes would occur?
- m. If I had a quantity of this substance at a pressure of 1.00 atm and a temperature of 200°C and lowered the temperature to 0°C, what phase change(s) would occur?
- n. If this substance was at a pressure of 2.0 atm, at what temperature would it melt?
- o. If this substance was at a pressure of 2.0 atm, at what temperature would it boil?
- p. If this substance was at a pressure of 0.75 atm, at what temperature would it melt?
- q. If this substance was at a pressure of 0.75 atm, at what temperature would it boil?