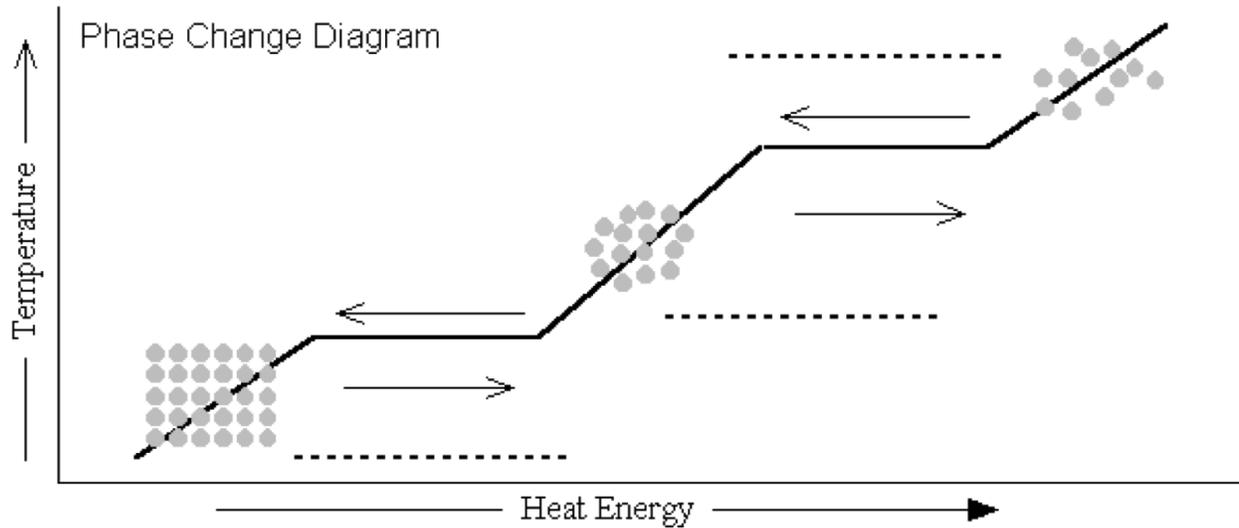


Phase Change Problems

Heating Curves

Use the following video to help you complete this activity: <https://youtu.be/gZVNe-EwuvQ>



1. In the diagram above, label all the states of matter.
2. Assuming the above diagram is water, label the temperatures of the flat portions of the diagram above.
3. In the first rising portion of the graph, describe what is happening as energy is added. Discuss this in terms of kinetic molecular theory.
4. In the first flat portion of the graph, describe what is happening as energy is added. Discuss this in terms of bonding forces of attraction.
5. In the second rising portion of the graph, describe what is happening as energy is added. Discuss this in terms of kinetic molecular theory.
6. In the second flat portion of the graph, describe what is happening as energy is added. Discuss this in terms of bonding forces of attraction.
7. In the third rising portion of the graph, describe what is happening as energy is added. Discuss this in terms of kinetic molecular theory.

Name: _____

Phase Change Problems

8. What is the formula used for calculating the heat involved in a phase change?
9. During a phase change, how much does the temperature change? How much does the kinetic energy change? Does the potential energy change?
10. What is the formula used to calculate the heat required to warm or cool one phase of matter?
11. When you heat one phase of matter, how do you know the kinetic energy changes?
12. What is meant by the negative sign in an answer like “-46.8 kJ”? When would you use a positive sign?
13. If you must add 25 kJ to raise the temperature of an ice cube from -15°C to -10°C , is this an endothermic or exothermic process?

Substance	Melting point ($^{\circ}\text{C}$)	ΔH_{fus} (kJ/g)	Boiling Point ($^{\circ}\text{C}$)	ΔH_{vap} (kJ/g)	Specific Heat (C) (J/g $^{\circ}\text{C}$)
H ₂ O	0.0	0.333	100.0	2.26	Ice: 2.09 Water: 4.18 Steam: 1.7
Benzene	5.0	0.1265	80.0	0.394	Solid: 0.55 Liquid: 0.96 Gas: 1.09

14. How much heat is required to raise 40 grams of water from 30°C to 70°C ?

Name: _____

Phase Change Problems

20. How much heat would it take to raise 5 grams of H₂O from -50.°C to +200.°C?

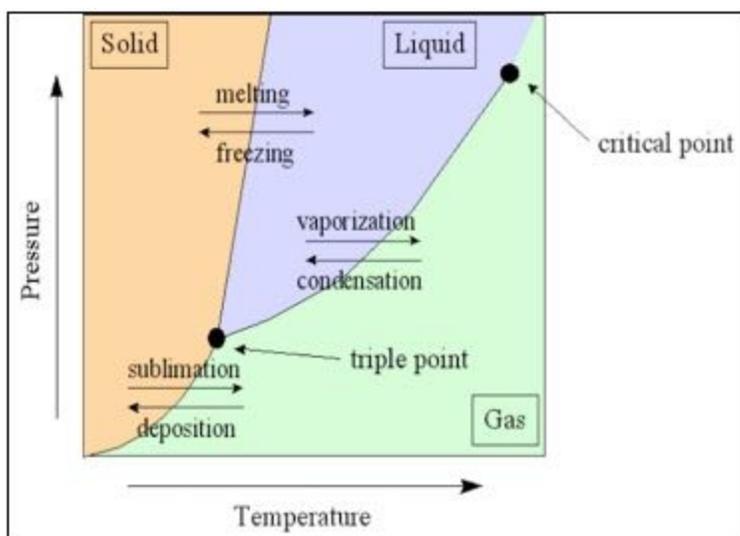
21. How much heat is needed to melt a tray of 14 ice cubes, presently at 0.0°C, each having a mass of 35 g?

22. How much energy is required to bring 45 grams of benzene from -10.°C to 70.°C?

Phase Diagrams

Use the following video to help you complete this activity: <https://youtu.be/B027c00VkeU>

A **phase diagram** is a graphical way to depict the effects of **pressure** and **temperature** on the phase of a substance:



The **CURVES** indicate the conditions of **temperature** and **pressure** under which “equilibrium” between different phases of a substance can exist. **BOTH** phases exist on these lines:

Melting/Freezing: Any point on this line (pressure & temperature) the substance is both **solid** and **liquid**

Sublimation/Deposition: Any point on this line (pressure & temperature) the substance is both **solid** and **gas**

Vaporization/Condensation: Any point on this line (pressure & temperature) the substance is both **liquid** and **gas**

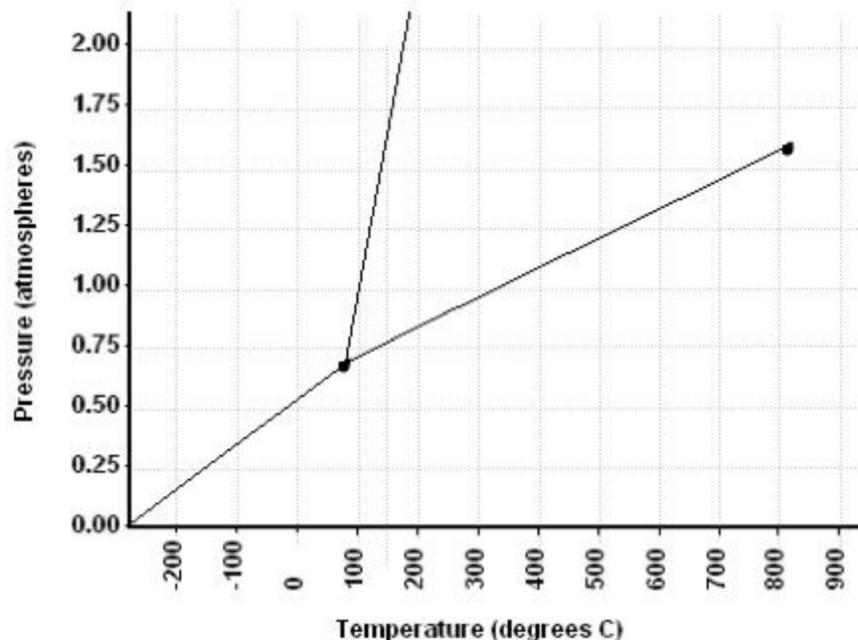
NOTE: the vapor pressure curve ends at the **critical point**, the temperature above which the gas cannot be liquefied no matter how much pressure is applied (the kinetic energy simply is too great for attractive forces to overcome). Any substance beyond this critical point is called a **supercritical fluid** – *indistinguishable* between gas or liquid (*neither one*)

The **TRIPLE POINT** is the condition of temperature and pressure where **ALL THREE** phases exist in equilibrium (solid, liquid, gas)

Phase Change Problems

Remember that pressure can be expressed in many units where: **1 atm = 101.3 kpa = 760 mmHg.**

Refer to the phase diagram below. **NOTE:** “Normal” refers to STP – Standard Temperature and Pressure.



1. What are the values for temperature and pressure at STP? T= _____, P= _____
2. What is the *normal* freezing point of this substance?
3. What is the *normal* boiling point of this substance?
4. What is the *normal* melting point of this substance?
5. What is the phase (s, l, g) of a substance at **2.0 atm** and **100 °C**?
6. What is the phase (s, l, g) of a substance at **0.75 atm** and **100 °C**?
7. What is the phase (s, l, g) of a substance at **0.5 atm** and **100 °C**?
8. What is the phase (s, l, g) of a substance at **1.5 atm** and **50 °C**?
9. What is the phase (s, l, g) of a substance at **1.5 atm** and **200 °C**?
10. What is the phase (s, l, g) of a substance at **1.5 atm** and **800 °C**?
11. What is the condition of the **triple point** of this substance? T= _____, P= _____
12. If a quantity of this substance was at an initial pressure of 1.25 atm and a temperature of **300° C** was lowered to a pressure of 0.25 atm, what phase transition(s) would occur?
13. If a quantity of this substance was at an initial pressure of 1.25 atm and a temperature of **0° C** was lowered to a pressure of 0.25 atm, what phase transition(s) would occur?

Name: _____

Phase Change Problems

14. If a quantity of this substance was at an initial pressure of **1.0 atm** and a temperature of 200°C was lowered to a temperature of -200°C , what phase transition(s) would occur?
15. If a quantity of this substance was at an initial pressure of **0.5 atm** and a temperature of 200°C was lowered to a temperature of -200°C , what phase transition(s) would occur?
16. If this substance was at a pressure of 2.0 atm, at what temperature would it **melt**?
17. If this substance was at a pressure of 2.0 atm, at what temperature would it **boil**?
18. If this substance was at a pressure of 0.75 atm, at what temperature would it **melt**?
19. If this substance was at a pressure of 0.75 atm, at what temperature would it **boil**?
20. At what temperature do the gas and liquid phases become indistinguishable from each other?
21. At what pressure would it be possible to find this substance in the gas, liquid, **and** solid phase?
22. If I had a quantity of this substance at a pressure of 1.00 atm and a temperature of -100°C , what phase change(s) would occur if I **increased the temperature** to 600°C ? At what temperature(s) would they occur?
23. If I had a quantity of this substance at a pressure of 2.00 atm and a temperature of -150°C , what phase change(s) would occur if I **decreased the pressure** to 0.25 atm? At what pressure(s) would they occur?