

## UNIT 11 - SOLIDS, LIQUIDS, & PHASE CHANGES

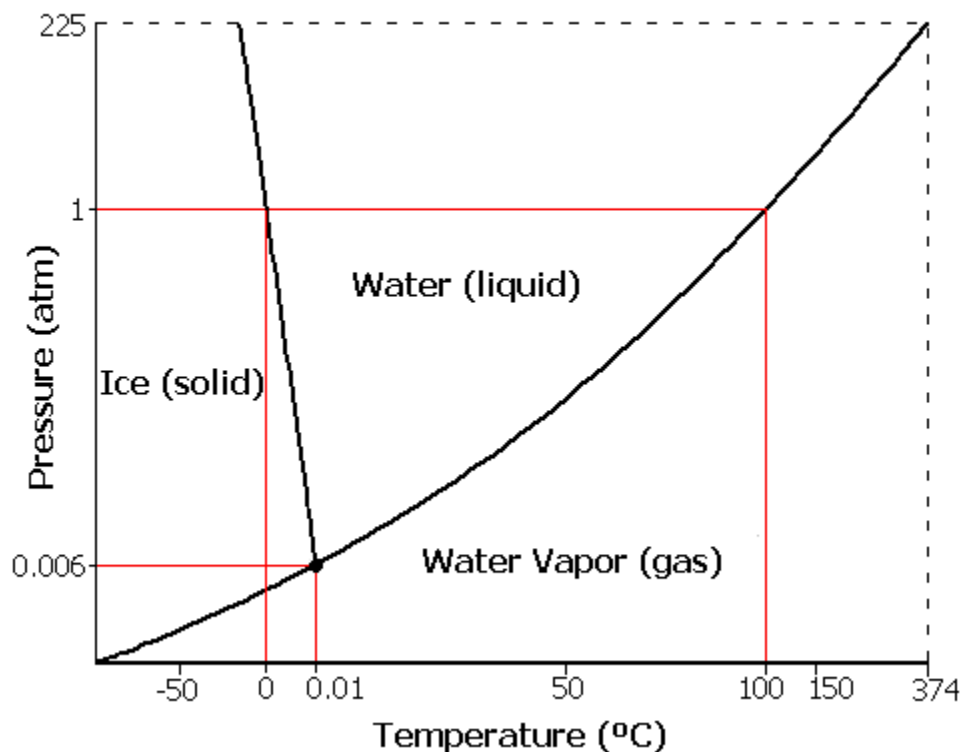
### HEAT & ITS MEASUREMENT WORKSHEET

- 1.) How many Joules of heat are given off when 5.00 grams of water cool from 75 °C to 25 °C?
- 2.) If 575 Joules of heat are added to 45.0 grams of water at 25.0 °C, what will the new temp. be?
- 3.) How many Joules does it take to boil 35.0 g of water at 100.0 °C?
- 4.) When 1550 Joules of heat are added to a 30.7 gram sample of H<sub>2</sub>O, the temperature changes by 25.0 °C. Is the H<sub>2</sub>O in solid, liquid, or gas form?
- 5.) How many Joules of heat are necessary to raise the temperature of 25.0 grams of steam from 110.0°C to 160.0°C?
- 6.) How many Joules are given off when 55.0 grams of water at 0.00 °C freezes?
- 7.) In a lab experiment, students were given a sample of water at 22.5 °C. The students added 935 Joules of heat to the sample, and the temperature increased to 49.2 °C. What is the mass of the sample of water?
- 8.) If 4,550 Joules of heat are added to 17.5 grams of water, by how many degrees Celsius would the water increase?
- 9.) How many Joules of heat are required to change 25.0 grams of water at 83.2 °C to steam at 100.0 °C?
- 10.) How much heat (in Joules) is required to change a 23.0 gram ice cube from -12.7 °C to liquid water at 19.4 °C?

Answers: 1.) 1045 J, 2.) 28.06°C, 3.) 79100 J, 4.) Gas, 5.) 2525 J, 6.) 18370 J, 7.) ~8.38 g, 8.) ~62.2°C, 9.) 58255.6 J, 10.) 10145.921 J

**PHASE DIAGRAMS WORKSHEET**

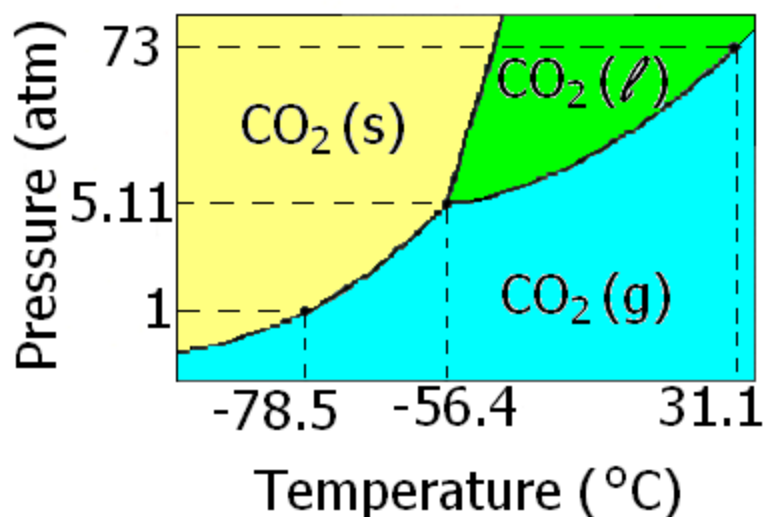
**Water - Phase Diagram**



1. Study the phase diagram of water. What two units are plotted against each other in a phase diagram graph?
2. Give the state or states of matter present at each of the following conditions:
 

(A) 100 °C and 1 atm	(F) 150 °C and 225 atm
(B) 0 °C and 1 atm	(G) 400 °C and 240 atm
(C) 100 °C and 225 atm	(H) 375 °C and 230 atm
(D) 50 °C and 1 atm	(I) -50 °C and 0.006 atm
(E) 50 °C and 0.0060 atm	(J) 0.01 °C and 0.006 atm
3. After a substance passes a certain temperature (critical temperature), it cannot be liquefied. Regardless of the amount of pressure applied, the substance will remain a gas. What is the critical temperature of water?
4. When a substance reaches its critical temperature, it can be liquefied if enough pressure is applied. The pressure necessary to do this is called critical pressure. What is the critical pressure of water?
5. Give the temperature and pressure for the triple point of water.
6. What unique condition occurs at the triple point?

PHASE DIAGRAM FOR CO<sub>2</sub>

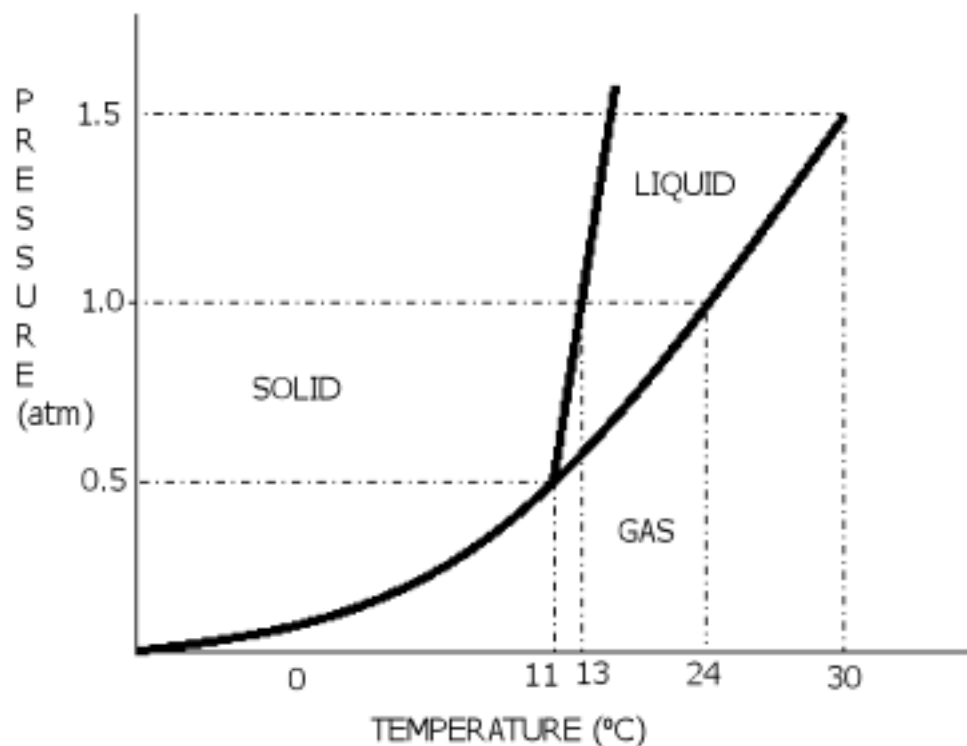


7. Label the following on the phase diagram:
  - critical temperature
  - critical pressure
  - triple point
  - sublimation line
  - freezing/melting point line
  - boiling point line
  
8. What are the critical temperature and critical pressure of carbon dioxide?
  
9. What is the triple point of carbon dioxide?
  
10. Identify the state or states of matter that CO<sub>2</sub> would exist under the following conditions:
  - (A) -78.5 °C and 1 atm \_\_\_\_\_
  - (B) -80 °C and 2 atm \_\_\_\_\_
  - (C) -40 °C and 6 atm \_\_\_\_\_
  - (D) 32 °C and 75 atm \_\_\_\_\_
  - (E) STP conditions \_\_\_\_\_
  
11. Can CO<sub>2</sub> ever be a liquid at room temperature? Explain why or why not.
  
12. When dry ice (solid carbon dioxide) is exposed to room temperature conditions, what process describes its phase change? How does the phase diagram explain why CO<sub>2</sub> does not "melt"?

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### UNIT 11 REVIEW WORKSHEET

Part 1 – Phase Diagram – Use the following phase diagram to answer questions 1 – 5.



1. What are the temperature and pressure at the triple point?
2. What is the critical temperature of this substance?
3. What is the normal melting point for this substance? The normal boiling point?
4. At 1.0 atm pressure (standard pressure), does this substance undergo sublimation?
5. Indicate the state(s) of matter present at:  
(A) 32 °C and 1.5 atm  
(B) 11 °C and 0.5 atm  
(C) 13 °C and 1.0 atm  
(D) 0 °C and 0.75 atm  
(E) 22 °C and 1.05 atm  
(F) 24 °C and 1.0 atm

Part 2 – Heat Calculations – Use the data given on the Reference Tables to solve the following problems.

6. How many Joules of heat are required to boil a 29.3 gram sample of water at 100.0 °C?
7. How many Joules of heat are required to heat a 29.3 gram sample of steam from 100.0 °C to 117.3 °C?
8. How many Joules of heat are required to heat a 15.75 gram sample of water from 95.0 °C to steam at 117.3 °C?