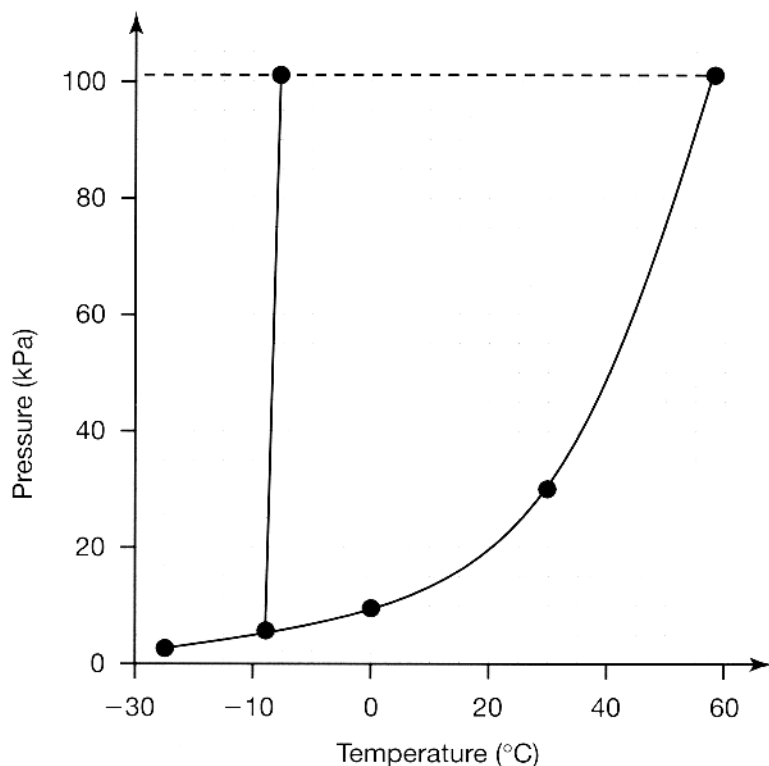


PHASE DIAGRAM WORKSHEET #2

Name _____

Period _____ Date _____

At standard temperature and pressure, bromine (Br_2) is a red liquid. Bromine sublimes when the temperature is -25°C and the pressure is 101.3 kPa. The phase diagram for bromine is shown below. Use this diagram for questions (1) – (9)



- (1) Label each region of the graph as *solid*, *liquid*, or *gas*.
- (2) Label the *triple point*, *normal melting point*, and *normal boiling point* on the graph and estimate their values in the spaces below.

Normal Melting Point = _____

Normal Boiling Point = _____

Triple Point = _____

- (3) Use the letter 'A' to label the line that gives the conditions for equilibrium between solid and liquid phases of bromine, the letter 'B' to label the curve that gives the conditions for equilibrium between liquid and vapor phases of bromine, and the letter 'C' to label the curve that gives the conditions for equilibrium between solid and vapor phases of bromine.
- (4) Describe how the melting point of bromine changes with the external pressure. Based on the slope of the melting-point curve in the phase diagram, would you characterize the solid phase of bromine as more dense or less dense than the liquid phase of bromine?

(5) What is the boiling point of bromine when the external pressure is 75 kPa?

(6) Explain the significance of the triple point?

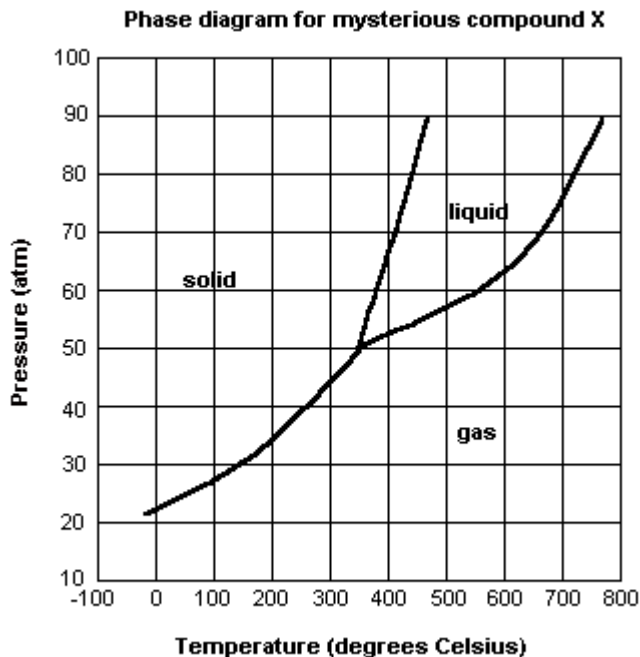
(7) Using arrows labeled 'S', 'V', and 'M', label those portions of the phase diagram where sublimation, vaporization, and melting occur, respectively.

Circle the correct word in parentheses in each of the following sentences.

(8) Bromine vapor at 15 °C (condenses, sublimes) when the pressure is raised to 50 kPa.

(9) Bromine liquid at 70 kPa (vaporizes, freezes) when the temperature is decreased to -15 °C.

For each of questions (10) - (15), refer to the phase diagram for mysterious compound X.



(10) What is the critical temperature of compound X? _____

(11) If you were to have a bottle containing compound X in your closet, what phase would it most likely be in?

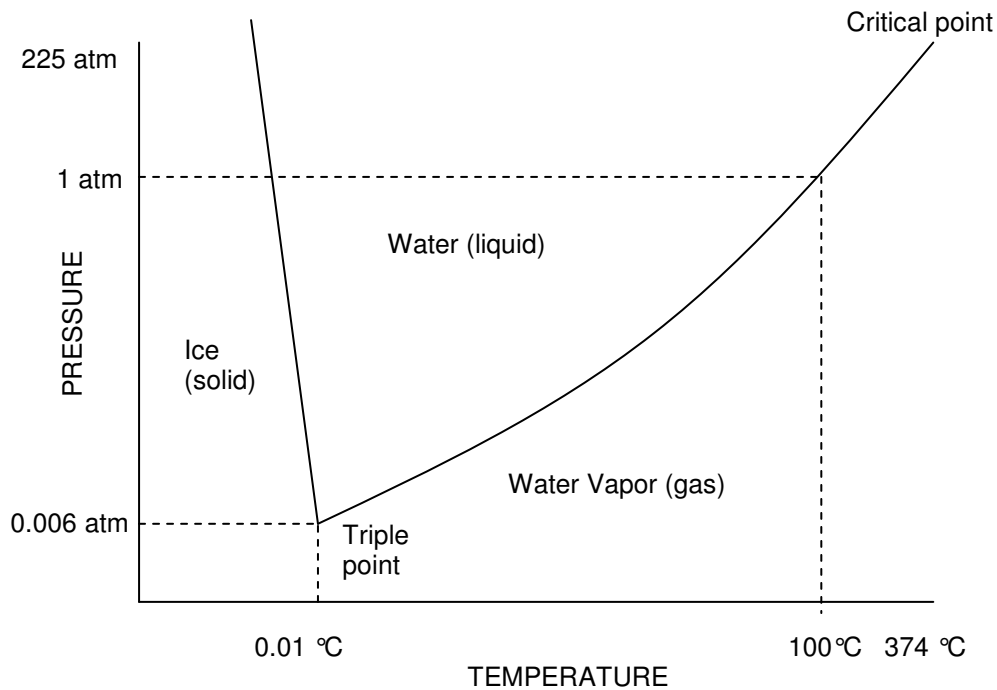
(12) At what temperature and pressure will all three phases coexist?

(13) If I have a bottle of compound X at a pressure of 45 atm and temperature of 100°C , what will happen if I raise the temperature to 400°C ?

(14) Why can't compound X be boiled at a temperature of 200°C ?

(15) If I wanted to, could I drink compound X?

Use the following phase diagram for problems (16) – (22)



(16) List the phase changes a sample of ice would go through if heated to its critical temperature at one atmosphere pressure.

(17) At what range of pressure will water be a liquid at temperatures above its normal boiling point?

(18) In what phase does water exist at its triple point?

(19) How does the melting point of water change as the pressure increases from 1 atm?

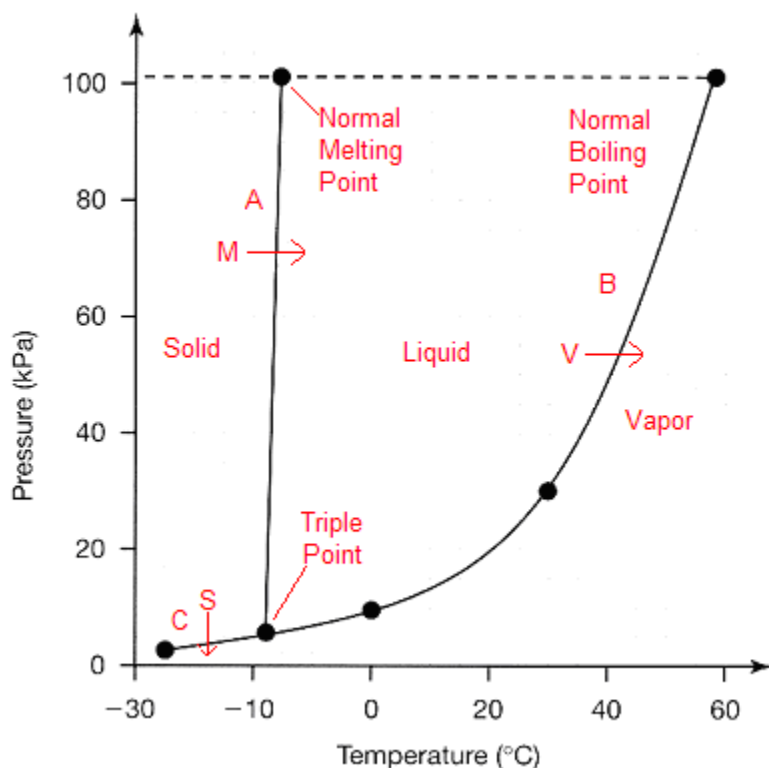
(20) What does the line separating the solid phase from the gas phase represent?

(21) What does the line separating the liquid phase from the gas phase represent?

(22) What is the vapor pressure of liquid water at 100 °C?

KEY: Phase Diagram Worksheet

(1)



(2) Normal Melting Point = -7.0°C
Normal Boiling Point = 58.5°C
Triple Point = -8°C and 6 kPa

(3) See answer to 1.

(4) The melting point curve leans slightly to the right (has a positive slope) indicating that, as pressure is increased, the melting point of bromine increases. Higher pressures favor the denser phase of a substance. Solid bromine is denser than liquid bromine. Choose any point on the melting-point curve, and move up vertically, in the direction of higher pressure; you should find yourself in the solid phase region of the diagram.

(5) 50°C

(6) The triple point is the temperature and pressure at which solid, liquid, and vapor phases of a substance are in equilibrium

(7) See answer to 1.

(8) condenses

(9) freezes

(10) $\sim 770^{\circ}\text{C}$

- (11) Extrapolating from this diagram, it's most likely a gas.
- (12) 350° C, ~51 atm
- (13) It will sublime
- (14) It does not form a liquid at this temperature. It only exists as a liquid at temperatures above 350° C.
- (15) No. At the temperatures and pressures that it forms a liquid, you'd probably die.
- (16) The ice would initially melt (become liquid water) and vaporize (become water vapor).
- (17) 1.00 atm – 225 atm
- (18) Ice, liquid water, and water vapor coexist at the triple point.
- (19) The melting point of water decreases as the pressure increases
- (20) This line represents the set of all temperature-pressure values at which the solid and gas phases of water are in equilibrium (sublimation/deposition)
- (21) This line represents the set of all temperature-pressure values at which the liquid and gas phases of water are in equilibrium (condensation/vaporization)