

Name: _____

PHYS 1220-02 Quiz 2

You may use an 8.5"×11" note sheet written on both sides, a calculator of any type, and an autumn leaf. Please write your answers in the boxes provided. Show your work outside the boxes. If you wish to change an answer written in a box, thoroughly erase the unwanted answer and write the desired answer in its place. If a numerical answer is a physical quantity rather than a pure number, include the units with your answer.

“Multiple choice” questions, in which only one answer is correct, have circular bubbles (○): select exactly one choice. “Select all” questions, in which any number of the choices may be correct, have square bubbles (□): select all correct answers. Select your choice by filling the circle or square: please do not “X”, check, circle, or otherwise mark your choice. Do not mark bubbles for rejected options.

If the point value of a question is not indicated, it is worth one point.

Constants and equivalents

$$1 \text{ cal} = 4.184 \text{ J}$$

$$1 \text{ Cal} = 1000 \text{ cal}$$

$$1 \text{ bar} = 10^5 \text{ Pa}$$

$$\text{latent heat of melting of water ice: } 334 \text{ kJ/kg}$$

$$\text{latent heat of vaporization of water: } 2,260 \text{ kJ/kg}$$

$$\text{Specific heat capacity of liquid water: } 4184 \text{ J/kg}$$

$$\text{Density of liquid water at } 0^\circ\text{C: } 999.9 \text{ kg/m}^3$$

$$\text{Density of water ice at } 0^\circ\text{C: } 917 \text{ kg/m}^3$$

$$\text{Universal gas constant } R: 8.31441 \text{ J/(mol}\cdot\text{K)}$$

$$\text{Boltzmann constant } k_B: 1.381 \times 10^{-23} \text{ J/K}$$

$$\text{Stefan-Boltzmann constant } \sigma: 5.670374419 \times 10^{-8} \text{ W/(m}^2\cdot\text{K}^4)$$

Some metric prefixes

$$\text{nano } n \times 10^{-9}$$

$$\text{micro } \mu \times 10^{-6}$$

$$\text{milli } m \times 10^{-3}$$

$$\text{centi } c \times 10^{-2}$$

$$\text{deci } d \times 10^{-1}$$

$$\text{deka } D \times 10^1$$

$$\text{hecta } h \times 10^2$$

$$\text{kilo } k \times 10^3$$

$$\text{mega } M \times 10^6$$

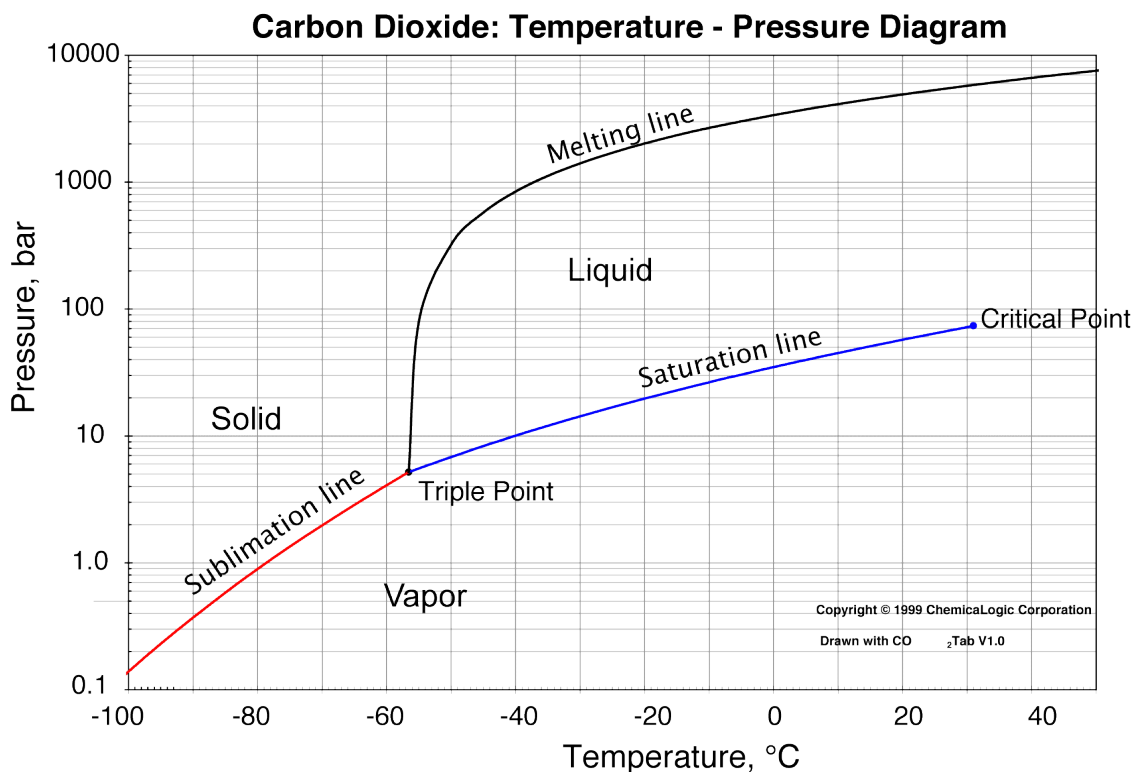
$$\text{giga } G \times 10^9$$

Questions

1. (3 points) A diatomic ideal gas in a 0.140 cubic meter cylinder at 24 bar pressure and 20°C temperature is heated (at constant volume—the cylinder functions properly) to 50°C. How much heat was added to the gas to accomplish this temperature increase?

2. (2 points) Your formula sheet probably tells you that more heat is required to raise the temperature of a gas held at constant pressure than one held at constant temperature from the same initial state. Explain why (conceptually—don't just write a formula).

3. A temperature-pressure phase diagram for carbon dioxide is reproduced below.



- A. What is the state of carbon dioxide at a pressure of 1 bar and -70°C ?

- B. A sample of carbon dioxide begins at 1 bar and -70°C . It is pressurized isothermally until it reaches the sublimation line.

- i. How does the sample's volume change before it reaches the sublimation line?

ii. What happens to the sample when it reaches the sublimation line?

C. A CO₂ fire extinguisher contains carbon dioxide liquid and vapor at equilibrium with each other. At a temperature of 20°C, what is the pressure inside the fire extinguisher?

D. If you shake a CO₂ fire extinguisher at a temperature of 20°C, you will feel and hear liquid sloshing inside the container. If the fire extinguisher is heated to a temperature of 40°C (perhaps it's in Death Valley or Dubai), nothing sloshes when you shake it. Explain why.

4. A 0.500-kg block of ice melts at 10.00 bars pressure and 0°C.

A. How much heat does the ice absorb in this process?

B. How much work does the ice do in this process?

C. (3 points) What is the change in internal energy of the ice in this process?

5. To cool its interior, a refrigerator adiabatically expands a sample of a diatomic ideal gas at $+30^{\circ}\text{C}$ and 5.00 bars until its temperature decreases to -15°C .

A. (3 points) What is the ratio of the final volume to the initial volume, V_2/V_1 , for this step?

B. (2 points) How much work does the gas do when an initial volume of $1.00 \times 10^{-3} \text{ m}^3$ ($+30^{\circ}\text{C}$, 5.00 bars) expands?

6. In five-card draw poker without wild cards, there are 624 possible four-of-a-kind hands and four possible royal flush hands.

A. Which hand has the higher probability of being dealt?

☐ a. four-of-a-kind ☐ b. royal flush

B. Which hand has the higher entropy?

☐ a. four-of-a-kind ☐ b. royal flush

7. (2 points) Why is a path ending at a higher-entropy state than its initial state considered *irreversible*?