Instructions: Show all work whenever a calculation is required! You will receive credit for how you worked each problem as well as for the correct answer. If you need more space, you may use the back of your periodic table — Write: “See PT” in box and then attach the periodic table. BOX YOUR ANSWERS! Write legibly.

1. (3 pts) Convert 422 mmHg to atmospheres.

2. (4 pts) Consider an open-ended manometer with mercury in the trap. The mercury in the arm connected to the gas-filled container is 12.5 cm higher than the arm open to the air. What is the pressure of the gas in the container if the external pressure is 725 mmHg?

3. (5 pts) A steel gas cylinder of oxygen has a volume of 49.0 L and the pressure is 150 atm. How many moles of O\(_2\)(g) are present at room temperature, 25 °C?

4. (5 pts) Suppose some of the gas in the same cylinder of oxygen described in the previous problem escaped underwater in an enclosed space. How does the volume of the escaped gas compare to its initial volume prior to escaping given the external pressure is 1050 mmHg and the temperature is 10 °C in the water? (Hint: Calculate \(V_f/V_i\))

5. (5 pts) What is the density of helium at STP?

6. (5 pts) What is the molar mass of a gas with a density of 2.55 g/L at 730 mmHg and 20 °C?

7. (5 pts) What is the density of a gas in the previous problem at STP?

8. (5 pts) Consider the reaction:

\[
2 \text{Na}_2\text{O}_2(s) + 2 \text{CO}_2(g) \rightarrow 2 \text{Na}_2\text{CO}_3(s) + \text{O}_2(g)
\]

What volume of oxygen is expected from the reaction of 48 L carbon dioxide with excess Na\(_2\)O\(_2\)(s)?

9. (5 pts) What is the molar mass of a gas that effuses 2.0 times faster than sulfur trioxide?
10. (5 pts) What is partial pressure of argon in a mixture of 5.0 g argon with 20.0 g nitrogen in a vessel in which the total pressure is 805 mmHg?

11. (3 pts) T or F

T   F   At constant temperature, all gases have the same average kinetic energy.

T   F   At any given temperature, the individual kinetic energy of gas molecules forms a distribution of values, with some molecules having more KE and some having less.

T   F   As the temperature is increased, the average kinetic energy of gases also increases.

12. (10 pts) In each pair of compounds, circle the one most likely to be a solid.

a. SCl₂ or CaCl₂
b. Xe or C
c. Fe(NO₃)₂ or C₆H₄(NO₂)₂
d. NI₃ or SO₃
e. Ti or C₂H₄F₂

13. (3 pts) Circle the member of each series with the largest London dispersion forces.

a. CH₄ C₂H₆ C₃H₈ C₄H₁₀
b. BF₃ SO₃ NCl₃ PCl₃
c. CCl₄ CHCl₃ CH₂Cl₂ CH₃Cl

14. (6 pts) Circle all compounds that are expected to exhibit hydrogen bonding.

CH₃OH HCl HOCl
CH₃OCH₃ NH₂Cl HF

15. (6 pts) Iodine has mp = 113.5 °C and bp = 184.4 °C. What, if any, phase change takes place under the following conditions at room temperature?

a. Heat is added to a sample of solid I₂ at 113.5 °C and the temperature does not change.

b. I₂ at 500 K is cooled to 300 K

c. A sample of I₂ at 400 K is heated to 450 K

16. (3 pts) Tungsten crystallizes with a body-centered cubic unit cell. How many tungsten atoms are present in each unit cell?

17. (4 pts) Sketch a heating/cooling curve diagram for water from −50 °C to +150 °C. The y-axis is temperature. Add labels: (s), (l), (g), T, time, s → l, l → g

18. (4 pts) Lead (Pb) crystallizes in a face-centered cubic unit cell with an edge length of 495 pm. What is the radius of the Pb atoms?

19. (8 pts) This is the structure of NaCl:

Which spheres are the sodium ions? Circle: Small or Large

What cubic unit cell is represented here: Circle: simple body-centered face-centered

How many sodium ions are present per unit cell?

How many chloride ions are present per unit cell?

20. (8 pts) This is the phase diagram for carbon dioxide:

What is the state of CO₂ at 10 atm and 10 °C? (s) (l) (g)

Can liquid CO₂ exist at 25 °C? Yes No

Draw an “X” on the graph representing STP.

What is the temperature of dry ice that is subliming on a desktop?

(1 pt) Print your name here:

Your exam score (100 possible):

Determine your grade:
A+ ≥ 95; A ≥ 90; B+ ≥ 85; B ≥ 80; C+ ≥ 75; C ≥ 70; D ≥ 60
Answers:

1. 0.555 atm
2. 600 mmHg
3. 300 mol O$_2$(g)
4. V$_f$/V$_i$ = 103:1
5. 0.18 g/L
6. 64 g/mol
7. 2.85 g/L
8. 24 L
9. 20 g/mol
10. 120 mmHg?
11. T T T
12. (a) CaCl$_2$; (b) C; (c) Fe(NO$_3$)$_3$; (d) Ni$_3$; (e) Ti
13. (a) C$_4$H$_{10}$; (b) PCl$_3$; (c) CCl$_4$
14. CH$_3$OH  HOCl  NH$_2$Cl  HF
15. 
   a. Solid $\rightarrow$ liquid
   b. Gas $\rightarrow$ liquid $\rightarrow$ solid
   c. No phase change
16. two
17. The first segment from $-50$ °C to 0 °C shows the solid warming up (the line has a + slope). The second region with slope = 0 is at 0 °C and is the solid melting. The third segment is a line with + slope from 0 °C to 100 °C and is the liquid warming up. The fourth segment with slope = 0 is the liquid boiling. Fifth segment, + slope, gas being heated to +150 °C.
18. 175 pm
19. Small; face-centered; 4; 4
20. gas; Yes; the “x” should be where P = 1 atm and T = 25 °C intersect; -78.5 °C