On the answer sheet (scantron) write your name, student ID number, and recitation section number. Choose the best (most correct) answer for each question and enter it on your answer sheet.

Potentially useful data:

\[
R = 0.08206 \text{ L} \cdot \text{atm} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} = 8.314 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}
\]

\[1 \text{ atm} = 760 \text{ Torr} = 760 \text{ mm Hg}
\]

Avogadro’s number: \(6.022 \times 10^{23}\)

1. Please choose the letter “a” as your answer for this question.

   ANSWER: a

2. Using the valence shell electron pair repulsion (VSEPR) model for the following three compounds, select the answer that gives the correct molecular geometries, respectively: \(\text{BF}_3, \text{CH}_4, \text{BeF}_2\)

   a. octahedral, triangular bipyramidal, triangular planar.
   b. linear, triangular planar, tetrahedral.
   c. tetrahedral, triangular planar, octahedral.
   d. triangular planar, tetrahedral, linear.
   e. linear, octahedral, linear.

   ANSWER: d.

3. Which molecule below is an example of \(AX_2E_0\) in the VSEPR model?

   a. \(\text{PF}_5\)
   b. \(\text{SF}_4\)
   c. \(\text{CH}_4\)
   d. \(\text{CO}_2\)
   e. \(\text{H}_2\text{O}\)

   ANSWER: d

4. How many lone pairs of electrons does the Lewis dot structure of \(\text{H}_2\text{S}\) have around its central atom and what is the shape of the molecule?

   a. 0, linear
   b. 0, bent
   c. 1, triangular planar
   d. 2, tetrahedral
   e. 2, bent

   ANSWER: e
5. In VSEPR Theory, under which of the following conditions will the electron-pair geometry be the same as the molecular geometry?
   a. in molecules with at least one lone pair of electrons on the central atom
   b. in molecules with no lone pairs of electrons on the substituent atoms
   c. in molecules with a central atom that is a nonmetal
   d. in molecules with no lone pairs of electrons on the central atom
   e. in molecules with more than one octet around the central atom

   ANSWER: d

6. Which of the following compounds does not have tetrahedral electron-pair geometry?
   a. CCl₄
   b. NO₂⁻
   c. H₃O⁺
   d. PCl₃
   e. H₂O

   ANSWER: b

7. Select the correct sequence of descriptors for the following four molecules, in order: H₂O, CBr₄, BCl₃, NH₃.
   a. polar, polar, polar, nonpolar.
   b. polar, nonpolar, nonpolar, polar.
   c. polar, polar, polar, polar.
   d. nonpolar, nonpolar, nonpolar, nonpolar.
   e. polar, polar, nonpolar, polar.

   ANSWER: b

8. London (or dispersion) forces exist:
   a. for all molecules.
   b. only for molecules with nonpolar bonds.
   c. only for molecules with polar bonds.
   d. only for molecules with metallic bonds.
   e. only for molecules with hydrogen bonding.

   ANSWER: a

9. H₂O, HF, and NH₃ to all have higher boiling points than would have been predicted. This is due to:
   a. higher than expected molecular masses.
   b. stronger than expected dipole moments.
   c. hydrogen bonding.
   d. ionic bonding.
   e. short bond lengths within each molecule.
10. What is the major type of force that must be overcome to allow the boiling of carbon tetrachloride (CCl₄)?
   a. ion-dipole forces  
   b. dipole-dipole attractions  
   c. hydrogen bonding  
   d. covalent bonds  
   e. London (dispersion) forces

   ANSWER: e

11. Pick the correct sequence of yes and no that describes whether each of the compounds in this list can participate in hydrogen bonding: H₂O, NH₃, CH₃OH, CH₄
   a. Yes, no, no, no.  
   b. Yes, yes, no, yes.  
   c. Yes, no, yes, no.  
   d. Yes, yes, yes, no.  
   e. Yes, no, no, yes.

   ANSWER: d

12. There are four main layers to our atmosphere. Which of the following is the correct name for the layer in which we live?
   a. troposphere  
   b. thermosphere  
   c. stratosphere  
   d. mesosphere  
   e. ionosphere

   ANSWER: a

13. NO₂ is a known air pollutant resulting from the combustion of petroleum in vehicles. Suppose at 6:00 am, there are 0.920 ppm NO₂ in a liter of air. Calculate the mass (in grams) of the NO₂ present in a liter, assuming there are 2.46 × 10²³ molecules of air in 1.00 L. (1 ppm = 10⁻⁶)
   a. 1.72 × 10⁻²⁴  
   b. 7.03 × 10⁻²³  
   c. 1.73 × 10⁻⁵  
   d. 4.23 × 10⁻⁵  
   e. 1.04 × 10⁻¹⁵

   ANSWER: c
14. Which concept is **not** associated with the kinetic-molecular theory of gases?
   a. No energy is lost when gas molecules collide with each other.
   b. Gas molecules move randomly in all possible directions at various speeds.
   c. The average kinetic energy of gas molecules increases as the temperature increases.
   d. The distance between gas molecules is close to the diameter of the gas molecules.
   e. The forces of attraction and repulsion between separate gas molecules are minimal.

   **ANSWER:** d

15. Arrange the following atomic gases in **increasing** order of average atomic speed at room temperature:
   krypton, neon, argon, helium, radon.
   
   a. helium < radon < argon < neon < krypton
   b. helium < argon < neon < krypton < radon
   c. radon < krypton < argon < neon < helium
   d. argon < neon < helium < radon < krypton
   e. helium < neon < argon < krypton < radon

   **ANSWER:** c

16. If, at constant temperature, the volume of a cylinder equipped with a moveable piston is reduced to 1/4 its original volume, what must happen to the pressure?
   a. It is increased by a factor of four.
   b. It is increased by a factor of eight.
   c. It is reduced to 1/4 the original pressure.
   d. It is reduced to 1/8 the original pressure.
   e. It remains the same as the original pressure.

   **ANSWER:** a

17. Which of the following correctly describes the relationship between the pressure of an ideal gas and the volume of the gas at constant temperature?
   a. as one increases the other increases
   b. unrelated
   c. directly proportional
   d. equal to each other
   e. inversely proportional

   **ANSWER:** e

18. If a 2.0-liter sample of gas experiences a decrease in pressure from 1.74 atm to 0.555 atm at 25°C, what is the resulting volume at 25°C?
   a. 0.48 L
   b. 0.64 L
   c. 1.9 L
d. 6.3 L  
e. 20 L  

ANSWER: d

19. A 125.0-mL volume contains a gas at 27°C and 760 mm Hg of pressure. The gas is pumped into an empty 1.50-L flask also at a temperature of 27°C. What is the pressure (in atm) of the gas in the new flask?
   a. $8.33 \times 10^{-2}$  
   b. 63.3  
   c. 83.3  
   d. $6.33 \times 10^{4}$  
   e. none of the above  

ANSWER: a

20. What conditions are referred to as standard temperature and pressure (STP) for gas behavior?
   a. 0°C and 1 atm  
   b. 0°C and 1 mm Hg  
   c. 273°C and 1 atm  
   d. 25°C and 1 atm  
   e. 298 K and 760 torr  

ANSWER: a

21. If at 29°C and 2.50 atm of pressure, a gas occupies 5.99 L, what volume (in L) will the same gas occupy at 19°C and 1.20 atm of pressure?
   a. $2.04 \times 10^{-4}$  
   b. $6.04 \times 10^{-1}$  
   c. 8.18  
   d. 12.1  
   e. 20.0  

ANSWER: d

22. What is the density of SO$_2$ (g) at 25°C and 0.750 atm?
   a. 3.92 g/L  
   b. 1.96 g/L  
   c. 0.980 g/L  
   d. 70.9 g/L  
   e. 0.750 g/L  

ANSWER: b
23. What volume of oxygen at 298K and 1.50 atm is required for the complete combustion of 25.0 g of hexane?

\[ 2 \text{C}_6\text{H}_{14} + 19 \text{O}_2 \rightarrow 12 \text{CO}_2 + 14 \text{H}_2\text{O} \]

a. 4.73 L  
b. 0.397 L  
c. 34.2 L  
d. 45.0 L  
e. 407 L

ANSWER: d