

MULTIPLE CHOICE

1. Gaseous mixtures \_\_\_\_\_
  - a) can only contain molecules
  - b) are all heterogeneous
  - c) can only contain isolated atoms
  - d) are all homogeneous
  - e) must contain both isolated atoms and molecules
  
2. A gas at a pressure of 325 torr exerts a force of \_\_\_\_ N on an area of 5.5 m<sup>2</sup>.
  - a)  $1.8 \times 10^3$
  - b) 59
  - c)  $2.4 \times 10^5$
  - d) 0.018
  - e) 2.4
  
3. A pressure of 1.00 atm is the same as a pressure of \_\_\_\_\_ of Hg.
  - a) 193
  - b) 101
  - c) 76.00
  - d) 29.92
  - e) 33.0
  
4. In a Torricelli barometer, one atmosphere pressure supports a 760 mm column of mercury. If the original tube containing the mercury is replaced with a tube having twice the diameter of the original, what will the height of the mercury column be at one atmosphere pressure?
  - a) 380 mm
  - b) 760 mm
  - c)  $1.52 \times 10^3$  mm
  - d)  $4.78 \times 10^3$  mm
  - e) 121 mm
  
5. If one was told that their blood pressure was 130/80, their systolic pressure was \_\_\_\_\_.
  - a) 130 Pa
  - b) 130 torr
  - c) 80 Pa
  - d) 80 torr
  - e) 80 psi
  
6. Of the following, \_\_\_\_\_ is a correct statement of Boyle's law.
  - a)  $PV = \text{constant}$
  - b)  $\frac{P}{V} = \text{constant}$
  - c)  $\frac{V}{P} = \text{constant}$
  - d)  $\frac{V}{T} = \text{constant}$
  - e)  $\frac{n}{P} = \text{constant}$

7. A sample of a gas (5.0 mol) at 1.0 atm is expanded at constant temperature from 10 L to 15 L. The final pressure is \_\_\_\_\_ atm.
- a) 1.5
  - b) 7.5
  - c) 0.67
  - d) 3.3
  - e) 15
8. A gas originally at 27°C and 1.00 atm pressure in a 3.9 L flask is cooled at constant pressure until the temperature is 11°C. The new volume of the gas is \_\_\_\_\_ L.
- a) 0.27
  - b) 3.7
  - c) 3.9
  - d) 4.1
  - e) 0.24
9. A sample of He gas (2.35 mol) occupies 57.9 L at 300.0 K and 1.00 atm. The volume of this sample is \_\_\_\_\_ L at 423 K and 1.00 atm.
- a) 0.709
  - b) 41.1
  - c) 81.6
  - d) 1.41
  - e) 57.9
10. The law of combining volumes says that at a given temperature and pressure, the reaction of 50 mL of  $\text{Cl}_2$  gas with 50 mL of  $\text{CH}_4$  gas via the equation:  $\text{Cl}_2(\text{g}) + \text{CH}_4(\text{g}) \rightarrow \text{HCl}(\text{g}) + \text{CH}_3\text{Cl}(\text{g})$  will produce a total of \_\_\_\_\_ mL of products.
- a) 100
  - b) 50
  - c) 200
  - d) 150
  - e) 250
11. A 0.325 L flask filled with gas at 0.914 atm and 19°C contains \_\_\_\_\_ mol of gas.
- a)  $1.24 \times 10^{-2}$
  - b)  $1.48 \times 10^{-2}$
  - c) 9.42
  - d) 12.4
  - e) 80.7
12. A sample of gas (1.9 mol) is in a flask at 21°C and 697 torr. The flask is opened and more gas is added to the flask. The new pressure is 795 torr and the temperature is now 26°C. There are now \_\_\_\_\_ mol of gas in the flask.
- a) 1.6
  - b) 2.1
  - c) 2.9
  - d) 3.5
  - e) 0.28
13. Standard temperature and pressure (STP), in the context of gases, refers to \_\_\_\_\_.
- a) 298 K and 1 atm
  - b) 273 K and 1 atm
  - c) 298 K and 1 torr
  - d) 273 K and 1 pascal
  - e) 273 K and 1 torr

14. The density of chlorine ( $\text{Cl}_2$ ) gas at  $25^\circ\text{C}$  and 450 torr is \_\_\_\_\_ g/L.
- a) 20
  - b) 4.9
  - c) 1.7
  - d) 0.86
  - e) 0.58
15. What volume (mL) of sulfur dioxide can be produced by the complete reaction of 3.82 g of calcium sulfite with excess HCl, when the final  $\text{SO}_2$  pressure is 827 torr at  $44^\circ\text{C}$ ?
- a) 761
  - b)  $1.39 \times 10^{-4}$
  - c)  $1.00 \times 10^{-3}$
  - d) 0.106
  - e) 578
16. The Mond process produces pure nickel metal via the thermal decomposition of nickel tetracarbonyl:  
 $\text{Ni}(\text{CO})_4(\text{l}) \rightarrow \text{Ni}(\text{s}) + 4\text{CO}(\text{g})$ .  
What volume (L) of CO is formed from the complete decomposition of 444 g of  $\text{Ni}(\text{CO})_4$  at 752 torr and  $22^\circ\text{C}$ ?
- a) 0.356
  - b) 63.7
  - c) 255
  - d) 20.2
  - e) 11.0
17. A 255 mL round-bottom flask is weighed and found to have a mass of 114.85 g. A few milliliters of an easily vaporized liquid are added to the flask and the flask is immersed in a boiling water bath. All of the liquid vaporizes at the boiling temperature of water, filling the flask with vapor. When all of the liquid has vaporized, the flask is removed from the bath, cooled, dried, and reweighed. The new mass of the flask and the condensed vapor is 115.23 g. Which of the following compounds could the liquid be? (Assume the ambient pressure is 1 atm.)
- a)  $\text{C}_4\text{H}_{10}$
  - b)  $\text{C}_3\text{H}_7\text{OH}$
  - c)  $\text{C}_2\text{H}_6$
  - d)  $\text{C}_2\text{H}_5\text{OH}$
  - e)  $\text{C}_4\text{H}_9\text{OH}$
18. Since air is a mixture, it does not have a "molar mass." However, for calculation purposes, it is possible to speak of its "effective molar mass." (An effective molar mass is a weighted average of the molar masses of a mixture's components.) If air at STP has a density of 1.285 g/L, what is its effective molar mass?
- a) 26.9 g/mol
  - b) 31.4 g/mol
  - c) 30.0 g/mol
  - d) 34.4 g/mol
  - e) 28.8 g/mol
19. A vessel contained  $\text{N}_2$ , Ar, He, and Ne. The total pressure in the vessel was 987 torr. The partial pressures of nitrogen, argon, and helium were 44, 486, and 218 torr, respectively. The partial pressure of neon in the vessel was \_\_\_\_\_ torr.
- a) 42.4
  - b) 521
  - c) 19.4
  - d) 239
  - e) 760

20. The pressure in a 12.2 L vessel that contains 2.34 g of carbon dioxide, 1.73 g of sulfur dioxide, and 3.33 g of argon, all at 42°C is \_\_\_\_\_ torr.
- a) 263
  - b) 134
  - c) 395
  - d) 116
  - e) 0.347
21. A mixture of He and Ne at a total pressure of 0.95 atm is found to contain 0.32 mol of He and 0.56 mol of Ne. The partial pressure of Ne is \_\_\_\_\_ atm.
- a) 1.7
  - b) 1.5
  - c) 0.60
  - d) 0.35
  - e) 1.0
22. CuS (4.22 g) was mixed with excess HCl and the resulting H<sub>2</sub>S was collected over water. What volume of H<sub>2</sub>S (L) was collected at 32°C when the atmospheric pressure was 749 torr? The vapor pressure of water at this temperature is 36 torr.
- a) 850
  - b) 0.124
  - c) 0.587
  - d) 1.18
  - e)  $1.55 \times 10^{-3}$
23. CO (5.0 g) and CO<sub>2</sub> (5.0 g) were placed in a 750 mL container at 50°C. The total pressure in the container was \_\_\_\_\_ atm.
- a) 10.3
  - b) 4.02
  - c) 6.31
  - d) 0.292
  - e) 1.60
24. A sample of He gas (2.0 mmol) effused through a pinhole in 53 s. The same amount of an unknown gas, under the same conditions, effused through the pinhole in 248 s. The molecular mass of the unknown gas is \_\_\_\_\_ g/mol.
- a) 0.19
  - b) 5.5
  - c) 88
  - d) 19
  - e) 350
25. Using the van der Waals equation, the pressure in a 22.4 L vessel containing 1.50 mol of chlorine gas at 0°C is \_\_\_\_\_ atm. ( $a = 6.49 \text{ L}^2\text{-atm/mol}^2$ ,  $b = 0.0562 \text{ L/mol}$ )
- a) 0.993
  - b) 1.50
  - c) 0.676
  - d) 1.91
  - e) 1.48

26. Which change increases the mean free path of molecules in a sample of gas?
- (A) increase in pressure at constant temperature
  - (B) increase in density at constant temperature
  - (C) increase in temperature at constant pressure
  - (D) increase in temperature at constant volume
  - (E) increase in pressure at constant volume
27. The density of an unknown gas is found to be  $1.65 \text{ g} \cdot \text{L}^{-1}$ . Under the same conditions, the density of oxygen gas is found to be  $1.10 \text{ g} \cdot \text{L}^{-1}$ . The molecular mass of the unknown gas is closest to
- (A) 14
  - (B) 24
  - (C) 36
  - (D) 48
  - (E) 72
28. Under certain conditions, methane gas,  $\text{CH}_4$ , diffuses at a rate of  $12 \text{ cm} \cdot \text{sec}^{-1}$ . Under the same conditions, an unknown gas diffuses at a rate of  $8.0 \text{ cm} \cdot \text{sec}^{-1}$ . The molecular mass of the unknown gas is closest to
- (A) 6
  - (B) 20
  - (C) 24
  - (D) 36
  - (E) 72
29. What is the resulting pressure when the quantities of gases listed below are mixed and placed in a 12 liter vessel at constant temperature?
- 4.0 L Ne measured at 2.0 atm
  - 2.0 L He measured at 3.0 atm
  - 2.0 L Ar measured at 5.0 atm
- (A) 2.0 atm
  - (B) 3.3 atm
  - (C) 6.7 atm
  - (D) 10. atm
  - (E) 40. atm

30 10. Assuming ideal behavior, which expression gives the density of krypton in grams per liter at 25°C and 745 mm Hg?

(A) 
$$\frac{83.8}{22.4 \times \frac{745}{760} \times \frac{298}{273}}$$

(B) 
$$\frac{83.8}{22.4 \times \frac{760}{745} \times \frac{298}{273}}$$

(C) 
$$\frac{83.8}{22.4 \times \frac{745}{760} \times \frac{273}{298}}$$

(D) 
$$\frac{83.8 \times 22.4}{\frac{745}{760} \times \frac{298}{273}}$$

(E) 
$$\frac{83.8 \times 22.4}{\frac{760}{745} \times \frac{298}{273}}$$

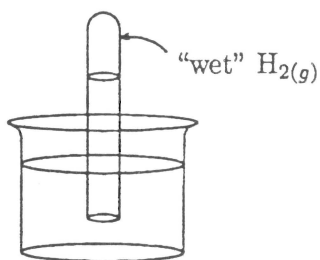
31 11. At certain conditions, the molar volume of a real gas may be less than the value predicted by the general gas law. Which property accounts for this deviation?

- (A) Each gas molecule occupies an absolute volume.
- (B) Forces of attraction exist between the gas molecules.
- (C) Resonance bonds exist between the atoms in the molecules of the gas.
- (D) The average velocity of the gas molecules is less than the value predicted by Graham's Law.
- (E) The kinetic energy of the gas molecules is less than the value predicted by the equation  $KE = \frac{1}{2}mv^2$

32 12. Compared to the normal boiling points of other substances with similar molecular mass, the normal boiling point of sulfur dioxide is much higher. Which property of sulfur dioxide molecules accounts for this behavior?

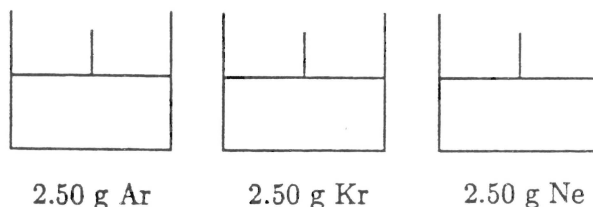
- (A) Each sulfur dioxide molecule occupies an absolute volume.
- (B) Forces of attraction exist between sulfur dioxide molecules.
- (C) Resonance bonds exist between sulfur and oxygen atoms.
- (D) The velocity of sulfur dioxide molecules is less than the value predicted by Graham's Law.
- (E) The kinetic energy of sulfur dioxide molecules is less than the value predicted by the equation  $KE = \frac{1}{2}mv^2$ .

- 33 13. A sample of hydrogen gas is collected by displacement of water as shown in the diagram below. All of the following describe this sample of gas EXCEPT:



- (A) The volume of H<sub>2</sub>(g) is greater than the volume of H<sub>2</sub>O(g).  
(B) The pressure of H<sub>2</sub>(g) is greater than the pressure of H<sub>2</sub>O(g).  
(C) The temperature of H<sub>2</sub>(g) is the same as the temperature of H<sub>2</sub>O(g).  
(D) The number of molecules of H<sub>2</sub>(g) is less than the number of molecules of H<sub>2</sub>O(g).  
(E) The mass of a molecule of H<sub>2</sub>(g) is less than the mass of a molecule of H<sub>2</sub>O(g).
- 34 14. In the sample described above in question 13, which property does not need to be measured during the experiment to determine the number of moles of gas in the measuring tube?
- (A) atmospheric pressure  
(B) vapor pressure of water  
(C) height of the water column  
(D) volume of the hydrogen gas  
(E) temperature of the water in the beaker
- 35 15. Which property of hydrogen sulfide gas is least closely related to the polarity of its molecules?
- (A) molecular mass  
(B) solubility in water  
(C) critical temperature  
(D) normal boiling point  
(E) elasticity of molecular collisions

Questions 16-18: Consider three pistons each containing 2.50 g of the gas specified in 2.24 liters measured at 273 K. The pressure is not specified. Assume ideal behavior.



36 16. Which is a correct comparison of the contents of the pistons?

- I. The number of molecules in each piston is the same.
- II. The density of the contents of each piston is the same.
- III. The average velocity of the molecules in each piston is the same.

- (A) II only
- (B) III only
- (C) I and II only
- (D) II and III only
- (E) I, II, and III

27 17. Which is a correct comparison of the contents of the pistons?

- (A) All have the same pressure because they have the same mass and volume.
- (B) All have the same pressure because they have the same average kinetic energy.
- (C) All have the same pressure because noble gases deviate little from ideal behavior.
- (D) The pressure of the krypton is the greatest because the molecular mass of krypton is the greatest.
- (E) The pressure of the neon is the greatest because the number of neon molecules is the greatest.

38 18. If the conditions are changed to STP, which change will be observed?

- (A) All volumes will change to the same lower value.
- (B) All volume will change to the same greater value.
- (C) All volumes will increase such that the neon becomes greater than the other two.
- (D) The volume of the neon will increase and the volumes of the other two will decrease.
- (E) The volume of the neon and the argon will increase and the volume of the krypton will decrease.



- 39 19. Consider a sample of gas confined at constant temperature and volume in the closed system shown below. If more of this same gas is added at constant temperature, what effect is observed on pressure and average molecular velocity?



- (A) Both pressure and average molecular velocity increase.  
 (B) Pressure decreases and average molecular velocity remains the same.  
 (C) Pressure remains the same and average molecular velocity increases.  
 (D) Pressure increases and average molecular velocity remains the same.  
 (E) Pressure remains the same and average molecular velocity decreases.
- 40 20. When a sample of ideal gas is heated from 20°C to 40°C, the average kinetic energy of the system changes. Which factor describes this change?

- (A)  $\frac{1}{2}$   
 (B)  $\frac{313}{293}$   
 (C)  $\sqrt{\frac{313}{293}}$   
 (D)  $\frac{293}{313}$   
 (E) 2

- 41 21. Which occurs when a substance is converted from liquid to gas at the normal boiling point?

- I. Potential energy of the system increases.  
 II. The distance between molecules increases.  
 III. The average kinetic energy of the molecules increases.

- (A) I only  
 (B) II only  
 (C) I and II only  
 (D) II and III only  
 (E) I, II, and III

- 42 22. Which describes a change that occurs when a sample of nitrogen is sealed in a metal tank then heated from 250 K to 300 K?

- (A) The density of the sample decreases.  
 (B) The volume of the sample increases.  
 (C) The pressure of the sample increases.  
 (D) The mean distance between molecules increases.  
 (E) The number of molecules in the container increases.

