1. The entropy of a sample of CO_2 increases as the CO_2 changes from

   A) gas to liquid
   B) gas to solid
   C) liquid to solid
   D) solid to gas

2. Which statement describes the particles of an ideal gas based on the kinetic molecular theory?

   A) The gas particles are relatively far apart and have negligible volume.
   B) The gas particles are in constant, nonlinear motion.
   C) The gas particles have attractive forces between them.
   D) The gas particles have collisions without transferring energy.

3. Under which conditions of temperature and pressure would a 1-liter sample of a real gas behave most like an ideal gas?

   A) 100 K and 0.1 atm
   B) 100 K and 10 atm
   C) 500 K and 0.1 atm
   D) 500 K and 10 atm

4. A real gas behaves *least* like an ideal gas under the conditions of

   A) low temperature and low pressure
   B) low temperature and high pressure
   C) high temperature and low pressure
   D) high temperature and high pressure

5. Which two samples of gas at STP contain the same total number of molecules?

   A) 1 L of $CO(g)$ and 0.5 L of $N_2(g)$
   B) 2 L of $CO(g)$ and 0.5 L of $NH_3(g)$
   C) 1 L of $H_2(g)$ and 2 L of $Cl_2(g)$
   D) 2 L of $H_2(g)$ and 2 L of $Cl_2(g)$

6. The table below shows data for the temperature, pressure, and volume of four gas samples.

   Data for Four Gas Samples

 | Gas Sample | Temperature (K) | Pressure (atm) | Volume (mL) |
   |---|---|---|---|
   | A | 100. | 2 | 400. |
   | B | 200. | 2 | 200. |
   | C | 100. | 2 | 400. |
   | D | 200. | 4 | 200. |

   Which two gas samples have the same total number of molecules?

   A) *A* and *B*
   B) *A* and *C*
   C) *B* and *C*
   D) *B* and D

7. A 220.0-mL sample of helium gas is in a cylinder with a movable piston at 105 kPa and 275 K. The piston is pushed in until the sample has a volume of 95.0 mL. The new temperature of the gas is 310. K. What is the new pressure of the sample?

   A) 51.1 kPa
   B) 216 kPa
   C) 243 kPa
   D) 274 kPa

8. Which set of values represents standard pressure and standard temperature?

   A) 1 atm and 101.3 K
   B) 1 kPa and 273 K
   C) 101.3 kPa and 0°C
   D) 101.3 atm and 273°C

9. At 25°C, gas in a rigid cylinder with a movable piston has a volume of 145 mL and a pressure of 125 kPa. Then the gas is compressed to a volume of 80. mL. What is the new pressure of the gas if the temperature is held at 25°C?

   A) 69 kPa
   B) 93 kPa
   C) 160 kPa
   D) 230 kPa

10. Which temperature change would cause a sample of an ideal gas to double in volume while the pressure is held constant?

    A) from 400. K to 200. K
    B) from 200. K to 400. K
    C) from 400.°C to 200.°C
   D) from 200.°C to 400.°C

11. Which graph represents the relationship between pressure and volume for a sample of an ideal gas at constant temperature?

    A)

    B)

    C)

    D)
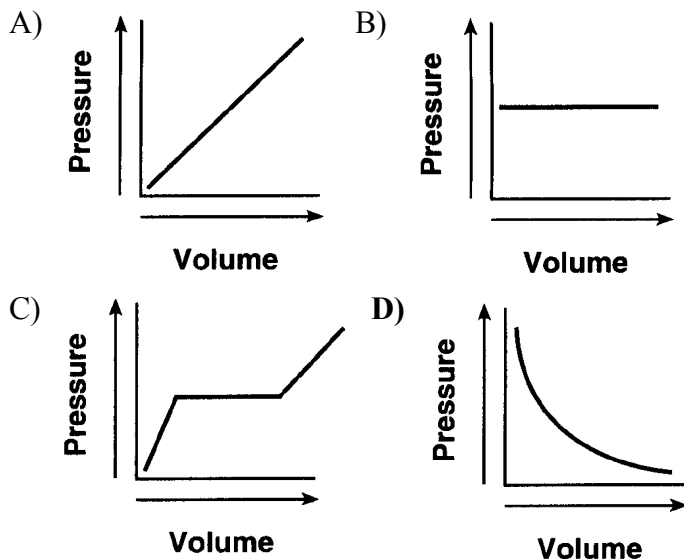
12. A rigid cylinder with a movable piston contains a 2.0-liter sample of neon gas at STP. What is the volume of this sample when its temperature is increased to 30.°C while its pressure is decreased to 90. kilopascals?

    A) 2.5 L   B) 2.0 L
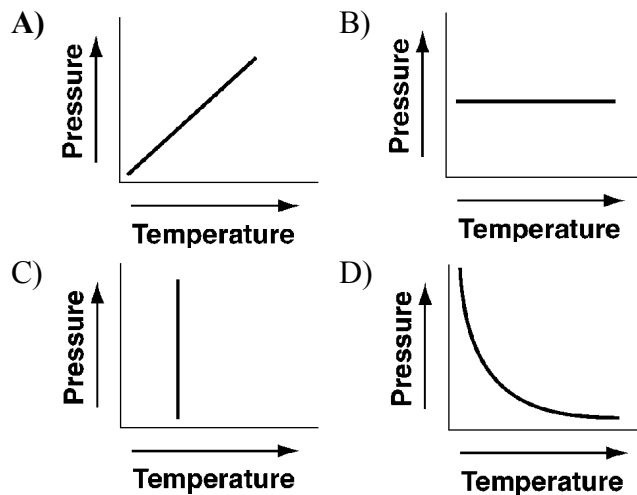   C) 1.6 L   D) 0.22 L

13. The stoppered tubes below, labeled *A* through *D*, each contain a different gas.
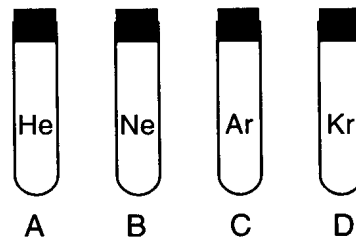
    When the tubes are unstoppered at the same time and under the same conditions of temperature and pressure, from which tube will gas diffuse at the fastest rate?

    A) *A*   B) *B*   C) *C*   D) *D*

14. Which graph shows the pressure-temperature relationship expected for an ideal gas?

    A)

    B)

    C)

    D)

15. As the temperature of a gas increases at constant pressure, the volume of the gas

    A) decreases   **B) increases**
    C) remains the same

Base your answers to questions **16** through **18** on the information below and on your knowledge of chemistry.

Cylinder A has a movable piston and contains hydrogen gas. An identical cylinder, B, contains methane gas. The diagram below represents these cylinders and the conditions of pressure, volume, and temperature of the gas in each cylinder.

Cylinder A

Cylinder B

Hydrogen gas
$P = 1.2$ atm
$V = 1.25$ L
$T = 293$ K

Methane gas
$P = 1.2$ atm
$V = 1.25$ L
$T = 293$ K

16. Show a numerical setup for calculating the volume of the gas in cylinder B at STP.

17. State a change in temperature and a change in pressure that will cause the gas in cylinder A to behave more like an ideal gas.

18. Compare the total number of gas molecules in cylinder A to the total number of gas molecules in cylinder B.

19. Base your answer to the following question on the information below.

A lightbulb contains argon gas at a temperature of 295 K and at a pressure of 75 kilopascals. The lightbulb is switched on, and after 30 minutes its temperature is 418 K.

Show a correct numerical setup for calculating the pressure of the gas inside the lightbulb at 418 K. Assume the volume of the lightbulb remains constant.

20. Base your answer to the following question on the information below.

    Air bags are an important safety feature in modern automobiles. An air bag is inflated in milliseconds by the explosive decomposition of $NaN_3(s)$. The decomposition reaction produces $N_2(g)$, as well as $Na(s)$, according to the unbalanced equation below.

 $NaN_3(s) \rightarrow Na(s) + N_2(g)$

    When the air bag inflates, the nitrogen gas is at a pressure of 1.30 atmospheres, a temperature of 301 K, and has a volume of 40.0 liters. Calculate the volume of the nitrogen gas at STP. Your response must include *both* a correct numerical setup and the calculated volume

21. A sample of oxygen gas in one container has a volume of 20.0 milliliters at 297 K and 101.3 kPa. The entire sample is transferred to another container where the temperature is 283 K and the pressure is 94.6 kPa. Show a correct numerical setup for calculating the new volume of this sample of oxygen gas.

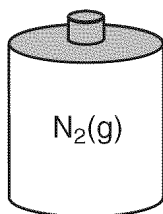22. Base your answer to the following question on the information and diagrams below.

    Cylinder Acontains 22.0 grams of $CO_2(g)$ and cylinder Bcontains $N_2(g)$. The volumes, pressures, and temperatures of the two gases are indicated under each cylinder.

    Cylinder A   Cylinder B

    $CO_2(g)$ $N_2(g)$
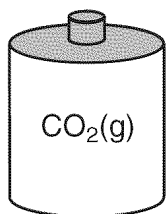
    V = 12.3 L   V = 12.3 L
    P = 1.0 atm   P = 1.0 atm
    T = 300. K   T = 300. K

    The temperature of the $CO_2(g)$ is increased to 450. K and the volume of cylinder A remains constant. Show a correct numerical setup for calculating the new pressure of the $CO_2(g)$ in cylinder A.

1. __D__

2. __A__

3. __C__

4. __B__

5. __D__

6. __B__

7. __D__

8. __C__

9. __D__

10. __B__

11. __D__

12. __A__

13. __A__

14. __A__

15. __B__

16. $\frac{(1.2\,\text{atm})(1.25\,\text{L})}{293\,\text{K}} = \frac{(1.0\text{atm})(V_2)}{273\,\text{K}}$

$\frac{(273)(1.2)(1.25)}{293}$

17. Temperature: above 293 K   Pressure : below 1.2 atm
Temperature: higher
Pressure: lower

18. −The number of gas molecules in cylinder *A* is the same as the number of gas molecules in cylinder *B*.

19. $\dfrac{75\ \text{kPa}}{295\ \text{K}} = \dfrac{x}{418\ \text{K}}$

$P_2 = \dfrac{(75)(418)}{295}$

20. 47.2 L
$V_2 = \underline{(273\ \text{K})(1.30}$
atm)(40.0 L)
        (301
K)(1.00 atm)
$\dfrac{(273)(1.30)(40.0)}{(301)(1.00)}$

21. Acceptable responses include, but are not limited to:

$V_2 = \frac{(20.0\,\text{mL})(101.3\,\text{kPa})(283\,\text{K})}{(94.6\,\text{kPa})(297\,\text{K})}$

$\frac{(101.3)(20.0)}{297.283} = (94.6)V_2$

22. $\frac{450}{300}$