1. Which statement describes the particles of an ideal gas?
   1) The particles move in well-defined, circular paths.
   2) When the particles collide, energy is lost.
   3) There are forces of attraction between the particles.
   4) The volume of the particles is negligible.

2. Which statement describes the particles of an ideal gas based on the kinetic molecular theory?
   1) The gas particles are relatively far apart and have negligible volume.
   2) The gas particles are in constant, nonlinear motion.
   3) The gas particles have attractive forces between them.
   4) The gas particles have collisions without transferring energy.

3. According to the kinetic molecular theory, which statement describes the particles in a sample of an ideal gas?
   1) The force of attraction between the gas particles is strong.
   2) The motion of the gas particles is random and straight-line.
   3) The collisions between the gas particles cannot result in a transfer of energy between the particles.
   4) The separation between the gas particles is smaller than the size of the gas particles themselves.

4. A real gas behaves *least* like an ideal gas under the conditions of
   1) low temperature and low pressure
   2) low temperature and high pressure
   3) high temperature and low pressure
   4) high temperature and high pressure

5. Under which conditions of temperature and pressure would a 1-liter sample of a real gas behave most like an ideal gas?
   1) 100. K and 0.1 atm
   2) 100. K and 10 atm
   3) 500. K and 0.1 atm
   4) 500. K and 10 atm

6. Under which conditions of temperature and pressure does a sample of neon behave most like an ideal gas?
   1) 100 K and 0.25 atm
   2) 100 K and 25 atm
   3) 400 K and 0.25 atm
   4) 400 K and 25 atm

7. Under which conditions of temperature and pressure would a real gas behave most like an ideal gas?
   1) 200. K and 50.0 kPa
   2) 200. K and 200.0 kPa
   3) 600. K and 50.0 kPa
   4) 600. K and 200.0 kPa

8. Which rigid cylinder contains the same number of gas molecules at STP as a 2.0-liter rigid cylinder containing $H_2(g)$ at STP?
   1) 1.0-L cylinder of $O_2(g)$
   2) 2.0-L cylinder of $CH_4(g)$
   3) 1.5-L cylinder of $NH_3(g)$
   4) 4.0-L cylinder of He(g)

9. Which two samples of gas at STP contain the same total number of molecules?
   1) 1 L of CO(g) and 0.5 L of $N_2(g)$
   2) 2 L of CO(g) and 0.5 L of $NH_3(g)$
   3) 1 L of $H_2(g)$ and 2 L of $Cl_2(g)$
   4) 2 L of $H_2(g)$ and 2 L of $Cl_2(g)$

10. The table below shows mass and volume data for four samples of substances at 298 K and 1 atmosphere.

Masses and Volumes of Four Samples

Sample	Mass (g)	Volume (mL)
A	30.	60.
B	40.	50.
C	45	90.
D	90.	120.

Which two samples could consist of the same substance?
1) *A* and *B*
2) *A* and *C*
3) *B* and *C*
4) *C* and *D*

11. 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?

1) *A* and *B*
2) *A* and *C*
3) *B* and *C*
4) *B* and D

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

1) from 400. K to 200. K
2) from 200. K to 400. K
3) from 400.°C to 200.°C
4) from 200.°C to 400.°C

13. A cylinder with a movable piston contains a sample of gas having a volume of 6.0 liters at 293 K and 1.0 atmosphere. What is the volume of the sample after the gas is heated to 303 K, while the pressure is held at 1.0 atmosphere?

1) 9.0 L
2) 6.2 L
3) 5.8 L
4) 4.0 L

14. A sample of gas confined in a cylinder with a movable piston is kept at constant pressure. The volume of the gas doubles when the temperature of the gas is changed from

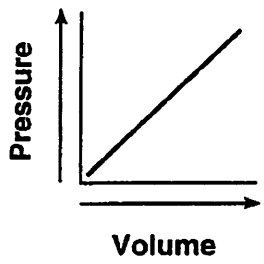
1) 400. K to 200. K
2) 200. K to 400. K
3) 400.°C to 200.°C
4) 200.°C to 400.°C

15. A rigid cylinder contains a sample of gas at STP. What is the pressure of this gas after the sample is heated to 410. K?

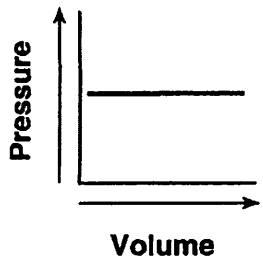
1) 1.0 atm
2) 0.50 atm
3) 0.67 atm
4) 1.5 atm

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

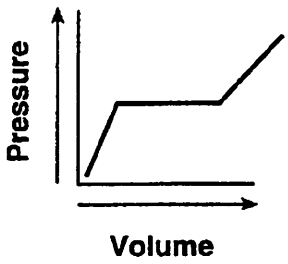
1)



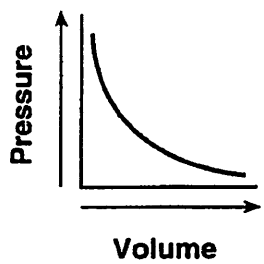
2)



3)



4)



17. A sample of gas occupies a volume of 50.0 milliliters in a cylinder with a movable piston. The pressure of the sample is 0.90 atmosphere and the temperature is 298 K. What is the volume of the sample at STP?

1) 41 mL
2) 49 mL
3) 51 mL
4) 55 mL

18. Standard pressure is equal to

1) 1 atm
2) 1 kPa
3) 273 atm
4) 273 kPa

19. 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?
1) 2.5 L
2) 2.0 L
3) 1.6 L
4) 0.22 L

20. At which temperature is the vapor pressure of ethanol equal to the vapor pressure of propanone at 35°C?
1) 35°C
2) 60.°C
3) 82°C
4) 95°C

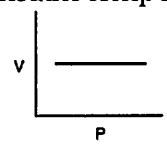
21. A sample of gas is held at constant pressure. Increasing the kelvin temperature of this gas sample causes the average kinetic energy of its molecules to
1) decrease and the volume of the gas sample to decrease
2) decrease and the volume of the gas sample to increase
3) increase and the volume of the gas sample to decrease
4) increase and the volume of the gas sample to increase

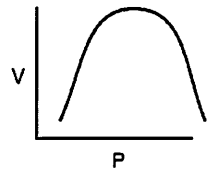
22. A sample of helium gas has a volume of 900. milliliters and a pressure of 2.50 atm at 298 K. What is the new pressure when the temperature is changed to 336 K and the volume is decreased to 450. milliliters?
1) 0.177 atm
2) 4.43 atm
3) 5.64 atm
4) 14.1 atm

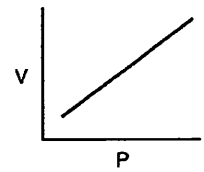
23. A gas occupies a volume of 444 mL at 273 K and 79.0 kPa. What is the final kelvin temperature when the volume of the gas is changed to 1880 mL and the pressure is changed to 38.7 kPa?
1) 31.5 K
2) 292 K
3) 566 K
4) 2360 K

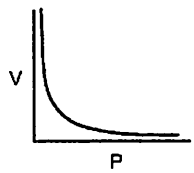
24. Under which conditions of temperature and pressure would a sample of $H_2(g)$ behave most like an ideal gas?
1) 0°C and 100 kPa
2) 0°C and 300 kPa
3) 150°C and 100 kPa
4) 150°C and 300 kPa

25. Which graph best represents the pressure-volume relationship for an ideal gas at constant temperature?

1)


3)


2)


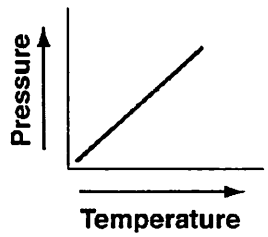
4)


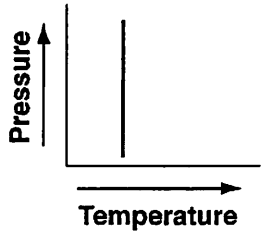
26. The volume of a gas is 4.00 liters at 293 K and constant pressure. For the volume of the gas to become 3.00 liters, the Kelvin temperature must be equal to
1) $\frac{3.00 \times 293}{4.00}$
2) $\frac{4.00 \times 293}{3.00}$
3) $\frac{3.00 \times 4.00}{293}$
4) $\frac{293}{3.00 \times 4.00}$

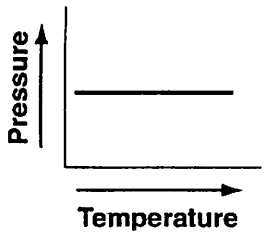
27. A gas occupies a volume of 40.0 milliliters at 20°C. If the volume is increased to 80.0 milliliters at constant pressure, the resulting temperature will be equal to
1) $20°C \times \frac{80.0mL}{40.0mL}$
2) $20°C \times \frac{40.0mL}{80.0mL}$
3) $293K \times \frac{80.0mL}{40.0mL}$
4) $293K \times \frac{40.0mL}{80.0mL}$

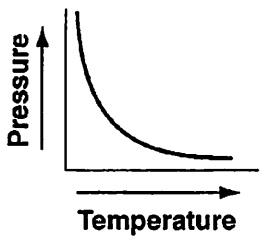
28. A 3.00-liter sample of gas is at 288 K and 1.00 atm. If the pressure of the gas is increased to 2.00 atm and its volume is decreased to 1.50 liters, the Kelvin temperature of the sample will be
1) 144 K
2) 288 K
3) 432 K
4) 576 K

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

1) 

3) 

2) 

4) 

30. According to the kinetic molecular theory, the molecules of an ideal gas
    1) have a strong attraction for each other
    2) have significant volume
    3) move in random, constant, straight-line motion
    4) are closely packed in a regular repeating pattern

31. A sample of a gas is contained in a closed rigid cylinder. According to kinetic molecular theory, what occurs when the gas inside the cylinder is heated?
    1) The number of gas molecules increases.
    2) The number of collisions between gas molecules per unit time decreases.
    3) The average velocity of the gas molecules increases.
    4) The volume of the gas decreases.

32. Under which conditions of temperature and pressure does carbon dioxide gas behave most like an ideal gas?
    1) low temperature and low pressure
    2) low temperature and high pressure
    3) high temperature and low pressure
    4) high temperature and high pressure

33. Under which conditions of temperature and pressure does oxygen gas behave least like an ideal gas?
    1) low temperature and low pressure
    2) low temperature and high pressure
    3) high temperature and low pressure
    4) high temperature and high pressure

34. Helium is most likely to behave as an ideal gas when it is under
    1) high pressure and high temperature
    2) high pressure and low temperature
    3) low pressure and high temperature
    4) low pressure and low temperature

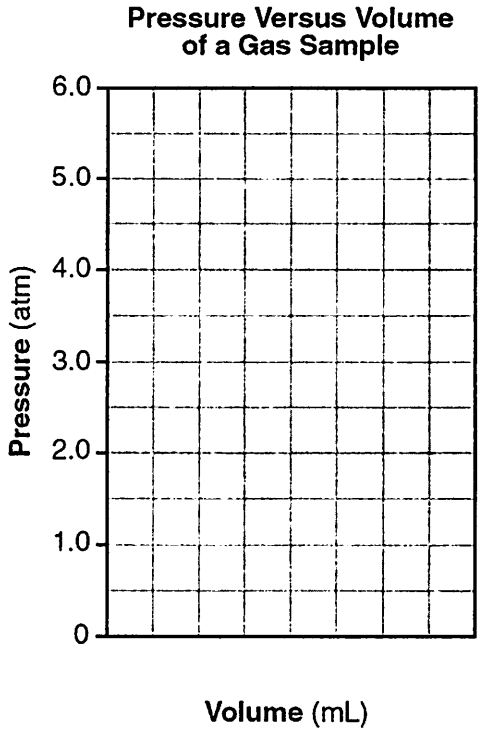
35. A real gas behaves more like an ideal gas when the gas molecules are
    1) close and have strong attractive forces between them
    2) close and have weak attractive forces between them
    3) far apart and have strong attractive forces between them
    4) far apart and have weak attractive forces between them

Base your answers to questions **39** through **41** on the information below

A gas sample is held at constant temperature in a closed system. The volume of the gas is changed, which causes the pressure of the gas to change. Volume and pressure data are shown in the table below.

Volume and Pressure of a Gas Sample

Volume (mL)	Pressure (atm)
1200	0.5
600	1.0
300	2.0
150	4.0
100	6.0



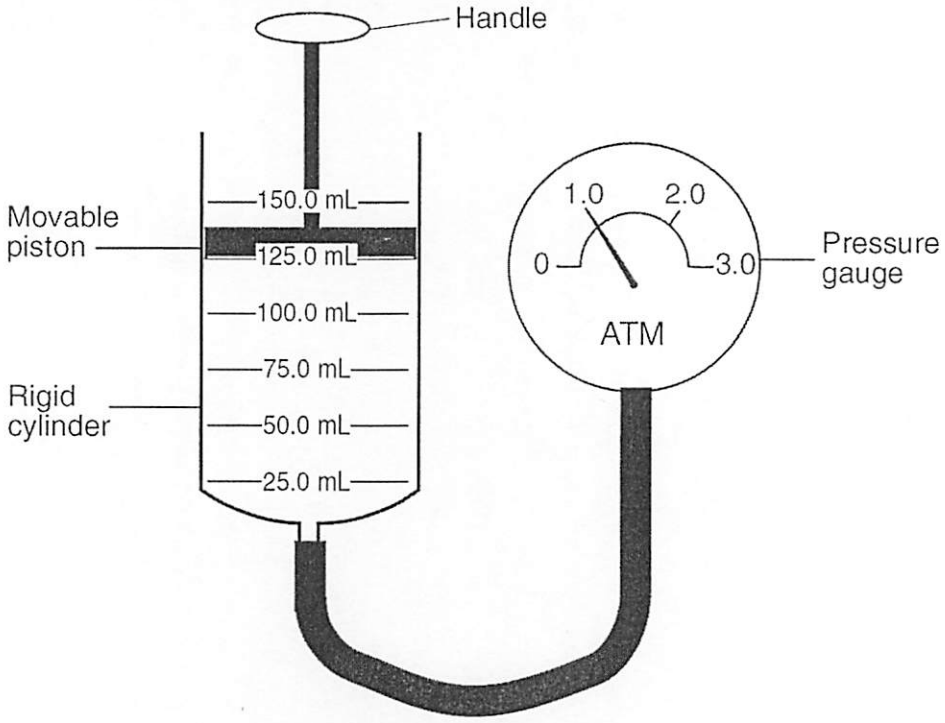
39. Based on your graph, what is the pressure of the gas when the volume of the gas is 200. milliliters?

40. On the same grid, plot the data from the table. Circle and connect the points.

41. On the grid above, mark an appropriate scale on the axis labeled "Volume (mL)."

Base your answers to questions **42** through **44** on the information below.

A rigid cylinder is fitted with a movable piston. The cylinder contains a sample of helium gas, He(g), which has an initial volume of 125.0 milliliters and an initial pressure of 1.0 atmosphere, as shown below. The temperature of the helium gas sample is 20.0°C.



42. Helium gas is removed from the cylinder and a sample of nitrogen gas, $N_2(g)$, is added to the cylinder. The nitrogen gas has a volume of 125.0 milliliters and a pressure of 1.0 atmosphere at 20.0°C. Compare the number of particles in this nitrogen gas sample to the number of particles in the original helium gas sample.

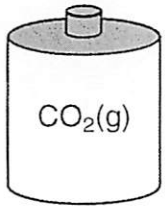
43. The piston is pushed further into the cylinder. In the space below, show a correct numerical setup for calculating the volume of the helium gas that is anticipated when the reading on the pressure gauge is 1.5 atmospheres. The temperature of the helium gas remains constant.

44. Express the initial volume of the helium gas sample, in liters.

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

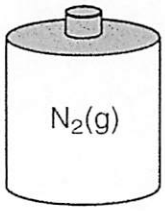
Cylinder A contains 22.0 grams of $CO_2(g)$ and cylinder B contains $N_2(g)$. The volumes, pressures, and temperatures of the two gases are indicated under each cylinder.

Cylinder A



V = 12.3 L
P = 1.0 atm
T = 300. K

Cylinder B



V = 12.3 L
P = 1.0 atm
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.