44 Gas Problems ANSWERS

1. At constant temperature, the pressure on 8.0 liters of a gas is increased from 1.0 atm. to 4.0 atm. What will be the new volume of this gas?

$P_1V_1 = P_2V_2$ (1.0 atm)(8.0 L) = (4.0 atm)(V_2) V_2 = 2.0 Liters

2. A gas at STP has a volume of 22.4 liters. If the volume is held constant but the temperature changes to 373K, what is the new pressure on this gas in kilopascals?

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ $\frac{101.3\ kPa}{273\ K} = \frac{P_2}{373\ K}$ 273X = 37784.9 P_2 = 138 kPa

3. Which of these real gases will most closely resemble an ideal gas at STP — and why?
Butane (C_4H_{10}), Ammonia (NH_3), or Argon (Ar)
Argon. With different gases at the same temp and pressure, the smallest particle gas would be "more ideal", and the largest particle gas would be least ideal.

4. Under what conditions does a real gas behave most like an ideal gas? **A. high temp & low pressure**

5. When the average kinetic energy of a gaseous system is increased, the average molecular velocity of the system **B. Increasing KE leads to increased molecular motion, but has no effect on mass.**

6. A sample of carbon monoxide occupies 15.0 liters at 4.00 atm and 300.Kelvin. What is the new volume of the CO if the pressure changes to 2.00 atm and the temperature is increased to 400.Kelvin?

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\frac{(4.00\ atm)(15.0\ L)}{300\ K} = \frac{(2.00\ atm)(V_2)}{400\ K}$ V_2 = 40.0 L

7. At 273K, a 409 mL gas sample has a pressure of 101.3 kPa. If the pressure changes to 50.65 kPa, at what temperature will the gas sample have volume of 609 mL?

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\frac{(101.3\ kPa)(409\ mL)}{273\ K} = \frac{(50.65\ kPa)(609\ mL)}{X\ Kelvin}$ X= 203 Kelvin

8. If the pressure on 36.0 milliliters of neon at standard pressure is changed to 0.250 atm. at constant temperature, what will be the new volume of the neon?

$P_1V_1 = P_2V_2$ (1 atm)(36 mL) = (0.25 atm)(V_2) V_2 = 144 mL

9. A sample of gas occupies 6.00 liters at a temperature of 200. Kelvin. if the pressure is held constant while the temperature is raised up to 600. Kelvin, the new volume would be __?

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{6.00\ L}{200.K} = \frac{V_2}{600.\ K}$ 200X = 3600 V_2 = 18.0 Liters

10. A bottle of radon gas fills a 86.5 L space at STP. If the pressure changes to 1.25 atm what is the new volume on the gas if temperature is 35.0°C?

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \qquad \frac{(1.0\text{ atm})(86.5\text{ L})}{273\text{ K}} = \frac{(1.25\text{ atm})(V_2)}{308\text{ K}}$$

(1.0 atm)(86.5 L)(308 K) = (1.25 atm)(V_2)(273 K) V_2 = 78.1 Liters

11. The pressure on 200. liters of xenon is decreased at constant temperature from 130. kPa to 120. kPa, what is the new volume of xenon in liters?

$P_1V_1 = P_2V_2$ (130. kPa)(200. L) = (120. kPa)(V_2) V_2 = 217 Liters

12. The volume of a given mass of an ideal gas at constant pressure is
D. directly proportional to Kelvin Temp

13. Skip

14. In theory, one reason that gases do not lose energy is because they **B. exhibit elastic collisions**

15. When a sample of gas is heated at constant pressure, the average kinetic energy of its molecules
D. increases and the volume of the gas increases

16. A gas has a volume of 1400 mL at 20.0 K and 101.3 kPa. What will be the volume when the temperature changes to 40.0 K and pressure is changed to 50.65 kPa?

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \qquad \frac{(101.3\text{ kPa})(1400\text{ mL})}{20.0\text{ K}} = \frac{(50.65\text{ kPa})(V_2)}{40.0\text{ K}}$$

V_2 = 5600 mL (2 SF)

17. When a gas is heated at constant pressure, the average kinetic energy of its molecules
D. increases & the volume of the gas increases

18. A gas has a pressure of 40.0 kPa, a temperature of 400. Kelvin and a volume of 50.0 mL. What volume will the gas have at a pressure of 20.0 kPa and 200. Kelvin?

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \qquad \frac{(40.0\text{ kPa})(50.0\text{ mL})}{400\text{ K}} = \frac{(20.0\text{ kPa})(V_2)}{200\text{ K}}$$

V_2 = 50.0 mL

19. The pressure on 200. liters of xenon is decreased at constant temperature from 130. kPa to 120. kPa, what is the new volume of xenon in liters?

$P_1V_1 = P_2V_2$ (130. kPa)(200. L) = (120. kPa)(V_2) V_2 = 217 Liters

20. At constant pressure, 205 mL of Ar is at 10.0°C is heated to 27.0°C. What's the new volume of the gas?

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \qquad \frac{205\text{ mL}}{283\text{ K}} = \frac{V_2}{300\text{ K}}$$

283X = 61500 V_2 = 217 mL
(same answer as 19, different units)

21. The pressure on 150 milliliters of nitrogen gas at constant temperature is changed from 50.65 kPa to 101.3 kPa. What is the new volume of nitrogen?

$P_1V_1 = P_2V_2$ (50.65 kPa)(150 mL) = (101.3 kPa)(V_2) V_2 = 75 mL

22. Under the same conditions of temperature and pressure, which gas would behave most like an ideal gas?
He (smallest particle)

23. If the pressure on a given mass of gas in an enclosed system is decreased and the temperature remains constant, the volume of the gas will **B. increase pressure and temperature are directly proportional.**

24. At STP, 3.0 liters of oxygen gas and 3.0 liters of helium gas have the same
C. number of particles (Avogadro's Hypothesis)

25. A 1.00 liter flask of CO_2 gas and another one liter flask of hydrogen gas are both at STP. The ratio of the number of molecules of CO_2 to the number of molecules of H_2 in these flasks is:
C. 1:1 Avogadro's Hypothesis again

26. What pressure, in atmospheres, is equal to 152 kPa? **Choice A**

$$\frac{152\ \text{kPa}}{1} \times \frac{1\ \text{atm}}{101.3\ \text{kPa}} = 1.50\ \text{atm}$$

27. A sample of gas A was stored in at 50°C + 0.50 atm. Compared to a gas B, stored at STP, gas A had a
C. higher temp and lower pressure

28. A 114.5 liter sample of oxygen is held at standard temperature while the pressure is changed from normal to just 560. mm of Hg. What is the new volume in liters?

$P_1V_1 = P_2V_2$ (760 mm Hg)(114.5 L) = (560. mm Hg)(V_2) V_2 = 155 L

29. The volume of a sample of hydrogen gas at STP is 1.00 liters. At constant pressure, the temperature decreases. PROVE with MATH that the volume of this gas will also decrease.
Make up an example with some of your own numbers, see how what changes and make a decision.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \qquad \frac{1.00\ \text{L}}{273\ \text{K}} = \frac{V_2}{223\ \text{K}}$$

V_2 = 0.817 Liters volume DECREASED

30. A gas at STP has a volume of 1.0 liters. If the pressure is doubled and the temperature remains constant, the new volume of the gas will be **C. 0.50 L (temp constant)**

$P_1V_1 = P_2V_2$ (1 atm)(1.0 L) = (2 atm)(X L) X = 0.50 L

31. The average kinetic energy of the molecules of an ideal gas is directly proportional to
C. temperature in Kelvin (Temp and KE always "do the same thing")

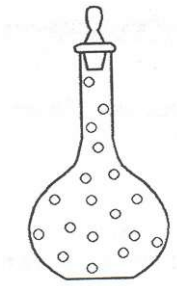
24. Which change must result in an increase in the average kinetic energy of the molecules of $N_{2(G)}$?
A. temperature change from 20 to 30 degrees centigrade
Kelvin is needed for MATH, this is just which is getting hotter — think, no math necessary.

25. A sample of gas has a volume of 6.0 liters at 0°C and 50.65 kPa. What will be its volume when the pressure is changed to 101.3 kPa at constant temperature?

$P_1V_1 = P_2V_2$ (50.65 kPa)(6.0 L) = (101.3 kPa)(V_2) V_2 = 3.0 Liters (2 SF)

34. A real gas behaves most like an ideal gas at high temperature and low pressure. Explain this.
A real gas behaves most like an ideal gas at high temperature and low pressure because it is least likely to turn into a liquid (or a solid) when the particles are banging into each other so hard (it won't stick together), or when they hardly bump into each other (low pressure).

35. If this gas is heated up the bottle holding it might explode. Using the KMT, explain why that happens. Try to use the words "directly proportional" in your answer.
Increase in temp = Increase in KE. That makes the particles have more and stronger collisions leading to greater pressure.
Temperature and Pressure are directly proportional.



36. Samples of SO_2 and N_2 contain equal numbers of molecules.
If the gases are at STP, the samples have
C. equal volumes (Avogadro's Hypothesis)

37. State 2 reasons (of many) why real gases are NOT ideal.
Real gases are not ideal because they do form liquids under low temps and high pressures, and they do have some attraction or repulsion from each other as well.

38. As the pressure on a given sample of gas increases at constant temperature, the mass of the sample of gas
C. remains the same (mass is not affected by P, V, or T)

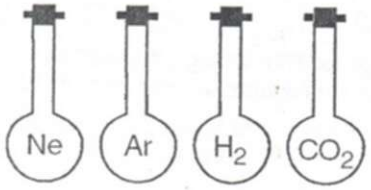
39. Equal volumes of sulfur dioxide gas and nitrogen monoxide gas at the same temperature and pressure would have the same **B. number of molecules**

40. A sample of H_2 and N_2 both at STP contain the same number of molecules. Each sample must have
C. same volume and different mass

41. Write out Avogadro's Hypothesis.
Equal volumes of different gases, at the same temperature and pressure, have the same number of moles, and the same number of particles. (Particles can be either atoms, or molecules).

42. Explain in terms of the Kinetic Molecular Theory, why the pressure of a gas increases when its temperature changes from 273 Kelvin to 298 Kelvin.
When temperature increases, so does kinetic energy. Higher KE means stronger and more frequent particle collisions. Collisions make the pressure. Temp and Pressure are directly proportional

43. The diagram below represents four 500 mL flasks containing the gases neon, argon, hydrogen and carbon dioxide, at STP. Each flask contains the same number of
D. particles
According to Avogadro's Hypothesis, the flasks contain the same number of atoms of Ne, atoms of Ar, molecules of H_2, and molecules of CO_2
The only answer that is correct is PARTICLES.



44. At constant pressure, which graph shows the correct relationship between gas volume + temperature?
Volume and Temperature (in Kelvin!) are directly proportional.
The graph that shows this is D: