Chemistry Unit 11 Gases & Gas Laws

Gas Law Example Problems

1. The highest pressure ever produced in a laboratory setting was about 2.0×10^{6} atm. If we have a 1.0×10^{-5} L sample of a gas at that pressure, then release the pressure until it is equal to 0.275 atm, what would the new volume of that gas be?

2. On hot days, you may have noticed that potato chip bags seem to "inflate", even though they have not been opened. If I have a 250 mL bag at a temperature of 19°C, and leave it in the car which has a temperature of 60°C, what will the new volume of the gas be?

3. A gas that has a volume of 28 liters, a temperature of 45°C, and an unknown pressure has its volume increased to 34 liters and its temperature decreased to 35°C. if I measure the pressure after the change to be 2.0 atm, what was the original pressure of the gas?

4. Calculate the final pressure inside a scuba tank after it cools from 1,000°C to 25.0 °C. The initial pressure in the tank is 130.0 atm.

Technical Chemistry: Gas Laws **Name:** _____

Match each example below with the appropriate gas property it illustrates.

_____1. the fragrance of perfume spreads through the room	a. compressibility
_____2. smog forms over Atlanta during summer days	b. diffuses through other gases
_____3. a cylinder of oxygen used in a hospital	c. exerts pressure
_____5. a balloon is inflated with helium	d. fills available space
_____6. a balloon filled with air weighs more than an empty balloon	e. has mass

Match the variables used to describe gases to the correct unit.

_____7. kPa	a. pressure
_____8. °C	b. temperature
_____9. mL	c. volume
____10. K	
____11. mm Hg	
____12. atmospheres (atm)	
____13. L	
____14. °F	

Complete the following statements by writing "**decreases**," "**increases**," or "**remains the same**" on the line provided.

As a gas is compressed in a cylinder

15. its mass _____.
16. the number of gas molecules _____.
17. its pressure _____
18. its volume _____.
19. the distance between gas molecules _____.
20. its density _____.

21. Boyle's Law states that the pressure of a gas is inversely proportional to its volume. Explain that statement. (Include the correct formula and examples)

22. Charles's Law states that the volume of a gas is directly proportional to its temperature. Explain that statement. (Include the correct formula and examples)

23. Gay Lussac's Law states that the pressure of a gas is directly proportional to its temperature. Explain that statement. (Include the correct formula and examples)

Problems

24. A 7.0 liter balloon at room temperature (22°C) contains hydrogen gas. If the balloon is carried outside to where the temperature is –3.0°C, what volume will the balloon occupy?

25. 10L of a gas at standard temperature and pressure is compressed to 4.73L. What is the pressure of the new gas?

26. A 500 liter volume of helium gas is at a pressure of 750 mm Hg and has a temperature of 300K. What is the volume of the same gas at STP?

27. If a gas is heated from 300.0 K to 350 K and the volume is kept constant what final pressure would result if the original pressure was 750.0 mm Hg?

28. At 225.0 °C a gas has a volume of 400.0 mL. What is the volume of this gas at 127.0 °C?

29. A gas has a pressure of 3.3 atm at 50.0 °C. What is the pressure at standard temperature?

Compete the following statements about the nature of gases as presented in the kinetic molecular theory by filling in the appropriate word (s) from the list below.

kinetic energy	no force	perfectly elastic	weak
potential energy	pressure	random motion	zero

30. Gas particles exert _____ on one another.

31. Gas molecules are said to be in _____.

32. The volume of gas particles themselves is said to be _____.

33. The collisions between gas particles are _____.

34. The temperature of a gas is a measure of the average _____ of the gas particles.

Dalton believed that the total pressure of the air around us is due to the individual partial pressures of each gas. This is known as **DALTON'S LAW OF PARTIAL PRESSURE**

THE EQUATION FOR DALTON'S LAW IS: _____

EXAMPLES:

1. A mixture of oxygen (O_2) gas, carbon dioxide (CO_2) gas, and nitrogen (N_2) gas has a total pressure of 0.97 atm. What is the partial pressure of oxygen if the partial pressure of carbon dioxide is 0.70 atm and the partial pressure of nitrogen is 0.12 atm?

2. What is the partial pressure of hydrogen gas in a mixture of hydrogen and helium if the total pressure is 600 mmHg and the partial pressure of helium is 439 mmHg?

3. Find the total pressure of a mixture that contains four gases with partial pressures of 5.00 kPa, 4.56 kPa, 3.02 kPa, and 1.20 kPa.

4. Find the partial pressure of carbon dioxide in a gas mixture with a total pressure of 30.4 kPa if the partial pressures of the other two gases in the mixture are 16.5 kPa nitrogen and 3.7 kPa oxygen.

5. A chamber contains nitrogen, oxygen, and helium gas. The partial pressure of nitrogen is 60.0 mmHg and oxygen is 55.5 mmHg. What is the **total pressure** of the chamber?

6. A sample of nitrogen gas is collected over water at 20°C. The vapor pressure of water at 20°C is 18 mmHg. What is the **partial pressure** of nitrogen gas if the total pressure of is 765 mmHg?

7. A sample of hydrogen gas is collected over water at 50°C. The vapor pressure of water at 50°C is 93 mmHg. What is the **partial pressure** of hydrogen gas if the total pressure is 855 mmHg?

8. A sample of oxygen gas is collected over water at a temperature of 70°C. The vapor pressure of water at 70°C is 234 mmHg. If the partial pressure of oxygen is 230 mmHg, what is the **total pressure**?

Name _____ Period ____ Date _____

IDEAL GAS LAW PROBLEMS

Solve the following problems using the Ideal Gas Law equation. SHOW ALL OF YOUR WORK.

PV = nRT

- P = pressure in atmospheres (atm) — 1 atm = 760 mmHg = 101.325 kPa
- V = volume in liters (L) or cubic decimeters (dm^3) — 1L = 1,000 mL = 1 dm^3
- n = number of moles (mol)
- R = Universal Gas Constant (0.0821)
- T = temperature in Kelvin (K)

1. What pressure is exerted by 0.622 moles of a gas contained in a 9.22-L container at a temperature of 16°C?

2. How many moles of gas occupy a 486-cm3 flask at 11° C and 66.7 kPa of press

3. What volume is occupied by 0.684 moles of gas at 99.1 kPa or pressure and a temperature of 9°C?

4. At what temperature is a gas if 0.0851 moles of it is contained in a 60.4-L vessel at 100.4 kPa of pressure?

5. What pressure is exerted by 0.00306 moles of a gas in a 2,500-mL container at 9°C?

6. A cylinder of oxygen contains 89.6 g O_2. If the volume of the cylinder is 8.58 L, what is the pressure of the oxygen if the gas temperature is 21°C?

7. In an experiment, you fill a heavy-walled 5.00-L flask with methane gas, CH_4. If the flask contains 7.68 g of methane at 19°C, what is the gas pressure?

8. An experiment calls for 3.50 moles of chlorine, Cl_2. What volume would this be if the gas volume is measured at 34° C and 2.45 atm?

9. According to your calculations, a reaction should yield 5.67 grams of oxygen, O_2. What do you expect the volume to be at 23°C and 0.985 atm?

10. The maximum safe pressure that a certain 4.00 L vessel can hold is 3.50 atm. If the vessel contains 0.410 moles of a gas, what is the maximum temperature (in degrees Celsius) to which this vessel can be subjected?

11. A 2.50-L flask was used to collect a 5.65-gram sample of propane gas, C_3H_8. After the sample was collected, the gas pressure was found to be 956 mmHg. What was the temperature of the propane in the flask?

Study Guide

KINETIC MOLECULAR THEORY OF GASES AND GAS LAW PROBLEMS

Each of the following problems are ones that you will likely encounter on the SOL test. Read the problems carefully, decide which equation (if any) to use and solve the problem showing all work.

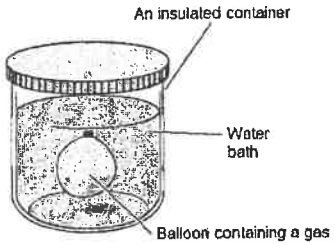
1. The **measure** of the **average kinetic energy** of a substance is referred to as _____.
2. The **measure** of the **force** exerted by a gas or liquid as it strikes the sides of a container is referred to as _____.
3. What are the **TWO** units of temperature? _____
4. What are the **three units** of **pressure** that we discussed? _____
5. At **STP**, the following conditions apply:
   ____ °C ____ K
   ____ atm ____ mmHg ____ kPa
6. According to Boyle's Law, volume and pressure have a(n) _____ relationship. That is:

   Draw a graph showing this relationship:

7. According to Charles' Law, volume and temperature have a(n) _____ relationship. That is:

   Draw a graph showing this relationship:

8. At STP, one mole of any gas is equal to _____ L.
9. At STP, 6.02×10^{23} atoms of any gas is equal to _____ L.
10. Which of the following is **NOT** part of the Kinetic Molecular Theory of Gases?
    A. There are no attractive forces between the gas molecules
    B. Gases are made of atoms that are moving rapidly.
    C. The volume of the gas is **always** equal to 22.4L.
    D. Gases at the same temperature have the same kinetic energy
    E. Temperature and kinetic energy are related.
11. What is always true of about two different gases at the same temperature? _____



12. One way to increase the volume of the gas in the balloon in the diagram above is to—
    A. cool the gas in the balloon only
    B. increase the temperature of the water
    C. push the balloon farther down into the water bath
    D. seal the top of the water bath
13. Ideal Gas Law: _____
    A. P must be in _____
    B. V must be in _____
    C. n must be in _____
    D. R must be _____
    E. T must be in _____
14. Combined Gas Law: _____
    A. P must be in _____
    B. V must be in _____
    C. T must be in _____
15. Dalton's Law of Partial Pressure: _____
16. If the volume of a sample of an ideal gas is **doubled**, at constant temperature, the **pressure** will likely—
    A. double
    B. remain the same
    C. be half the initial pressure
    D. be reduced by a factor of four
17. If the temperature of sample of an ideal gas is **doubled** at constant pressure, the volume will likely—
    A. double
    B. remain the same
    C. be half the initial pressure
    D. be reduced by a factor of four
18. A gas has a volume of 50 mL at a temperature of -73°C. What volume will it occupy at a temperature of -123°C if the pressure remains **constant**?

19. How many moles of CO_2 are there in a 50.0 L container at a pressure of 100.0 kPa and a temperature of 50°C? (R= 8.31 L-kPa/K-mol)

20. A sample of oxygen gas occupies a volume of 250 mL at a pressure of 740 mmHg. What volume will it occupy at a new pressure of 800 mmHg? (Assume temperature remains constant)

21. A sample of nitrogen gas occupies a volume of 250 mL at a temperature of 25°C. What volume will it occupy at a new temperature of 95°C? (Assume pressure remains constant)

22. What volume will 2.0 moles of nitrogen occupy at a pressure of 0.950 atm and a temperature of 20°C? (R=0.0821 L-atm/K-mol)

23. At what temperature will 0.500 moles of chlorine gas have if it has a pressure of 205 kPa and a volume of 750 mL? (R= 8.31 L-kPa/K-mol)

24. Ammonia gas occupies a volume of 450 mL at a pressure of 720 mmHg. What volume will it occupy at standard pressure? (Assume temperature is constant)

25. How many moles of oxygen gas will occupy a volume of 347 mL at standard temperature and pressure. (R=0.0821 L-atm/K-mol)

26. If I have a 50 L container that holds 45 moles of oxygen gas at a temperature of 200°C, what is the pressure inside the container in atmospheres? (R=0.0821 L-atm/K-mol)

27. It is not safe to put aerosol cans in a campfire because the pressure inside the cans gets very high and can explode. If I have a 1.0 L can that holds 2.0 moles of gas, and the campfire temperature is 1,400°C, what is the pressure inside the can? (R=0.0821 L-atm/K-mol)

28. Carbon dioxide gas is **kept** in a 6.00 L container at a pressure of 740 mmHg and a temperature of 20°C. If the temperature is increased to 60°C, what will be the new pressure in the tank?

29. A chamber contains nitrogen, oxygen, and helium gas. The partial pressure of nitrogen is 55.0 mmHg, oxygen is 75.5 mmHg, and helium is 25.5 mmHg. What is the **total pressure** of the chamber?

30. A chamber contains hydrogen, nitrogen, and oxygen gas. The partial pressure of hydrogen is 55.0 mmHg and nitrogen is 75.0 mmHg. If the total pressure of the chamber is 200 mmHg, what is the **partial pressure** of oxygen?

31. A sample of nitrogen gas is collected over water at 20°C. The vapor pressure of water at 20°C is 18 mmHg. What is the **partial pressure** of nitrogen gas if the total pressure of is 765 mmHg?

32. A sample of hydrogen gas is collected over water at 50°C. The vapor pressure of water at 50°C is 93 mmHg. What is the **partial pressure** of hydrogen gas if the total pressure is 855 mmHg?

33. A sample of oxygen gas is collected over water at a temperature of 70°C. The vapor pressure of water at 70°C is 234 mmHg. If the partial pressure of oxygen is 230 mmHg, what is the **total pressure**?

Extra

Boyles' Law

Use Boyles' Law to answer the following questions:

1) 1.00 L of a gas at standard temperature and pressure is compressed to 473 mL. What is the new pressure of the gas?

2) In a thermonuclear device, the pressure of 0.050 liters of gas within the bomb casing reaches 4.0×10^6 atm. When the bomb casing is destroye by the explosion, the gas is released into the atmosphere where it reaches a pressure of 1.00 atm. What is the volume of the gas after the explosion?

3) Synthetic diamonds can be manufactured at pressures of 6.00×10^4 atm If we took 2.00 liters of gas at 1.00 atm and compressed it to a pressure of 6.00×10^4 atm, what would the volume of that gas be?

4) The highest pressure ever produced in a laboratory setting was about 2.($\times 10^6$ atm. If we have a 1.0×10^{-5} liter sample of a gas at that pressure, then release the pressure until it is equal to 0.275 atm, what would the new volume of that gas be?

Extra

Charles' Law Worksheet

1) The temperature inside my refrigerator is about 4^0 Celsius. If I place a balloon in my fridge that initially has a temperature of 22^0 C and a volum of 0.5 liters, what will be the volume of the balloon when it is fully cooled by my refrigerator?

2) A man heats a balloon in the oven. If the balloon initially has a volume c 0.4 liters and a temperature of 20 ^{0}C, what will the volume of the balloon be after he heats it to a temperature of 250 ^{0}C?

3) On hot days, you may have noticed that potato chip bags seem to "inflate", even though they have not been opened. If I have a 250 mL ba at a temperature of 19 ^{0}C, and I leave it in my car which has a temperature of 60^0 C, what will the new volume of the bag be?

4) A soda bottle is flexible enough that the volume of the bottle can change even without opening it. If you have an empty soda bottle (volume of 2 L at room temperature (25 ^{0}C), what will the new volume be if you put it in your freezer (-4 ^{0}C)?

Extra

Name: Date:
Period: Gay-Lussac's Law

1. Determine the pressure change when a constant volume of gas at 1.00 atm is heated from 20.0 °C to 30.0 °C.

2. A gas has a pressure of 0.370 atm at 50.0 °C. What is the pressure at standard temperature?

3. A gas has a pressure of 699.0 mm Hg at 40.0 °C. What is the temperature at standard pressure?

4. If a gas is cooled from 323.0 K to 273.15 K and the volume is kept constant what final pressure would result if the original pressure was 750.0 mm Hg?

5. If a gas in a closed container is pressurized from 15.0 atmospheres to 16.0 atmospheres and its original temperature was 25.0 °C, what would the final temperature of the gas be?

6. A 30.0 L sample of nitrogen inside a rigid, metal container at 20.0 °C is placed inside an oven whose temperature is 50.0 °C. The pressure inside the container at 20.0 °C was at 3.00 atm. What is the pressure of the nitrogen after its temperature is increased?

7. A sample of gas at 3.00×10^3 mm Hg inside a steel tank is cooled from 500.0 °C to 0.00 °C. What is the final pressure of the gas in the steel tank?

8. The temperature of a sample of gas in a steel container at 30.0 kPa is increased from -100.0 °C to 1.00×10^3 °C. What is the final pressure inside the tank?

9. Calculate the final pressure inside a scuba tank after it cools from 1.00×10^3 °C to 25.0 °C. The initial pressure in the tank is 130.0 atm.

Extra

Combined Gas Law Problems

Use the combined gas law to solve the following problems:

1) If I initially have a gas at a pressure of 12 atm, a volume of 23 liters, and temperature of 200 K, and then I raise the pressure to 14 atm and increase the temperature to 300 K, what is the new volume of the gas?

2) A gas takes up a volume of 17 liters, has a pressure of 2.3 atm, and a temperature of 299 K. If I raise the temperature to 350 K and lower the pressure to 1.5 atm, what is the new volume of the gas?

3) A gas that has a volume of 28 liters, a temperature of 45 ^{0}C, and an unknown pressure has its volume increased to 34 liters and its temperature decreased to 35 ^{0}C. If I measure the pressure after the change to be 2.0 atm, what was the original pressure of the gas?

4) A gas has a temperature of 14 ^{0}C, and a volume of 4.5 liters. If the temperature is raised to 29 ^{0}C and the pressure is not changed, what is the new volume of the gas?

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