SELF-ASSESSMENT - MODULE 3-4: Gas Laws

1. With each gas law identified below, indicate which two factors stay constant

   A. Boyle's Law
      i. **TEMPERATURE** &
      ii. **MASS**

   B. Charles' Law
      i. **PRESSURE** &
      ii. **MASS**

   C. Gay Lussac's Law
      i. **VOLUME** &
      ii. **MASS**

2. Write the formula for each of the gas laws

   A. Boyle's
      $P_1 \times V_1 = P_2 \times V_2$

   B. Charles' $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

   C. Gay Lussac's $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

3. BTPS means the

   A. Temperature is **37°C**

   B. Pressure is **ATMOSPHERIC PRESSURE**

   C. PH_2O is **47 mm Hg**

4. Given the following solve for the unknown at ATPD:
   A. V_1= 6.4 L
   B. P_1 = 720 mmHg
   C. V_2 = 4.75 L
   D. Solve for P_2

$$P_1 \times V_1 = P_2 \times V_2$$

$$P_2 = \frac{P_1 \times V_1}{V_2} = \frac{720\ mm\ Hg \times 6.4\ L}{4.75\ L} = \frac{4{,}608}{4.75}\ mmHg = 970.1\ mm\ Hg = 970\ mm\ Hg$$

5. Given the following solve for the unknown at ATPD:

A. V_1= 2 L
B. T_1 = 37°C
C. T_2 = 68°C
D. Solve for V_2

$$T_1 = 37°C + 273 = 310°K$$
$$T_2 = 68°C + 273 = 341°K$$
$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$
$$V_2 = \frac{V_1 \times T_2}{T_1} = \frac{2\,L \times 341°K}{310°K} = \frac{682}{310} L = 2.2\,L$$

6. Given the following solve for the unknown at ATPD:

A. P_1= 750 mm Hg
B. T_1 = 40°C
C. T_2 = 25°C
D. Solve for P_2

$$T_1 = 40°C + 273 = 313°K$$
$$T_2 = 25°C + 273 = 298°K$$
$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$
$$P_2 = \frac{P_1 \times T_2}{T_1} = \frac{750\ mm\ Hg \times 298°K}{313°K} = \frac{223{,}500}{313}\ mm\ Hg = 714\ mm\ Hg$$

7. A gas at ATPD is at 42° C and a pressure of 760 mmHg. It occupies a volume of 2.5 liters. The temperature is decreased to 37° C and the volume decreases to 2 liters while remaining at ATPD. What is the new pressure?

$$T_1 = 42°C + 273 = 315°K$$
$$T_2 = 37°C + 273 = 310°K$$
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$
$$P_2 = \frac{P_1 \times V_1 \times T_2}{T_1 \times V_2} = \frac{760 \times 2.5 \times 310}{315 \times 2} = \frac{589{,}000}{630} = 935\ mm\ Hg$$

8. Using Boyle's Law, explain what happens to gas volume when pressure is increased.

A. Volume increases
B. Volume decreases
C. Volume stays the same because it is constant
D. Volume is not effected to pressure
E. Volume change can be in either direction - it varies

9. In Charles's Law, what is constant?

A. Volume
B. Pressure
C. Mass
D. A & C
E. B & C

10. When applying the gas laws, temperature must be converted to _____ scale.

A. Celsius
B. Fahrenheit
C. Kelvin
D. Rankine
E. Metric

11. In BTPS the pressure is equal to _____.

A. Absolute pressure
B. One atmosphere
C. 760 mmHg
D. 0 mmHg
E. Barometric pressure

12. In ATPS the water vapor pressure is…

A. 47 mmHg
B. 44 mg/L
C. 0 mmHg
D. Dependent upon the barometric pressure
E. Dependent upon the temperature

13. Isothermal is a condition where the temperature remains constant.

A. True
B. False

14. If you have 2 liters of dry gas at 37°C and 752 mmHg and you change the temperature of the gas to 68°C without changing its pressure or mass, what is the new gas volume?

A. 2.2 liters
B. 1.8 liters
C. 2 liters
D. 2.4 liters
E. 1.6 liters

$$T_1 = 37°C + 273 = 310°K$$

$$T_2 = 68°C + 273 = 341°K$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$V_2 = \frac{V_1 \times T_2}{T_1} = \frac{2\,L \times 341°K}{310°K} = \frac{682}{310}\,L = 2.2\,L$$

15. You have 3 liters of dry gas at 770 mmHg. The volume is changed to 2.5 liters while the temperature and mass remain constant. Which of the following statements would be true regarding this situation?

i. The new pressure will be higher
~~ii. The new pressure will be lower~~
iii. The new pressure will be 924 mmHg
~~iv. The new pressure will be 641.7 mmHg~~
~~v. It makes no difference~~

$$P_1 \times V_1 = P_2 \times V_2$$
$$P_2 = \frac{P_1 \times V_1}{V_2} = \frac{770\ mm\ Hg \times 3\ L}{2.5\ L} = \frac{2{,}310}{2.5}\ mmHg = 924\ mm\ Hg$$

A. i & ii
B. i & iii
C. ii & iii
D. ii & iv
E. v only

16. You have a gas cylinder containing 46.2 liters of gas at 2200 psi pressure. There is a fire and the cylinder is exposed to increased temperature. Whose gas law will explain what happens to pressure and volume in the cylinder?

A. Boyle's
B. Charles's
C. Gay Lussac's
D. Henry's
E. Graham's

17. A dry gas is at 42C and 760 mmHg pressure. It occupies 2.5 liters of volume. The volume is changed to 2 liters and its temperature to 37C. What will be the new pressure of the gas?

A. 598 mmHg
B. 965 mmHg
C. 837 mmHg
D. 935 mmHg
E. 760 mmHg

$$T_1 = 42°C + 273 = 315°K$$
$$T_2 = 37°C + 273 = 310°K$$
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$
$$P_2 = \frac{P_1 \times V_1 \times T_2}{T_1 \times V_2} = \frac{760 \times 2.5 \times 310}{315 \times 2} = \frac{589{,}000}{630} = 935\ mm\ Hg$$

18. An exhaled gas of 3.25 liters is measured at 26C and 760 mmHg pressure. What is the water vapor content of this gas?

A. 24.4 mg/L
B. 25.2 mg/L
C. 24.4 mmHg
D. 25.2 mmHg
E. 47 mmHg

19. An ***exhaled gas*** from a patient's lungs of 3.25 liters is measured in the pulmonary function machine at 26C and 760 mmHg pressure. Convert to BTPS.

A. 3.1 liters
B. 4.8 liters
C. 3.5 liters
D. 3.3 liters
E. 3.0 liters

$V_1 = 3.25L$

$T_1 = 26C = 26 + 273K = 299K$

$P_1 = 760 - 25.2 = 734.8$

$T_2 = 37C = 37 + 273K = 310K$

$P_2 = 760 - 47 = 713$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{734.8x3.25x310}{299x713} = \frac{740{,}311}{213{,}187} = 3.47L \approx 3.5L$$

$Volume\ @\ ATPS \times Factor = BTPS$

$3.25\,\text{L} \times 1.068 = 3.47\,\text{L} \approx 3.5\,\text{L}$