Practice Test: Gas Laws

1. Perform the following conversions of pressure units:
   1.6×10^5 torr = _____ atm

   [A] 3.2×10^2 [B] 4.6×10^2 [C] 3.2×10^3 [D] 2.1×10^2 [E] 2.1×10^3

2. A sample of helium gas occupies 2.65 L at 1.20 atm. What pressure would this sample of gas exert in a 1.50-L container at the same temperature?

   [A] 3.31 atm [B] 1.20 atm [C] 2.12 atm [D] 0.679 atm [E] none of these

3. A sample of helium gas occupies 12.4 L at 23°C and 0.956 atm. What volume will it occupy at 40°C and 0.956 atm?

   [A] 7.13 L [B] 11.7 L [C] 21.6 L [D] 13.1 L [E] none of these

4. A balloon has a volume of 1.20 L at 24.0°C. The balloon is heated to 48.0°C. Calculate the new volume of the balloon.

   [A] 2.40 L [B] 1.70 L [C] 1.30 L [D] 2.10 L [E] 1.20 L

5. If the temperature of an ideal gas is raised from 100°C to 200°C, while the pressure remains constant, the volume

   [A] remains the same [B] doubles [C] goes to 1/2 the original volume
   [D] increases by a factor of 100 [E] none of these

6. A 4.37-g sample of a certain diatomic gas occupies a volume of 3.00 L at 1.00 atm and a temperature of 45°C. Identify this gas.

   [A] O_2 [B] F_2 [C] Cl_2 [D] H_2 [E] N_2

7. What do the initials STP stand for, and what are the numerical values of each?

8. What is the numerical value of the molar volume of any gas at STP?

9. An oxygen sample has a volume of 4.50 L at 27°C and 800.0 torr. How many oxygen molecules does it contain?

   [A] 5.8×10^{22} [B] 1.16×10^{22} [C] 1.16×10^{23}
   [D] 2.32×10^{24} [E] none of these

10. Mercury vapor contains Hg atoms. What is the volume of 200. g of mercury vapor at 822 K and 0.500 atm?

    [A] 82.2 L [B] 67.2 L [C] 329 L [D] 135 L [E] none of these

11. Zinc metal is added to hydrochloric acid to generate hydrogen gas and is collected over a liquid whose vapor pressure is the same as pure water at 20.0°C (18 torr). The volume of the mixture is 1.7 L, and its total pressure is 0.810 atm.
Determine the number of moles of hydrogen gas present in the sample.

[A] 0.056 mol [B] 42 mol [C] 22 mol [D] 1.3 mol [E] 0.82 mol

12. A vessel with an internal volume of 10.0 L contains 2.80 g of nitrogen gas, 0.403 g of hydrogen gas, and 79.9 g of argon gas. At 25°C, what is the pressure (in atm) inside the vessel?

[A] 2.38 atm [B] 6.43 atm [C] 0.471 atm [D] 3.20 atm [E] 5.62 atm

13. What would happen to the average kinetic energy of the molecules of a gas sample if the temperature of the sample increased from 20°C to 40°C?

[A] It would double. [B] It would become half its value.

[C] It would decrease. [D] It would increase. [E] two of these

14. Which conditions of *P* and *T* are most ideal for a gas?

[A] low *P*, high *T* [B] high *P*, low *T* [C] high *P*, high *T*

[D] depends on the gas [E] low *P*, low *T*

15. An ideal gas is a hypothetical substance consisting of particles with _____ volume and _____ attraction for one another.

[A] large; strong [B] small; weak [C] zero; no

[D] small; strong [E] large; weak

16. C_2H_4 reacts with O_2 according to the following equation:
$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$
What volume of oxygen at STP is needed to react with 1.50 mol of C_2H_4?

[A] 33.6 L [B] 67.2 L [C] not enough information given

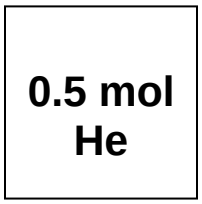
[D] 4.50 L [E] 101 L

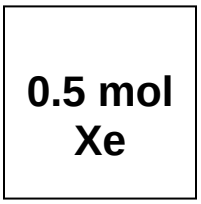
17. Given the equation
$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$
A 3.00-g sample of $KClO_3$ is decomposed and the oxygen at 24.0°C and 0.982 atm is collected. What volume of oxygen gas will be collected assuming 100% yield?

[A] 608 mL [B] 911 mL [C] 1820 mL [D] 304 mL [E] none of these

18. Describe the relationship between the following variables, including graphs.
    a. P and V
    b. V and T
    c. P and T

19. These two containers of gas contain 0.5 moles of gas each (not necessarily drawn to scale):





Both gases have a temperature of 93.8 K and have a pressure of 132 kPa.
    a. Which box contains more molecules? How many times more?
    b. Which gas has the greater volume? How many times greater?
    c. Which gas has the greater mass? How many times greater?

[1] [D]

[2] [C]

[3] [D]

[4] [C]

[5] [E]

[6] [B]

[7] standard temperature = 273 K
pressure = 1 atm

[8] 22.4 L/mol

[9] [C]

[10] [D]

[11] [A]

[12] [E]

[13] [D]

[14] [A]

[15] [C]

[16] [E]

[17] [B]

TEST Review! Gas Laws

① $1.6 \times 10^5 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = \underline{210} \text{ atm}$

② $V_1 = 2.65 \text{ L}$ $\quad V_2 = 1.50 \text{ L}$

$P_1 = 1.20 \text{ atm}$ $\quad P_2 = ?$

$P_1V_1 = P_2V_2 \qquad P_2 = \frac{P_1V_1}{V_2}$

$= \frac{(1.20 \text{ atm})(2.65 \text{ L})}{1.50 \text{ L}}$

$= \underline{2.12 \text{ atm}}$

③ $P_1 = 0.956 \text{ atm}$ $\quad P_2 = 0.956 \text{ atm}$

$V_1 = 12.4 \text{ L}$ $\quad V_2 = ?$

$T_1 = 23^\circ\text{C} = 300\text{K}$ $\quad T_2 = 40 + 273 = 313\text{K}$

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

$\frac{12.4 \text{ L}}{300\text{K}} = \frac{V_2}{313\text{K}}$

$V_2 = 12.9 \text{ L}$

④ $V_1 = 1.20 \text{ L}$ $\quad V_2 = ?$

$T_1 = 24.0^\circ\text{C} + 273 = 297\text{K}$ $\quad T_2 = 48.0^\circ\text{C} + 273 = 321\text{K}$

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

$\frac{1.20 \text{ L}}{297\text{K}} = \frac{V_2}{321\text{K}}$

$1.30 \text{ L} = V_2$

⑤ $100^\circ\text{C} \rightarrow 200^\circ\text{C}$

$= 373\text{K} \rightarrow 473\text{K}$

$\frac{473}{373} = 1.27 \times \text{greater}$

Temp goes up by factor of 1.27x, thus volume will go up by factor of 1.27.

(6) 4.37g = mass
V = 3.00L
P = 1.00 atm
T = 45°C + 273 = 318K
$R = 0.0821 \frac{L\,atm}{K \cdot mol}$

(a) Find moles → $\frac{\#g}{\#mol}$ = molar mass (5) → use molar mass to identify gas (c)

(a) $n = \frac{PV}{RT} = \frac{(1\,atm)(3\,L)}{(0.0821 \frac{L\,atm}{K\,mol})(318\,K)} = 0.115\,mol$

(b) $\frac{4.37g}{0.115\,mol} = 38.0\,g/mol$ = molar mass of F_2 (c)

(7) Std temp & pressure.
see ref tables

(8) 22.4L = 1 mol

(9) (a) Find moles
(b) convert mol → molecules

$P = 800\,torr \times \frac{1\,atm}{760\,torr} = \underline{1.0526\,atm}$
V = 4.50L

n = ?
$R = 0.0821 \frac{L\,atm}{K\,mol}$
T = 27 + 273 = 300K

$n = \frac{PV}{RT} = \frac{(1.0526\,atm)(4.50\,L)}{(0.0821 \frac{L\,atm}{K\,mol})(300K)} = 0.192\,mol$

$0.0192\,mol \times \frac{6.02 \times 10^{23}\,molecules}{1\,mol} = \underline{1.16 \times 10^{23}}\,molecules$

(10) (a) find moles
(b) use $PV=nRT$

(a) $200.\text{g} \times \frac{1\ \text{mol}}{200.59\ \text{g}} = 0.997\ \text{mol}$

$n = 0.997\ \text{mol}$
$P = 0.5\ \text{atm}$
$V = ?$
$T = 822\text{K}$
$R = 0.0821 \frac{\text{L atm}}{\text{K mol}}$

$PV = nRT$

$V = \frac{nRT}{P} = \frac{(0.997\ \text{mol})(0.0821 \frac{\text{L atm}}{\text{K mol}})(822\text{K})}{0.500\ \text{atm}}$

$= 135\ \text{L}$

(11) Vapor pressure of liquid $= 18\ \text{torr} \times \frac{1\ \text{atm}}{760\ \text{torr}} = 0.0237\ \text{atm}$

$P_{TOT} = 0.810\ \text{atm}$

$P_{H_2} = P_{TOT} - P_{liquid} = 0.810\ \text{atm} - 0.0237\ \text{atm} = 0.786\ \text{atm}$

$V = 1.7\ \text{L}$
$T = 293\ \text{K}$
$R \quad 0.0821 \frac{\text{L atm}}{\text{K mol}}$
$n = ?$

$n = \frac{PV}{RT} = \frac{(0.786\ \text{atm})(1.7\text{L})}{(0.0821 \frac{\text{L atm}}{\text{K mol}})(293\text{K})} = 0.0556\ \text{mol}$

$= \boxed{0.056\ \text{mol}}$

(12) $2.80\text{g} \times \frac{1\ \text{mol}}{28\ \text{g}} = 0.1\ \text{mol}\ N_2$

$0.403\text{g} \times \frac{1\ \text{mol}}{2.02\ \text{g}} = .2\ \text{mol}\ H_2$

$79.9\text{g} \times \frac{1\ \text{mol}}{39.95\text{g}} = 2\ \text{mol Ar}$

total moles $= 2.3$ moles

$P = \frac{nRT}{V} = \frac{(2.3\ \text{mol})(0.0821 \frac{\text{L atm}}{\text{K mol}})(298\text{K})}{10.0\ \text{L}}$

$= 5.63\ \text{atm}$

(13) 293K ⟶ 313K

Temp goes up, so A.K.E. goes up.
(Avg K.E. is measured as temperature.)

$\frac{313}{293} = 1.07$ thus a.k.e. would increase by a factor of 1.07X

(14) Far apart = ideal behavior = high Temp + low P

(15) zero, no

(16) $1.50\ mol\ C_2H_4 \times \frac{3\ mol\ O_2}{1\ mol\ C_2H_4} \times \frac{22.4\ L\ O_2}{1\ mol\ O_2} =$ **101 L O_2**

(17) $3.00\ g\ KClO_3 \times \frac{1\ mol\ KClO_3}{122.54\ g\ KClO_3} \times \frac{3\ mol\ O_2}{2\ mol\ KClO_3} =$ 0.0367 mol O_2

$n = 0.0367\ mol\ O_2$
$V = ?$
$P = 0.982\ atm$
$T = 24 + 273 = 297\ K$
$R = 0.0821\ \frac{L\,atm}{K\,mol} =$

$$V = \frac{nRT}{P} = \frac{(0.0367\ mol)\left(0.0821\ \frac{L\,atm}{K\,mol}\right)(297\ K)}{0.982\ atm}$$

$$= 0.911\ L \times \frac{1000\ mL}{1\ L} = 911$$

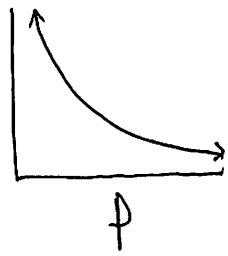
= 911 mL

18. Describe the relationship between the following variables, including graphs.
    a. P and V
    b. V and T
    c. P and T

19. These two containers of gas contain 0.5 moles of gas each (not necessarily drawn to scale):

Both gases have a temperature of 93.8 K and have a pressure of 132 kPa.
    a. Which box contains more molecules? How many times more?
    b. Which gas has the greater volume? How many times greater?
    c. Which gas has the greater mass? How many times greater?

(18) a) P and V are inversely related



(b) V & T are directly related

(c) P & T are directly related

(19) (a) Each box has the same # of moles: 0.5 mol. Thus both have $(0.5)(6.02\times10^{23}) = 3.01\times10^{23}$ molecules

(b) Same volume. Avogadro's hypothesis: equal # of particles at same T & P have equal volumes,

(c) Xe. $0.5\text{mol Xe}\times\frac{131.3\text{g}}{1\text{mol Xe}} = 65.6\text{ g}$ but the He only weighs 2g $\left(0.5\text{mol}\times\frac{4\text{g}}{1\text{mol}}=2\text{g}\right)$