4/22/16

Gas Laws Hmwk #1

C 1 — 6 Temp + Pressure

D 2 — 7 diffusion

A 3 — 8 elastic

B 4 — 9 increase.

E 5 — 10 density

$V_1 P_1 = V_2 P_2$

11. $V_1 = 250ml$, $P_1 = 720mmHg$, $V_2 = ?$, $P_2 = 750mmHg$ — 2sf

$\frac{(250ml)(720mmHg)}{750mmHg} = V_2$

$V_2 = \boxed{240ml}$

15. a) 293K b) 358K c) 258K d) 83K

18. $V_1 = 100ml$, $P_1 = 735mmHg$, $V_2 = ?$, $P_2 = 700mmHg$ — 1sf

$(100ml)(735mmHg) = V_2(700mmHg)$

$V_2 = 105 \rightarrow \boxed{100ml}$

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

$V_1 = 180ml$, $T_1 = \cancel{43°C} \rightarrow 316K$, $V_2 = 135ml$, $T_2 = ?$

$\frac{180ml}{316K} = \frac{135ml}{T_2}$

$T_2 = 237K - 273 = \boxed{-36°C}$

19. $V_1 = 50.0L$, $T_1 = 300K\ (27°C)$, $V_2 = ?$, $T_2 = 273K$ — 2sf

$(273K)\frac{50.0L}{300K} = \frac{V_2}{\cancel{273K}}$

$V_2 = 45.5 \rightarrow \boxed{46L}$

21. $\frac{V_1P_1}{T_1} = \frac{V_2P_2}{T_2}$

$V_1 = 1000\,ml$
$P_1 = 700\,mmHg$
$T_1 = -23°C \rightarrow 250K$
$V_2 = ?$
$P_2 = 760\,mmHg$
$T_2 = 273K$
@STP

$\frac{(1000ml)(700mmHg)}{250K} = \frac{V_2(760\,mmHg)}{273K}$

$V_2 = 1005\ldots \rightarrow \boxed{1000\,ml}$

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23. $V_1 = 500\,ml$
$P_1 = 80.0\,cmHg$
$T_1 = 27°C \rightarrow 300K$
$V_2 = ?$
$P_2 = 75.0\,cmHg$
$T_2 = 270K$
(1st)

$\frac{(500ml)(80.0cmHg)}{300K} = \frac{V_2(75.0cmHg)}{270K}$

$V_2 = 480 \rightarrow \boxed{500\,ml}$

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25. $V_1 = 350ml$
$P_1 = 740.0mmHg$
$T_1 = 25°C \rightarrow 298K$
$V_2 = ?$
$P_2 = 760.\,mmHg$
$T_2 = 273K$

$\frac{(35.0ml)(740.0mmHg)}{298K} = \frac{V_2(760\,mmHg)}{273K}$

$V_2 = 31.2 \rightarrow \boxed{31\,ml}$

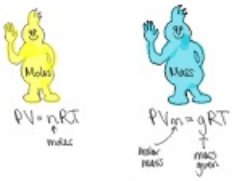
STP
0°C
273K

1 ATM 101.3 kPa 760 mmHg

Boyle's Law: $V_1P_1 = V_2P_2$ (inverse relationship)

Charles' Law: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (direct)

Combined Gas Law: $\frac{V_1P_1}{T_1} = \frac{V_2P_2}{T_2}$



$PV = nRT$ (n = moles)

$PV_m = gRT$ (m = molar mass, g = mass given)

R = depends on pressure unit

$0.0821 \frac{L \cdot atm}{mol \cdot K}$ $8.31 \frac{L \cdot kPa}{mol \cdot K}$ $62.4 \frac{L \cdot mmHg}{mol \cdot K}$

1. $PV = nRT$

P = 3.42 atm
V = 2.62 L
n = ?
R = 0.0821 $\frac{L \cdot atm}{mol \cdot K}$
T = 558K

$\frac{(3.42\,atm)(2.62\,L)}{(0.0821 \frac{L \cdot atm}{mol \cdot K})(558K)} = n$

n = 0.196 mol

2. $PV_m = gRT$

P = 760 mmHg
V = 0.475 L
m = 39.95 g/mol
g = ?
R = 62.4 $\frac{L \cdot mmHg}{mol \cdot K}$
T = 273 K

$\frac{(760\,mmHg)(0.475L)(39.95\,g/mol)}{(62.4 \frac{L \cdot mmHg}{mol \cdot K})(273K)} = g$

g = 0.847g Argon

3. P = 1.26 atm
V = 1.350 L
m = 4.00 g/mol
g = 0.2484 g
R = 0.0821 $\frac{L \cdot atm}{mol \cdot K}$
T = ?

$(1.26\,atm)(1.350L)(4.00\,g/mol) = (0.2484g)(0.0821 \frac{L \cdot atm}{mol \cdot K})(T)$

T = 309.7 K
− 273.0
36.7 °C

$D = \frac{m}{V}$ $D_{STP} = \frac{\text{molar mass}}{\text{molar volume}}$ (for gases only)

$D_{O_2\,STP} = \frac{32.00\,g}{22.4\,L} = 1.43\,g/L$

* If pressure is NOT @ STP use Combined gas Law to find new volume.
$V_1 = 22.4L$, P_1 = Standard pressure, $T_1 = 273K$
$V_2 = ?$, P_2, T_2 > word problem

Dalton's Law of Partial Pressure

$P_{TOTAL} = P_1 + P_2 + P_3 + P_4 + \ldots$

STP 0°C 273K 1 Atm 101.3 kPa 760 mmHg

Boyle's Law
$V_1P_1 = V_2P_2$
(Inverse)

Charles Law
$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
(Direct)

Combined Gas Laws
$\frac{V_1P_1}{T_1} = \frac{V_2P_2}{T_2}$

$PV = nRT$ (n: moles)

$PVm = gRT$ (m: molar mass; g: grams given)

R values (Ideal Law Gas Constant)

$0.0821 \frac{L \cdot atm}{mol \cdot K}$ $8.31 \frac{L \cdot kPa}{mol \cdot K}$ $62.4 \frac{L \cdot mmHg}{mol \cdot K}$

1. $PV=nRT$
$P = 3.42$ atm
$V = 2.62$ L
$n = ?$
$R = 0.0821 \frac{L \cdot atm}{mol \cdot K}$
$T = 558$ K

$\frac{(3.42 atm)(2.62 L)}{(0.0821 \frac{L \cdot atm}{mol \cdot K})(558 K)} = n$ $n = \frac{PV}{RT}$

$n = 0.196$ mol

2. $PVm=gRT$
$P = 760$ mmHg
$V = 0.475$ L
$m = 39.95$ g/mol
$g = ?$
$R = 62.4 \frac{L \cdot mmHg}{mol \cdot K}$
$T = 273$ K

$(760 mmHg)(0.475 L)(39.95 g/mol) = g(62.4 \frac{L \cdot mmHg}{mol \cdot K})(273 K)$

$g = 0.847$ g Ar

3. $PVm=gRT$
$P = 1.26$ atm
$V = 1.250$ L
$m = 4.009$ g/mol
$g = 0.2494$ g
$R = 0.0821 \frac{L \cdot atm}{mol \cdot K}$
$T = ?$ (°C)

$(1.26 atm)(1.250 L)(4.009 g/mol) = (0.2494 g)(0.0821 \frac{L \cdot atm}{mol \cdot K})(T)$

$T = 307.7$ K
-273
34.7 °C

$D = \frac{m}{V}$ $D_{STP} = \frac{\text{molar mass}}{22.4L}$ (gas only)

CO_2 ? $D_{STP} = \frac{44.01g}{22.4L} = \boxed{1.969/L}$

O_2 ? $D_{STP} = \frac{32.00g}{22.4L} = \boxed{1.439/L}$

if NOT at STP use combined gas Law to find volume. Use

$V_1 = 22.4L$ $V_2 = ?$

P_1 = Standard pressure P_2 } in problem

$T_1 = 273K$ T_2

C_2H_6 @ 3atm 41°C

STP: $V_1 = 22.4L$ $V_2 = ?$

$P_1 = 1atm$ $P_2 = 3atm$

$T_1 = 273K$ $T_2 = 41°C \rightarrow 314K$

$\frac{(22.4L)(1atm)}{273K} = \frac{V_2(3atm)}{314K}$

$V_2 = 8.588L$

$D_{new} = \frac{30.08g}{8.588L} = \boxed{4g/L}$

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4. $V_1 = 22.4L$ $V_2 = ?$

$P_1 = 760mmHg$ $P_2 = 800mmHg$

$T_1 = 273K$ $T_2 = 250K$

$\frac{(22.4L)(760mmHg)}{273K} = \frac{V_2(800mmHg)}{250K}$

$V_2 = 19.487L$

$D_{new} = \frac{m}{V_2} = \frac{70.90g}{19.487L} = \boxed{4g/L}$

$3K \cdot 4g/L = 12g$

Dalton's Law of Partial Pressures

$P_{TOTAL} = \sum$ of parts $= P_1 + P_2 + P_3 + P_4 \ldots$

Container = $D_2(g)$ 1.2 atm

$H_2(g)$ 0.8 atm

$N_2(g)$ 1.4 atm

3.4 atm = P_{TOTAL}

2. Convert to STP: 1000 ml of gas at −23°C and 700 mmHg pressure. (? V_2)

change

V_1 T_1 P_1

$V_1 = 1000\ ml$

$P_1 = 700\ mmHg$

$T_1 = 250\ K$

$V_2 = ?$

$P_2 = 760\ mmHg$

$T_2 = 273\ K$

1st

$$\frac{(273\ K)(1000\ ml)(700\ mmHg)}{(760\ mmHg)(250\ K)} = \frac{V_2(760\ mmHg)}{273\ K}$$

$V_2 = 1005.789 \rightarrow 1000\ ml$

STP 0° 273K 1 ATM 101.3 kPa 760 mm Hg

Boyle's Law	Charles's Law	Combined Gas Law
$V_1P_1 = V_2P_2$	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$	$\frac{V_1P_1}{T_1} = \frac{V_2P_2}{T_2}$
inverse	direct	

$PV = nRT$ (# of moles)

$PV_m = gRT$ (V_m: molar mass; g: grams given)

$$\text{moles} = \frac{\text{mass given}}{\text{molar mass}}$$

R = Ideal Gas Law Constant (Do NOT memorize!)

$0.0821 \frac{L \cdot atm}{mol \cdot K}$ $8.31 \frac{L \cdot kPa}{mol \cdot K}$ $62.4 \frac{L \cdot mmHg}{mol \cdot K}$

Practice:

1. $PV = nRT$ 2. $PV_m = gRT$ 3. $PV_m = gRT$

1. $P = 3.42 atm$, $V = 2.62 L$, $n = ?$, $R = 0.0821 \frac{L \cdot atm}{mol \cdot K}$, $T = 558 K$

$$n = \frac{(3.42 atm)(2.62 L)}{(0.0821 \frac{L \cdot atm}{mol \cdot K})(558 K)}$$

$n = 0.196 mol$

2. $P = 760 mmHg$, $V = 0.475 L$, $m = 39.95 g/mol$, $g = ?$, $R = 62.4 \frac{L \cdot mmHg}{mol \cdot K}$, $T = 273 K$

$PV_m = gRT$ $\quad \frac{PV_m}{RT} = g$

$$\frac{(760 mmHg)(0.475 L)(39.95 g/mol)}{(62.4 \frac{L \cdot mmHg}{mol \cdot K})(273 K)} = g$$

$g = 0.847 g$