AP Chem - Unit 3 - Gases Test

Key 14 mc 3 pts each = 42 pts

97 pts 3 FR 1 - 25 2 - 20 3 - 10 = 55 pts

MULTIPLE CHOICE

1. ANS: C

$PV = nRT$, but we have 3 constants: volume (rigid container), temperature, and R. So, this simplifies to $P \propto n$, so the pressure for each gas depends on the number of moles of each gas AND equal masses of each gas were placed in the container, so P really depends on the molar mass of each gas. Also note the gases are "ideal". Thus collisions are elastic and IMFs are neglected.

$PV = nRT$

$P = \frac{nRT}{V}$ R, T, V constant

$P = n$ $n = \frac{mass}{molar\ mass}$

$P = \frac{mass}{molar\ mass}$

DIF: Medium OBJ: 1.4 NAT: 7.1 TOP: Gas Laws
KEY: ideal | gas | pressure | Avogadro's Law NOT: 54% answered correctly

2. ANS: A

Since the volume of the three original flasks are equal, the pressures are proportional to the number of molecules in the containers, which are in the ratio of 2:1:6. The pressure in the first flask is given as 2 atm, therefore the pressures in the three containers are 2 atm, 1 atm, and 6 atm, respectively. If these were combined into a single flask with a volume equal to that of the original vessels (1 liter), the total pressure would be the sum of these partial pressures, corresponding to 9 atm. Since the final flask has a volume of 3 liters, which lowers the pressure by a factor of 3, to 3 atm.

$P = \frac{n}{V}$ when R, T, constant

new V = 3

DIF: Medium OBJ: 2.5 NAT: 1.3 | 6.4 TOP: Gases
KEY: gases | gas laws | ideal gas law | Dalton's Law of Partial Pressure

$= \frac{2n + 1n + 6n}{3} = \frac{9n}{3}$

$P = 3$ Atm

3. ANS: C

Expect easy math!

When density (or density data) is given and molar mass (weight) is required, think "molar mass kitty cat". You know, "every good cat puts "dirt" over its "pee" (Apologies!):

D = 2.0 g/L

P = 3.00 Atm

T = 127°C + 273 = 400

$PV = nRT$ $n = \frac{mass}{mm}$

$PV = \frac{mass\,RT}{mm}$ $D = \frac{mass}{V}$

$mm = \frac{mass\,RT}{PV}$

$$MM = \frac{dRT}{P} = \frac{\left(\frac{2\,g}{1\,L}\right)R(127+273\,K)}{3\,atm} = \frac{(2)(400)R}{3} = \frac{800}{3}R$$

DIF: Easy OBJ: 2.6 NAT: 2.2 | 2.3 TOP: Gas Laws
KEY: molar mass of gas | density of gas NOT: 75% answered correctly

$mm = \frac{DRT}{P}$

or

molar kitty

$mm_{molar} = \frac{DRT}{P}$

$mm = \frac{DRT}{P}$

$= \frac{(2)R\,400}{3}$

$mm = \frac{800}{3}R$

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4. ANS: C

$$PV = nRT \therefore n = \frac{PV}{RT} = \frac{g}{MM} \therefore \frac{MM}{g} = \frac{RT}{PV} \therefore MM = \frac{gRT}{PV} = \frac{[(3.0)(0.08)(400)]}{[(1.0)(1.5)]}$$

DIF: Easy OBJ: 1.2 NAT: 2.2 TOP: Gas Laws
KEY: ideal gas law | molar mass NOT: 81% answered correctly

5. ANS: D
"Effuse" is simply diffuse through a small opening. So, the heaviest molecule will effuse the slowest. HBr has the highest molecular mass (about 80 g/mol), thus it is the slowest to effuse.

DIF: Medium OBJ: 2.4 NAT: 1.4 | 6.4 TOP: Gas Laws | Gases
KEY: Graham's Law of Effusion KMT | rate of effusion | molar mass of gas
NOT: 62% answered correctly

6. ANS: B
Once the water level inside the tube is equilibrated with the water level in the trough, it is safe to assume the total pressure within the tube is equal to atmospheric pressure of the lab room.

So, the P of the H_2 gas collected + the P of the water vapor within the tube = 765.5 mm Hg. Next, we perform a simple subtraction of the pressure of the water vapor to determine the pressure attributed to *just* the hydrogen gas collected.

∴765.5 mm Hg – 21.1 mm Hg of water contributing to the total P = 744.4 mm Hg is exerted by the H_2 gas *alone*.

DIF: Easy OBJ: 2.6 NAT: 2.2 | 2.3 TOP: Gas Laws
KEY: Dalton's Law | dry gas | partial pressures | wet gas | lab

7. ANS: D
Once the water level inside the tube is equilibrated (leveled) with the water level in the trough, it is safe to assume the total pressure within the tube is equal to atmospheric pressure of the lab room. There's no easy way to measure the pressure *within* the tube AND the measured volume of the gas will *change* during the leveling process. If you fail to level the two, then your recorded volume of H_2 gas collected will be flat incorrect! While answer (B) is enticing, the volume is measured at room temperature, whether the levels are equal or not

DIF: Hard OBJ: 2.6 | 2.4 NAT: 2.2 | 2.3 | 1.4 | 6.4
TOP: Gases | Lab KEY: Dalton's Law | dry gas | wet gas | lab

8. ANS: B
Expect easy math!

Rxn:	F_2	+	Xe	→	Xe_xF_y
Initial:	8.0 atm		1.7 atm		0
After:	4.6 atm*		0		

So subtract! And you realize that 3.4 atm of F_2 reacted AND 1.7 atm of the Xe reacted which is a 2 F_2 : 1 Xe ratio which is equivalent to a 4 F : 1 Xe ratio or XeF_4

DIF: Hard OBJ: 3.3 NAT: 2.2 | 5.1 TOP: Gas Laws
KEY: stoichiometry | partial pressure | molecular formula NOT: 38% answered correctly

9. ANS: C
"Rigid" is code for constant volume. The pressure would increase due to the increased number of molecules colliding with the container. Since the temperature is held constant the average KE of the molecules remains the same and since their mass remains constant (only oxygen in the tank), their velocity also remains constant (correct answer). If you added oxygen to the tank you increased the total number of molecules within the tank so obviously the number of molecules could not remain the same.

DIF: Medium OBJ: 1.4 NAT: 7.1 TOP: Gas Laws
KEY: kinetic molecular theory NOT: 54% answered correctly

10 ANS: A
Light gas molecules move faster than heavy ones. So, He moved out quickest, with Ne in second place and Ar dragging up the rear. That left more Ar in the container to exert a greater pressure (more molecules colliding with the container) with Ne being in the middle and He having the fewest molecules remaining, thus exerting the least pressure. So, P_{He} is less than P_{Ne} which is less than P_{Ar}.

DIF: Medium OBJ: 2.4 NAT: 6.4 | 1.4 TOP: Gas Laws
KEY: partial pressure | effusion | rate of effusion NOT: 65% answered correctly

11. ANS: D
Temperature is a function of the KE_{avg} of the molecules and since all 3 gas samples are at the exact same temperature, they have identical KE_{avg}.

DIF: Easy OBJ: 5.2 NAT: 1.1 | 1.4 | 7.2 TOP: Gases | Kinetics
KEY: average KE | KE avg | gases

12. ANS: B
The density is proportional to the product of the pressure and the molar mass since V is the same for each gas in the "identical containers".

P × molar mass =

Container A: 4 × 16 = 64

Container B: 2 × 30 = 60

Container C: 2 × 58 = 116

This product is greatest for container C and least for Container B

DIF: Hard OBJ: 2.6 NAT: 2.2 TOP: Gases | Kinetics
KEY: average KE | KE avg | gases

13 ANS: C
The kinetic molecular theory states that gases behave most ideally at high temperatures (since they have enough KE to avoid being attracted to each other and condensing) and low pressures (since they remain far enough apart to avoid being attracted to each other *and* their molecular volumes remain insignificant). So, shop for the highest T which are answers (C) & (D) coupled with the lowest P which is answer (C).

DIF: Hard OBJ: 2.4 NAT: 1.4 | 6.4 TOP: Gas Laws
KEY: kinetic molecular theory | behavior of gases NOT: 37% answered correctly

14 ANS: A
I would call this an easy question, but you may call it a trick! If 2 samples are at the same temperature, their average molecular kinetic energy is the same since that's the definition of temperature! Over half the country missed this question.

DIF: Medium OBJ: 2.4 NAT: 1.4 | 6.4 TOP: Gas Laws
KEY: temperature | kinetic molecular theory | average kinetic theory
NOT: 47% answered correctly

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① Given:

Ⓐ 66.50% C

6pts empirical Formula

Soln: $\left(\frac{66.50\,g\,C}{1}\right)\left(\frac{1\,mole}{12.01\,g\,C}\right) = 5.54$ mole C $/5.54 = 1$ +1 +1

$\left(\frac{33.50\,g\,H}{1}\right)\left(\frac{1\,mole\,H}{1.008\,g\,H}\right) = \frac{33.23\,mole\,H}{5.54} = 5.998 \approx 6$ +1 +1

$\boxed{CH_6}$ +2

Ⓑ $D = 2.0\,g/L$

$T = 50°C + 273 = 323\,K$

$P = .948\,Atm$

6pts

Soln:

i) $MM = \frac{DRT}{P}$ +1

$= \frac{(2.0\,g/L)(0.08206)(323\,K)}{.948\,Atm}$

$\boxed{MM = 56\,g}$ ~~mole~~ +2

ii) molecular Formula?

$CH_6 = 18.06$ g/mole

$\left(\frac{56\,g}{1}\right)\left(\frac{1\,mole}{18.06\,g}\right) = 3.1 \approx 3$ +1

$\therefore \boxed{C_3H_{18}}$ +2

Ⓒ

Assume T = constant

10pts

N_2	O_2
2.0L	3.0L
1.0 Atm	2.0 Atm
25°C = 298K +1	25°C = 298K

$P_T = P_{N_2} + P_{O_2}$ +1

Total volume = 5.0L +1

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C cont:

N_2 $PV = nRT$

$P_1V_1 = P_2V_2$ +1

$P_2 = \frac{P_1V_1}{V_2} = \frac{(1.0\,Atm)(2.0\,L)}{5.0\,L} = .4\,Atm$ +2

or $n = \frac{PV}{RT}$ .082 m

O_2

$P_2 = \frac{P_1V_1}{V_2} = \frac{(2.0\,Atm)(3.0\,L)}{5.0\,L} = 1.2\,Atm$ +2

N_2 .25 m

$P_T = P_{N_2} + P_{O_2} = .4\,Atm + 1.2\,Atm$

$P = \frac{nRT}{V}$ ($n_{O_2} + n_{N_2}$)

$P_T = 1.6\,Atm$ +2

get same Answer!

D $2C_8H_{18(l)} + 25\,O_{2(g)} \longrightarrow 16\,CO_{2(g)} + 18\,H_2O_{(g)}$

D= 0.703 g/ml Excess ? moles gas products

T = 20°C = 293K

V = 355 ml

3 pts

$\left(\frac{.703\,g\ C_8H_{18}}{ml}\right)\left(\frac{355\,ml}{1}\right)\left(\frac{1\ mole\ C_8H_{18}}{114.22\,g\ C_8H_{18}}\right)\left(\frac{34\ mole\ gas\ Products}{2\ mole\ C_8H_{18}}\right)$ +1

= 37.1 moles GAS Products

+2

2009 AP FR — FR #1 on AP TEST - Unit GASES

(2) Given:

$V_{FLASK} = 843\ mL = .843L$ $MASS_{FLASK+Air} = 157.70g$

$T = 23C + 273 = 296K$ $MASS_{FLASK+gas} = 158.08g$

$P = 750.\ Torr\left(\frac{1Atm}{760Torr}\right) = .987Atm$

(A) ?g Air soln: $D = \frac{m}{V}$ +1

3/3 $D = 1.18g/L$ $m = DV = \left(\frac{1.18g}{L}\right)(.843L)$

$\boxed{m = .995g}$ +2

(B) ?g of Flask +1

3/3 $M_{FLASK} = M_{FLASK} - M_{Air} = 157.70g - .995g$

$\boxed{M_{FLASK} = 156.71g}$ +2

(C) ?g GAS +1

3/3 $M_{GAS} = M_{FLASK+GAS} - M_{FLASK} = 158.08g - 156.71g$

$\boxed{M_{GAS} = 1.37g}$ +2

3/3 (D) MM? gas $MM = \frac{dRT}{P}$ +1 $d = \frac{m}{V}$

$= \frac{mRT}{PV} = \frac{(1.37g)(0.08206)(296K)}{(.987Atm)(.843L)}$

$\boxed{MM = 40.0\ g/mole}$ +2

3/3 (E) ?% Error if gas is CO_2 44.0g/mole

+1 +2

$\frac{|44.0 - 40.0|}{44.0} \times 100 = \boxed{9.09\%\ \text{ERROR}}$

4/4 (F) (1) Stik air in flask ⇒ less mass CO_2 ⇒ $\frac{\text{smaller mass}}{\text{same MM}}$ = smaller MM larger % ERROR

(2) Air 23°C, CO_2 ↓ 23°C ⇒ $\frac{mRT}{PV}$ = mm smaller MM larger % ERROR

1 (G) Fill Flask w/ water, measure Liquid in Graduated Cylinder

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(3) $C_5H_{12(l)} + 8O_{2(g)} \xrightarrow{\Delta} 5CO_{2(g)} + 6H_2O_{(g)}$ +4pts

2.50g ?V

T = 25°C = 298 K

$P = (785\,mm)\left(\frac{1\,atm}{760\,mm}\right) = 1.03\,Atm$

$$\left(\frac{2.50g\ C_5H_{12}}{1}\right)\left(\frac{1\,mole\ C_5H_{12}}{72.15\,g\ C_5H_{12}}\right)\left(\frac{5\,mole\ CO_2}{1\,mole\ C_5H_{12}}\right) = .173\ mole\ CO_2$$ +2pts

6

PV = nRT +1

$$V = \frac{nRT}{P} = \frac{(.173\,mole\ CO_2)(0.08206)(298K)}{1.03\,Atm}$$ +1

3

V = 4.11 L +2pts

12