SELF-ASSESSMENT - MODULE 3-3: Properties of Gases and Gas Mixtures

I. Altitude and Partial Pressure

A. Calculate the partial pressure of oxygen in a dry gas at a barometric pressure of 760 Torr and an FO_2 of 60%?

$PO_2 = \boxed{P_{BARO} \times FO_2 = 760\ torr \times 0.60 = 456\ torr}$

B. The patient is breathing room air. Calculate the partial pressure of CO_2 in a dry gas where the barometric pressure is 740 Torr?

$PCO_2 = \boxed{P_{BARO} \times FCO_2 = 740\ torr \times 0.0003 = 0.22\ torr}$

C. The patient is breathing room air. Calculate the partial pressure of N_2 in a dry gas at a barometric pressure of 650 mm Hg?

$PN_2 = \boxed{P_{BARO} \times FN_2 = 650\ torr \times 0.78 = 507\ torr}$

D. The patient is breathing room air. The barometric pressure is 750 mm Hg. What is the partial pressure of oxygen after it enters the patient's lungs (saturated gas)? $PaCO_2$ 40 torr & RQ 0.8

PAO_2 =

$$\boxed{[(P_{BARO} - 47\ torr) \times FIO_2] - \frac{PaCO_2}{0.8} = [(750 - 47) \times .21] - \frac{40}{0.8} = (703 \times .21) - 50 = 147.6 - 50 = 97.6 = 98 torr}$$

E. What is the FO_2 on top of Pike's Peak at a barometric pressure of 550 mm Hg? **.21**

F. What is the FO_2 in a deep, deep well at an atmospheric pressure of 620 mm Hg? **.21**

G. What is the PO_2 if the PBaro is 734 Torr and the FO_2 is 1.0 (100% Oxygen & dry gas).

$\boxed{PO_2 = P_{BARO} \times FO_2 = 734 \times 1 = 734\ torr}$

II. Dalton's Law

A. 85 cm H_2O = ? mm Hg $\boxed{85\ cm\ H_2O \times \frac{1 mm\ Hg}{1.36\ cm\ H_2O} = 62.5\ mm\ Hg}$

B. 650 mmHg = ? cm H_2O. $\boxed{650\ mm\ Hg \times \frac{1.36\ cm\ H_2O}{1 mm\ Hg} = 884\ cm\ H_2O}$

C. Calculate the PO_2 of dry air at a PBARO of 752 mmHg.

$\boxed{PO_2 = P_{BARO} \times FO_2 = 754 \times .21 = 158\ torr}$

D. Calculate the PAr at 1 atmosphere.

$\boxed{PAr = P_{BARO} \times FAr = 760 \times .0093 = 7.07\ torr = 7.1 torr}$

E. Calculate the PIO2 at a PBARO of 688 mm Hg.

$$\boldsymbol{PIO_2 = (P_{BARO} - 47\ torr) \times FIO_2 = (688 - 47\ torr) \times .21 = 134.6\ torr = 135\ torr}$$

F. Calculate the PN_2 at 1 atmosphere.

$$\boldsymbol{PN_2 = P_{BARO} \times FN_2 = 760 \times .78 = 592.8\ torr = 593\ torr}$$

G. Calculate the PO_2 of dry air at PBARO of 1088 cm H_2O.

$$PO_2 = P_{BARO} \times FO_2 = 1088\ \text{cm}\ H_2O \times .21 = 228.5\ cm\ H_2O = 229\ cm\ H_2O$$

H. Calculate the PN_2 at 2 atmospheres.

$$PN_2 = P_{BARO} \times FN_2 = 1{,}520\ \text{torr} \times .78 = 1{,}185.6\ torr = 1{,}186\ torr$$

I. Calculate the PCO_2 of dry air at PBARO of 745 mm Hg.

$$\boldsymbol{PCO_2 = P_{BARO} \times FCO_2 = 745 \times .0003 = 0.224\ torr = 0.22\ torr}$$

J. Calculate the PIO_2 at an FIO_2 of 40% and a PBARO of 750 mm Hg.

$$\boldsymbol{PIO_2 = (P_{BARO} - 47\ torr) \times FIO_2 = (750 - 47\ torr) \times .40 = 281.2\ torr = 281\ torr}$$

K. Calculate the PIO_2 at an FIO_2 of 28% and a PBARO of 755 mm Hg.

$$\boldsymbol{PIO_2 = (P_{BARO} - 47\ torr) \times FIO_2 = (755 - 47\ torr) \times .28 = 198.2\ torr = 198\ torr}$$

L. Calculate the PIO_2 at an FIO_2 of 100% and a PBARO of 760 mm Hg.

$$\boldsymbol{PIO_2 = (P_{BARO} - 47\ torr) \times FIO_2 = (760 - 47\ torr) \times 1.0 = 713\ torr}$$

M. Calculate the PIO_2 at an FIO_2 of 60% and a PBARO of 740 mm Hg.

$$\boldsymbol{PIO_2 = (P_{BARO} - 47\ torr) \times FIO_2 = (740 - 47\ torr) \times .60 = 415.8\ torr = 416\ torr}$$

N. Assume the total pressure exerted by four gases during anesthesia is 750 torr. The partial pressure of O_2 in the mixture is 200 torr, N_2 480 torr, and water vapor is 25 torr. What is the partial pressure of the anesthetic gas?

$$P_{ANESTHETIC\ GAS} = (P_{BARO} - 25\ \text{torr} - \text{PO}_2 - \text{PN}_2) = (750\ \text{torr} - 25\ \text{torr} - 200\ \text{torr} - 480\ \text{torr}) = 45\ torr$$

O. A He/O_2 mixture (30%/70%) is being administered to a patient at a PBARO of 760 mm Hg. The PIO_2 is 499.1 mm Hg, what is the partial pressure of He (PIHe)?

$$PBaro = (PiO_2 + PiHe)$$
$$\text{PIHe} = \text{PBaro} - \text{PiO}_2 = 760 - 499.1 = 260.9\ \text{torr}$$

P. The total pressure in a gas mixture is 540 mm Hg. Gas A has a partial pressure of 290 mm Hg, Gas B has a partial pressure of 30 mm Hg, Gas C has a partial pressure of 50 mm Hg. What is the partial pressure of gas D?

$$PBaro = (P_A + P_B + P_C + \text{P}_\text{D})$$
$$540\ \text{mm Hg} = (290\ \text{mm Hg} + 30\ \text{mm Hg} + 50\ \text{mm Hg} + \text{P}_\text{D})$$
$$\text{P}_\text{D} = (540 - 370\ \text{torr}) = 170\ \text{torr}$$

III. ALVEOLAR AIR EQUATION (PAO_2)

A. Given the following, calculate the PAO_2:
Barometric pressure of 750 mm Hg
FIO_2 60%
$PaCO_2$ 45 mm Hg
RQ=0.8

$$[(P_{BARO} - 47\ torr) \times FIO_2] - \frac{PaCO_2}{0.8} = [(750-47)\times .60] - \frac{45}{0.8} =$$
$$(703 \times .60) - 56.3 = 421.8 - 56.3 = 365.5 = 366\ torr$$

B. The patient is receiving 40% oxygen via a Venturi mask. The barometric pressure is 755 mm Hg, and an arterial blood sample reveals a $PaCO_2$ of

$$[(P_{BARO} - 47\ torr) \times FIO_2] - \frac{PaCO_2}{0.8} = [(755-47)\times .40] - \frac{50}{0.8} =$$
$$(708 \times .40) - 62.5 = 283.2 - 62.5 = 220.7 = 221\ torr$$

50 mm Hg. Assuming a normal RQ, calculate the PAO_2

C. The patient is receiving 100% oxygen via a trach mask. The barometric pressure is 730 mm Hg, and the $PaCO_2$ is 60 mm Hg. Assuming a normal RQ, calculate the PAO_2.

$$[(P_{BARO} - 47\ torr) \times FIO_2] - \frac{PaCO_2}{0.8} = [(730-47)\times 1.0] - \frac{60}{0.8} =$$
$$(683 \times 1.0) - 75 = 683 - 75 = 608\ torr$$

D. The patient is receiving 80% oxygen via an aerosol mask. The barometric pressure is 650 mm Hg and the $PaCO_2$ is 57 mm Hg. Assuming a normal RQ, calculate the PAO_2.

$$[(P_{BARO} - 47\ torr) \times FIO_2] - \frac{PaCO_2}{0.8} = [(650-47)\times .80] - \frac{57}{0.8} =$$
$$(603 \times .80) - 71.25 = 482.4 - 71.25 = 411.2 = 411\ torr$$

E. The patient is receiving 30% oxygen via a T-piece. The barometric pressure is 760 mm Hg and the $PaCO_2$ is 30 mm Hg. Assuming a normal RQ, calculate the PAO_2.

$$[(P_{BARO} - 47\ torr) \times FIO_2] - \frac{PaCO_2}{0.8} = [(760-47)\times .30] - \frac{30}{0.8} =$$
$$(713 \times .30) - 37.5 = 213.9 - 37.5 = 176.4 = 176\ torr$$

F. The patient is receiving 40% oxygen via a face tent. The barometric pressure is 740 mm Hg and the $PaCO_2$ is 66 mm Hg. Assuming a normal RQ, calculate the PAO_2.

$$[(P_{BARO} - 47\ torr) \times FIO_2] - \frac{PaCO_2}{0.8} = [(740-47)\times .40] - \frac{66}{0.8} =$$
$$(693 \times .40) - 82.5 = 277.2 - 82.5 = 194.7 = 195\ torr$$

G. The patient is receiving 70% oxygen via an aerosol mask. The barometric pressure is 720 mm Hg and the $PaCO_2$ is 46 mm Hg. Assuming a normal RQ, calculate the PAO_2.

$$[(P_{BARO} - 47\ torr) \times FIO_2] - \frac{PaCO_2}{0.8} = [(720-47)\times .70] - \frac{46}{0.8} =$$
$$(673 \times .70) - 57.5 = 471.1 - 57.5 = 413.6 = 414\ torr$$

H. The patient is receiving 55% oxygen via a trach mask. The barometric pressure is 653 mm Hg and the $PaCO_2$ is 45 mm Hg. Assuming a normal RQ, calculate the PAO_2.

$$[(P_{BARO} - 47\ torr) \times FIO_2] - \frac{PaCO_2}{0.8} = [(653 - 47) \times .55] - \frac{45}{0.8} =$$
$$(606 \times .55) - 56.25 = 333.3 - 56.25 = 277.1 = 277\ torr$$

I. The patient is receiving 65% oxygen via a T-Piece. The barometric pressure is 742 mm Hg and the $PaCO_2$ is 60 mm Hg. Assuming a normal RQ, calculate the PAO_2.

$$[(P_{BARO} - 47\ torr) \times FIO_2] - \frac{PaCO_2}{0.8} = [(742 - 47) \times .65] - \frac{60}{0.8} =$$
$$(695 \times .65) - 75 = 451.8 - 75 = 376.8 = 377\ torr$$

J. The patient is receiving 28% oxygen via an aerosol mask. The barometric pressure is 753 mm Hg and the $PaCO_2$ is 38 mm Hg. Assuming a normal RQ, calculate the PAO_2.

$$[(P_{BARO} - 47\ torr) \times FIO_2] - \frac{PaCO_2}{0.8} = [(753 - 47) \times .29] - \frac{38}{0.8} =$$
$$(706 \times .28) - 47.5 = 197.7 - 47.5 = 150.2 = 150\ torr$$

IV. Molar Calculations

A. A container holds 45 g of sugar, $C_6H_{12}O_6$ (molecular mass 180g). How many moles of sugar are present?

$$45g \times \frac{1 mole}{180g} = 0.25\ mole$$

B. How many molecules are present in 27 g of water (H_2O)? (Note: water's molecular mass is 18g)?

$$27g \times \frac{1 mole}{18g} = 1.5\ mole$$

C. Complete the following table:

SUBSTANCE	ATOMIC MASS UNITS (AMU)	MOLES
196 g of H_3PO_4	H = 3 (1 x 3) P = 31 (1 x 31) O = 64 (16x4) 98 g	$\frac{196\ g}{98\ g/mole} = 2\ moles$
513 g of $C_{12}H_{22}O_{11}$	C = 144 (12 x 12) H = 22 (22 x 1) O = 352 (11 x 16) 518 g	$\frac{513\ g}{518\ g/mole} = 0.99\ moles$
138 g of C_2H_6O	C = 24 (2 x 12) H = 6 (6 x 1) O = 16 (1 x 16) 46 g	$\frac{138\ g}{46\ g/mole} = 3\ moles$
16 g of CH_3OH.	C = 12 (1 x 12) H = 4 (4 x 1) O = 16 (1 x 16) 32 g	$\frac{16\ g}{32\ g/mole} = 0.5\ moles$
68 g of $C_3H_8O_3$	C = 36 (3 x 12) H = 8 (8 x 1) O = 48 (3 x 16) 92 g	$\frac{68\ g}{92\ g/mole} = 0.74\ moles$

VOLUME IN LITERS	SUBSTANCE	ATOMIC, MOLECULAR OR FORMULA MASS (OR WEIGHT)	# MOLES	***WEIGHT OF ONE MOLE*** *****	# PARTICLES	TYPE OF PARTICLES
22.4 L	He	4 amu	1	**4 g**	**6.02×10^{23}**	**Atom**
22.4 L	O_2	32 amu	1	**32 g**	**6.02×10^{23}**	**Molecule**
	H_2O	H = 1 H = 1 18 amu O = 16	1	**18 g**	**6.02×10^{23}**	**Compound**
	12 large eggs		1 dozen	**na**	12	eggs
	12 medium delicious apples		1 dozen	**na**	12	apples

What is Avogadro's number? **6.02×10^{23}** How many particles are there in a mole of any substance? **6.02×10^{23}**
If I express the atomic weight (mass) of a substance in grams, what do I have? **1 Mole** (example: Hydrogen amu = 1.01, what is 1.01 grams of Hydrogen?)

What volume does a mole of any gas occupy (at STP)? **22.4** Liters How many molecules does this gas contain? **6.02×10^{23}**

Fill in the chart below:

SUBSTANCE	MOLECULAR OR FORMULA MASS (WEIGHT) amu	WEIGHT OF ONE MOLE IN GRAMS	NUMBER OF PARTICLES IN ONE MOLE	TYPE OF PARTICLES
NH_3	**N = 14 (1 x 14)** **H = 3 (3 x 1)** **17 amu**	**17.0 g**	**6.02×10^{23}**	**Compound**
Na_2SO_4	**Na = 46 (2 x 23)** **S = 32 (1 x 32)** **O = 64 (4 x 16)** **142 amu**	**142 g**	**6.02×10^{23}**	**Compound**
PBr_3	**P = 31 (1 x 31)** **Br = 240 (3 x 80)** **271 amu**	**271 g**	**6.02×10^{23}**	**Compound**
H_2CO_3	**C = 12 (1 x 12)** **O = 48 (3 x 16)** **H = 2 (2 x 1)** **62 amu**	**62 g**	**6.02×10^{23}**	**Compound**