Problem: Blood Gases and Dead Space[i]

Arterial blood of several individuals was analyzed for O_2 and CO_2 gas tensions (P_{aO2} and P_{aCO2}, respectively), O_2 concentration (C_{aO2} in $\frac{cc\ O_2}{100\ cc\ blood}$), and percent O_2 saturation (S_{aO2}).

INDIVIDUAL	P_{aO2}	P_{aCO2}	C_{aO2}	S_{aO2}
A	100	40	20	97
B	100	40	10	97
C	120	20	20	98
D	600	40	22	100
E	45	35	20	90

Assume individual **A is a normal human breathing room air at sea level**. Indicate what might be responsible for the blood gas values in the four other individuals.

B ANEMIA: the P_{AO2} is normal but the blood only contains half the O_2 that would be expected in a normal person yet the blood is still nearly saturated. One alternative is CO poisoning.

C HYPERVENTILATION (HYPERNEA): P_{AO2} is elevated while P_{aCO2} is depressed; total O_2 carried is slightly up.

D BREATHING AIR ENRICHED IN O_2 **or** breathing compressed air at about 4 ATM (100' sea water) these are the only ways one could get such a high P_{AO2} . Note that the P_{aCO2} is low.

[i] thanks to Dr. J.F. Anderson, Dept Zoology, Univ of Florida, Gainesville for the original idea for this problem

E <u>HIGH ALTITUDE</u>: lowered ambient P_{O2} results in lowered P_{AO2} . Subjects at high altitude typically hyperventilate slightly; notice that P_{aCO2} is lower than normal. Also notice that even thought the P_{AO2} has decreased greatly, the blood still carries an amount of air similar to that at sea level. However, notice it is only 90% saturated. The body has compensated by raising the hct (not shown but the only explanation for the normal CaO2 and, of course, it is the normal acclimation result).

Estimate V_D given the following information. Do <u>not</u> convert to STPD.

V_E: 0.5 liters
F_{ECO2}: 0.035
F_{ACO2}: 0.054
breathing rate: $\frac{15}{min}$

Recall that $V_D = V_E - V_A$
and that $\dot{V}_A = \dot{V}_{CO_2} / F_{ACO2}$
and that $V_A = \dot{V}_A / f$

Solving first for alveolar minute ventilation, we get:

$\dot{V}_A = \dot{V}_{CO_2} / F_{ACO2}$ = 0.5 L/ b * 15 b/min * 0.035 / 0.054 = 4.86 L/m
and for V_A = (4.86 L / min) / 15 (b/ min) = 0.32 Liters
And finally for V_D:

$V_D = V_E - V_A$ = 0.5 L - 0.32 L = **0.18 L**

Note: I could have solved this by simply calculating the volume of CO_2 expelled per breath V_{CO2} which would have been equal to F_{ECO2} * V_E ; I stuck with the exact form of the equation we learned in class.