RESPIRATION CALCULATIONS[i]

Assume the values given below were obtained from measurements made on a healthy human at sea level.

F_{ECO2}: 0.037

F_{IO2}: 0.2094

F_{ACO2}: 0.054

F_{ICO2}: 0.00

F_{EO2} : 0.1737

F_{AO2}: 0.1557

$P_{(total)}$: 760 mm Hg

pKa (carbonic acid bicarb system): 6.10

P_{AH2O}: 47 mm

Systemic arterial plasma pH: 7.40

$\dot{V}_E$: $\frac{6 \text{ liters}}{\text{min}}$

αCO_2: $\frac{0.03 \text{ mM}}{\text{L . mmHg}}$

R: 0.85

f : $\frac{12 \text{ breaths}}{\text{min}}$

ESTIMATE:

(a) $\dot{V}_{CO_2}$

$$\dot{V}_{CO_2} = F_{ECO2} * \dot{V}_E = 0.037*6 \text{ l/min} = 222 \text{ ml / min}$$

$\dot{V}_{O_2}$

(b) $\dot{V}_{O_2} = (F_I O2 - F_{EO2})/ (1- F_{EO2}) * \dot{V}_E$

$$= (0.2094-.01737)/(1-0.1737) * 6 \text{ L/m} = 259 \text{ ml/min}$$

$\dot{V}_A$

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

(c) $\dot{V}_A$ **=** $\dot{V}_{CO_2}$ **/ F_{ACO2} = 0.2220 / 0.054 = 4.07 L / min**

(d) $\dot{V}_D$ -- need $\dot{V}_A$ from previous question

$\dot{V}_D = \dot{V}_E - \dot{V}_A$

= 6 L/ min - 4.07 L/ min = 1.93 L/ min

(e) V_D -- need $\dot{V}_E$ from previous quesiton

V_D = $\dot{V}_D$ / f = 1.93/12 = 0.160 L

P_{ACO2}

(f) **$P_{ACO2} = F_{ACO2}$ * (P_b - P_{H2O}) = 0.054 * (760 - 47)**

= 38.5 torr

(g) systemic arterial [HCO_3^-]

The $P_{ACO2} = P_{aCO2}$, using H-H and given data:

$[HCO_3^-] = \alpha P_{CO2}$ * (antilog(*p*H - *pKa*))

$= \frac{0.03 \text{ mmols}}{\text{L . mm Hg}}$ * 38.5* (10^(7.4-6.1))

$[HCO_3^-]$ = 23mM

(h) P_{AO2}

$P_{AO2} = F_{ACO2}$ * (P_b - P_{H2O}) = 0.1557 * (760 - 47)

= 111 torr

(i) P_{AN2} We need to get this by subtraction since we have no value for F_{AO2} but we do have values for P_{AH2O}, P_{AO2} and P_{aCO2} and total pressure.

P_{AN2} = 760 - 111 (P_{AO2}) - 38.5 (P_{aCO2}) - 47 (P_{H2O}) = 563 torr

(j) F_{ACO2} **IF** $\dot{V}_A$ doubles and $\dot{V}_{CO_2}$ stays the same as above

Recall that:

$\dot{V}_A = \dot{V}_{CO_2} / F_{ACO2}$

or

$F_{ACO2} = \dot{V}_{CO_2} / \dot{V}_A$

So, if $\dot{V}_{CO_2}$ remains constant and $\dot{V}_A$ doubles, then the ***F_{ACO2}* will be cut in half**

(k) F_{ACO2} **IF** breathing frequency doubles but $\dot{V}_E$ and $\dot{V}_{CO_2}$ stay the same as above

This one is easy. It appears that even though the subject is breathing at a higher rate, nevertheless, no hyperventilation is occurring since $\dot{V}_E$ has not increased. However, the possibility that hypoventilation has occurred is still there (the person could be breathing faster and not ventilating their alveolar space sufficiently). However, since $\dot{V}_{CO_2}$ remains the same we can be relatively (but not absolutely) certain that alveolar ventilation is normal. Thus, **the most logical conclusion is that alveolar ventilation has remained the same.**

F_{ACO2} **IF** both $\dot{V}_A$ and $\dot{V}_{CO_2}$ double

Recall from two problems previously:

$F_{ACO2} = \dot{V}_{CO_2} \; / \; \dot{V}_A$

(I) If both double, there will be no change (F_{ACO2} remains the same) since both change by the same amount.