Quiz 11

Key

1. A person decides to take a trip to the Himalayas, where the concentration of oxygen in the air is much lower than most places in the world[1]. Suppose this person has a lung capacity of 4.5 L, and that in a normal breath they exhale 0.5 L. Assume the concentration of oxygen in the air is about 0.15 mol/L (not mmol).

   (a) [1 pt] While the person is on the plane, they have a concentration of 0.345 mol/L of oxygen in their lungs. Right before they take their first breath off the plane, exactly how much oxygen is in their lungs?
   (0.345 mol/L) (4.5 L) = 1.5525 mol

   (b) [1 pt] When this person first exhales, how much oxygen has left their lungs?
   (0.345 mol/L)(0.5 L) =0.1725 mol

   (c) [1 pt] After exhaling and before inhaling, how much oxygen is in their lungs?
   (.345 mol/L)(4.0 L) = 1.38 mol

   (d) [1 pt] How much (total) oxygen is breathed in when they inhale?
   (.15 mol/L)(.5 L) = 0.075 mol

   (e) [2 pts] How much oxygen is in their lungs once they inhale?
   Take the sum of answers (c) and (d): 1.38 mol + 0.075 mol = 1.455 mol

   (f) [2 pts] What is the concentration of oxygen in their lungs after this first breath?
   concentration = (1.455 mol)/(4.5 L) = 0.323 mol/L.

   (g) [2 pts] The equation for how the concentration updates after each breath is $c_{t+1} = c_t\left(1 - \frac{W}{V}\right) + \gamma\frac{W}{V}$. With $c_0 = 0.345$, what does this equation predict for c_1?
   $c_1 = (0.345)(1 - \frac{0.5}{4.5}) + (0.15)(\frac{0.5}{4.5}) = 0.307 + 0.017 = 0.324$, so the answer matches part (f) (which may be slightly off due to rounding errors).

[1] Actually, the concentration is the same; there's just less air around! But our model still applies since there's effectively less oxygen coming in during each breath.