Midterm Problems

January 21, 2022

1. **Barometric Formula** The barometric formula is given by

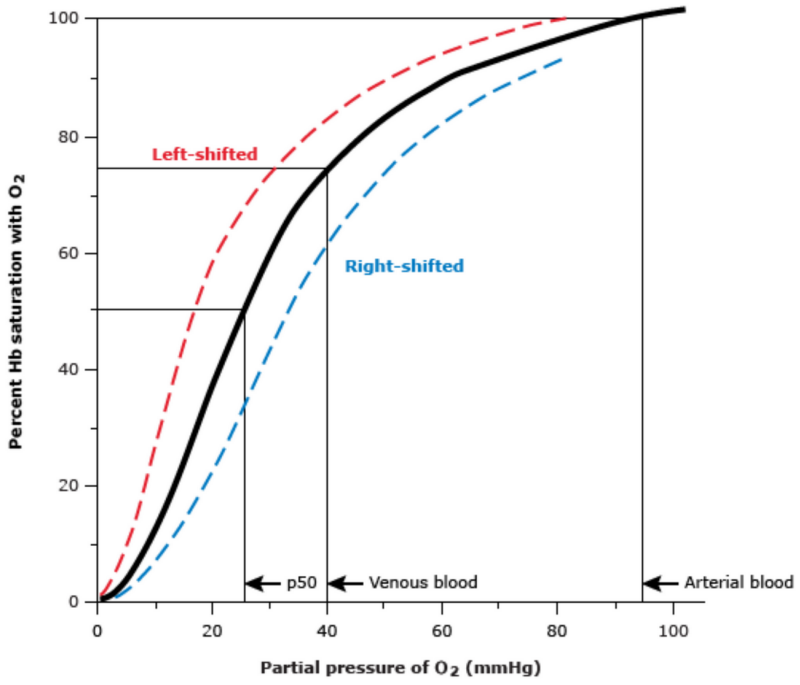
$$P_h = P_0 e^{-\frac{Mgh}{RT}}$$

where P_h is the pressure at height h, P_0 is the pressure at ground level, M is the molar mass of air (28.97 g/mol), R is the gas constant, and T is the temperature. This formula has been used to approximate the elevation of mountains. Report to 3 significant figures.

(a) A hiker brings a mercury barometer to measure the height of Mount Everest. At the summit, the hiker reports the barometric pressure to be 253.0 Torr at $-9°$C. Use the barometric formula to approximate the height of Mount Everest.

(b) Mount Everest has an official height of 8,485 meters. Is the calculated height in (a) overestimated or underestimated? Explain potential errors.

(c) Given the barometric pressure in (a), compute the partial pressure of O_2(g) at the summit (P_{O2}) assuming that the atmosphere is made of 21% O_2. With the oxyhemoglobin dissociation curve, estimate the percent hemoglobin saturated with O_2 assuming that the P_{O2} in the blood is equivalent to the P_{O2} at the summit.



2. **Isothermal Compression** Suppose 1.87 moles of $Cl_2(g)$ at 35°C are compressed isothermally from a volume of 15.0L to 4.79L. Report to 3 significant figures.

(a) Sketch the process on the PV diagram. Define all variables and show what corresponds to the work (w) done on the gas

(b) Compute the work (w) and the heat (q) in kJ/mol.

(c) What is the final pressure of the gas?

3. **Decomposition of N_2O_4(g)** Supposed a sample of $N_2O_4(g)$ has a pressure of 6.6 kPa. After some time, a portion of it decomposes to form $NO_2(g)$. The total pressure of the mixture of gases is then 9.8 kPa. Assume the volume and the temperature do not change. What percentage of $N_2O_4(g)$ has decomposed? Report to 3 significant figures.