1. The enzyme formyltetrahydrofolate synthetase employs ATP hydrolysis to form a carbon-nitrogen bond between tetrahydrofolate and formate. The enzyme has four binding sites for ATP.

a) In an equilibrium dialysis experiment, $1 \times 10^{-4}$ M enzyme (E) is placed in a dialysis bag. It is put in a solution containing ATP. When the binding comes to equilibrium, there is $1 \times 10^{-4}$ M ATP outside the bag and $3 \times 10^{-4}$ M ATP inside the bag. What is the concentration of ATP that is bound to E in the bag?

b) If the four ATP binding sites are identical and do not interact with each other, what is the binding association constant for ATP binding to a single site on E?

c) If the four ATP binding sites are identical and do not interact with each other, at what concentration of ATP will half of the enzyme sites be occupied by ATP?

d) If the four ATP binding sites are positively cooperative with a Hill coefficient of 2.3, at what concentration of ATP will half of the enzyme sites be occupied by ATP?
1. The collisional diameter $\sigma$ of a H$_2$ molecule is about 2.5 Å, or $2.5 \times 10^{-10}$ m. The H$_2$ gas is at 0 °C and 1 atm pressure. The molecular weight of H$_2$ is 2 g/mol. You may assume the gas behaves ideally.

a) What is the most probable velocity of a H$_2$ molecule under these conditions?

b) What is the translational kinetic energy of 1 mol of H$_2$ molecules under these conditions?

c) What is the volume of 1 mole of the gas?

d) What is the characteristic distance that an H$_2$ molecule will fly before it collides with another H$_2$ molecule?

e) How many collisions with other H$_2$ molecules will an individual H$_2$ molecule have in 60 sec?