Name: Date:

Partial Exam
(version A)

Biophysics
Bioinformatics degree

1) a) Estimate the root mean square velocity of the molecules of carbon dioxide in 2 m^3 at 35ºC and 1 atm.
b) Calculate the pressure of a system of ten mols of carbon dioxide molecules having the most probable velocity equal to 300 m/s in a container of 5 m^3.

2) We have a container with 2 litres of nitrogen at 55ºC. Are there more nitrogen molecules travelling at 450 m/s or at 550 m/s? Calculate the probabilities associated with these velocities.

3) We have a system of 4 levels at 90ºC.
a) Calculate the *weight* of the {3, 2, 5, 4} instantaneous configuration.
b) Calculate the logarithm of the *weight* of the {200, 100, 400, 25} instantaneous configuration using the Stirling's approximation.

4) Obtain the energy difference between the levels of a two-level systems if the fraction of molecules being in the most stable energy level (0 kJ/mol) is 0.9 at T=50ºC.

5) Consider a three-level system with energy levels: 0, 1.5 kJ/mol and 2.5 kJ/mol. Calculate the population corresponding to these energy levels at T=35ºC. Comment what happens with the population of the most stable level (0 kJ/mol) if the temperature is increased.

6) In a study of the alcohol-dehydrogenase-catalyzed oxidation of ethanol, the molar concentration of ethanol decreased in a first-order reaction from 220 mmol L^{-1} to 56.0 mmol L^{-1} in $1.22x10^4$ s. Determine at which time the concentration of ethanol is 10 mmol L^{-1}. What is the rate constant of the reaction?

7) The half-live of a solution of 10 mmol L^{-1} of pyruvic acid in the presence of an aminotransferase enzyme was found to be 3.7 min at 50ºC. How long will it take for the concentration of pyruvic acid to fall to 1/50 or to 1/100 of its initial concentration in this first-order reaction.

8) The rate constant of a reaction increases by a factor of 1.23 when the temperature is increased from 20ºC to 27ºC. What is the activation energy of the reaction? If the reaction follow a second-order rate law, explain what happens with the half-live if the temperature is decreased.

9) A reaction A→P has a second-order rate law with k =1.24 cm^3 mol^{-1} s^{-1}. Calculate how many hours are required for the concentration of A to change from 0.260 mol L^{-1} to 0.026 mol L^{-1}.

10) The following data were obtained on the initial rate of binding of glucose to the enzyme hexokinase at 3.0 mmol L^{-1}:

$[glucose]_0$/(mmol L^{-1})	**1.00**	**4.02**
v_0/(mol L^{-1} s^{-1})	7.0	31.0

Find the order of the reaction with respect to glucose. Consider that the order of the reaction of hexokinase is one. Find the rate constant.

Additional data:

$M(CO_2)$=44 g /mol $M(O_2)$=32 g/mol $M(N_2)$=28 g/mol
$k_B=1.3806488\cdot10^{-23}$ J/K
R=8.314 J K^{-1} mol^{-1}
R=0.082 atm L K^{-1} mol^{-1}
$N_A=6.022\cdot10^{23}$ mol^{-1}