Name:_____

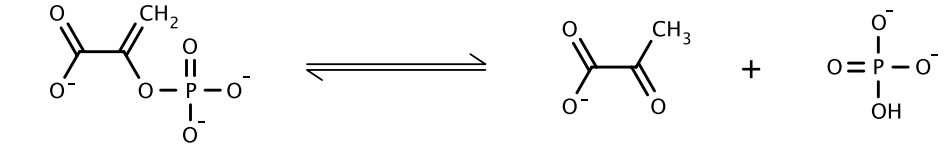
Biology 3820
Physical Principles in Biology
Fall Semester 2015

Quiz 4
20 November 2015

Please write your name on each page.
Be sure to show your work and include correct units in all of your answers!
25 points total.

Some possibly useful constants:
The Boltzmann constant: $1.3806\times10^{-23}\,\mathrm{J\cdot K^{-1}}$
The gas constant: $R = 8.314\,\mathrm{J\cdot mol^{-1}K^{-1}} = 0.08206\,\mathrm{L\cdot atm\cdot K^{-1}mol^{-1}}$
Avogadro's number: 6.02×10^{23}

1. (18 pts) Phosphoenolpyruvate (PEP) is an important metabolic intermediate and undergoes hydrolysis to produce pyruvate and inorganic phosphate (P_i), as shown below:



The standard free energy change, $\Delta G°$, for the reaction as drawn above is -62 kJ/mole at 25°C and pH 7.

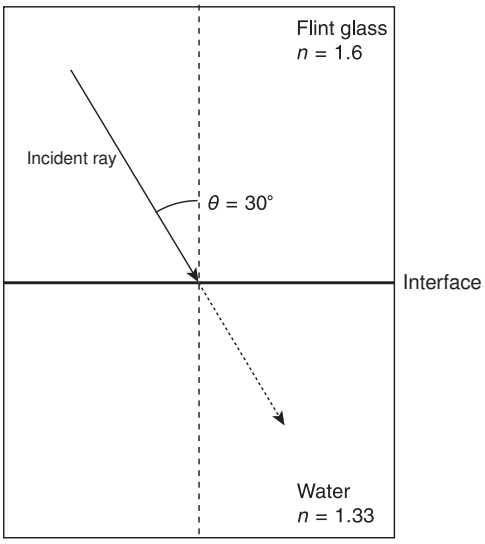
(a) Write the equilibrium expression for the hydrolysis reaction (ignoring the water molecule consumed in the reaction) and calculate the value of the constant at 25°C and pH 7.

(b) Suppose that, under a given set of conditions, the concentrations of PEP, pyruvate and P_i are each 1 mM. Calculate the free energy change for hydrolysis under these conditions.

(c) Under the conditions specified in part b, is hydrolysis favorable or unfavorable? That is will the concentration of pyruvate spontaneously increase or decrease under these conditions? Briefly explain how you reached this conclusion.

Name:_____

2. (7 pts) The figure below represents an arrangement in which a block of glass has been layered over water, with no air trapped below the glass. Different kinds of glass have different indices of rerfraction, but this piece of glass is assumed to be of the type called flint glass, which has a relatively high index of refraction of 1.6. Water, as discussed in class, has an index of refraction of 1.33.



For the incident ray drawn above, with an angle of 30° from the normal, calculate the angle from the normal for the refracted ray that would propagate through the water. Add this ray to the drawing and clearly indicate its angle from the normal. For reference, the dashed arrow represents the path that the light would take if there was no refraction.