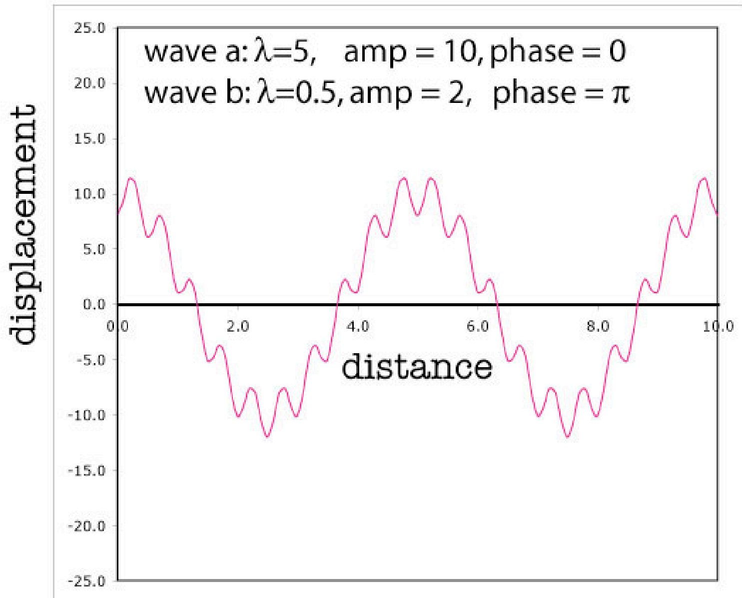
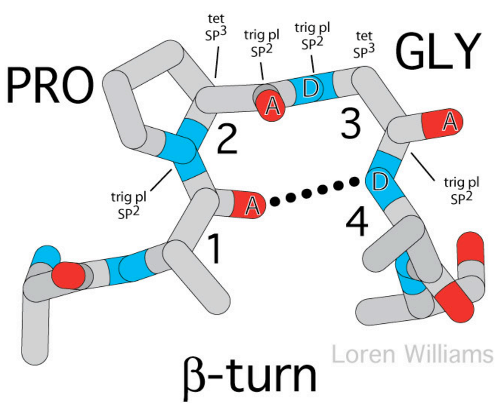
Biophysical Chemistry 6582
Exam 1
February 4, 2004

I will not cheat today, signed ___________________ print name:__KEY__



1) [12] The line on the graph above is obtained by adding waves. Give the wavelength, amplitude, and phase at x=0 of each wave.



2) [20] This peptide contains a glycine and a proline. For the backbone atoms of these two residues:

a) Indicate the orbital hybidization,
a) Indicate the geometry,
a) Mark hydrogen bond donors with a D,
d) Mark hydrogen bond acceptors with an A.

3) [18] Define the variables/parameters in the equations below.

$f = 6\pi\eta R_s$

f: frictional coefficient
η: viscosity
R_s: Stokes radius for a sphere

$D = RT/\mathrm{N}f$

D: Diffusional coefficient
R: gas constant
T: temperature
N: Avogadro's number
f: frictional coefficient

$s = v/\omega^2 r$

s: sedimentation coefficient
v: angular velocity
r: distance from rotor spindle

$$\frac{i_\theta}{I_0} = \frac{2\pi^2 n_o^2 \left(\frac{dn}{dC}\right)^2}{r^2 \lambda^4 \mathrm{N}} CM(1+\cos^2\theta)$$

i_θ: intensity of scattered light at angle θ
I_θ: intensity of scattered light at angle 0
n_o: index of refraction of solvent
n: index or refraction of solution
$\frac{dn}{dC}$: specific refractive index increment, i.e., the change in index of refraction with concentration
r: distance
N:Avogadro's number
λ: wavelength of light
C: concentration
M: molecular weight
θ: scattering angle

4) [4] Why is the ski blue? Because of the equation for $\frac{i_\theta}{I_0}$ above. Scattering is wavelength dependent, blue light (small λ) is scattered more effectively than other colors.

5) [10] Assume brick 1 is at temperature T_1 and brick 2 is at temperature T_2, and that the two bricks can exchange heat and only heat with each other and are otherwise isolated, and that T_1(initial) > T_2(initial). S_1 is the entropy of brick 1 and S_2 is the entropy of brick 2.

a) What is the relationship between T_1(final) and T_2(final)?

   T_1(final) = T_2(final)?

b) What is the relationship between S_1(initial) and S_1(final)?

   Brick 1 cools and so looses entropy: S_1(initial) > S_1(final)

c) What is the relationship between S_2(initial) and S_2(final)?

   Brick 1 heats and so gains entropy: S_2(initial) < S_2(final)

d) What is the relationship between [S_1(initial)+ S_2(initial)] and [S_1(final)+ S_2(final)]?

   For any spontaneous process the total entropy (of the universe) increases: [S_1(initial)+ S_2(initial)] < [S_1(final)+ S_2(final)]

6) [15] The optimum distance for interaction between two atoms is 0.40 nm. The favorable energy of the interaction is 25 kJ/mol at that distance. Assuming a Lennard-Jones 6-12 potential:

a) Estimate the repulsive and dispersive parameters (A & B).

Use $25 = \frac{A}{r^{12}} - \frac{B}{r^6}$

and

$$0 = \frac{-12A}{r^{13}} + \frac{6B}{r^7}$$

b) Will the energy be more unfavorable 0.35 or at 0.45 nm?

   3.5 nm is more unfavorable, because repulsive term has a greater dependence (12th power) on distance than the attractive term (6th power).

7) [15] Estimate the entropy of folding of a six residue peptide to a native state (assume the native state is restricted to a single conformational state).

Use $S = k \ln \omega$, were ω = 1 for folded peptide and ω = 3^n for the random coil (n=# of residues).

8) [6] Sketch a right-handed double helix.