(5)   1.   List five unusual properties of water resulting from its hydrogen
               bonded structure.

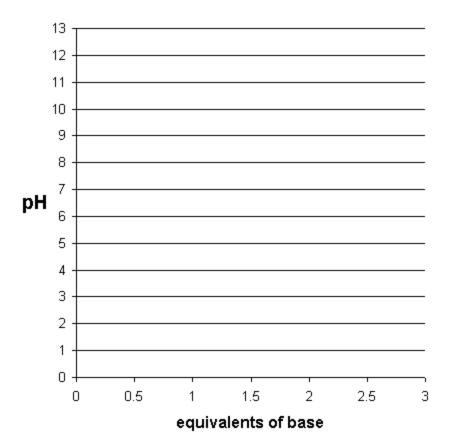| Page	Points
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(5)   2.   Draw a diagram to show how water will interact with an amphipathic molecule such as
               sodium palmitate. What is the name for the structure assumed by the sodium palmitate in
               water?

(12)   3.   You have a solution of 300 mL of 0.30 M acetate buffer with a pH of 4.0. The pK of
               acetic acid is 4.8. To this solution you add 20.0 mL of 1.0 M sodium hydroxide. What is
               the final pH of the solution? (Show your work).

(10)   4.   A glutamic acid side chain residue of the enzyme **lysozyme** is found in a hydrophobic environment, and has a pK of 6.3.

        (a) What is the normal pK for a glutamic acid side chain, and why would the hydrophobic environment cause this change?

        (b) What **fraction** of this side chain will be **protonated** at pH 7.0?

(14)   5.   Draw a titration curve for **lysine** on the graph below.
        (a) Locate and identify the points on the curve corresponding to pK_1, pK_2, and pK_3.
        (b) Calculate the approximate **pI** value and locate its position on the curve.
        (c) Indicate the pH region of the graph in which the **side chain functional group** is **more than** 90% charged.

(7)   6.   Draw the full structure of the following peptide and indicate on the structure the pK of each group with a dissociable proton. Calculate the pI of the peptide.

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(15)   7.   Identify the following amino acids by giving the **name**, the **three letter abbreviation**, and the **one letter abbreviation**. The number of amino acids in each category is given in parenthesis.

Category	Name	Abbreviations
Contains a sulfur atom (2)		
Absorbs UV light above 250 nm (3)		
Contains an amide group in the side chain (2)		
Contains an imidazole group in the side chain (1)		
Contains a guanidinium group in the side chain (1)		
An alpha **imino** acid (1)		

(4)   8.   Peptide A has a pI of 5.5. Peptide B has a pI of 8.5. Put a check by each of the following statements which is true.

____ Both peptides will bind to an anion exchange resin at pH 7.   ____ Peptide A will bind to an anion exchange resin at pH 7.

____ Both peptides will bind to a cation exchange resin at pH 7.   ____ Peptide B will bind to an anion exchange resin at pH 7.

____ Peptide A will bind to a cation exchange resin at pH 7.   ____ Both peptides will bind to an anion exchange resin at pH 4.

____ Peptide B will bind to a cation exchange resin at pH 7.   ____ Both peptides will bind to a cation exchange resin at pH 4.

(4)   9.   Explain what is meant in thermodynamics by an **isolated system**, a **closed system**, and an **open system**. When you study the energetics of a bacterial cell, which type of system are you studying?

(4)   10.   Define **chemical potential**.

(2)   11.   Hydrophobic bonding between non-polar groups is primarily a result of:

____ dispersion forces of attraction between the groups.

____ electrostatic attraction between the groups.

____ an entropy increase in water when the groups associate.

____ an entropy decrease in water when the groups associate.

(2)   12.   A process with a negative entropy change and a positive enthalpy change will be

____ spontaneous at all temperatures.

____ non-spontaneous at all temperatures.

____ spontaneous at high temperatures only.

____ spontaneous at low temperatures only.

Use the following standard free energy of hydrolysis values to answer questions **13 and 14**.

Compound	$¥G^{o'}$ (kJ/mol)	Compound	$¥G^{o'}$ (kJ/mol)
phosphoenolpyruvate	-62	glucose-1-phosphate	-21
acetyl phosphate	-43	glucose-6-phosphate	-14
ATP	-31	glycerol-3-phosphate	-9

(12)   13.   The first reaction glucose undergoes in cells is its conversion to glucose-6-phosphate by the enzyme **hexokinase**, which catalyzes the following process:

glucose   +   ATP $\rightleftarrows$ glucose-6-phosphate   +   ADP

(a)   Calculate $¥G^{o'}$ and **K'** for this reaction as written. (**R = 8.315 J/mol-K. Assume body temperature --37 ^{o}C or 310 K**)

(b)   What would **Q'** and **DG** be for the reaction if the [ATP]/[ADP] ratio were 25 and the [glucose-6-phosphate]/[glucose] ratio were 100?

(4)   14.   Tell whether each of the following reactions is **spontaneous** or **non-spontaneous** as written.

_____ (a)   glucose + glycerol-3-phosphate $\rightleftarrows$ glucose-6-phosphate   +   glycerol

_____ (b)   glucose-1-phosphate $\rightleftarrows$ glucose-6-phosphate

_____ (c)   acetyl-phosphate   +   pyruvate $\rightleftarrows$ acetate   +   phosphoenolpyruvate

_____ (c)   ATP   +   pyruvate $\rightleftarrows$ ADP   +   phosphoenolpyruvate