Chemistry 785 NAME_____
EXAM I
October 15 1997
Answer Sheet

1. (A) (B) (C) (D)
2. (A) (B) (C) (D)
3. (A) (B) (C) (D)
4. (A) (B) (C) (D)
5. (A) (B) (C) (D)
6. (A) (B) (C) (D)
7. (A) (B) (C) (D)
8. (A) (B) (C) (D)
9. (A) (B) (C) (D)
10 (A) (B) (C) (D)
11. (A) (B) (C) (D)
12. (A) (B) (C) (D)
13. (A) (B) (C) (D)
14. (A) (B) (C) (D)
15. (A) (B) (C) (D)

Table of pKa values

Amino Acid	**pK_1**	**pK_2**	**pK_R**	**Amino Acid**	**pK_1**	**pK_2**	**pK_R**
Alanine	2.4	9.8		Leucine	2.3	9.7	
Arginine	1.8	9.0	12.5	Lysine	2.2	9.1	10.5
Asparagine	2.1	8.7		Methionine	2.1	9.3	
Aspartic Acid	2.0	9.9	3.9	Phenylalanine	2.2	9.3	
Cysteine	1.9	10.7	8.4	Proline	2.0	10.6	
Glutamic Acid	2.1	9.5	4.1	Serine	2.2	9.2	
Glutamine	2.2	9.1		Threonine	2.1	9.1	
Glycine	2.4	9.8		Tryptophan	2.5	9.4	
Histidine	1.8	9.3	6.0	Tyrosine	2.2	9.2	10.5
Isoleucine	2.3	9.8		Valine	2.3	9.7	

Name _____

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INSTRUCTIONS

- *The questions for Part I are to be answered on the cover sheet. Your grade for this section will be determined only from the cover/answer sheet.*

- *Answers for Part II should be answered directly in the space given. Partial credit will be given on this part of the exam so remember to SHOW ALL WORK.*

- *PRINT your name on EACH of the exam pages in the designated space.*

PART I (45 points)

-For each of the following questions, circle the one answer that best fits the description. More than one answer per question will receive no points. Blacken the letter of the answer on the cover sheer as you go. Make sure that your circled answers on the exam agree with those on the COVER sheet. Each question is worth 3 points.

1. Phosphoric acid is tribasic with pK_a's of 2.14, 6,86 and 12,4. The ionic form that predominates at pH 3.4 is:

A) H_3PO_4 ***B)*** **$H_2PO_4^-$** *C)* HPO_4^{2-} *D)* PO_4^{3-}

2. Consider an acetate buffer, initially at a pH that is equal to the value of its pK_a (4.76). When sodium hydroxide is mixed with this buffer:

A) pH remains constant.
B) pH rises more that when an equal amount of NaOH is added to distilled water at pH 4.76.
C) **the ratio of acetic acid to sodium acetate falls.**
D) pH rises more than when an equal amount of NaOH is added to an acetate buffer at pH 6.76.

3. If 100 mL of 0.1 M NaOH is added to 55 mL of 0.2 M lactic acid (pKa = 3.9), the resulting mixture will have a pH near:

A) 3 *B)* 4 ***C)*** **5** *D)* 6

Name _____

4. Three buffers are made by combining a 1 M solution of citric acid with a 1 M solution of sodium citrate in the ratios given below:

	1 M citric acid	1 M sodium citrate
Buffer 1	10 mL	90 mL
Buffer 2	50 mL	50 mL
Buffer 3	90 mL	10 mL

Which of these statements is true of the resulting buffers?

A) **pH of buffer 1 > pH of buffer 2 > pH of buffer 3**

B) pH of buffer 1 = pH of buffer 2 = pH of buffer 3

C) pH of buffer 1 < pH of buffer 2 < pH of buffer 3

D) the problem cannot be solved without knowing the value of pK_a.

5. In an aqueous solution of pH = 7.0, the amino acid glutamine would be expected to be:

A) **a fully ionized zwitterion with no net charge.**

B) a net positive ion due to protonation of the R group nitrogen.

C) a net negative ion due to deprotonation of the R group nitrogen.

D) a totally neutral molecule with no net charge.

6. For amino acids with neutral R groups, at any pH below the pI of the amino acid, the population of amino acids in solution will:

A) have positive and negative charges in equal concentration.

B) show no net charge.

C) **have a net positive charge.**

D) have a net negative charge.

7. Titration of leucine by a strong base results in two pK_a values. The titration that occurs at pK_2 is:

A) $\text{-COOH} + \text{OH}^- \longrightarrow \text{-COO}^- + \text{H}_2\text{O}$

B) $\text{-COOH} + \text{-NH}_2 \longrightarrow \text{-COO}^- + \text{-NH}_3^+$

C) $\mathbf{\text{-NH}_3^+ + \text{OH}^- \longrightarrow \text{-NH}_2 + \text{H}_2\text{O}}$

D) $\text{-NH}_2 + \text{OH}^- \longrightarrow \text{-NH}^- + \text{H}_2\text{O}$

8. An octapeptide (GLY-ALA-GLY-ALA-GLY-ALA-GLY-ALA) has:

A) two free amino and two free carboxyl groups.

B) a single free amino group on an alanyl residue.

C) a single free amino group on an alanyl residue and a single free carboxyl group on a glycyl group.

D) **a single free amino group on a glycyl residue and a single free carboxyl group on an alanyl residue.**

Name _____

9. What will be the net charge of the tripeptide, LYS-HIS-TYR at pH 7.0?

A) **+1** *B)* 0 *C)* -1 *D)* -2

10. Amino acids commonly found in turns and loops are:

A) ALA and GLY.
B) **PRO and GLY.**
C) two CYS.
D) those with ionizable R groups.

11. Which of the following does not formally define one of the four (4) major levels of protein structure?

A) complete conformation of oligomeric (multiple subunit) proteins.
B) amino acid sequence
C) three dimensional conformation of a polypeptide chain.
D) **regular repeating structures that do not necessarily occur on consecutive sequences of the polypeptide chain**

12. Proteins have regions that show specific patterns of folding or function. These regions are called

A) **domains** *B)* sites *C)* subunits *D)* motifs

13 The dihedral angle Φ, describes the rotation about which bond?

A) peptide bond *B)* C_α - C(O) ***C)*** **N - C_α** *D)* C_α - R

14. In an α-helix, the R groups in the amino acid residues:

A) **are found on the outside of the helix spiral.**
B) generate the H-bonds that form the helix.
C) stack within the interior of the helix.
D) cause only right-handed helices to form.

15. Which of the following groups correctly shows intrachain hydrogen bonding (|||) in an β-sheet?

A) -N-H ||| H-N-
B) -C=O ||| H-C-
C) **-C=O ||| H-N-**
D) -N-H ||| H-R-

Name _____

Part II (60 points)

- Answers for Part II should be answered directly in the space given. Partial credit will be given on this part of the exam so remember to SHOW ALL WORK.

1. For a weak acid with a pK_a of 6.0, calculate the ratio of conjugate base to acid at a pH of 5.0.

pH = pKa + log $[A^-]/[HA]$

5.0 = 6.0 + log $[A^-]/[HA]$

-1 = log $[A^-]/[HA]$

0.1 = $[A^-]/[HA]$

2. Give the full name for the tripeptide, LYS-CYS-GLY, and determine its pI.

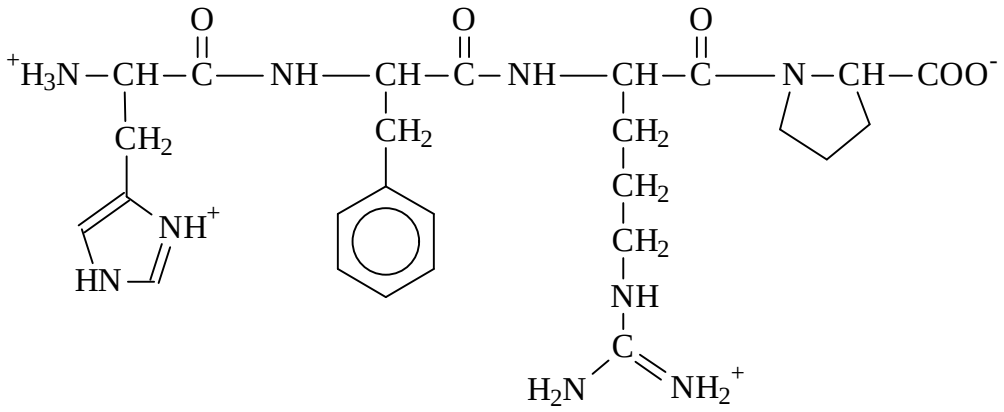
lysinylcysteinylglycine

pK(N) = 9.1
pK(Lys-R) = 10.5
pK(Cys-R) = 8.4
pK(C) = 2.4

At pH of 1, charge is +2; at pH of 2.4, charge is +1.5; at pH of 8.4, charge is +0.5 and at a charge of 9.1, charge is -0.5. Therefore pI is average of 8.4 and 9.1 = 8.75.

Name _____

3. Draw the structure of the tetrapeptide, HIS-PHE-ARG-PRO at a pH of 2.0. What would be the net charge of this peptide at pH = 7?



charge at pH 7 would be +1.

4. Name four factors (bonds or other forces) that contribute to stabilizing the native structure of a protein and describe one way in which each can be disrupted.

covalent bonds-thiol reducing reagents
hydrogen bonds- chaotropic agents
Van der Waals forces - heat, organic solvents
ionic interactions - high salt/ionic strength
hydrophobic interactions - detergents, heat

Name _____

5. A biochemist is trying to separate a DNA-binding protein (protein X) from other proteins in a solution. Only three other proteins are present (A, B, and C). The proteins have the following properties:

	pI	M_r	binds to DNA?
protein A	7.4	82 kDa	yes
protein B	3.8	21.5 kDa	yes
protein C	7.9	23 kDa	no
protein X	7.8	22 kDa	yes

What type of separation techniques might be used to separate:

a) protein X from protein A?

size exclusion chromatography

b) protein X from protein B?

isoelectric focusing

c) protein X from protein C?

DNA-affinity chrmatography

6. Draw the structure of the following protein chain segment (ASP-SER-ALA-PHE-ILE-ASN) and clearly show where you expect to see an example of intrachain hydrogen bonding if this segment were part of an α-helix.