

YOUR NAME: _____

NOTES:

1. where appropriate please show work - if in doubt show it anyway.
2. pace yourself - you may want to do the easier questions first.
3. please note the point value of questions - adjust your answers and effort accordingly.
4. some questions may have more data than you need.
5. please be brief - unfocused, rambling answers won't receive as much credit as a few short appropriate phrases.
6. Please write CLEARLY - if I cannot read it - it is wrong.
7. Good luck

Question 1. (21 pts.) Short problems. Show work, but most credit goes to the correct numerical answer.

a. the pH of a solution is 4.7. What is the hydroxide concentration?

$[\text{OH}^-] = \underline{\hspace{2cm}} \text{M}$

b. You mix 300 mL of 10 mM KOH with 700 mL of 5 mM HCl.
What is the pH of the mixture?

pH =

c. You add 0.5 mmol of formic acid ($\text{pK} = 3.70$) in 250 mL of water to 20 mmol of lithium formate in 250 mL of water. What is the new pH?

pH =

d. In part "c" calculate the pH of the 250 mL of formic acid before the lithium formate was added.

pH =

e. A solution of 0.2 moles of lactic acid in 2 L of water showed a pH of 2.4. What is the pK of lactic acid.

$\text{pK} = \underline{\hspace{2cm}}$

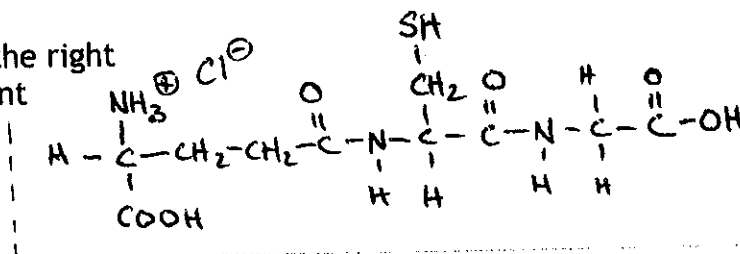
f. If you add 0.1 moles of sodium hydroxide to a solution of 0.25 moles of acetic acid ($\text{pK} = 4.7$) in 1 L what is the resulting pH?

pH =

- g. Human insulin contains 3 disulfide bonds and no free cysteine side chains. How many possible combinations of disulfide bridged insulin molecules exist?

Number = _____

Question 2. (15 pts) The molecule shown to the right is called glutathione. It is crucial for antioxidant properties of mammalian cells.



- a. What is unusual about its structure? _____
- b. Assume pK of 9.5 for the amino group, 8.5 for the -SH group and 3 for the carboxyl groups give the net electrical charge on glutathione at

pH = 1 _____ pH = 7 _____ pH = 12 _____

- c. You have 0.3 moles of glutathione as shown above. How much KOH needed to get to:

pH = 8.5 _____ mol pH = 9.5 _____ mol

- d. Two molecules of glutathione can form a **disulfide-linked** dimeric molecule. What is the charge on the dimer at the following pH values:

pH = 1 _____ pH = 12 _____

- e. Name and draw a specific chemical reagent you might use to convert the dimer back to monomers

- _____

- g. Draw the chemistry involved in your answer in f.

Question 3. (7 pts.) write out the 3 letter amino acid abbreviations for the sequence

-MARY- : - _____

- a. What is the chance that the sequence -MARY- would appear in any 4 adjacent amino acid residues in a protein?

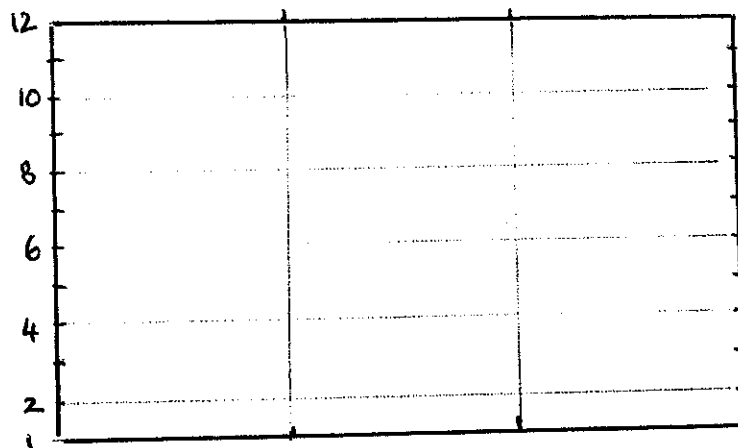
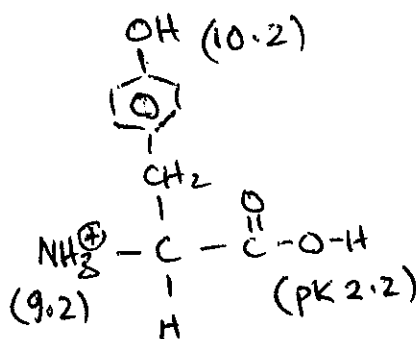
Answer = _____

- b. If each amino acid had 4 possible pairs of phi/psi angles, how many possible combinations of the 3 dimensional shape of this peptide exist?

Combinations = _____

Question 4. (6 pts) Draw the tripeptide ASP-PHE-LYS in the form that predominates at pH 5. Assume the following pK values terminal amino and carboxyl 10 and 2 respectively, side chain carboxyl 4 and amino group 11.

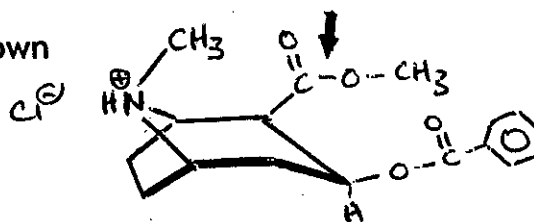
Question 5. (8 pts) Tyrosine is shown to the left. At the right draw a clear titration curve of tyrosine. CLARITY and ACCURACY rewarded.



The listed amounts of KOH were added to 0.2 moles of tyrosine in the form shown. Show what pH would result.

0.5 moles _____ ; 0.2 moles _____ ; 0.1 moles _____ ; 0.3 moles _____

Question 6. (7 pts.) Cocaine hydrochloride is shown to the right and has a pK of 5.6. Cocaine is dissolved in buffers of pH 3, 5 and 8.



Which would provide the faster absorption into a biological membrane? pH = _____

Which pH (3, 5 or 8) would you expect cocaine to be most soluble? pH = _____

What happens to the pK of the amino group if cocaine goes from water into a hydrophobic solvent? Circle one answer:

It remains the same it increases it decreases cannot predict

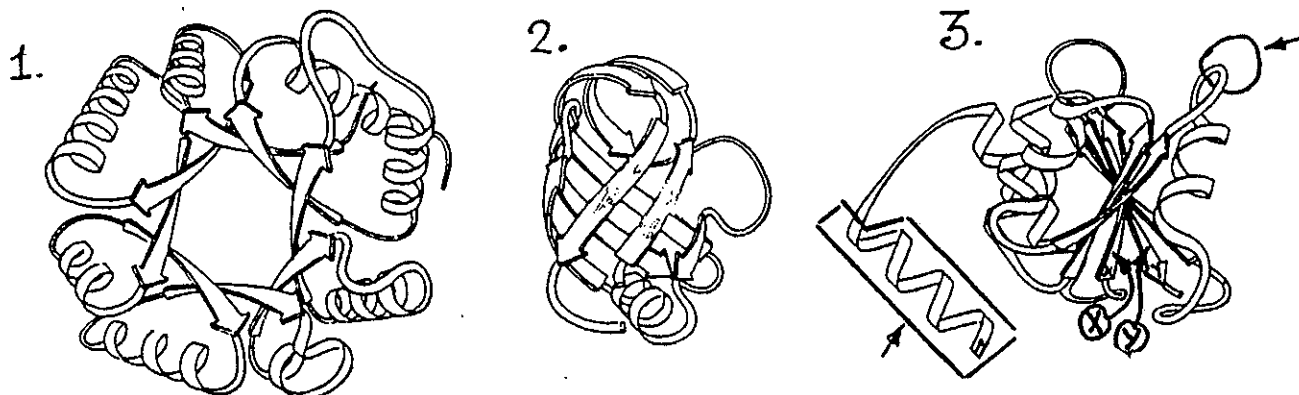
Hydrolysis of the ester linkage shown by the arrow in the diagram generates an acid derivative with a pK of 3.0. The new rate of absorption of the derivative would be _____ than cocaine at the same pH:

At pH = 3: faster slower unchanged (circle)

At pH = 5: faster slower unchanged

At pH = 8: faster slower unchanged

Question 7. (14 pts) the following domains are found in the enzyme pyruvate kinase:



- In domain 1 - clearly label the N and C termini.
- In domain 3 - draw a short stretch of the two adjacent polypeptide chains labeled X and Y. Use R- to represent the side chains, but otherwise include all atoms in your drawing. Clearly indicate the H-bonds stabilizing this secondary structure.

(domain 3)
X and Y are part of what type of structure? _____

How many amino acids would you expect in the boxed in area of domain 3

Number: _____

Which amino acid would you least expect in the middle of this section _____

Name the structural element circled in domain 3 _____

Domain 2 has many lysine and arginine residues - but it is not attacked by trypsin treatment. Suggest a reason why.

Question 8. (7 pts.) From the following 8 peptides (A-H) select a single letter for each question. You may use letters more than once.

A TRP-LEU-LYS B LYS-THR-GLY C GLU-CYS-MET D GLU-ASP-ARG
E ALA-LYS-ARG F PHE-THR-GLU G PHE-ARG-PRO H MET-PHE-LEU

Which peptide has the largest absorbance at 280 nm _____

Which peptide is the most positively charged at pH 6 _____

Which peptide has approximately no charge at pH 6 _____

Which peptide could be fragmented by CNBr (cyanogen bromide) _____

A peptide resistant to trypsin and chymotrypsin _____

The most polar peptide at pH 7 _____

This peptide tends to dimerize on standing _____

Question 9. (6 pts) Using the table, answer the following. None of the protein contained disulfide bonds

Protein	overall molecular weight	pI	# subunits
A	45,000	4	2
B	90,000	3	1
C	15,000	9	1
D	160,000	7	4

a. the protein sticking tightest to a positively charged resin at pH 8 _____

b. the protein sticking tightest to a negatively charged resin at pH 7 _____

c. The protein running slowest on SDS-PAGE _____

d. The protein with the largest proportion of (ASP + GLU) compared to (LYS + ARG) _____

e. The protein that emerges slowest on gel filtration _____

f. The protein that comes out first on gel filtration _____

Question 10 (pts.) Fill in the blanks with not more than 3 legible words.

- a. these catalysts aid folding of large proteins _____
- b. the amino acid obligatorily present at every 3rd position in collagen _____
- c. A shell of ordered water around an organic molecule is called _____
- d. Plots of the frequency of phi/psi angles in proteins are called _____
- e. An example of a protein toxin _____
- f. A vitamin required for collagen maturation _____
- g. A method for determining 3D structure without crystals _____
- h. The name of the most commonly used protein sequencing method _____
- zz. the word that best describes this exam _____

the end