Two Q8 & Q9
answer all

CHEM 527
Final exam, Fall 2006

Disregard (Id) ☐

☐ **NAME** Key

9b is conc. of ent (not amount)

9c 1 M formic ☐

NOTES:

Second I

1. Please stay calm.
2. Where appropriate, show work to receive full credit.
3. This exam contains 11 pages + metabolic charts (*detach gently, please*).
4. Pace yourself - you may want to do the easiest questions first.
5. Note the point value of questions varies widely - adjust your answers accordingly.
6. Please give concise answers - if there isn't much space allotted - a short answer is appropriate.
7. Questions may have more data than needed to tackle the problem.
8. PLEASE write clearly. If I cannot read it .... it is wrong.
9. As mentioned you are allowed to refer to a single piece of 8.5 x 11" paper during this exam. It can feature any material distributed over both sides.

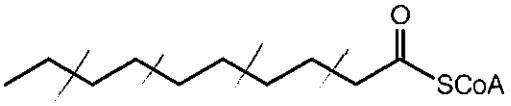
Question 1 (10 pts) Yield of ATP. In the space provided give the yield of ATP (or equivalent e.g. GTP) that would be formed in the following processes:

a. per molecule of glucose completely oxidized to CO_2 and water 30

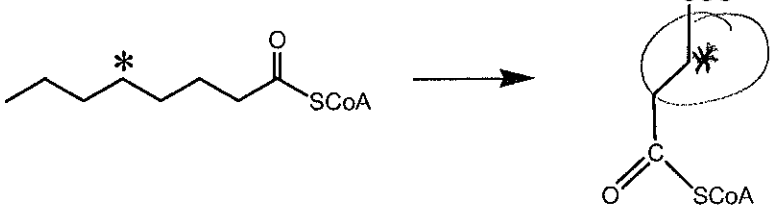
b. per isocitrate in the presence of arsenite 2.5

c. per molecule of ethanol converted to CO_2 [redacted]

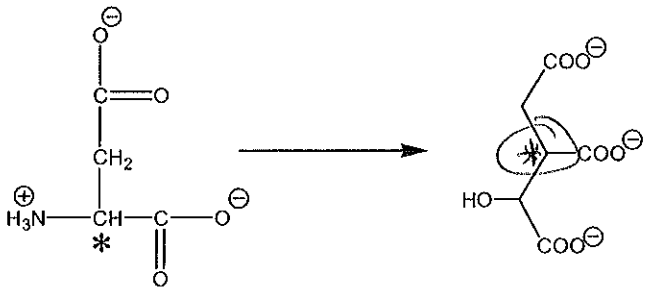
d. per molecule of alanine completely oxidized to CO_2 and water (disregard the costs of the urea cycle) disregard (12.5 + 2.5)

e. per  4×4 = 16, 5×10 = 50 to CO_2 and water 66

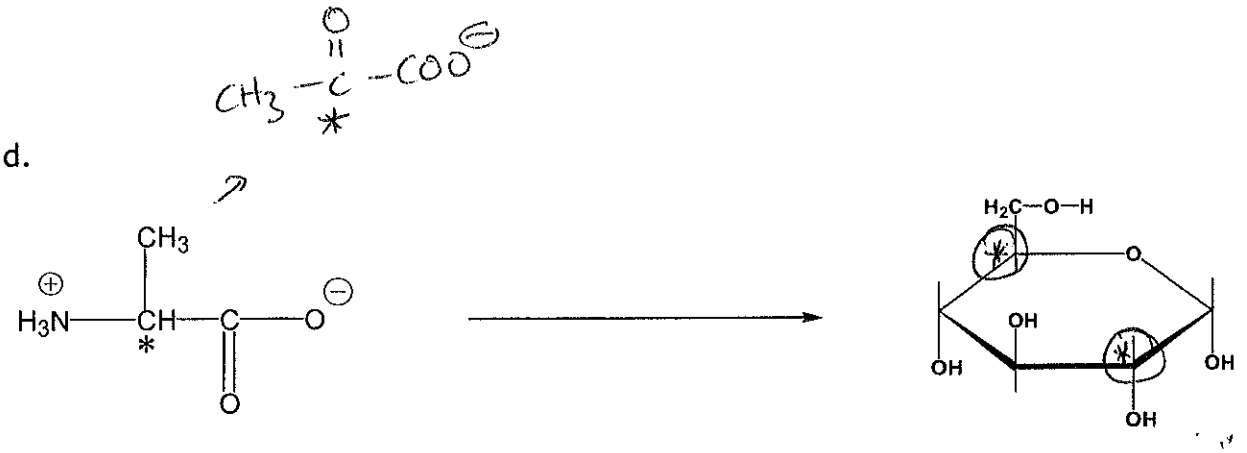
Question 2 (12 pts) Tracing radiolabels. Place asterisks indicating the position of the radiolabel in the molecules shown to the right - if the product contains no radiolabel write **"NONE".** 3ea

a. 

b. 

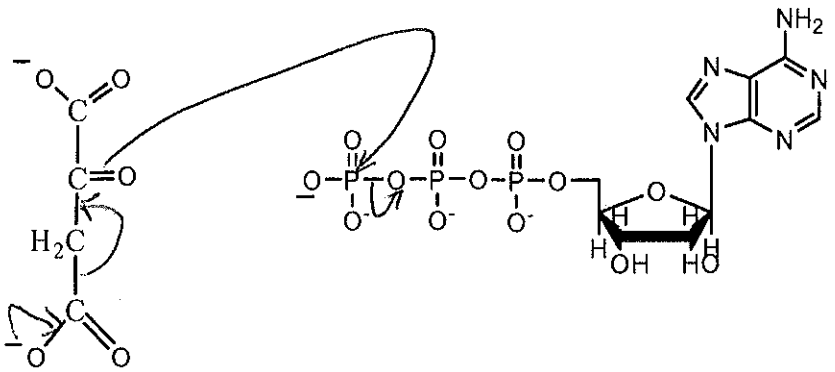
c. 

d.



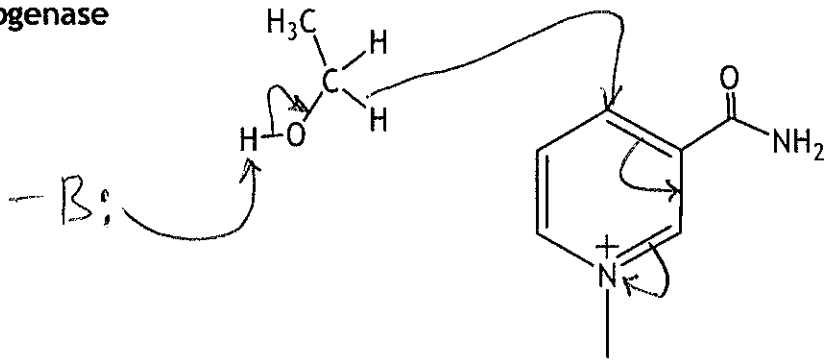
Question 3 (7 pts) Fill in the initial series of curved arrows that start the reactions of the following enzymes. The curved arrows should make chemical sense. Don't draw any more structures.

a. PEP carboxykinase



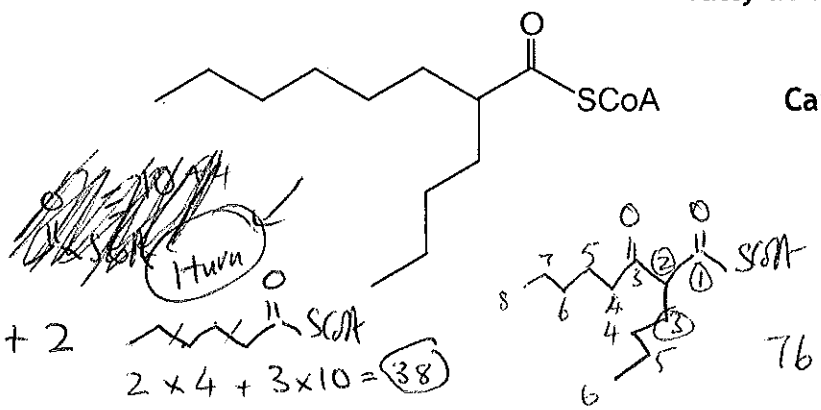
3

b. Alcohol dehydrogenase



4

Question 4. (4 pts). Assume that this molecule can be converted to CO_2 and water via fatty acid oxidation and the TCA cycle.



Calculate the yield of ATP per molecule

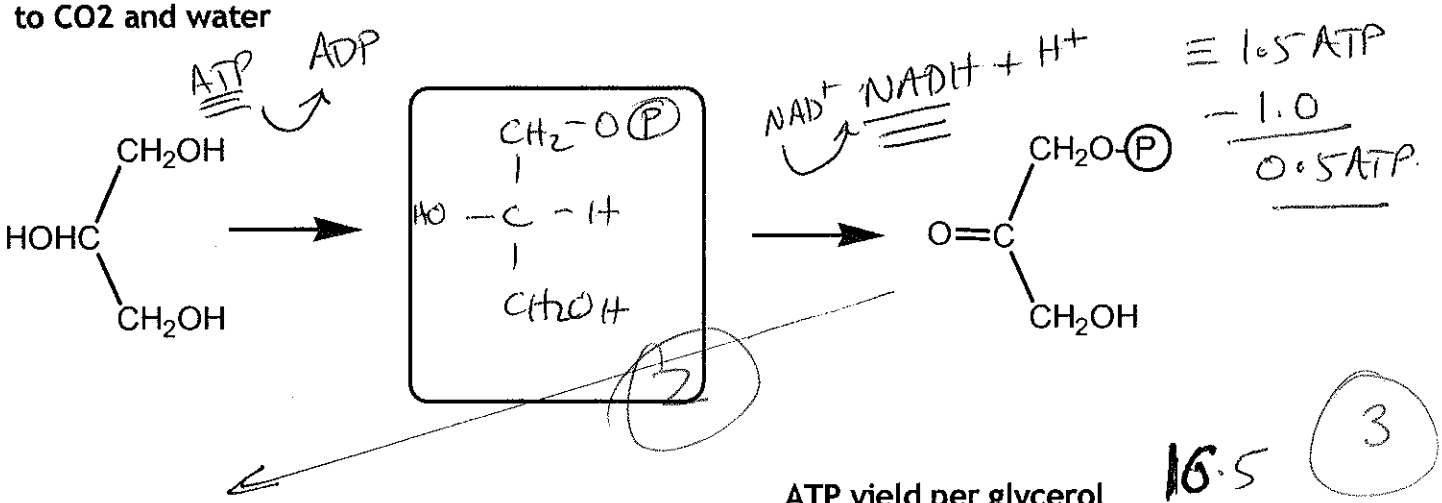
4

80 ATP

3

Assume cytoplasm

Question 5 (5 pts) Glycerol (shown) can be converted to the molecule at the right. In the central box place one LOGICAL 3 carbon-containing intermediate. Then taking into account all cofactors needed, calculate the ATP yield per molecule of glycerol converted to CO2 and water



≡ 1.5 ATP
− 1.0
0.5 ATP

2

3

ATP yield per glycerol 16.5

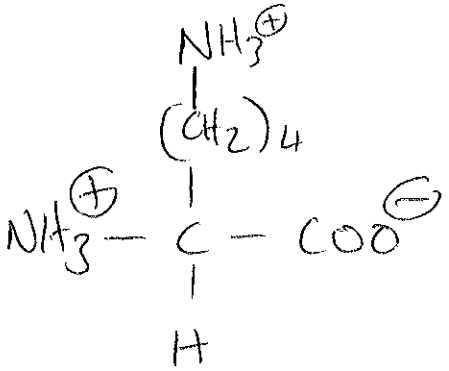
pyr. ≡ 1.5 + 2 ATP ≡ 3.5 ATP

Question 6 (7 pts) Which of these molecules would you expect to counteract ketosis (high levels of ketone bodies) when supplied in a cell? Circle all that apply.

Glucose 1	Acetate	Alanine 1	Aspartic Acid 1
Acetyl-SCoA	Cholesterol	Fatty acids	Lactose
? Hypoglycin 1	Ethanol	Beeswax	Succinyl-SCoA 2

−1 for each incorrect

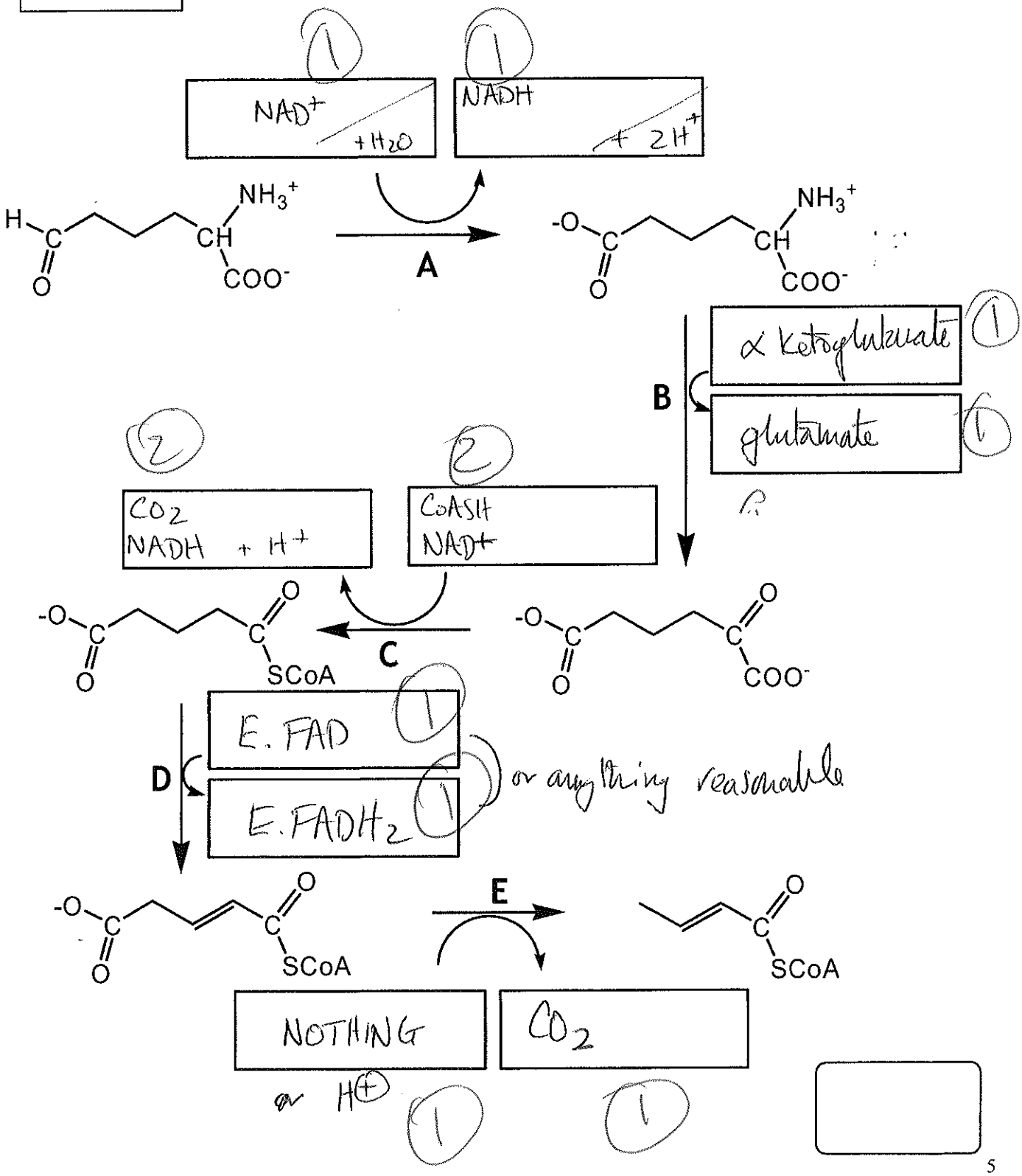
Question 7 (14 pts). (see also next page). Draw the structure of lysine below in the form that predominates at pH 6; (pK 2.1, 9.0, 10.5_{R-})



2

Question 7 (cont.) The following is part of the degradation pathway for LYSINE. Reason by analogy to **clearly indicate in the boxes every <u>substrate and product</u> missing for each reaction A-E. Don't put enzyme names - a hypothetical example for one box is shown below). If nothing is needed in the box put "NONE".**

NADH, H_2O, CO_2



Question 8 (16 pts) Place in the space provided a single number from 0 - 100. Number are the only valid answer.

a. In the biosynthesis of glucose from lactate, ATPs needed per glucose 6

b. In the pentose phosphate pathway 6 pentoses become ___ hexoses 5

c. The complete oxidation of ethanol generates how many molecules of CO_2 2

d. What intermediate of the TCA cycle would accumulate at low flavin levels 3

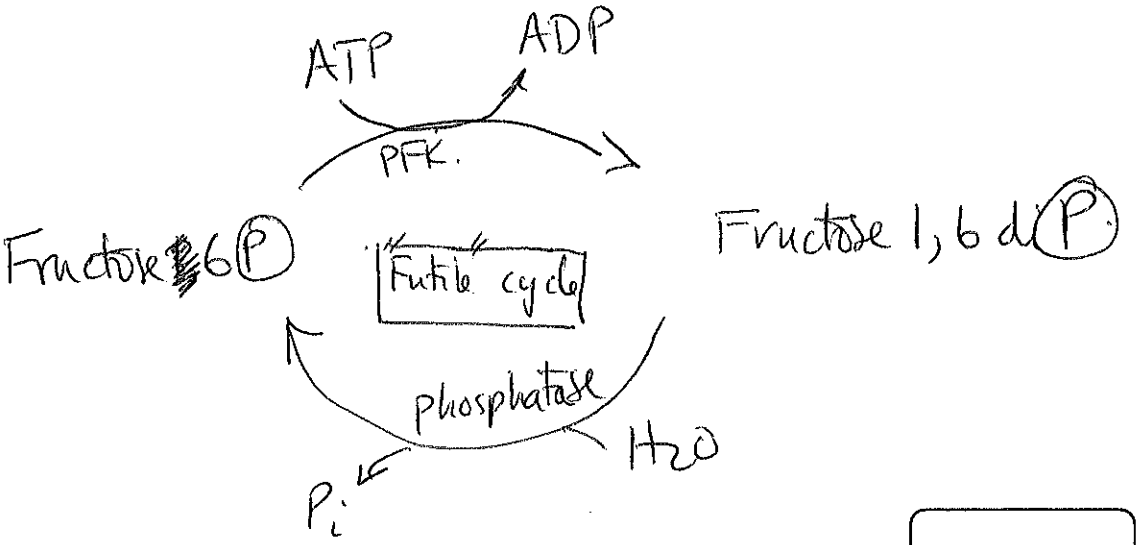
e. An aldotriose derivative in glycolysis (the number) 6

f. The number of phosphate groups in coenzyme A 3

g. placing a molecule of glucose on the growing end of a glycogen molecule costs how many ATP equivalents? 2

h. The number of electrons required to reduce one oxygen molecule to water 4

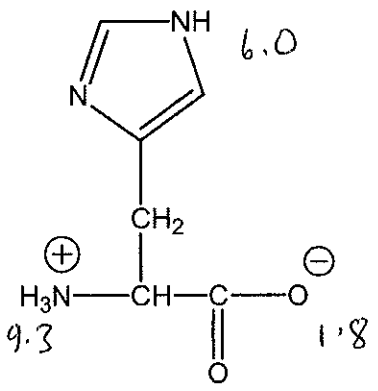
Question 9 (4 pts) Draw a simple accurate picture of one "futile cycle" in biochemistry. If it is not clear it will not receive credit.



overall :-

$ATP + H_2O \rightarrow ADP + P_i$

Question 8 (6 pts) The structure of <u>one form</u> of histidine is shown at the right. (pK 1.8, 9.3, 6.0$_{R}$)



You have 0.2 moles of histidine in the form shown at the right.

How much KOH or HCl (circle as appropriate) in moles do you need to take the original 0.2 moles to a pH of:

9.3 0.1 (KOH) or HCl (circle one) 2

6.0 0.1 KOH or (HCl) (circle one) 2

1.8 0.3 KOH or (HCl) (circle one) 2

Question 9 (28 pts). Short problems. Most of the credit goes for the correct numerical answer

a. **The osmotic pressure of a 1 mM solution of a monomeric protein in water (the protein sequence has 120 amino acids) is 0.024 atmospheres. Then a series of proteases are added to the solution (a negligible volume increase occurred) and all of the peptide bonds were broken.**

New osmotic pressure 2.88 **atm**

0.024 (atm) × 120 mM =

4

X

b. **10 nM of an enzyme converts 2.0 µmol of substrate to product/min at 25 °C. The substrate concentration is 10 mM and the Km for this substrate is 25 mM. What is the ~~amount~~ concentration of enzyme required to attain a rate of 4.0 µmol/min**

Enzyme amount 20 nM **µmol**

4

1.0 M

c. You add 0.2 moles of KOH to 0.8 L of ~~0.5~~ M formic acid (pK 3.7). What is the pH of the mixture?

pH = 3.22

$$\frac{0.8 \text{ moles formic acid}}{0.2 \text{ moles KOH}} \quad \text{pH} = 3.7 + \log \frac{0.2}{0.6}$$

0.6 moles formic + 0.2 moles formate

3

d. the concentration of oxygen dissolved in 1L of buffer in equilibrium with air is 0.24 mM. You then add 14 g of myoglobin and stir gently in air until equilibrium is reached. What is the total concentration of oxygen (free and bound) now carried in the solution. (MW oxygen 32, myoglobin, 16,700, water 18).

$\frac{14g}{16{,}700 g/mole} = 8.38 \times 10^{-4} M \equiv$ myoglobin conc

$[O_2] = 2.4 \times 10^{-4} M$

3

[total oxygen] = 1.078 mM $1.078 \times 10^{-3} M$

[free oxygen concn.] = 0.24 mM

e. Mootase (30 µg) catalyzes the breakdown of 7 µmol of product formation per minute at room temperature. The molecular weight of the enzyme is 35,000 g/mol, the substrate 350 g/mol and the product 350 g/mol. What is the turnover number of Mootase?

Turnover number 8167 /min

$\frac{7 \times 10^{-6} \text{ mol/min}}{30 \times 10^{-6} g / 35000 g/mole}$

3

f. the $\Delta G^{o'}$ of reaction A $\leftrightarrow$ B is + 2 Kcal/mole. If reactant A is maintained at 0.1 M what concentration of B accumulates at equilibrium? Assume temp. of 37 °C and R=2 cal/mole.

[B] = 5.95×10^{-5} M

$0 = 2000 + (273+37) \times 2 \times \log\left(\frac{[B]}{[0.1]}\right)$

$\left(\frac{[B]}{0.1}\right) = 5.95 \times 10^{-4}$

$[B] = 5.95 \times 10^{-5}$ M

3

g. a negligible volume of aldolase was added to 0.02 M fructose-1,6-diP and, at equilibrium, the concentration of fructose-1,6-diP declined by 10^{-3} M. Calculate the equilibrium constant for the aldolase reaction:

$\frac{[.001][.001]}{[.019\ M]} =$

$K_{eq} = 5.26 \times 10^{-5}$ M

3

h. Thyroglobulin is a large single polypeptide chain containing 2769 amino acids (4.4% of them are cysteine). If all the cysteines form intramolecular disulfides, how many pairings are possible? Circle most appropriate answer.

<10^3 about 10^8 about 10^{20} about 10^{40} >10^{40}

3

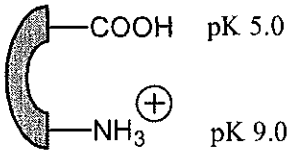
$2769 \times .044 \cong 122$ cysteines

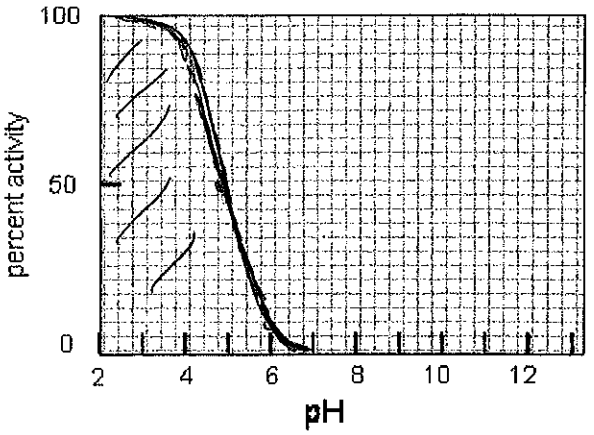
$121 \times 119 \times 117 \times 115 \times 113$ etc ....

Question 10 (6 pts) Graphs. Draw clear accurate graphs to describe the behavior of the following systems. Clarity and accuracy rewarded.

a. only this form of the enzyme show below is active.

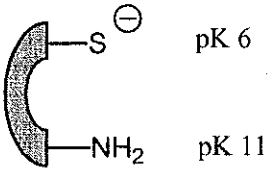
3 ea

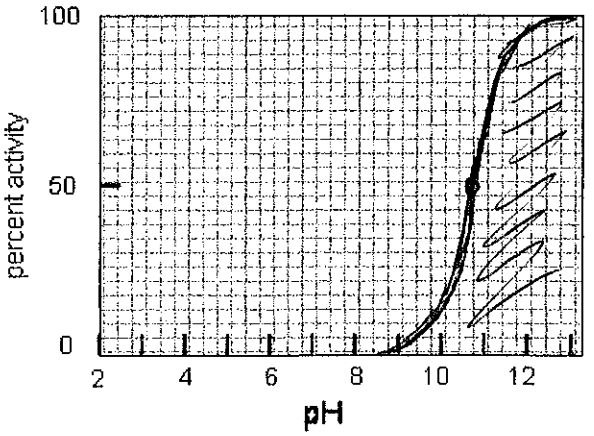




b. only this form of the enzyme show below is active.

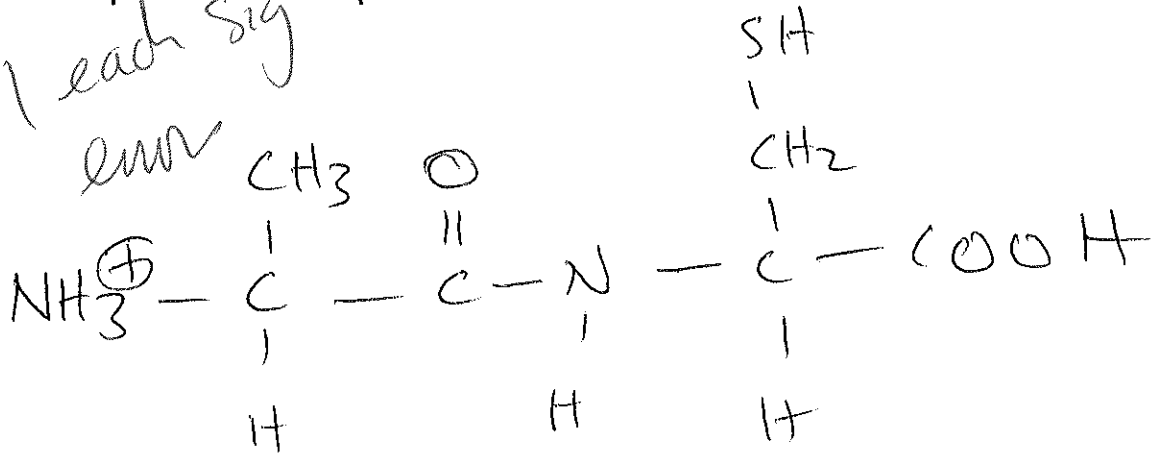
3 ea





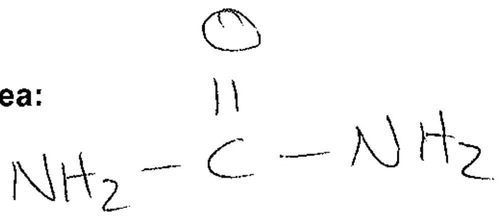
Question (6 pts) Draw a clear representation of the dipeptide ALA-CYS in the form that predominates at pH 1.

-1 each sig error



Question (8 pts) Structures. Show the complete chemical structures of the following (each mentioned in class):

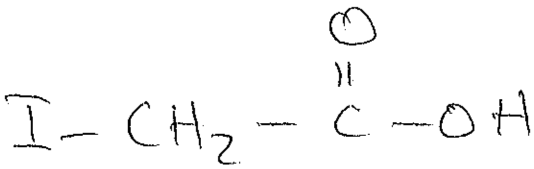
urea:



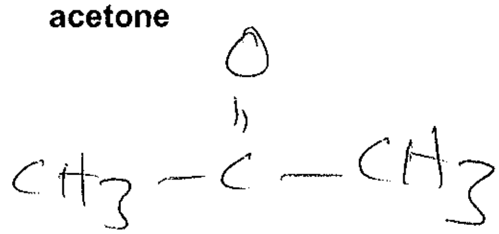
Zea

beta-mercaptoethanol

iodoacetic acid



acetone



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The end of CHEM527 for Fall MMVI. Bon voyage !