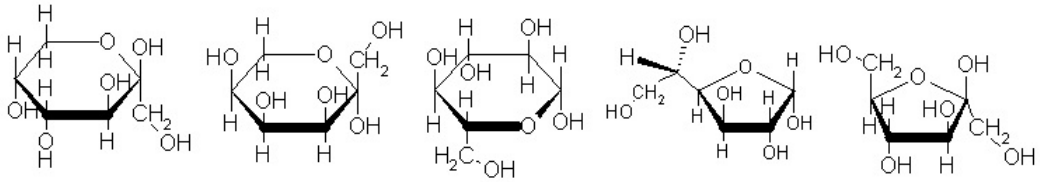
Use these structures as answers for the following questions



[I] [II] [III] [IV] [V]

βDfruct-pyr **β** Lcetose **β** Dglu **β** Lald rlr **β** Dfructo fur no αs!

21. ..... are aldoses

A) [I], [II], [III] B) [III] , [IV] C) [IV] , [V] D) [I] , [II] E) [I] , [V]

22. ..... has the L-configuration

A) [I], [V] B) [II] , [III] C) [II] , [IV] D) [II] , [V] E) [III]

23. Sugar [I] has a prochiral carbon at position :

A) 1 B) 1, 2, 6 C) 1, 6 D) 2, 3, 4 E) 5

24. Sugar [I] is :

A) Glucose
B) Fructose
C) Mannose
D) An L-sugar but not one to know by heart
E) A D-sugar but not one to know by heart

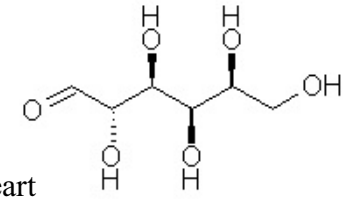
25. Sugar [IV] is :

A) Glucose
B) Fructose
C) Mannose
D) An L-sugar but not one to know by heart
E) A D-sugar but not one to know by heart

26. In solution, mutarotation will give the other anomeric form of :

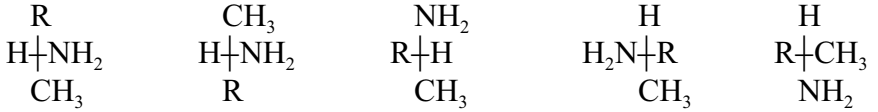
A) [I], [II], [III] B) [IV] , [V] C) [I], [II], [III] , [V]
D) All of these structures E) None of these structures

27. The molecule on the right is:



A) D-glucose
B) L-mannose
C) D-galactose
D) An L-sugar but not one of the ones to know by heart
E) A D-sugar but not one of the ones to know by heart

28. The enantiomer/s of (I) is / are :



(I) (II) (III) (IV) (V)

A) II B) III C) IV D) IV et V E) II, III, IV et V

29. If you had 3 mg of sugar in 10 ml of your blood, your blood sugar would be :

A) 4 times normal B) 2 times normal C) normal D) 1/3 normal E) You would be dead

30. Approximate size of a prokaryotic cell :

A) 100 nm B) 2 µm C) 25 µm D) 300 µm E) 4,000 µm

31. An acid has a dissociation constant of $2\ 10^{-8}$. Its pK will be about:

A) 7.7 B) 8.0 C) 8.3 D) 8.6 E) 8.9

32. UV light has a wavelength that is shorter than :

A) 100 nm B) 400 nm C) 800 nm D) 1.2 µm E) 1.6 µm

33. You plan a scuba dive to the Andrea Dorea (a famous wreck that is 100 m down in the ocean). When you are on the bottom you will be breathing gas that is at a pressure of about :

A) 3 Atm B) 4 Atm C) 6 Atm
D) 8 Atm E) 10 Atm

34. Acetic acid has a pK of 4.75. One will have a pH of 3.75, for a solution that contains:

A) 11 mM acetic acid
B) 1 mM acetic acid and 10 mM sodium acetate
C) 5 mM acetic acid and 5 mM sodium acetate
D) 10 mM acetic acid and 1 mM sodium acetate
E) 11 mM sodium acetate

35. You take in a lot of nitrogen every day as protein. The extra nitrogen leaves your body as

A) amino acids B) ammonia C) ammonium carbonate
D) urea E) excreted proteins

36. You have prepared a 5mg/ml protein solution in 0.5 M salt. To remove the salt, you seal 10 ml of the protein in a dialysis bag and you dialyse it against 1 L of water. At the end of your dialysis the salt concentration in the dialysis bag will be about :

A) 0.055 M B) 50 mM C) 5 mM D) 0.55 mM E) less than 5uM

37. Hyperventilation is a physiological mechanism to:

A) lower [CO_2 (g)] in the blood and increase blood pH.
B) raise [CO_2 (g)] in the blood and increase blood pH.
C) lower [CO_2 (g)] in the blood and decrease blood pH.
D) raise [CO_2 (g)] in the blood and decrease blood pH.
E) lower [CO_2 (g)] in the blood and increase the pK

38. At pH 1, the ratio of H^+ to H_2O is about: :

A) 1 / 500 B) 1 / 50,000 C) 1 / 5,000,000 D) 1 / 50,000,000 E) 1 / 500,000,000

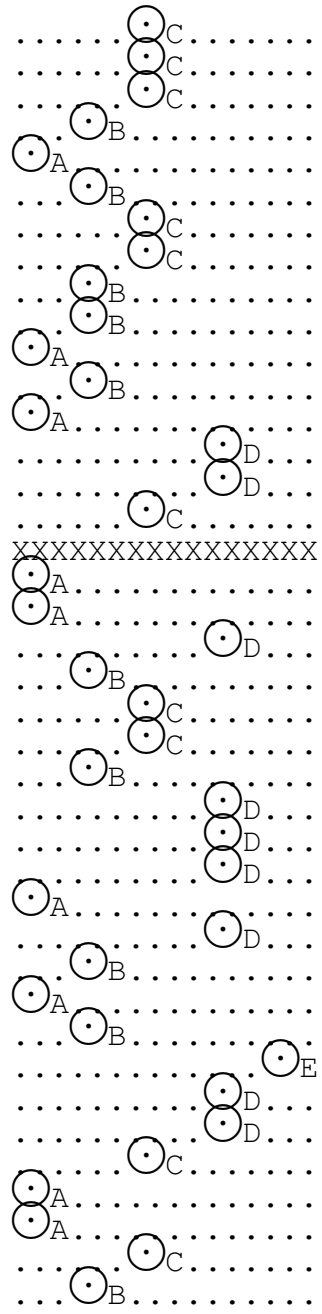
39. In blood the concentration of hydrogen ions is about :

A) 0.4 mM B) 4 µM C) 40 nM
D) 0.4 nM E) 4 pM

40. The pH of 1 mL of 20 mM acetate buffer is 4. For this problem use a pK of 4 for acetic acid. When 5 microlitres of 1 N HCl are added to this solution, the pH will be about :

A) 3.9 B) 3.5 C) 3 D) 2.7 E) 2

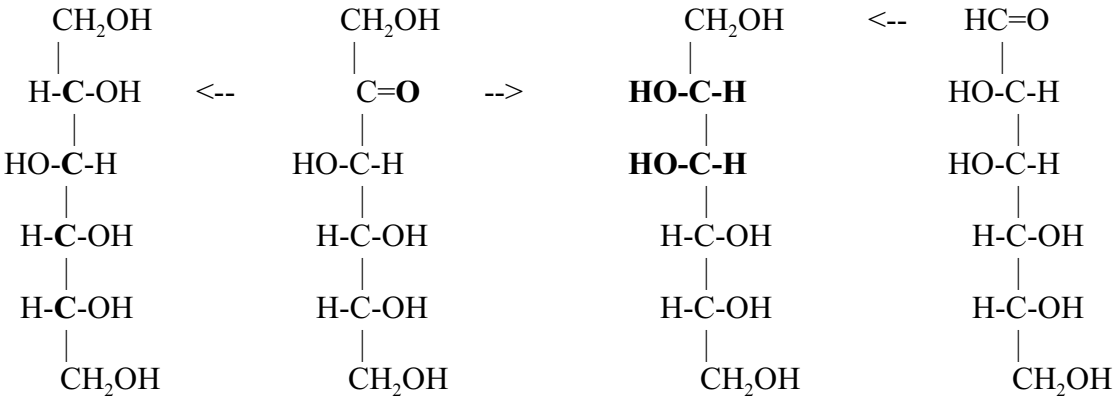
#29 0.3mg/ml 300ug/ml /200= 1.5umol/ml= 1.5mM; normal=5
#31 log2 = .3, + -8 = 7.7 pas besoin de calculatrice!
#36 500mM x 10/1000
#38 H= 10-1 ratio= 10-1 /55 = 1/ 550
#39 pH= 7.4 -pH=-7.4 H+=3.98E-08 = 40 10-9 M= 40 nM
#40 = 4+log(10-5/10+5)= ...+(log0.33)= ..(-0.48)= 3.5



\0meAnsSht
100226
2nd #11 not used
#17 not used

Answer **3 OF THE 4 FOLLOWING QUESTIONS** directly on this exam.

1) Use Fischer projections to show what happens (draw substrates & products) when you chemically reduce the most oxidized carbon on mannose and fructose to the level of an alcohol. Compare the two reactions. Among all these structures, identify those that will not turn polarized light and explain why. Pick just one of the products of these reductions and discuss what you would think is its predominant form in solution (linear, pyranose, furanose?).



Product 1 50% <- Fructose -> 50% Product 2 100% <- Mannose

5 Reaction 1 for each structure, 1 for arrows (must show fruc-2 products; man-1 product)
-0.5 for error on 1 chiral centre of each starting compound, -1 if is error is ref carbon
-2 if all is shorthand (give only 3 if all done in shorthand)

2 Compare 1 -> fructose gives equal amounts of 2 products, mannose gives 1 product
1 -> product 2 is obtained from both or both give product 2
give just 1 if these things are not stated and just shown as above

2 will not turn polarized light: 1 mark for: it's product 2
1 mark for explanation: either, 2 is equal to its mirror image, or, 2 has an internal plane of symmetry, or 2 is a meso compound, or the two halves of 2 cancel each other out
-1 for each wrong compound that is picked

1 -Predominant form of product : linear- reduceds can not cyclize, have no aldehyde or ketone (this must be said for the 1 mark)

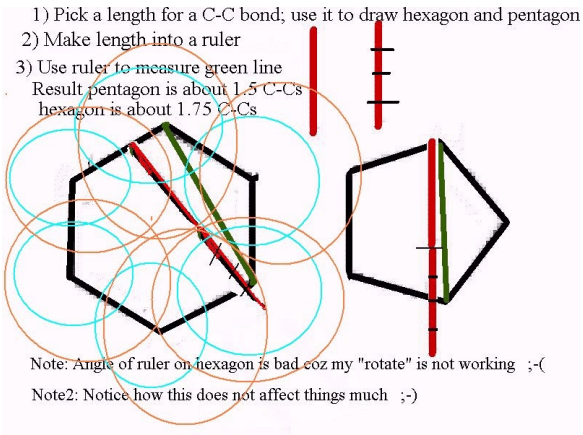
10 marks total

2) Show and explain your calculations for the following 3 short problems.
a)Compare the dissociation of NaCl in formamide with its dissociation in methanol. Formamide has a dielectric constant of 110 and a dipole moment of 3.4. Methanol has a dielectric constant of 33 and a dipole moment of 1.7.
b) Calculate the approximate osmotic pressure obtained at room temperature for a 10 g/L solution of a 100 amino acid long protein. R = 0.082 L Atm deg^{-1} M^{-1}
c) Compare the straight line distance between carbons 1 and 3 in a flat 5 member ring with their distance in a flat 6 member ring. Express your results in nm. Use your drawing to explain why a hydrogen atom would not fit inside the 6 member ring.

3 a) 1.5-> $F_f = (kq_1q_2)/(D_f r^2))$ $F_m = (kq_1q_2)/(D_m r^2))$ $F_f / F_m = 33 /110 = 1/3$
1.5-> negative repulsion (q_1q_2) = attraction -> attraction is 3 x better in methanol
thus dissociation, the opposite, will be 3 x better in formamide than in methanol
give 1 if they at least give the formula.
If they understand and just do the ratio without full formula-give full marks

3 b) $\pi = cRT$ 1-> MW= 100 aa x about 100/aa (estimate done in class)
accept any reasonable estimating procedure but give only 0.5 if no explanation
1-> 10 g/L= 10,000 mg/L /10,000mg/mMol = 1 mM
give 0.5 if 1000 fold unit error in above
1-> $\pi = 0.001 \times 0.08 \times (273 +20) =$ 0.001 x 0.08 x 300 = 0.024 Atm
don't penalize for earlier error. give 0.5 if can't do temperature

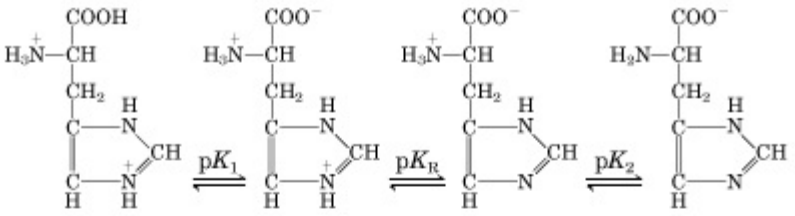
4



1 for 1) there should be something saying drawings are to scale (-0.3 if not)
1 for 2) this could be combined with 3) -give full marks if done
1 for 3) 1.75-1.5= 0.25 thus about 1/6 further in hex (17%). Give full marks if they do this.
If they do not compare and just give distances 1.75x0.15=0.26nm 1.5x0.15=0.22 nm give only 0.7
1 for hydrogen (I showed them this in CHIME): they must draw something like the lite blue circles or the orange circles
give 0.5 for a by heart explanation ("CHIME shows that there is no room") that does not use drawing

3) Plot the net electrical charge (Y axis) vs the pH (X axis) for histidine. The pH values on the X axis should vary between 1 and 13. Clearly identify the 'approximate' pKa values and the molecular structures for the protonation/deprotonation reactions occurring at each plateau within the plot. The full chemical structure of histidine should be provided above your plot

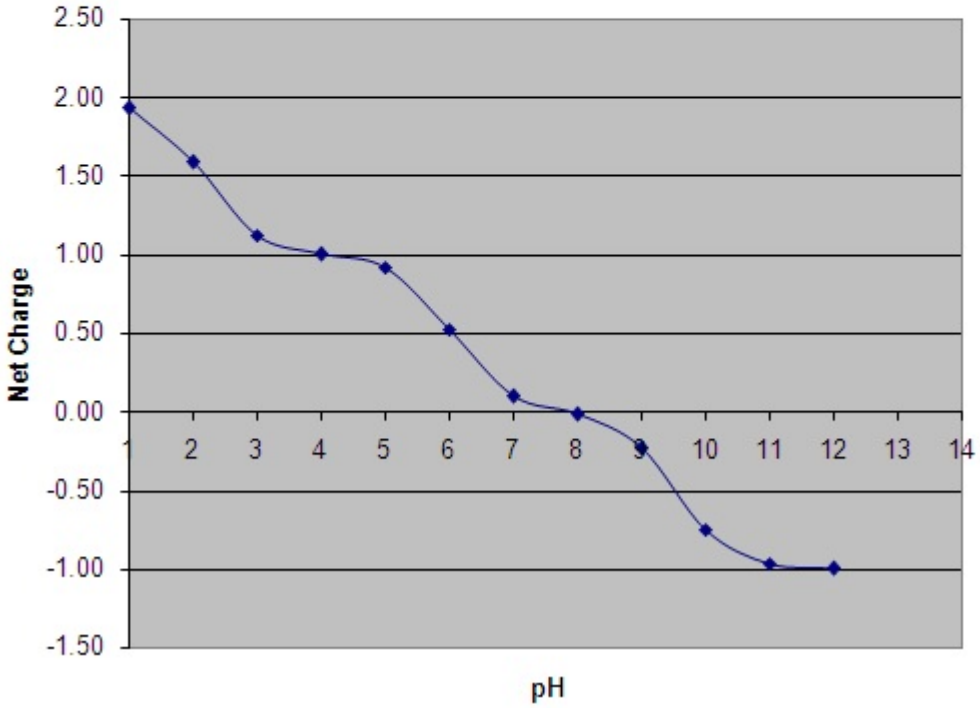
1. 13.3 marks



pK1 is about 2-3

pKr is about 6

pK2 is about 9-10



6.3 marks for ionization profile (charge vs pH)

4 marks for 4 chemical structures

3 marks for 3 pKa values

4) Derive the Michaelis-Menten equation. In you answer you should clearly emphasize each of the underlying assumptions for the Michaelis-Menten model. Simple algebraic reorganization of your equations does NOT require any justification, but you are expected to carefully explain any substitution among different equations.

13.3 marks

General model is **(2 marks)**

1. 1st assumption of linear rates: k-2 is negligible **(2 marks)**

2. 2nd assumption: equilibrium state of ES **(2 marks)**

$$V_1 = V_{-1} + V_2$$
$$k_1 [E_f][S] = k_{-1}[ES] + k_2[ES]$$

3. Definition of Km **(2 marks)**

$$Km = (k_{-1} + k_2)/ K_1$$

4. Algebric reorganization of equations (**2 marks)**
5. Final equation **(3.3 marks)**

$$V_0 = V_{max}[S]/(K_m + [S])$$