Chem 14C Spring 2018 First Midterm Exam

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Signature: [signature] ID Number: 904813707

Circle the TA whose discussion section or office hour you attend. This is who will return the exam to you in their discussion section or office hour:

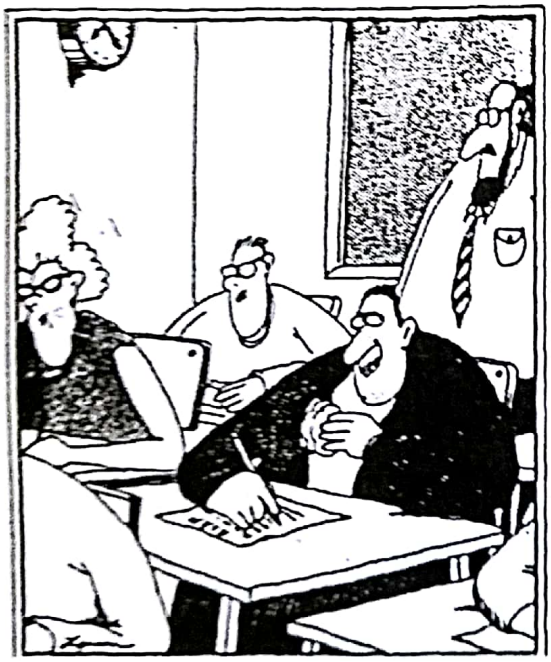
Anton (Jay) Sydnee

Do Not Open This Exam Until Instructed To Do So.

Pay attention to any word limits. Exceeding the word limit will result in a point deduction for that question.

Please stop writing when time is called. There are significant penalties – such as a zero for the exam – if you continue to write after time is called.

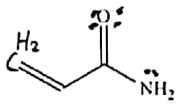
																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn



Midway through the exam, Allen pulls out a bigger brain.

Page	Points	Score
1	20	20
2	18	18
3	18	13
4	17	9
5	21	20
6	06	4
Total	100	84

Acrylamide is produced when food are processed at high temperature, for example in deep frying or coffee bean roasting. The molecule is a suspect human carcinogen. California Proposition 65 "requires businesses to provide warnings...about significant exposures to chemicals that cause cancer, birth defects, or other reproductive harm." Accordingly it has been suggested that Starbucks coffee must carry a cancer risk-warning label.



Acrylamide

1. (4) Write the name(s) of all functional groups present in acrylamide.

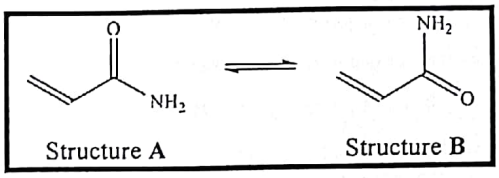
Alkene, Amide

4

2. (4) Write a number in each blank. Acrylamide has 3 lone pairs and 5 sp^2 atoms.

4

3. (2) What is the relationship of structures A and B? Write one or more answer choices in the space below. Answer choices: Resonance contributors, constitutional isomers, conformational isomers, configurational isomers, stereoisomers, enantiomers, diastereomers, meso, not isomers.



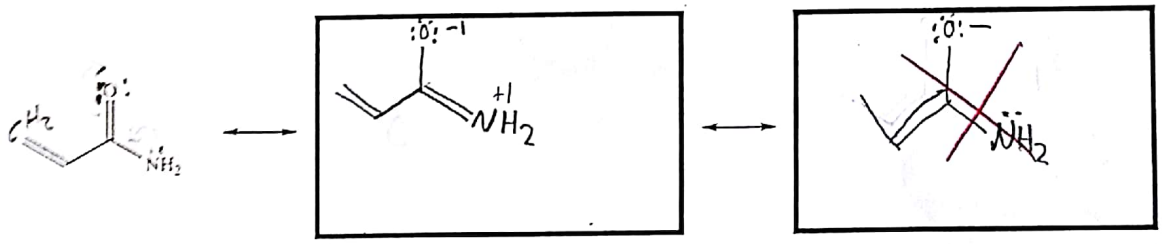
Structure A Structure B

conformational isomers

2

4. (6) In each box write an additional, significant acrylamide resonance contributor. ***Include all lone pairs and formal charges.*** Curved arrows are not necessary but can be included if desired. If there are not enough significant resonance contributors to fill all boxes write "X" in the unused box(es).

6



Contributor C Contributor D Contributor E

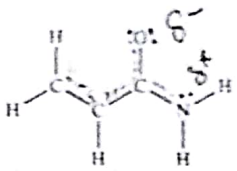
5. (4) Complete the following statement by writing 'Y' (for yes) or 'N' (for no) in the blank. Write 'X' in the blank if you wrote 'X' for this contributor in question 3. If you write 'Y' or 'X' in the blank you are done with this question. If you write 'N' complete the statement by adding ***no more than ten words*** of explanation.

Contributor **D** is more significant than contributor **C** (Y/N/X): N because contributor **D**...

4 has more avoidable charges than E.

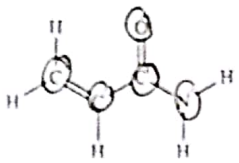
Page 1 score = 20

6. (4) Complete this acrylamide resonance hybrid by adding all lone pairs, partial charges, partial bonds, etc.



4

7. (3) Circle each of the conjugated atoms of acrylamide:



3

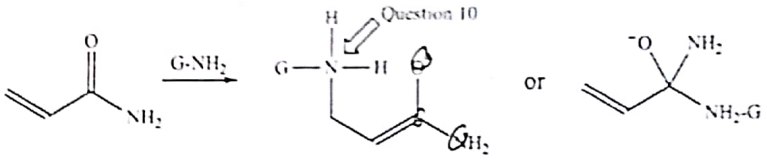
8. (2) Write a number in the blank. When in its lowest energy conformation, ___10___ atoms of acrylamide must lie in the same plane.

2

9. (2) Absorption of ultraviolet light may be used to measure the concentration of acrylamide in a sample. Ethylene ($H_2C{=}CH_2$) absorbs most strongly at 162 nm and benzene most strongly at 255 nm. (Recall lower wavelength = higher energy photons.) Therefore the strongest absorption for acrylamide is probably (write an answer choice letter in the blank): ___C___. Answer choices: (a) less than 162 nm; (b) very close to 162 nm; (c) between 162 nm and 255 nm; (d) very close to 255 nm, or (e) more than 255 nm.

2

Questions 10 and 11 concern the reaction of acrylamide with guanine (abbreviated as G–NH_2), a part of DNA. The reaction might be the molecular basis for acrylamide's carcinogenicity. There are two reasonable pathways for this reaction:



Product F Product G

10. (2) Complete this statement by writing a number with sign (+2, 0, -8, etc.) in the blank. The formal charge of the indicated nitrogen atom is ___+1___.

2

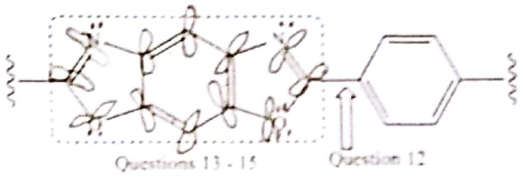
11. (5) Complete this statement by writing a letter (F or G) in the blank, and then add ***no more than fifteen words*** of explanation. Be precise and specific. The more likely reaction pathway produces product ___F___ because compared to the other product, this more likely product...

has conjugation which increases stability and lowers energy.

5/5

Page 2 score = 18

Zylon is a polymer (a material composed of many repeating units) that is stiffer than Kevlar (the polymer used to make bulletproof body armor). In addition to body armor, Zylon has been used in tennis rackets and on the Mars rovers. Shown below is the repeating unit (monomer) in Zylon.



12. (2) Zylon's stiffness might be related to the ease with which it can change conformations. Compare the barrier to rotation around the bond labeled as 'question 12' above to the barrier to rotation around the carbon-carbon bond of ethane ($H_3C–CH_3$). Complete this sentence by writing 'more', equal', or 'less' in the blank: The barrier to rotation around the 'question 12' bond is more than the barrier to rotation around the carbon-carbon bond in ethane.

2/2

13. (8) An additional structural issue that might influence the properties of Zylon is the coplanarity of the two ring systems. Complete each statement by adding ***no more than ten words in each case. Be precise and specific.***

(a) A factor ***favoring*** the questions 13–15 ring system (the ring in the dotted circle) and the other benzene ring to lie in the same plane is...

• There is a partial double bond increasing barrier to rotation.

8/8

(b) A factor ***disfavoring*** the questions 13–15 ring system (the ring in the dotted circle) and the other benzene ring to lie in the same plane (i.e., to be perpendicular) is...

torsional strain from being aligned.

14. (8) Let's determine if the questions 13–15 ring system is aromatic. Complete each question about the questions 13–15 ring system (the ring in the dotted circle) system by writing a number in the blank, or 'Y' (for yes) or 'N' (for no), as appropriate.

The total number of pi electrons: 14

Does this ring system have a closed loop of *p* orbitals (Y/N)? N

What is the total number of *p* orbitals in the closed loop (write 0 if there is no closed loop): 0

Is this ring system planar (Y/N)? Y

Does this ring system obey Hückel's rule (Y/N)? N

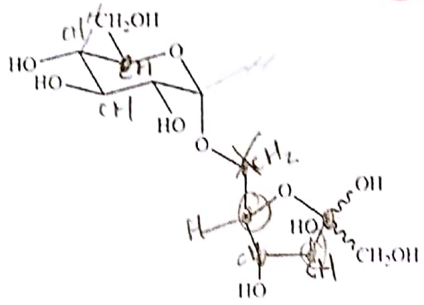
Is the ring system aromatic (Y/N)? N

3/8

Page 3 score = 13

15. (1) While Zylon provides excellent bullet protection when new, a recent lawsuit alleges that the questions 13–15 ring system breaks down readily and quickly over just a few months, due to the wearer's body heat and humidity. In light of your answer to questions 12–14, is this logical? Write 'Y' (for yes) or 'N' (for no) in the blank: ___X___. 0/1

Isomaltulose is a main component of Glucerna, a nutritional product for diabetics. This molecule is also found naturally in honey and sugarcane.



Isomaltulose

16. (4) Complete this statement by writing a number (not a formula) in each blank: Including the structure shown above, there are ___8___ isomaltulose stereoisomer(s). ***Hint: None of these stereoisomer(s) is/are meso.*** Of all possible isomaltulose stereoisomer(s), ___8___ is/are an enantiomer of another isomaltulose stereoisomer. 0/4

17. (2) What monosaccharide(s) are present in isomaltulose? Write one or more of the following answer choices in the space below: amylose, amylopectin, cellulose, fructose, galactose, glucose, lactose, maltose, ribose, starch, and sucrose. 2/2

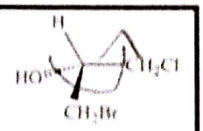
18. (7) Which of the following are present in isomaltulose? Write one or more of the following answer choices in the space below: pyranose, furanose, alpha (for α at an anomeric carbon), beta (for β at an anomeric carbon), acetal, hemiacetal, triose, tetrose, pentose, hexose. 4/7

19. (2) Complete this statement by writing a number in each blank: The disaccharide linkage of isomaltulose joins carbon ___1___ of one ring with carbon ___6___ of the other ring. 2

20. (1) Is isomaltulose easily digestible by humans? Write 'Y' (for yes) or 'N' (for no): ___Y___ 1

Page 4 score = 9

Questions 21–23 refer to molecule **H**:



Molecule **H**

21. (3) Complete this sentence by adding ***no more than fifteen words***: In molecule **H**, the — symbol indicates...

The wedge indicates that the H is moving out towards the reader. 3

22. (2) Write the atoms or groups around the stereocenter of molecule **H** in decreasing Cahn-Ingold-Prelog priority. ***Hint: There are no ties.*** Highest priority = OH > CH_2Br > CH_2Cl > H = lowest priority. 2

23. (2) Complete this statement by writing R in the blank if the stereocenter of molecule H has *R* configuration, S if it has *S* configuration, or N if the configuration cannot be determined from the given information (R/S/N): R 2

The remaining exam questions do not refer to acrylamide, Zylon, isomaltulose, or molecule **H**.

24. (6) For each phenomenon listed below, write 'Y' (for yes) if this phenomenon always involves *p*-orbital overlap, or 'N' (for no) if this phenomenon does not always involve *p*-orbital overlap.

Resonance (Y/N): Y Pi bond (Y/N): Y Conjugation (Y/N): Y

Aromaticity (Y/N): Y Formal charge (Y/N): N Lone pair (Y/N): N 6

25. (2) Write the name of one molecule encountered in Chem 14C lecture, in the Chem 14C Thinkbook, or on the Chem 14C course web site whose stereoisomers definitely have different biological properties.

Thalidomide 2

26. (2) In each blank write 'T' if the statement is true, or 'F' is the statement is false.

(a) A stereocenter is always a carbon atom (T/F): F

(b) A stereocenter must have four attachments (T/F): ~~F~~ 1

27. (2) Complete this statement by writing one word in the blank: Pasteur's separation of racemic acid into (+)-tartaric acid and (-)-tartaric acid is an example of a process called resolution. 2

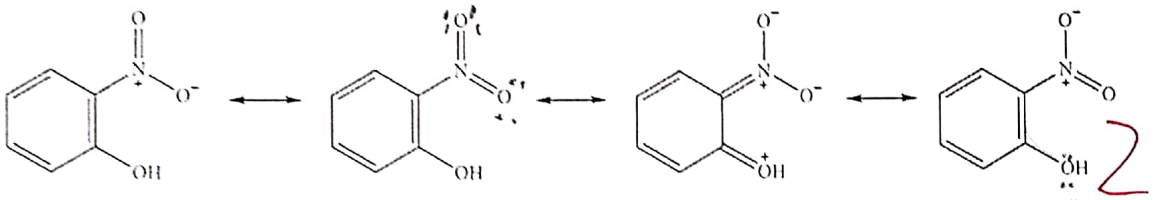
28. (2) Write a number in the blank: A diastereomer must always have at least 2 stereocenter(s). 2

Page 5 score = 20

29. (4) Consider each set of structures, then write a letter in the blank. If there is a tie write more than one letter.

(a) The most significant resonance contributor(s) is/are structure(s) (I, J, K, and/or L): I, L .

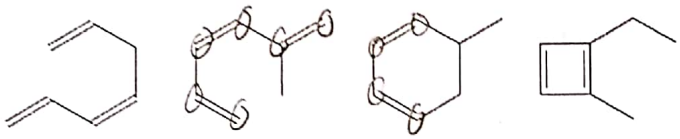
2



Structure I Structure J Structure K Structure L

2

(b) The most stable isomer(s) is/are structure(s) (M, N, O, and/or P): N .



Structure M Structure N Structure O Structure P

30. (2) Complete this statement by writing ***just one word*** in the blank: Amide resonance is critical to the structure and function of a group of ubiquitous (very widespread) biological structures called teratogens .

0

Page 6 score = 4