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CHM 2123 ORGANIC CHEMISTRY LABORATORY

MIDTERM EXAM – NOVEMBER 2014

THE FINAL PAGE CONTAINS IMPORTANT INFORMATION

Professor: Alex Bush contains 12 pages. Date: Saturday, November 1, 2014 9h30 – 11h00

Time: 90 minutes

Verify that your exam

Name _____ Student Number _____

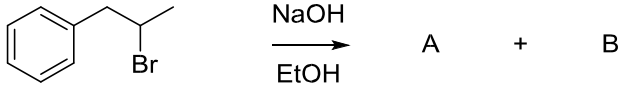
Lab Day _____ Name of your TA _____

QUESTION	POINTS	RÉSULTAT
1	8	
2	12	
3	8	
4	8	
5	8	
6	3	
7	13	
Points Boni	2	

1.

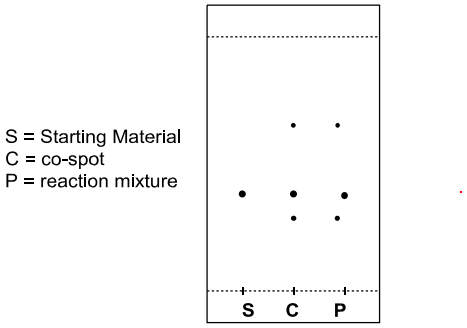
TOTAL	60	

1). (8 points) Prior to throwing his 509th TD pass in the NFL, Peyton Manning completed an organic chemistry experiment on the sideline. He was asked to react 3-phenyl-2-bromopropane with KOH in ethanol, as shown in the reaction scheme below.



a. There are two possible <u>organic</u> reactions pathways for this experiment, giving products A and B. Identify the structure of each. **(2 points)**

b. Peyton's knowledge of chemistry is as vast as his knowledge of football. He decided to follow the reaction by TLC analysis. He observes the following TLC plate. Circle which spot corresponds to the starting material and justify your decision **(2 points)**



c. Identify which spot is associated with product A and which is associated with product B and justify your decision using the principles of TLC analysis. **(3 points)**

d. Upon closer inspection, he notices four spots on the TLC plate in lane P. Identify the structure of the 4^{th} spot? **(1 point)**

2). (12 points) Before making his way to the Superbowl, Colin Kaepernick must first complete CHM2123. In one experiment, Colin mixed 0.500 mL of 2-bromobutane with 8.00 g KOH and heated

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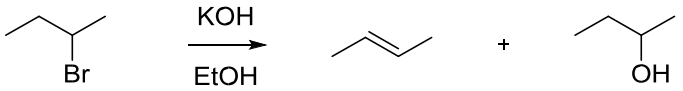
the reaction to reflux in ethanol for 30 minutes. While the reaction heated, he collected the gas produced in a eudiometer. Can you help Colin with his lab report?



a. Help Colin fill out his table of reagents. **(4 points)**

Compound	**MW**	**Amount**	**Density**	**mol**	**Equivalents**
2-bromobutane			1.255 g/mL		
KOH			Solid		

b. At the end of the reaction, Colin collected 52.0 mL of gas in the eudiometer and 0.260 g of solid KBr. He measured the atmospheric pressure (755.0 mmHg) and temperature (24.5 °C). How many moles of gas was produced (use P* = 36.7 mmHg)? **(2 points)**

c. What ratio of S_N2:E2 did Colin obtain? **(3 points)**

d. Explain why substitution reactions are favoured at lower temperature and elimination reactions are favoured at higher temperature. **(3 points)**

3).

(8 points) Derek Carr was studying the kinetics of the hydrolysis of *t*BuCl with water under basic conditions. He used bromothymol blue as an indicator to measure the progress of the reaction. During his experiment, he performed three trials in two different solvent systems, 70:30 H_2O:acetone and 85:15 H_2O:acetone. He then averaged the times until the indicator changed color:

	[*t*BuCl] = 0.135 M	**[*t*BuCl] = 0.120 M**	**[*t*BuCl] = 0.105 M**	**[*t*BuCl] = 0.090 M**
Average time solvent A	9.0 s	26.0 s	43.8 s	60.5 s
Average time solvent B	40.0 s	112.3 s	235.7 s	345.1 s

a. Sketch a graph of time vs. concentration of [*t*BuCl] remaining in solution for each solvent system. How could Derek transform the data in order to get a linear plot? **(3 points)**

b. Derek forgot to label his data sets and did not know which times were associated with each solvent systems. Identify which solvent system (85:15 H_2O:acetone and 70:30 H_2O:acetone) goes with which trial (A or B) and justify your decision. **(3 points)**

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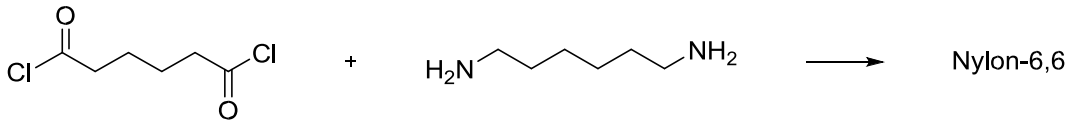
c. While running the experiment, explain why Derek kept his reaction flasks in a water bath at room temperature. **(2 points)**

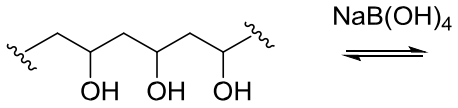
4). **(9 points)** During his last game, Cam Newton ripped his nylon jersey while performing his trademark Superman pose after scoring a touchdown. Rather than buy a new one, Cam wants to synthesize nylon-6,6 and stitch his jersey back together.



a. Give the mechanism of the formation of one repeating unit of nylon-6,6. **(5 points)**

b. After letting the reaction stir for a few minutes, Cam is disappointed to see no nylon is being formed. What reagent is he missing? Why does polymerization stop? **(2 points)**

c. What is the role of H_2O in the cross-linking of polyvinyl alcohol and sodium borate. Draw the structure of the cross-linked polymer. **(2 points)**



5). (7 points) Until getting called up into the NFL, Nick Foles was pursuing his life-long dream in organic chemistry. While studying for the midterm, he realized he didn't fully understand the difference between the purification techniques taught in his lab course. He has come to your for help.

a. From experiment 1, he did not understand why caffeine was recrystallized. Explain why caffeine was recrystallized and the principles of recrystallization. **(4 points)**

b. Nick also has difficulties with extraction. Help him by explaining the principles and goals of liquid-liquid extraction. **(2 points)**

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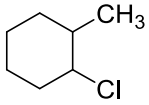
c. Nick wants to set up a similar experiment to isolate sugar ($C_{12}H_{22}O_{11}$) from a Tim Hortons French Vanilla. Since sugar is an organic compound, he reasons he can perform a liquid-liquid extraction with an organic solvent. Do you think his experiment will be successful? If so, why? If not, why not? **(1 points)**

6). (3 points) In his locker room, Andy Dalton found a bottle of 2-methyl-1-chlorocyclohexane, however, the relative stereochemistry of the methyl and chloro group was unknown.



Based on the different reactivity of the isomers, what experiment could Andy perform to determine the relative stereochemistry of the molecule? Clearly explain your answer using structures. **(3 point)**

7. **(13 points)** The Wonderlic Test is a series of short answer questions used as a measure of football player's IQ. This year's version had only the chemistry questions listed below. (Aaron Rodgers had a perfect score!)

   a. During recrystallization, why is it important to not add all the solvent at once?

   b. Why is ethyl acetate and water not a suitable solvent combination for recrystallization?

   c. Why is it important to put the lid back on the jar containing Na_2SO_4 (or $MgSO_4$)?

   d. How would the rate of reaction change if the concentration of NaOH was doubled in the hydrolysis of 1-bromobutane?

   e. What type of polymer is DNA?

   f. What reagent would you add to convert chlorophylls to pheophytins?

   g. Why is water added to the bottom of a reflux condenser?

h. In experiment 2, the hydrolysis of *t*BuCl with water, what is the role of the bromothymol blue indicator?

i. Why do carboxylic acids have a tendency to streak along TLC plates?

j. Explain how adding acetic acid into the already polar solvent system can prevent streaking of carboxylic acids on TLC plates.

k. Explain how a more polar solvent will move a spot further along a TLC plate?

l. What is the order of a unimolecular elimination reaction?

m. In experiment 1, spinach was ground up with sand. What is the role of the sand?

Bonus (1 point) – PLEASE READ AND ANSWER THIS QUESTION ONLY AFTER COMPLETING ALL THE ABOVE QUESTIONS!

Every name used in a question in this exam is a current NFL quarterback. Connect each player used with their current NFL team. (In the spirit of socialism, if one student gets this correct, every student will receive the mark!)

Quarterback	Team	Running Back
A. Andy Dalton	1.	
B. Derek Carr	2.	
C. Nick Foles	3.	
D. Colin Kaepernick	4.	
E. Peyton Manning	5.	
F. Cam Newton	6.	
G. Aaron Rodgers	7.	

Double bonus (1 point): Correctly fill in the #1 running back for each team.

Useful info

$$R = 0.08206\ \frac{atm \cdot L}{mol \cdot K}$$

$$PV = nRT$$

$$P = P_{atm} - P_{water} - P^*$$

T (K)	***P_{water}* (mmHg)**	***T (K)***	***P_{water}* (mmHg)**	***T (K)***	***P_{water}* (mmHg)**
290	14.7	294	18.8	298	24.0
291	15.8	295	19.5	299	25.5
292	16.5	296	21.0	300	27.0
293	17.3	297	22.5	301	28.5