

ROUND UP  
FINAL SCORE  
TO NEAREST WHOLE  
PT

NAME (PLEASE PRINT)

Check the section that you are in: Gugino Stukey Clark

Please sign here to indicate that you agree to abide by all terms of the Hope College Code on

Academic Integrity: \_\_\_\_\_

1. (a) (2 pts.) Clearly define the term *specific gravity*?

Specific gravity is a ratio of the density of some liquid substance to the density of water. It can be represented mathematically as  $\text{specific gravity} = \rho_x / \rho_{H_2O}$  (where  $\rho$  means density)

(b) (1 pts.) Name the device that was used in lab to measure the specific gravity of liquids.

hydrometer

(c) (3 pts.) Consider the properties of the following substances:

(i) LIQUID A has a density of 1.1 g/mL

(ii) SOLID B weighs 1.6 grams & displaces 1.4 mL of water if placed in a graduated cylinder

(iii) LIQUID C has a specific gravity of 1.40

Which of these substances has the greatest density? You must show all work to receive full credit.

(i) Density of Lig A = 1.1 g/mL

(ii) " of solid B =  $(1.6g / 1.4mL) = 1.14g/mL$

(iii) Density of Lig C = 1.40 g/mL

LIQUID C has the GREATEST DENSITY!

2. Answer the following questions that involve the element IRON.

(a) (1 pts.) How many protons does a neutral atom of iron have? 26

(b) (1 pts.) Is iron likely to gain or lose electrons? lose

(c) (2 pts.) What is the charge on iron in the compound FeO? +2

(d) (1 pts.) What is the name of the compound FeCl<sub>3</sub>? Iron (III) chloride

(e) (2 pts.) What is the molar mass of the compound FeCl<sub>3</sub>? 162.2 g/mol

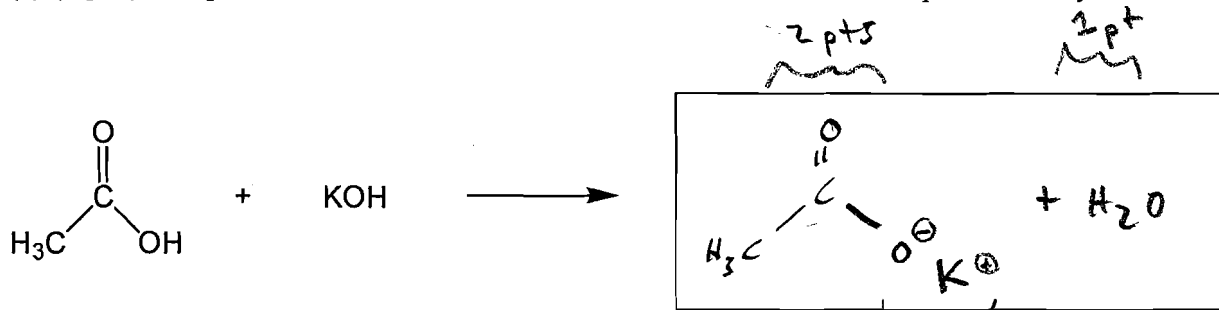
+2 pts  
work = +1 pt

(-0.5 if say "tri"  
or  
-0.5 if they  
don't include  
" (III) ")

(-1 if no units)



6. (a) (3 pts.) The products of an acid-base reaction between acetic acid & potassium hydroxide are:



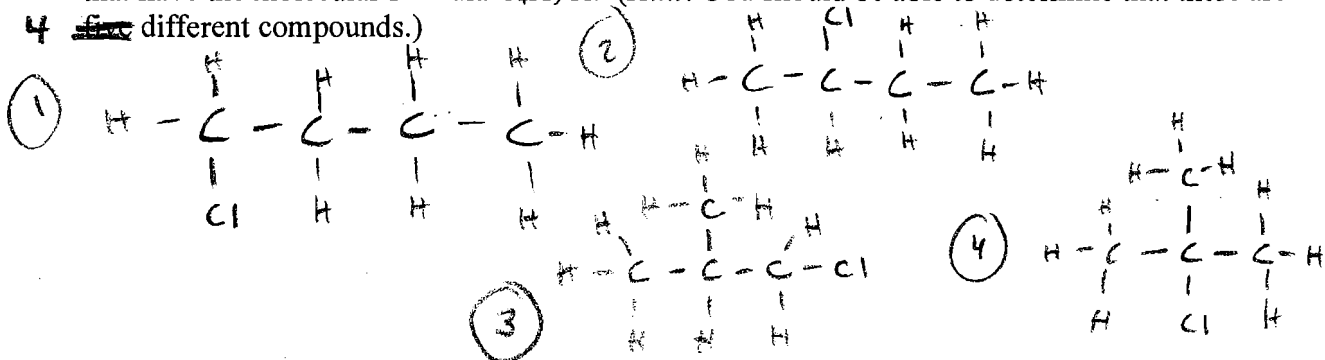
(b) (5 pts.) It requires 25 mL of 1.0 M ~~KOH~~ <sup>HCl</sup> to neutralize ANTACID A, and 45 mL of 0.60 M ~~KOH~~ <sup>HCl</sup> to neutralize ANTACID B. Which of the antacids, ANTACID A or ANTACID B, has the greater neutralizing strength? You must show *all* your work to receive full credit.

3 pts

- $0.025 \text{ L} \times \frac{1.0 \text{ mol HCl}}{1 \text{ L}} = 0.025 \text{ mol}$  required to neutralize ANTACID A
- $0.045 \text{ L} \times \frac{0.60 \text{ mol HCl}}{1 \text{ L}} = 0.027 \text{ mol}$  required to neutralize ANT. B.

2 pts **ANTACID B** has greater neutralizing strength b/c more moles of HCl are required to neutralize it

7. (6 pts.) Write the complete structural formula of all constitutional isomers (structural isomers) that have the molecular formula  $\text{C}_4\text{H}_9\text{Cl}$ . (Hint: You should be able to determine that there are ~~4~~ <sup>4</sup> different compounds.)

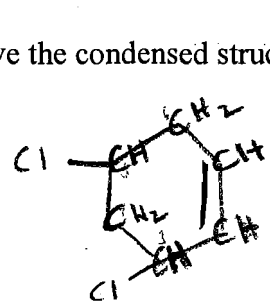


8. (3 pts.) Would you expect ethanol or 2,3-dimethylpentane to be *more* soluble in hexane? Explain your choice in a sentence or two.

2 pts 2,3-dimethylpentane is more soluble in hexane

1 pt - good discussion of "like-dissolves-like"

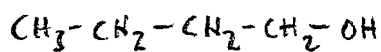
9. (3 pts.) Give the condensed structural formula of 3,5-dichlorocyclohexane



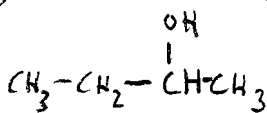
hexane  
 $+1 \text{ pt} +1 \text{ pt} +1 \text{ pt}$

all correct = +6  
 3 correct = +4.5  
 2 correct = +3  
 1 correct = +1.5  
 (-1 for each incorrect structure)

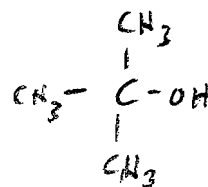
10. (a) (3 pts.) Provide the structural formulas (condensed or expanded) of a 1°, 2°, and 3° alcohol that all have the same molecular formula, C<sub>4</sub>H<sub>10</sub>O.



1° ALCOHOL



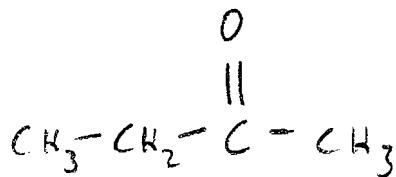
2° ALCOHOL



3° ALCOHOL

(b) (4 pts.) If the secondary alcohol you generated in part (a) is treated with the oxidizing agent CrO<sub>4</sub><sup>2-</sup> in the presence of a strong acid (H<sup>+</sup>), determine the major organic product molecule(s) produced and record the structural formula and IUPAC name of this molecule in the space provided below.

(if <sup>only</sup> say produces ketone, +1)



(+3)

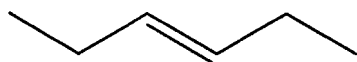
2-butanone

(+1)

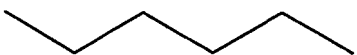
(accept methyl ethyl ketone)

11. Consider the following three compounds:

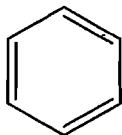
(i)



(ii)



(iii)



(a) (2 pts.) Which of these compounds is a saturated compound?



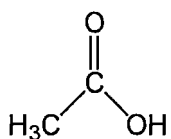
(b) (2 pts.) Which of these compounds will cause a bromine solution to go from a reddish-brown color to a colorless color?



(c) (2 pts.) Which of these compounds is an alkene?

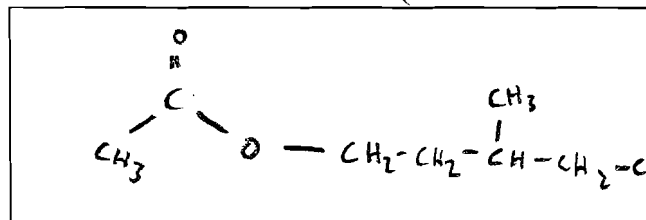


12. (3 pts.) Draw the product(s) of the following reaction:

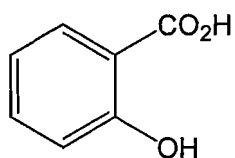


+ 3-methyl-1-pentanol

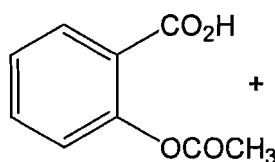
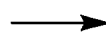
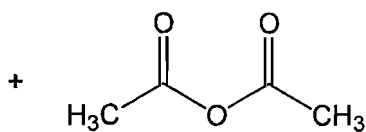
$\xrightarrow{\text{H}^+}$



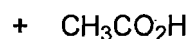
13. You are to prepare aspirin starting with 13.8 g of salicylic acid and an excess of acetic anhydride, according to the reaction shown below:



salicylic acid (S.A.)  
138 g/mole



aspirin  
180 g/mole



(a) (4 pts.) What is the maximum possible amount of aspirin (report in grams) that can be produced? You must show *all* work to receive full credit.

$$\frac{13.8 \text{ g S.A.}}{138 \text{ S.A.}} \times \frac{1 \text{ mol S.A.}}{1 \text{ mol S.A.}} \times \frac{1 \text{ mol aspirin}}{1 \text{ mol aspirin}} \times 180 \text{ g} = 18 \text{ g}$$

work = +2pts

answer = +2pts

(b) (2 pts.) What is your percent yield if you obtained 9.0 grams of aspirin product? Again, you must show *all* work to receive full credit.

$$\% \text{ yield} = \left( \frac{9.0 \text{ g}}{18 \text{ g}} \right) \times 100\% = 50\% \text{ yield}$$

(only take off 1pt for a minor math mistake)

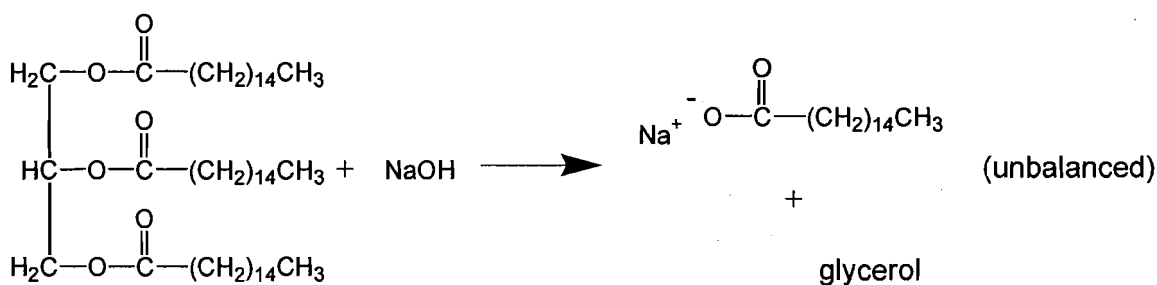
14. (2 pts.) The process of making a soap from fat and lye (a base) is called:

- i. condensation
- ii. esterification
- iii. hydrogenation
- iv. saponification
- v. none of the above

15. (2 pts.) In the soap-making lab exercise, you investigated the ability of different soaps to dissolve vegetable oil in water. In general, soaps can "solubilize" non-polar molecules by forming a particular structure around the non-polar molecule. What is the name of this particular structure?

- i. triacylglyceride
- ii. sodium palmitate
- iii. micelle
- iv. glycerol
- v. none of the above

16. Suppose that you are going to make soap using 1 mole of tripalmitoyl glyceride as shown below:



(a) (2 pts.) How many moles of NaOH would be required if you wanted to convert all of the tripalmitoyl glyceride into soap?

3 mol

(b) (2 pts.) How many moles of glycerol would also be produced in this reaction?

1 mol

17. (5 pts.) Suppose that you are given an unknown solution that either contains the monosaccharide glucose, the disaccharide sucrose, or the polysaccharide starch. To determine the identity of this unknown, you perform several tests, the results of which are described below:

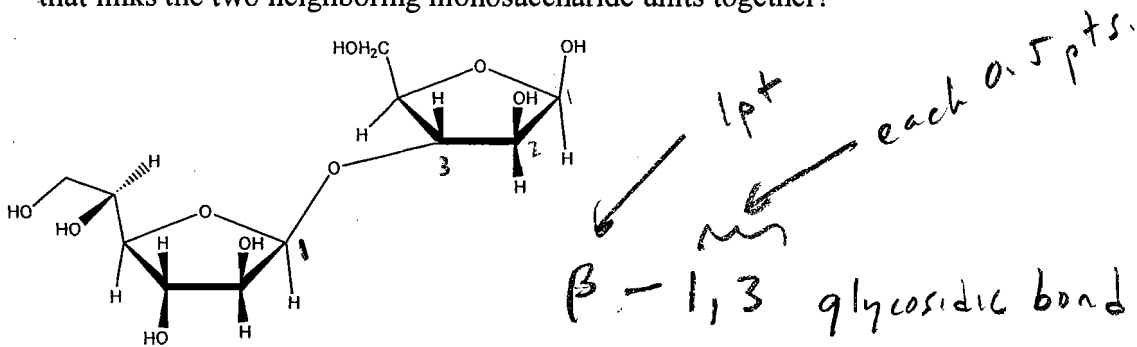
| Type of Test Performed              | Observation  |
|-------------------------------------|--|
| Benedict's Test for Reducing Sugars | A brick-red precipitate forms (positive result)                              |
| Seliwanoff's Test for Ketoses       | A <del>brick-red</del> color is observed (positive result) (negative result) |
| Iodine Test for Polysaccharides     | Solution does not turn a blue-black color (negative result)                  |

Based on your superior skills of deduction, what is the identity of your unknown? In recording your answer, provide a clear, concise explanation of how you ~~both~~ determined your choice.

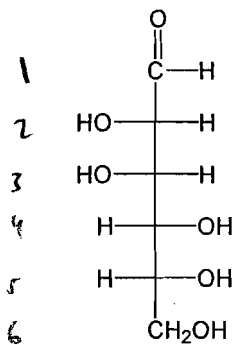
3 pts { Benedict's test → rules out sucrose/starch (could be glucose)  
 Seliwanoff's test → rules out sucrose (could be glucose/starch)  
 Iodine test → rules out starch (could be sucrose/glucose)

2 pts — Based on above results, must be glucose

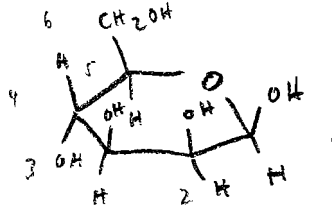
18. (2 pts.) Below is a diagram showing a disaccharide. What is the specific type of glycosidic bond that links the two neighboring monosaccharide units together?



19. (3 pts.) Given the following Fisher projection of the monosaccharide D-mannose, draw the corresponding cyclic Haworth structure of  $\beta$  D-mannose.



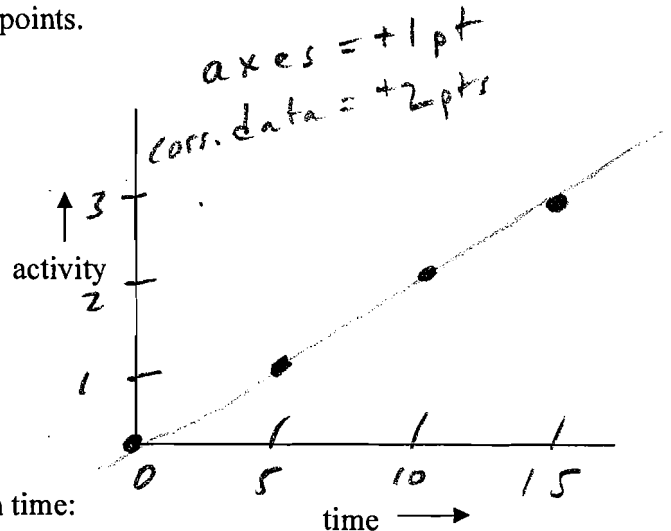
*6-membered ring = +1*  
 *$\beta$  = +1*  
*all correct stereochemistry = +1*



20. (3 pts.) Below is a description of the progress of an amylase reaction as a function of time. Plot on the graph below (using the enzyme activity level values shown below) the predicted iodine test results if performed at each of the indicated time points.

Possible iodine test results are as follows:

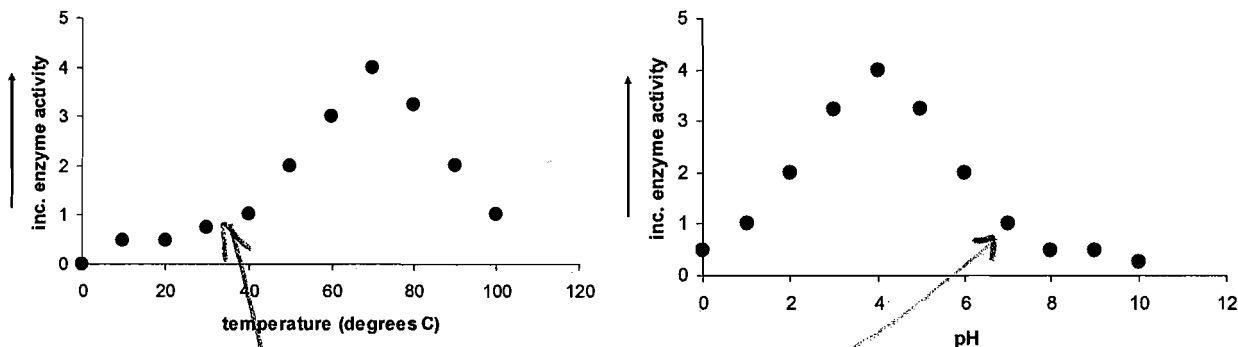
| Iodine Test Result | Enzyme Activity Level |
|--------------------|-----------------------|
| Dark blue/black    | 0                     |
| Blue               | 1                     |
| Light brown        | 2                     |
| Gold               | 3                     |



Actual data from an amylase reaction monitored with time:

| Time (min) | Sugars Present in Solution                                      |
|------------|---|
| 0          | Only starch   |
| 5          | Some starch, but mostly shorter polysaccharides & disaccharides |
| 10         | Some shorter polysaccharides, but mostly maltose & some glucose |
| 15         | All glucose   |

21. Below are two graphs that show the effects of pH and temperature on the activity of an unknown enzyme derived from a bacterial organism.



(a) (2 pts.) What do you expect the relative activity of this enzyme to be at pH 7.0 & 37 °C?

- i) relative activity = 0 (no activity)
- ii) relative activity = 1 (low)
- iii) relative activity = 2 (medium)
- iv) relative activity = 3 (high)
- v) relative activity = 4 (very high)

(b) (3 pts.) The optimal reaction conditions of bacterial enzymes often reflect the growth conditions of the organism from which the enzyme is derived. Based on the optimal conditions of enzyme activity reported on the graphs above, do you expect that this enzyme comes from an organism that lives a) in a volcanic vent in Honolulu, HI, b) under a rock in Nashville, TN, or c) at the North Pole with Santa Claus? Explain your choice based on your knowledge of enzymes and from the data presented above.

2 pts { accept either (a) or (b), but preferred answer is (a) since temp will be elevated (~70°C)

1 pts { (optimal conditions are pH 4 & 70°C)

22. (3 pts.) Draw the product(s) of the following reaction:

