

CHEM 103 LAB
Cumulative Laboratory Test
April 24-25, 2006

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*?

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

(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.

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

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

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

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

(d) (1 pts.) What is the name of the compound FeCl₃? _____

(e) (2 pts.) What is the molar mass of the compound FeCl₃? _____

3. (a) (2 pts.) Construct a Lewis Dot structure for a molecule of CO₂.

(b) (2 pts.) What is the molecular shape of the molecule that you determined in part (a)?

(c) (2 pts.) Is the molecule CO₂ polar or nonpolar?

4. A sample consisting of 0.25 moles of EITHER sodium or magnesium metal was *very* carefully reacted with molecular oxygen, and it was determined that 3.78 grams of oxygen *atoms* were incorporated into the resulting metal oxide product.

(a) (2 pts.) Determine the number of moles of oxygen *atoms* present in the metal oxide product?

(b) (2 pts.) What is the *simplest formula* of the metal oxide product?

Formula: **Metal** **O**
 ← subscripts

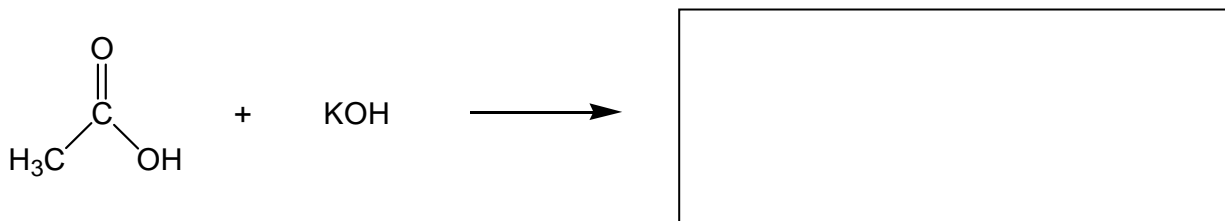
(c) (3 pts.) Based on the simplest formula that you determined in part (b), is the metal that was present in the original sample sodium or magnesium? Briefly *explain* your choice.

5. A solution has an [OH⁻] = 1 × 10⁻¹⁰ M.

(a) (2 pts.) What is the [H₃O⁺] of the solution? _____

(b) (1 pts.) Is the solution acidic, neutral, or basic? _____

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 HCl to neutralize ANTACID A, and 45 mL of 0.60 M HCl 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.

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

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, C₄H₁₀O.

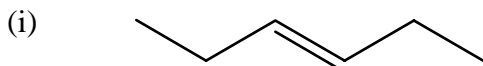
1° ALCOHOL

2° ALCOHOL

3° ALCOHOL

(b) (4 pts.) If the secondary alcohol you generated in part (a) is treated with the *oxidizing agent* CrO₄²⁻ in the presence of a strong acid (H⁺), determine the *major organic product molecule(s)* produced and record the structural formula and IUPAC name of this molecule in the space provided below.

11. Consider the following three compounds:

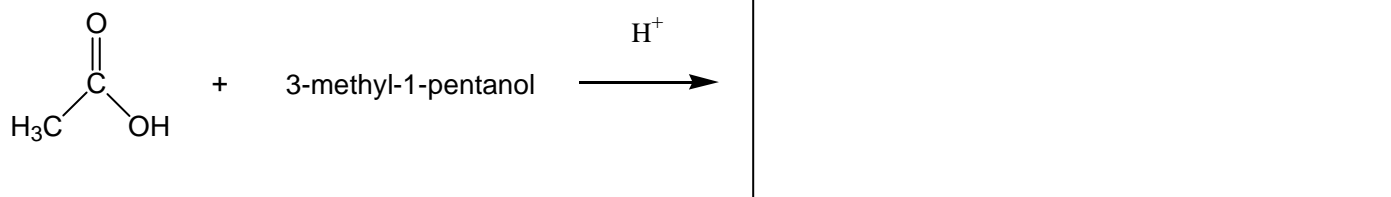


(a) (2 pts.) Which of these compounds is a *saturated* compound?

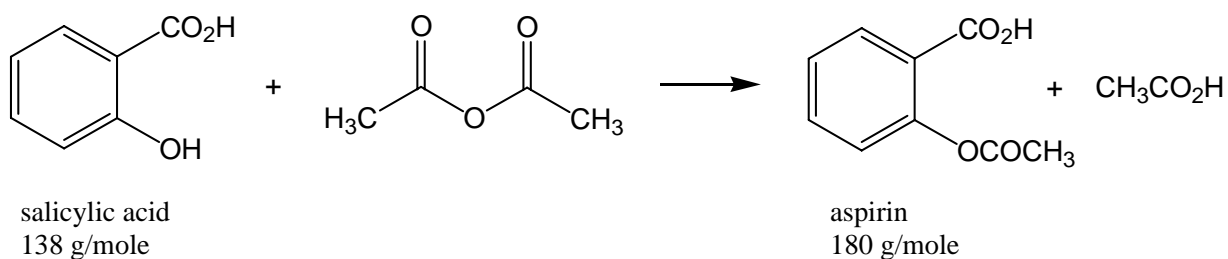
(b) (2 pts.) Which of these compounds will cause a bromine solution to go from a reddish-brown color to a colorless color?

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

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



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:



(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.

(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.

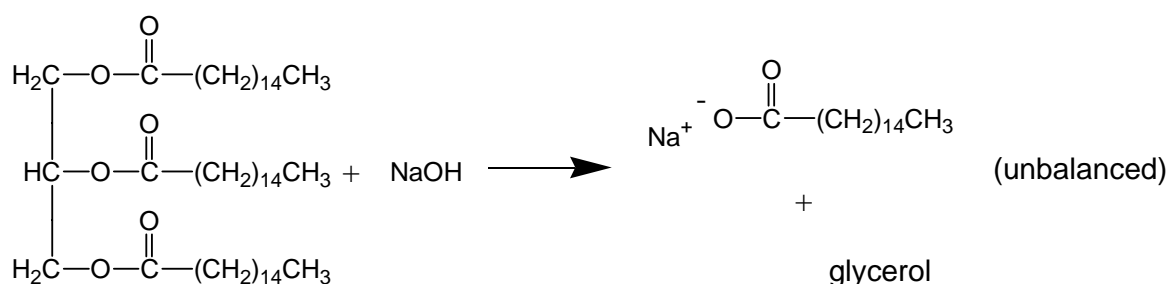
14. (2 pts.) The process of making a soap from fat and lye (a base) is called:

- 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:



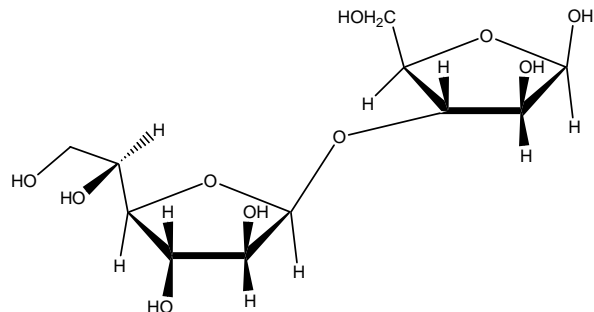
- (a) (2 pts.) How many moles of NaOH would be required if you wanted to convert all of the tripalmitoyl glyceride into soap?
- (b) (2 pts.) How many moles of glycerol would also be produced in this reaction?

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:

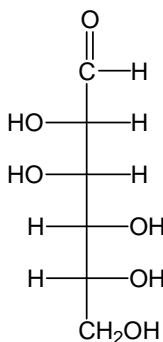
Type of Test Performed	Observation
Benedict's Test for Reducing Sugars	A brick-red precipitate forms (positive result)
Seliwanoff's Test for Ketoses	A pink color is observed (negative result)
Iodine Test for Polysaccharides	Solution does not turn a blue-black color (negative result)

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.

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 β D-mannose.



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

↑
activity

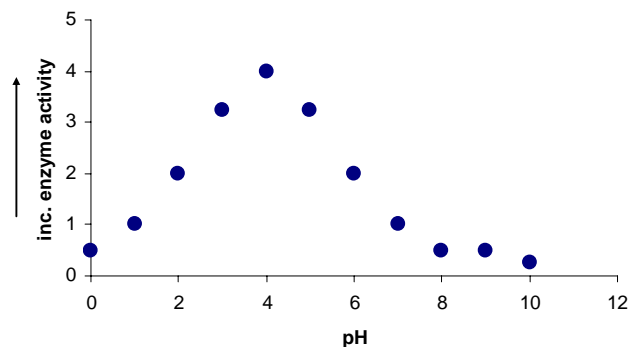
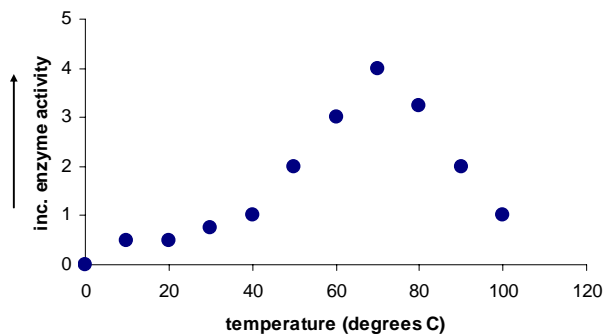


Actual data from an amylase reaction monitored with time:

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.

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

