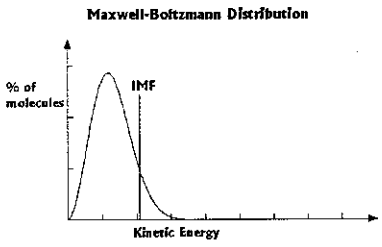
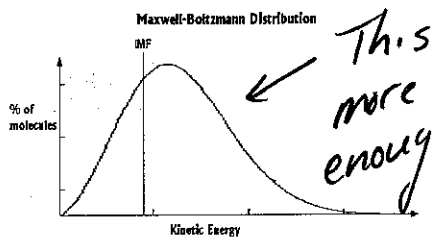
KEY

CH30S **Final Exam Review**

Unit 1: Physical Properties and Changes

1. What is the difference between a physical change and a chemical change.
   Chemical → something new is made.
2. Are the following physical changes or chemical changes?
   a. Iron Rusting C
   b. Gallium melts in your hand P
   c. A platinum wire is heated until it glows P
   d. Sugar is added to coffee P
   e. Water is filtered through a Brita P
3. Draw the 3 states of matter at the molecular level. For each state, discuss the types of motion in each, the strength of the intermolecular forces, and properties (density, diffusion, volume, etc.) SEE NOTES!
4. Briefly describe the plasma state of matter.
   Ionized Gas
5. What is an amorphous material? Give an example.
   Solid w irregular arrangement of particles. ex) glass.
6. What is an allotrope? Give an example.
   different arrangements of same substance ex) Carbon → diamond → coal
7. Define STP, state the conditions (pressure & temperature) at STP.
   STD. Temp/Press. 0°C & 101.3 kPa
8. Given the following graphs, which scenario will have a greater rate of evaporation? Why?





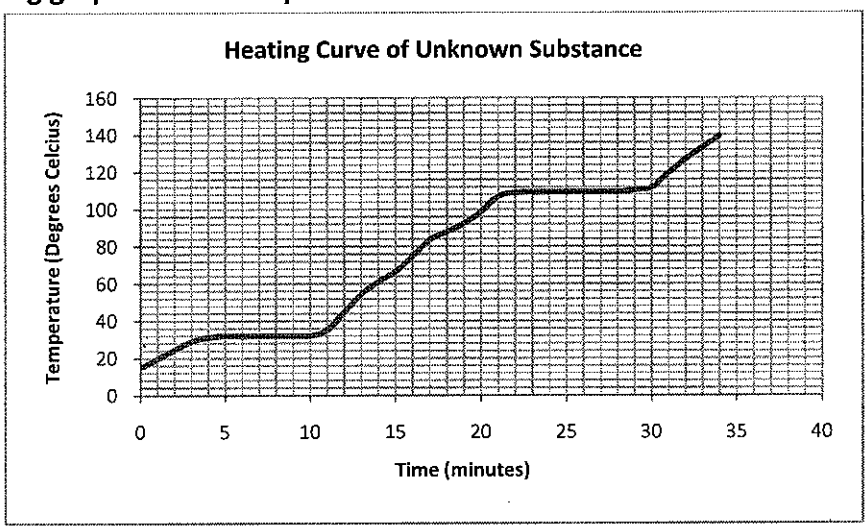
This one! more particles have enough KE. To evaporate.

9. In the graphs in question #9, what does the average kinetic energy of the molecules represent? TEMP!
10. When does boiling occur? Your answer should not have anything to do with temperature. when $P_{VAP} \geq P_{ATM}$

11. What is the NORMAL boiling point of water? What does the word NORMAL mean in terms of boiling point? 100°C → B.P. @ STD Pressure (sea level)

12. How would the boiling point of water on Mount Everest compare to the the normal boiling point? Explain why at the molecular level.
lower → less P_{ATM} so easier for molecules to escape

Use the following graph to answer questions #13 - #17



13. What is the melting point of the unknown substance? How can you tell?
≈ 30°C 1st Plateau

14. What is the boiling point of the unknown substance? How can you tell?
≈ 110°C 2nd Plateau

15. What phases is/are present at each of the following points in time:
   a. 2min S
   b. 6min S/L
   c. 11min L
   d. 17min L
   e. 26min L/G
   f. 34min G

16. Explain why the temperature is not changing during the 5-10 min and 23-29min intervals, even though the substance is still being heated.
energy is used to change state (Break IMF's)

17. How would the graph change if you:
   a. Doubled the amount of heat applied? 2x faster
   b. Heated twice as much of the substance? 2x slower
   c. Cooled the substance from 140°C to 20°C? reversed
   d. Used a different substance altogether? different Plateaus.

18. Explain the process by which our body cools itself.
Sweat → moisture evaporates → high KE particles escape & leave cooler (slower) particles behind.

Freezing - Exo
Melting - Endo
Boiling - Endo
Condensing - Exo

19. List the 6 different changes of state. For each, state whether it is exothermic or endothermic. Sublimation - endo
deposition - exo

20. Define vapour pressure. If a substance has a high vapour pressure, what can you say about: equilibrium pressure above a liquid in a closed container
    a. The strength of its intermolecular forces? High PVAP = WEAK IMF'S
    b. Its boiling point?
    HIGH PVAP = LOW B.P.

21. How does vapour pressure vary with temperature? Why?
AS TEMP ↑, PVAP ↑

22. **Use the attached vapour pressure curve to answer the following questions.**
    a. What is the vapour pressure of acetic acid at 80°C ?
    ≈ 27 kPa
    b. What is the approximate vapour pressure of chloroform at 0°C?
    10 kPa
    c. What is the temperature at which the vapour pressure of ethanol is 50 kPa?
    62 °C
    d. Which of these substances has the highest vapour pressure?
    Chloroform
    e. Which of the three substances would evaporate fastest at room temperature?
    Chloroform
    f. Which of the three substances would evaporate slowest at room temperature?
    Acetic Acid
    g. Which substance has the weakest intermolecular forces?
    Chloroform
    h. From the graph, what are the normal boiling points of the four substances?
    Chloro = 58°C, Ethanol = 76°C, H2O = 100°C, Acetic = 118°C
    i. What would be the boiling point of water on a day when the atmospheric pressure is 95 kPa?
    98°C
    j. j. Alcohol is heated in a container in which there is a partial vacuum. The air pressure in the container is 25 kPa. At what temperature will the alcohol boil?
    45°C
    k. If substance "X" had a normal boiling point of 30°C, where would you expect to find the vapour pressure curve of "X"? Explain your answer.
    To the left of chloroform.
    l. What would the atmospheric pressure have to be in order to have ethanol boil at 20.0°C ?
    7 kPa
    m. If the temperature was 50.0°C and the atmospheric pressure was 20 kPa, which substances if any would boil?
    Ethanol & Chloroform

Unit 2: Gases and the Atmosphere

N_2, O_2, Ar

1. What are the main gases that comprise our atmosphere? What is their relative abundance? For the 3 most abundant gases in our atmosphere, give their importance and how they are deposited. See NOTES

2. Briefly describe the greenhouse effect. What are some major greenhouse gases and what are their sources?
Gases like CO_2 trap heat in the atmosphere.

3. State the major contributions of the following scientists:

NOTES!

- Galileo	- Torricelli	- Von Guericke	- Pascal
- Huygens	- Dalton	- Gay-Lussac	- Avogadro

4. Define the following terms:
   - Pressure: force per unit area
   - Standard Pressure: Pressure at sea level (1atm)
   - Absolute zero: -273°C - temp when Volume of a gas = Ø

5. Explain why Galileo's pump could only raise water about 32ft?
P_{ATM}

6. Compare & contrast manometers and barometers.
manometers → measure P_{gas} Barometers → measure P_{ATM}

7. Compare and contrast mercury and aneroid barometers
NOTES.

8. State the relationships each of the following scientists developed. Show how they can be combined into one "combined gas law".
   - Robert Boyle: $P_1V_1 = P_2V_2$
   - Jaques Charles: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
   - Joseph Gay-Lussac: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

9. Describe how absolute zero was determined. A graphical representation may help here.
V vs T graph → extrapolate to zero Volume.

10. Convert 107.2 kPa into the other 4 units we have learned (atm, mmHg, bar, mbar).
107.2 kPa = 1.05 atm = 804.3 mmHg = 1.05 bar = 1050 mbar

11. If 35.0mL of gas a 787mmHg is changed to 17.90mL at constant temperature, what is the final pressure?
1538.8 mmHg

12. If 4.75L of gas at 1.74 atm is changed to 545 mmHg at constant temperature, what is the new volume?
11.5 L

13. If 3.20L of gas a 0.00°C is changed to 2874mL at constant pressure, what is the final temperature?
245 K = -27.8°C

14. If 11.7L of neon at 48°C is heated to 54°C, what is the new volume?
11.9 L

15. A propane tank has a pressure of 140mmHg at 25°C. If the temperature drops to -5°C what is the new pressure in the tank?
125.9 mmHg

16. A gas has a pressure of 485mmHg at 20°C. If the pressure changed to 900mmHg, what would the new temperature be? 543.7 K = 270.7°C

17. A gas occupies a volume of 340.2 mL at a temperature of 15.0 °C and a pressure of 5.8 atm. What will be the volume of this gas at standard conditions?
1869.3 mL

18. The volume of a gas originally at standard temperature and pressure was recorded as 278.8 mL. What volume would the same gas occupy when subjected to a pressure of 101.0 atm and temperature of minus 222.0 °C?
0.5 mL

19. At a pressure of 760.0 mm Hg and 24.2 °C, a certain gas has a volume of 750.0 mL. What will be the volume of this gas under STP
688 mL

20. A gas sample occupies 3.25 liters at 34.7 °C and 825 mm Hg. Determine the temperature at which the gas will occupy 5454 mL at 1.75 atm.
832.4 K = 559.4 °C

Unit 3: Chemical Reactions

1. Name the following compounds:

a) $Mg(NO_3)_2$ Magnesium Nitrate
b) $NaHCO_3$ Sodium bicarbonate
c) N_2O_5 dinitrogen Pentoxide
d) $Sn(NO_4)_2$ Tin (II) pernitrate
e) CCl_4 Carbon tetra chloride
f) $KMnO_4$ Potassium Permanganate

2. Give the molecular formula for the following compounds.

a) dinitrogen trioxide N_2O_3
b) copper (II) sulfate $CuSO_4$
c) Chlorine Cl_2
d) Aluminum dichromate $Al_2(Cr_2O_7)_3$
e) ammonium phosphate $(NH_4)_3PO_4$
f) diphosphorus pentoxide P_2O_5

3. State the law of conservation of mass, AND give an example of where you may see this in action (could be a demo, a real life example, etc.)
Matter can't be lost in a chem rxn (mass is constant)

4. State the use of 2 isotopes that you studied in this course.
ex) C-14 - used to determine age of old artifacts.

5. Elemental Boron is a combination of two naturally occurring isotopes: Boron-10 has a relative abundance of 19.78%, and boron-11 has a relative abundance of 80.22. Find the average atomic mass.

B-10 $10 \times 0.1978 = 1.978$
B-11 $11 \times 0.8022 = 8.8242$
10.8 amu

6. Determine the average atomic mass of the element Germanium from the relative abundances below.

Isotope	Relative Abundance	
Ge-70	20.5%	14.35
Ge-72	27.4%	19.728
Ge-73	7.8%	5.694
Ge-74	36.5%	27.01
Ge-76	7.8%	5.928

Avg = 72.71 amu

7. Predict the products of the reactions below. Then write the balanced equation and the reaction type.

S.R a. magnesium bromide + Chlorine → $MgBr_2 + Cl_2 \rightarrow MgCl_2 + Br_2$

S.R b. aluminum + iron(III) oxide → $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$

Synth c. nitrogen + hydrogen → $N_2 + 3H_2 \rightarrow 2NH_3$

Comb. d. methanol + oxygen → $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

8. Solve the following stoichiometry problems. Show all work.

a) How many moles of hydrogen are produced from the reaction of 12.8 g of zinc with excess hydrochloric acid? ← HCl

0.196 mol H_2

b) How many grams of potassium chloride are produced if 25g of potassium chlorate decompose? How many litres of O_2 are produced? $2KClO_3 \rightarrow 2KCl + 3O_2$

15.2g KCl & 6.85 L O_2

c) If 10.0 g of aluminum chloride are decomposed, how many molecules of Cl_2 are produced? $2AlCl_3 \rightarrow 2Al + 3Cl_2$ 6.76 molecules Cl_2

d) Silver nitrate and sodium phosphate are reacted in equal amounts of 175 g each. How many grams of silver phosphate are produced? How many grams of the excess is remaining from problem d?

418.7g Ag_3PO_4, 119 g of excess remains (Na_3PO_4)

e) Given the reaction $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O + 1377\ kJ$ How much energy is produced when 4700 grams of propane(C_3H_8) is burned?

146 821.7 kJ

9. A sample of a molecule is found to contain 18.7% lithium, 16.3% carbon, and 65.0% oxygen. Find the empirical formula for the compound. Li_2CO_3

10. If the molar mass of the compound in question #6 is known to be 73.8g/mol, what is the molecular formula of the compound? 1x ∴ Li_2CO_3 (same as empirical)

11. Determine the empirical and molecular formula for a compound that has a molar mass of 227g/mol, and the following percent composition: 37.0% carbon, 2.20% hydrogen, 18.5% nitrogen and 42.3% oxygen.

empirical = $C_7H_5N_3O_6$

molecular = $C_7H_5N_3O_6$

Unit 4: Solubility

1. Describe how one could increase the solubility of a solid in a liquid.
   heat, more solvent, different solute
2. A glass of cold water left sitting on a counter at room temperature usually develops many small gas bubbles on the inside of the glass. Describe what is likely happening.
   Air is dissolving
3. Discuss how the solubility of a substance is dependent on the nature of the solute and solvent. like dissolves like.

4. Solve the problems below.
   a) What is the molarity of 5.30 g of Na_2CO_3 dissolved in 400.0 mL solution? 0.125M
   b) How many grams of $Ca(OH)_2$ are needed to make 100.0 mL of 0.250 M solution? 1.853g
   c) What volume of Li_2SO_3 is produced when 4.67 moles is dissolved to make a 1.89M solution? 2.47L
   ~~d)~~ Ammonia solution is made by diluting 150 mL of the concentrated commercial reagent until the final volume reaches 850 mL. What is the concentration of the new solution? OOPS, forgot to give starting conc.
   e) Calculate the final concentration if 2.00 L of 3.00 M NaCl and 4.00 L of 1.50 M NaCl are mixed. 2 mol/L

5. Explain the difference between an unsaturated, a saturated and a supersaturated solution.
   Saturated – max solute in given solvent
   unsat. – less than max solute in given solvent
   super – more than max solute in given solvent
   } at given temp
6. What is meant by the saying "like dissolves like"
   polar dissolves polar, nonpolar dissolves non polar, polar + non polar don't mix
7. There are 9 different types of solutions. List 3 giving examples of each.
   NOTES: solid-solid, gas-gas, gas-solid, liq-liq, gas-liq, solid-solid etc.
8. Explain, on a particle level, the difference between dissolving an ionic compound versus a molecular (covalent) compound.
   ionic dissociates into ions, covalent just dissolves.
9. Describe how you would use a 250ml volumetric flask to make 250ml of a 0.75 mol/L solution of aluminum hydroxide. (show any calculations)

$0.75\ \frac{mol}{L} \times 0.25\ L = 0.1875\ mol\ Al(OH)_3$ ~~x (g/mol)~~ = 0.0024 mol

$0.1875\ mol \times \frac{78.03\ g}{1\ mol} = 14.36\ g$

- add 14.36g $Al(OH)_3$ to flask.
- ½ fill with deionized H_2O
- shake/stir to dissolve
- dilute to the mark

10. **Use the attached solubility curve to answer the following questions:**

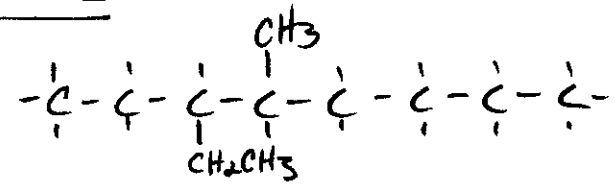
a) What is the solubility of potassium nitrate in 100 grams of water at 40°C? 62g/100g H2O
b) What is the solubility of potassium chloride in 100 grams of water at 40°C? 38g/100g H2O
c) What is the solubility of sodium chloride in 100 grams of water at 80°C? 39g/100g H2O
d) What is the minimum temperature needed to dissolve 125 grams of potassium nitrate in 100 grams of water? 67°C
e) What is the minimum temperature needed to dissolve 25 grams of potassium chloride in 100 grams of water? ≈ 0°C
f) At what temperature do potassium chloride and potassium nitrate have the same solubility? ~~38°C~~ 20°C
g) If 20 grams of potassium chlorate are mixed with 100 grams of water at 50°C, how much will not dissolve? 0g
h) If 200 grams of potassium nitrate are mixed with 100 grams of water at 55°C, how much will not dissolve? 110g
i) If 65 grams of sodium nitrate are added to 100 grams of water at 35°C, how much more must be added to saturate the solution? ~~45g~~ 35g
j) If 95 grams of potassium iodide are added to 100 grams of water at 15°C, how much more must be added to saturate the solution? ~~50g~~ 46g
k) 250 grams of water are saturated with sodium nitrate at 25°C. If this solution is heated to 65°C, how much more can be dissolved? 95g
l) 30 grams of water at 70°C are saturated with potassium chlorate. If this solution is cooled to 25°C, how much of the solid will precipitate (change, from the dissolved state to the solid state)? 7.2g
m) How much potassium nitrate will dissolve in 55 grams of water at 50°C? 44g
n) How much potassium nitrate will dissolve in 10 grams of water at 50°C? 8g

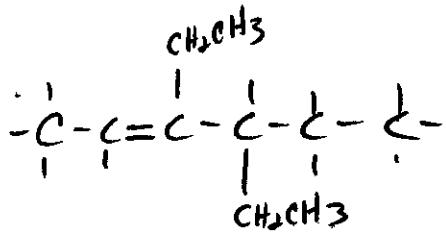
Unit 5: Organic Chemistry

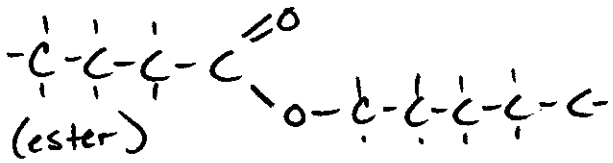
1. Draw each of the following structures and give the name of the group to which each belongs.
   a) 3- ethyl – 4 methyloctane
   b) 3,4 - diethyl-2 hexene
   c) pentyl- butanoate
   d) 2-methyl butane
   e) 2-ethyl-4-methyl 2-pentene
   f) 2-butene
   g) 2-propanol
   h) 2,4,-dimethyl-3 hexanol
   i) 3-ethyl-2,4-dimethyl-3-hexanol
   j) 2,2,3,3-tetramethyl-1-butanol
   k) 3-ethyl-2-methyl heptanoic acid
   l) 3,3-dimethylbutanoic acid
   m) 5 ethyl-2,2 dimethyl 3-octyne
   n) butanoic acid

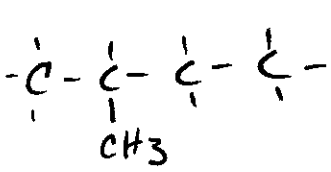
- SEE NEXT Pg.

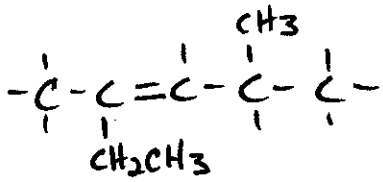
ORGANIC

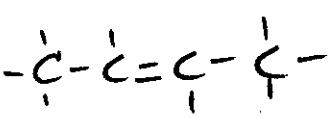
1. a) 

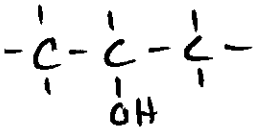
b) 

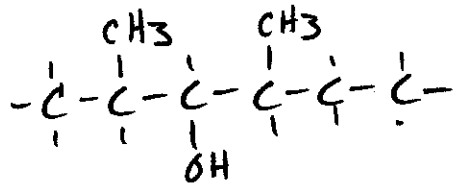
c) 

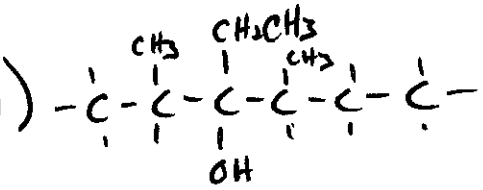
d) 

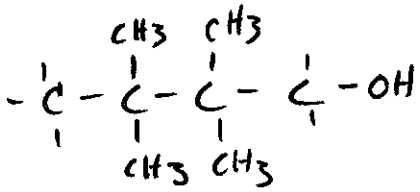
e) 

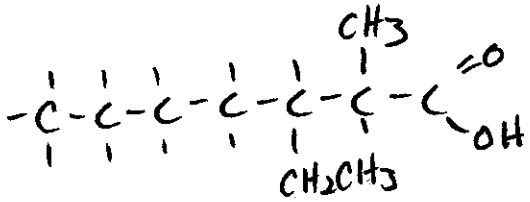
f) 

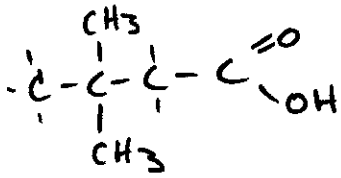
g) 

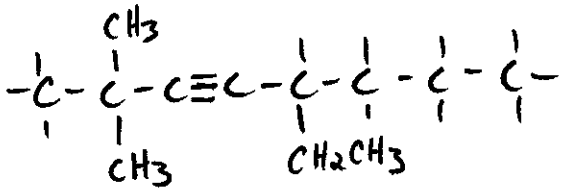
h) 

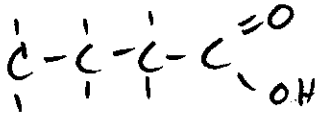
i) 

j) 

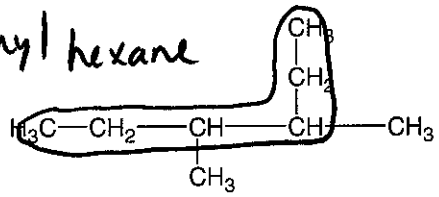
k) 

l) 

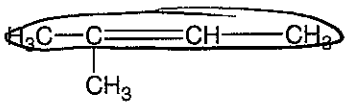
m) 

n) 

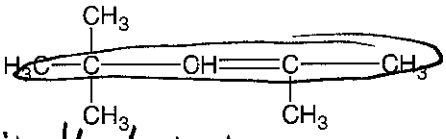
2. Give the IUPAC name for each of the following:



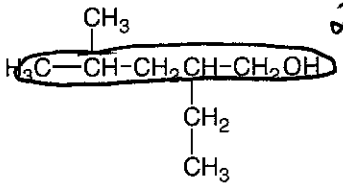
3,4 dimethyl hexane



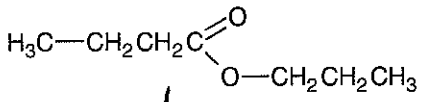
2 methyl 2-butene



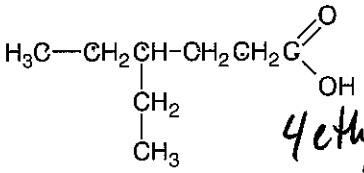
2,4,4 trimethyl 2 butene



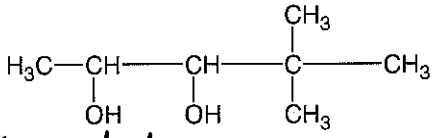
2 ethyl 4 methyl 1-pentanol



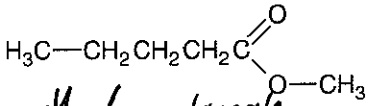
(ester) propyl butanoate



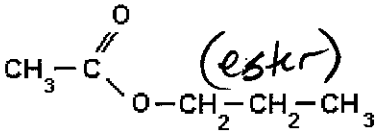
4 ethyl hexanoic acid



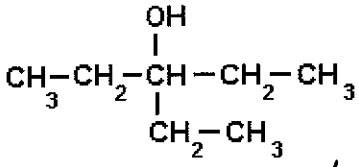
3,3 dimethyl 2,3 pentane diol



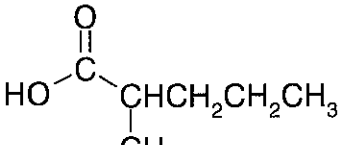
methyl pentanoate (ester)



propyl ethanoate



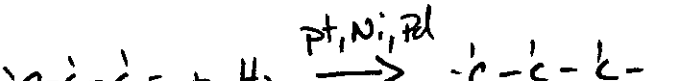
3 ethyl 3 pentanol



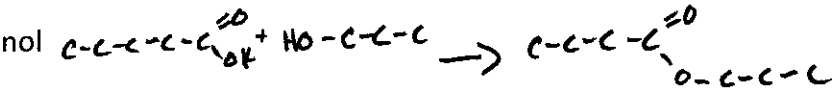
2 methyl pentanoic acid

3. Write a balanced equation for each of the following reactions. Use structural formulas for all organic compounds.

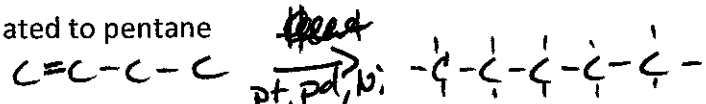
a) Hydrogenation of propene to propane



a) pentanoic acid reacting with propanol (esterification)



c) 2- pentene ~~h~~ hydrogenated to pentane



d) The complete combustion of octane

$$2\,C_8H_{18} + 25\,O_2 \longrightarrow 16\,CO_2 + 18\,H_2O$$

4. Describe what is meant by saturated and unsaturated in organic chemistry.
SATURATED = Single bonds, unsaturated double/triple bonds

5. What happens to the solubility of alcohols and carboxylic acids as the chain length increases? Sol. ↓ as chain gets longer

6. Write the general formulas for each of the following:
   a) alkanes C_nH_{2n+2}
   b) alkenes C_nH_{2n}
   c) alkynes C_nH_{2n-2}
   d) aromatic hydrocarbons 
   e) ester $R-C(=O)-O-C-R'$
   f) carboxylic acid $R-C(=O)-OH$
   g) alcohol $R-C-OH$

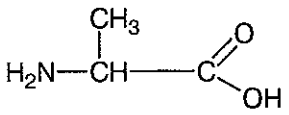
7. What is the name of the functional group in alcohols? In acids?
alcohols = hydroxyl Acids = carboxyl

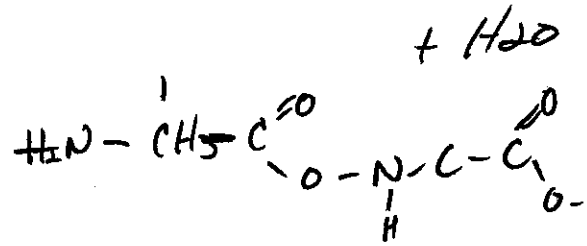
8. What are structural isomers? Draw and name 5 structural isomers of octane.
- same molecular formula, different name & structure

9. How many Litres of oxygen ~~gas, at STP, are needed to burn~~ 25.0 g of octane? (hint: think stoichiometry)
61.3 L O_2

10. Choose an alkene. Write the hydrogenation and dehydrogenation reaction for your alkene. Be sure to include any catalysts/conditions that may be necessary, and to draw the expanded structural formula for all hydrocarbons.
See NOTES.

11. a) Given the following starting monomer for polymerization, write the polymerization of three units. Clearly show the products





   b) Classify the polymerization as CONDENSATION or ADDITION polymerization. Explain why.

12. How does the length of the carbon chain affect the melting/boiling points in aliphatic hydrocarbons?
↑ chain length, BP/MP ↑

13. Give a similarity and a difference between addition, condensation, and cross-linked polymers.
Similarity = both connect smaller monomers to make polymers

diff. → NOTES