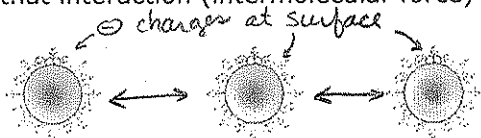


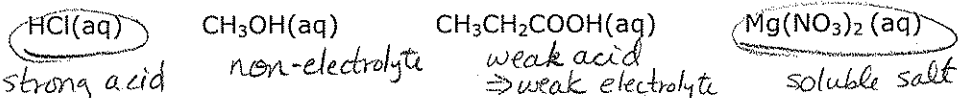
See the last page for some useful information

1. a. Below is a sketch of a few gold nanoparticles with their adsorbed citrate layer. Alter the sketch to show the interactions that keep these nanoparticles suspended in solution. Identify that interaction (intermolecular force) by name: ion-ion repulsions



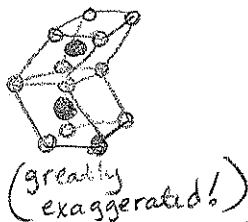
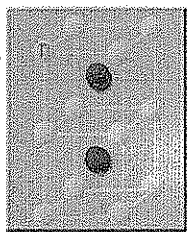
(ion-dipole w/ H₂O would also occur but are not as strong)

- b. You observed in lab that adding certain aqueous solutions to a suspension of gold nanoparticles will cause them to aggregate. Predict (circle) which of the following solutions will cause aggregation: lots of ions needed ⇒ strong electrolytes



2. One type of orthodontic archwire is NiTi in the austenite phase. The wire is stiff and so, when wrapped around the braces, applies high, constant force to the teeth. Directions to an orthodontist bending this wire to fit an orthodontic brace include: "For easier insertion, try using Chill Spray (an aerosol spray that lowers temperature). Spray the Chill Spray onto a swab and rub the swab on the desired section of the NiTi archwire. This will transform the wire and allow the clinician to easily engage (bend) the wire. The wire will return to its original high force shortly after it is placed in the mouth."

- a. What phase transformation does 'Chill Spray' cause in NiTi? austenite → martensite
(inflexible → flexible)
- b. What happens to cause the wire to return to its original high force?
heat from mouth causes phase transition from martensite → austenite
- c. Instructions for the orthodontist include a diagram of a portion of the austenite crystal lattice (see below, light spheres = Ti, dark spheres = Ni). Make a sketch to show how this section of the lattice might change if the NiTi were martensite instead of austenite.



slight shifts in planes of atoms ⇒ distortion of crystal

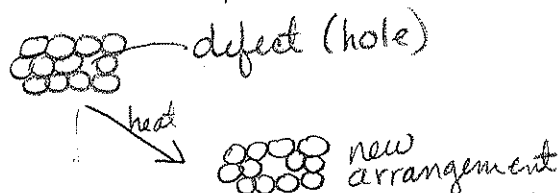
- d. Sketch the NiTi unit cell. Is it correct to say that this is a body-centered cubic cell?



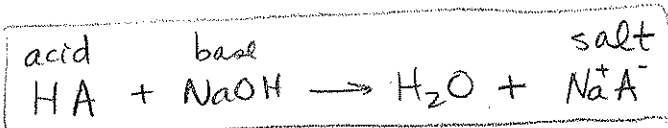
Not BCC since all atoms are not identical. (It's really two interwoven simple cubic cells.)

- e. In lab, you 'trained' NiTi to a new shape. Explain, using words and sketches, what happens to the atoms in the crystal during 'training.'

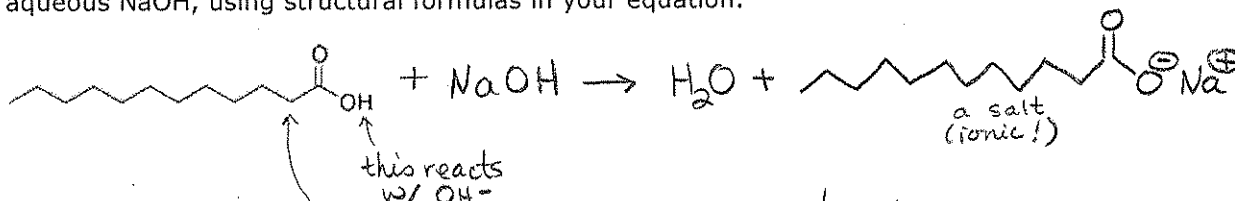
Crystal defects (holes in lattice) are rearranged



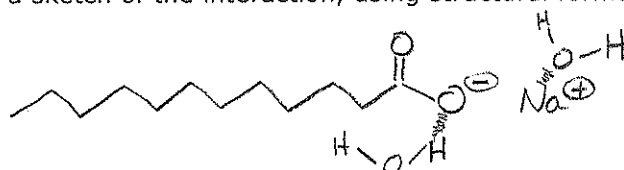
From Prelim Assignment
Question 1a:



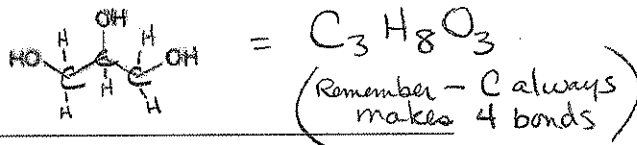
3. a. The breakdown of oils produces fatty acids - e.g., coconut oil yields lauric acid (C₁₂H₂₄O₂, structural formula shown below). When you 'titrate oil' with NaOH, it is these fatty acids that react with NaOH. Write a balanced equation for the reaction of lauric acid with aqueous NaOH, using structural formulas in your equation.



- b. Predict the solubility of lauric acid in water (high or low?): low
The long hydrophobic tail makes the water solubility low
- c. The 'main' product (the one derived from lauric acid) of the titration reaction is soluble in water. Name the intermolecular attraction that accounts for this: ion-dipole
(dipole = H₂O)



4. The byproduct of biodiesel synthesis is glycerol:



- a. What is the molar mass of glycerol? 92.1 g/mole

Based on Prelim Assignment Question #2

- b. If you use 100. mL of vegetable oil plus 10.0 mL of methanol in your biodiesel synthesis, how many moles of glycerol should you be able to make? See the last page for essential data. Clearly outline your reasoning and show all calculations.

① Find moles

$$\left\{ \begin{array}{l} (100. \text{ mL oil}) (0.92 \text{ g/mL}) \left(\frac{1 \text{ mol}}{506 \text{ g}} \right) = 0.18 \text{ mol oil} \\ (10.0 \text{ mL CH}_3\text{OH}) (0.79 \text{ g/mL}) \left(\frac{1 \text{ mol}}{32.0 \text{ g}} \right) = 0.25 \text{ mol CH}_3\text{OH} \end{array} \right.$$

② Identify Limiting Reactant

$$\left\{ \begin{array}{l} 0.18 \text{ mole oil requires: } 0.18 \text{ mol oil} \left(\frac{3 \text{ mol methanol}}{1 \text{ mol oil}} \right) = 0.54 \text{ mole CH}_3\text{OH} \\ \text{we don't have this much} \Rightarrow \text{CH}_3\text{OH is limiting} \end{array} \right.$$

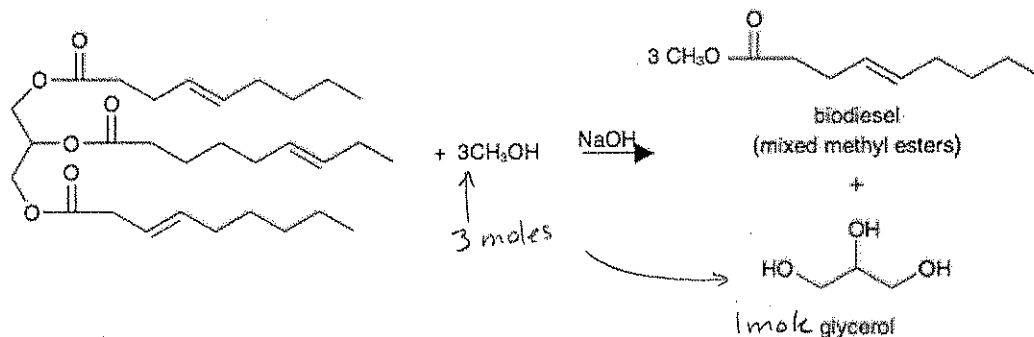
③ Calc Theor. Yield Based on L.R.

$$\left\{ \begin{array}{l} 0.25 \text{ mol CH}_3\text{OH} \times \frac{1 \text{ mol glycerol}}{3 \text{ mol CH}_3\text{OH}} = \boxed{0.083 \text{ mol glycerol}} \\ \text{limiting reactant} \end{array} \right.$$

Bonus Question: In 15 words or less, explain the role that NaOH plays in the synthesis of biodiesel:

It acts as a catalyst (plus it neutralizes free fatty acids)

Possibly Useful Information – you may detach this page if you like....



Density of vegetable oil:	0.92 g/mL ←	Used in 4b
Density of methanol:	0.79 g/mL ←	
Density of Biodiesel:	0.88 g/mL	
Average molar mass of vegetable oil:	506 g/mole ←	

The Solubility Rules

- nitrates All *nitrates* are soluble.
- acetates All *acetates* are soluble, (silver acetate only moderately).
- chlorides All *chlorides* are soluble, except silver, mercury(I), and lead(II) chlorides. (Lead(II) chloride is slightly soluble in cold water.)
- sulfates All *sulfates* are soluble, except those of barium and lead. (Sulfates of silver, mercury (I) and calcium are slightly soluble.)
- carbonates & phosphates All *carbonates* and *phosphates* are insoluble, except those of sodium, potassium, and ammonium. (Many acid phosphates are soluble.)
- hydroxides All *hydroxides* are insoluble, except those of sodium, potassium, barium, and strontium. (Calcium hydroxide is slightly soluble.)
- sulfides All *sulfides* are insoluble, except those of sodium, potassium, and ammonium, magnesium, calcium, strontium, and barium.
- some cations All salts of *sodium*, *potassium*, and *ammonium* are soluble, except several uncommon ones. All *silver* salts are insoluble, except silver nitrate and silver perchlorate. (Silver acetate and sulfate are moderately soluble.)