Name: _____

Chem 1A, Instructor: L. Yee
October 3, 2008

QUIZ 1

Show all work!

Quiz 1 is worth 10% of your grade (50 points). For full credit, show all work in a logical and legible sequence. Clearly underline or circle your final answer. Include units where needed. You may use a Periodic Table, one 3"x5" note card, and a calculator. You may ask me for a hint; however, each hint will cost you 1 point.

1. (6 points) Agree or disagree with the following statements. Support your answer with chemical reasoning, calculations, analogies, examples, etc.

a. Sodium hydroxide is an ionic compound, is soluble in water, is a base, and is a poor electrolyte.

b. When 200 ml of 50% ethanol is distilled, the ethanol boils off because it has a higher freezing point than water.

2. (9 points) a. What do the subscripts in a chemical formula and coefficients in a chemical equation represent?

b. A chemical reaction is represented by a chemical equation. Why is it necessary to balance a chemical equation?

c. When exposed to air, Al metal becomes coated with an oxide layer whereas Au metal does not become coated with an oxide layer. Explain this observation in terms of the Activity Series of the Elements.

d. Explain why a 0.1 M solution of a strong acid, e.g., HCl, has a higher conductivity than 0.1 M solution of a weak acid, e.g., acetic acid.

3. (15 points) You are cleaning out your lab locker and see three flasks partially filled with liquids. The liquid in each flask is coloress. The label on each flask reads "Na *#-" with the rest of the chemical formula smudged so you can't identify the solution. You review your lab notebook and find you prepared solutions of sodium carbonate, sodium phosphate (TSP), and sodium chloride. To identify the liquid, you perform the following tests:

Test/Observation	Conclusion
(i) red litmus turns blue	
(ii) add a few drops of 0.1 M $AgNO_3$ (aq) to the liquid and a white solid forms	
(iii) add 0.1 M HCl and bubbles form	

a. Draw a conclusion for each observation in the space above. Which substance can you eliminate from the test?

b. What is the identity of this liquid? If you can't definitively identify the liquid, what other observation or test would you need to do to identify the liquid?

c. For Test (ii), write a molecular equation and net ionic equation that shows the formation of the white solid.

d. For Test (iii), write a molecular equation and net ionic equation that shows the formation of the bubbles.

4. (20 points) You have an upset stomach after eating too much spicy food last night. Somehow, you figure that you have 150 ml of excess stomach acid (pH 1.5 hydrochloric acid). You take 500 mg of Milk of Magnesia antacid (active ingredient: magnesium hydroxide).

a. Calculate $[H^+]$ of pH 1.5 HCl.

b. Describe how you would prepare 150 ml of pH 1.5 hydrochloric acid from 0.100 M hydrochloric acid.

c. Write a molecular and net ionic equation that represents the reaction between hydrochloric acid and Milk of Magnesia.

d. Will the 500 mg of Milk of Magnesia completely neutralize the 150 ml of pH 1.5 hydrochloric acid? Fill in the blanks below to support your answer. Show your calculations for full credit.

_____ $Mg(OH)_2$ (s) + _____ HCl (aq) → _____ + _____

amount	500 mg	150 ml pH 1.5
moles	_____	_____
moles that react	_____	_____
moles leftover	_____	_____

Chem 1A, QUIZ 2
Posted November 7, 2008

Quiz 2 is worth 10% of your grade (50 points). Quiz 2 will be given on Friday, November 14, 2008 during lecture. Questions from the following two topics will be given on Quiz 2. **Approximately half of Quiz 2 will involve questions on these two topics.** The remaining half of Quiz 2 will cover other Chem 1A topics.
Between now and November 14, 2008, I encourage you to work with other Chem 1A students to attempt to identify questions from each topic and the solutions. If you work in a group, every person should contribute.
1. Methyl salicylate($C_8H_8O_3$) is the wintergreen flavor in Wint-o-green Lifesavers. When Wint-o-green Lifesavers are crushed with a tool (such as your teeth), they emit a blue spark. This phenomena is referred to as triboluminescence. When the candy is crushed, the crystalline structure is stressed and broken, sugar molecules are broken unequally, and an electrical potential difference is created across the pieces of candy. Electrons flow through the air space between two pieces of candy. Nitrogen molecules in the air absorb this electrical energy and undergo a transition to an excited state. The excited nitrogen molecules then emit ultraviolet light which is absorbed by the methyl salicylate molecules in the candy. The methyl salicylate molecules emit visible light in the form of blue-green sparks.
The triboluminescence of Wint-o-green Lifesavers occurs in 5 steps as represented by the following chemical reactions. The * represents an excited state.

sucrose + mechanical energy -----> broken sucrose + electrical energy	(1)
N_2 (g) + electrical energy ----> N_2* (g)	(2)
N_2* (g) -----> N_2 (g) + UV light (330 nm)	(3)
$C_8H_8O_3$ + UV light (330 nm) ------> $C_8H_8O_3$*	(4)
$C_8H_8O_3$* -----> $C_8H_8O_3$ + blue light (455 nm)	(5).

2. Read the Department of Energy web page on Greenhouse Gases, Global Climate Change, and Energy (http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html).

Name: _____

Chem 1A, Instructor: L. Yee
November 14, 2008

QUIZ 2
Show all work!

Quiz 2 is worth 10% of your grade (50 points). For full credit, show all work in a logical and legible sequence. Clearly underline or circle your final answer. Include units where needed. You may use your textbook, notes, a Periodic Table, a 3"x5" note card, and a calculator. You may ask me for a hint; however, each hint will cost you 1 point.
1. (6 points) Agree or disagree with the following statements. Support your answer with chemical reasoning, calculations, analogies, examples, etc.
a. If the amount of energy needed to break bonds in the reactants is greater than the amount of energy released when bonds form in the products, the chemical reaction will be exothermic.
b. Wave 1 (shown below) could represent blue light whereas Wave 2 could represent red light.

Wave 1:

Wave 2:

2. (8 points) a. What experiment showed that light behaves like a particle?
b. Electron energy states (levels) are quantized. What does quantized mean?
c. Explain why much smaller objects can be observed with an electron microscope compared to a light microscope. Be specific. What specific equation or idea led to the use of electrons instead of light in microscopes?

3. (10 points) Sulfuric acid is the most produced chemical in the U.S. Its production and manufacture is described on the following website: http://www.ausetute.com.au/sulfacid.html. In 1995, 95.4 billion lbs of sulfuric acid was manufactured.
a. The overall reaction for the sulfuric acid manufacturing process is:

___ S (s) + ____ O_2 (g) + _____ H_2O (l) ------> _____ H_2SO_4 (l)

Balance the chemical equation. Is this reaction an oxidation-reduction reaction? If so, identify the oxidizing agent and reducing agent.

b. Calculate the heat of reaction for the reaction in part a.

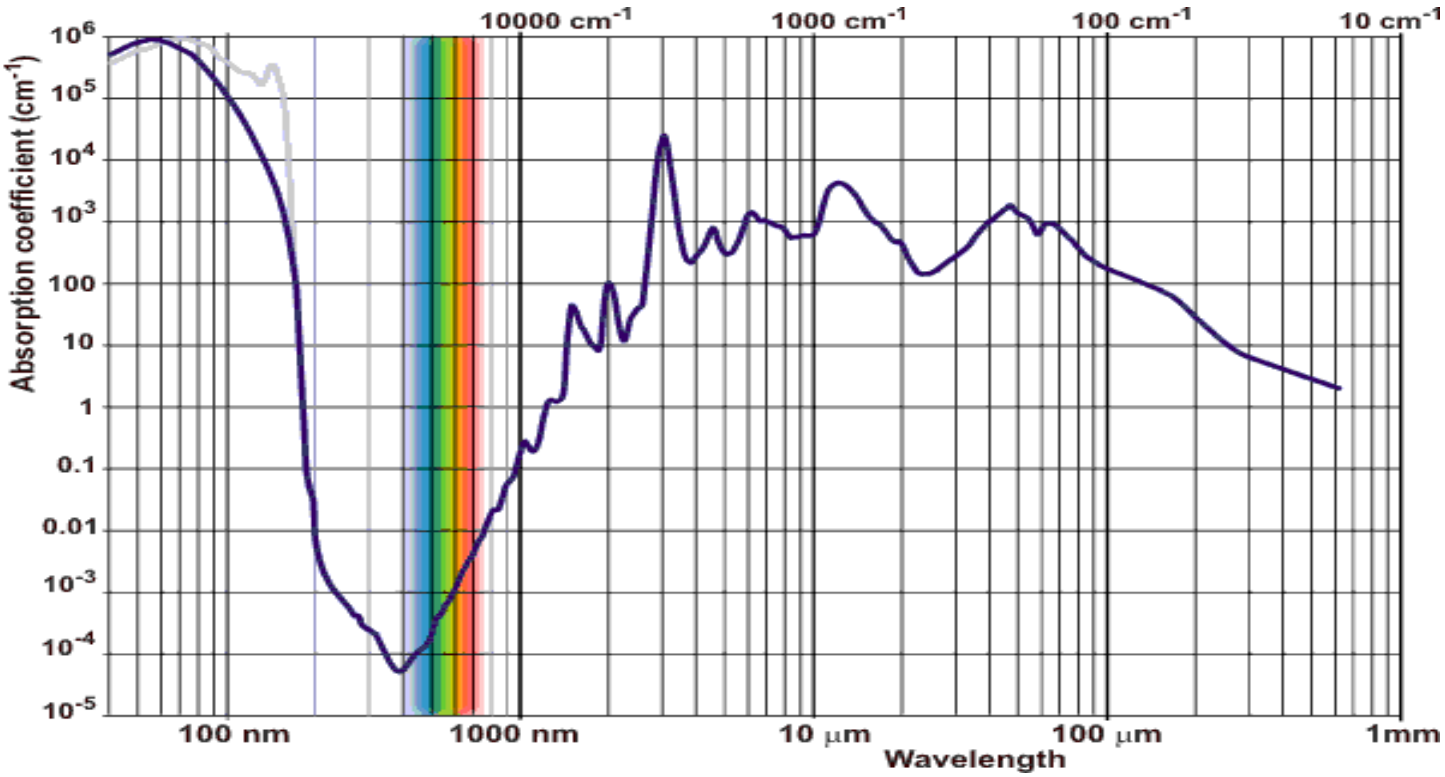
c. Calculate the volume of water that could be heated from 25°C to 100°C using the heat produced in the manufacture of one mole of sulfuric acid.

4. (14 points) Go to the Department of Energy web page on Greenhouse gases, global climate change, and energy (http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html).

a. What makes a gas a greenhouse gas?

b. Name the top 3 greenhouse gases that are emitted by the U.S. For each gas, give the chemical formula and draw the Lewis structure. Which gas(es) are soluble in water? Give reasons.

c. The absorption spectrum of water is shown below (reference: http://www.lsbu.ac.uk/water/vibrat.html). Based on this spectrum, is water a greenhouse gas? Give reasons. (Extra credit: 1 point. Explain why water is coloress.)

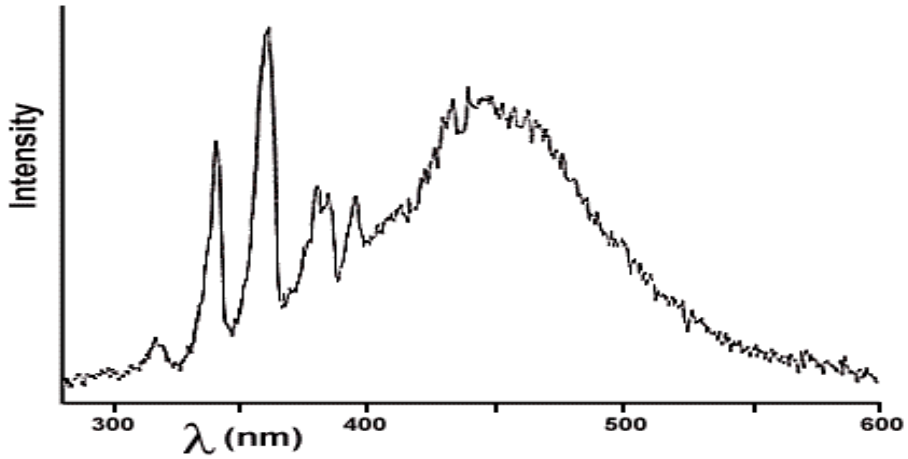


5. (12 points) Methyl salicylate($C_8H_8O_3$) is the wintergreen flavor in Wint-o-green Lifesavers. When Wint-o-green Lifesavers are crushed with a tool (such as your teeth), they emit a blue spark. This phenomena is referred to as triboluminescence. When the candy is crushed, the crystalline structure is stressed and broken, sugar molecules are broken unequally, and an electrical potential difference is created across the pieces of candy. Electrons flow through the air space between two pieces of candy. Nitrogen molecules in the air absorb this electrical energy and undergo a transition to an excited state. The excited nitrogen molecules then emit ultraviolet light which is absorbed by the methyl salicylate molecules in the candy. The methyl salicylate molecules emit visible light in the form of blue-green sparks. The triboluminescence of Wint-o-green Lifesavers occurs in 5 steps as represented by the following chemical reactions. The * represents an excited state.

sucrose + mechanical energy -----> broken sucrose + electrical energy	(1)
N_2 (g) + electrical energy ----> N_2* (g)	(2)
N_2* (g) -----> N_2 (g) + UV light (330 nm)	(3)
$C_8H_8O_3$ + UV light (330 nm) ------> $C_8H_8O_3$*	(4)
$C_8H_8O_3$* -----> $C_8H_8O_3$ + blue light (455 nm)	(5).

a. A partial Lewis structure of methyl salicylate is shown below. Fill in the double bonds, lone pairs of electrons, and hydrogens in the structure.

b. According to the above steps, 330 nm UV light excites methyl salicylate from its ground state to an excited state. 455 nm blue light is emitted when methyl salicylate de-excites (relaxes) back to its ground state. Draw a simple energy level diagram for methyl salicylate. Calculate the energy differences (ΔE) between the ground state and the excited states and show these ΔE in your diagram.
c. The emission spectrum of Wint-o-green Lifesavers is shown below. Circle the peak in the emission spectrum which corresponds to Step (3) in the triboluminescence of Wint-o-green Lifesavers.



Chem 1A, FINAL EXAM - TAKE-HOME PART
due Wednesday, December 17, 2008 at 8 am

The Take Home Part of the Final Exam is worth 10% of your grade (50 points). For full credit, show all work in a logical and legible sequence. Clearly underline or circle your final answer. Include units where needed. You may work in groups on Questions 1 – 3 of the Final Exam. **You must do Question 4 on your own.** If you work in a group, make sure every member contributes to the solutions. Turn in one set of solutions with the names of each member of your group. If you discuss any question or part of a question with another student, you are working in a group.
1. (6 points) You have solid lye (NaOH), vinegar (0.9 M CH_3COOH), solid salt (NaCl), 1M Cu^{2+} solution, and gasoline (C_8H_{18}) to use as cleaning agents. You need to clean up the following substances:
(i) You have a rust (Fe_2O_3) stain in your stainless steel sink.
(ii) Automotive grease ($C_{12}H_{26}$).
a. Which cleaning agent would you use to clean up each substance? Give reasons. If a chemical reaction occurs in the clean up, write a balanced molecular equation and net ionic equation that represents this reaction.
b. You consider using a mechanical method, i.e., scrubbing, to clean off the rust off of your stainless steel sink. You want to choose a scouring pad that is softer than the stainless steel sink otherwise the sink will be scratched. Would you use a diamond pad, pour solid NaCl on a dry sponge and scrub, use a HDPE (high density polyethylene plastic), or stick to a chemical method to clean the sink without scratching? Give reasons.

2. (20 points) In the World of Chemistry, Part 13 The Driving Forces, a chemical process in an industrial plant is designed so the highest energy products are produced first followed by successively lower energy products in a chain of reactions. The video showed a coal or petroleum processing plant that produced ethane (C_2H_6) first, followed by ethanol (C_2H_5OH), ethylene glycol ($C_2H_6O_2$), acetic acid, and finally, carbon dioxide and water.
a. For each organic substance, draw the Lewis structure, circle the organic functional group(s), write the name of the functional group next to your circle.
b. Explain this energy chain. In other words, why is ethane the highest energy substance and CO_2 and H_2O the lowest energy? Confirm that the energy order (ethane, ethanol, ethylene glycol, acetic acid, and carbon dioxide) of each product goes from highest to lowest. Draw an energy diagram to show your answer. (This diagram was shown in the video). Give quantitative energy values for each substance in your energy diagram.
c. For what reason is a plant designed so that the highest energy products are produced first followed by successively lower energy products?
d. Calculate the heat of combustion of each organic substance in kJ/mole and kJ/g. Write a chemical equation that represents each reaction. Show your results in a table.
e. Based on your answer in part d, which substance is the best fuel in terms of energy released? Give reasons. Is there a trend in the energy of the substance and the energy content of a fuel? Give reasons.

f. Where would ethylene (C_2H_4) be located on the energy chain? Give reasons.

3. (15 points) Concentrated sulfuric acid (18 M, density = 1.84 g/ml) is used in new car batteries. As a car battery gets discharged, the acid reacts with the lead metal plates leaving the acid less concentrated and dense. You don't have a hydrometer (a device that measures the density of a liquid) to measure the density of the acid; however, you can titrate the acid with NaOH and relate the concentration to density.
a. Write a chemical equation and net ionic equation that represents the reaction of lead with sulfuric acid.
b. Describe how you would make 400 ml of 2.5 M NaOH solution from solid NaOH. Calculate the mass of NaOH that you need to prepare this solution.
c. You standardized your NaOH solution with _____ and stopped adding NaOH, which was contained in a _____, when the solution turned _____ due to the addition of a few drops of _____. Your titration results for your three runs are 2.55 M, 2.41 M, and 2.62 M. Fill in the blanks. Comment on the accuracy and precision of this standardization. Calculate the % error or % difference or both from these results.
d. 98.25 ml of your NaOH solution from part c is used to titrate 10.00 ml of battery acid. Write a chemical equation and net ionic equation that represents this reaction. Calculate the concentration of the battery acid. Then, calculate the pH of this battery acid solution.
e. Do you think your battery needs to be replaced based on your results? Give reasons.

4. (10 points) According to the Chem 1A Course Information Handout, your "grade will be based on your performance and mastery of the last Course Objective." Each course objective is shown below.
a. For each objective, give yourself a grade (A – F) that reflects your understanding of that objective. Be honest and be fair to yourself. Don't be too easy but don't be too harsh either
b. Identify the course objective that you understand the best. What did you do to help you understand this objective so well?
c. Identify the course objective that you understand the worst. What could you have done to understand this objective better?
d. Give yourself an overall course grade based on your understanding of the course objectives. (The grade you give yourself may not be your official course grade. Your instructor will determine your overall course grade.)

Objective	Description	Grade
1	use the Periodic Table to obtain information about elements, identify elements and compounds by type, write chemical formulas, name compounds, identify atomic structure, calculate molar mass	
2	predict properties of elements, compounds, and mixtures based on element or compound type and structure	
3	identify and describe acids and bases by name, structure, properties, and reactions; relate these compounds to pH	
4	determine the solubility of substances in water and perform solution calculations involving volume, concentration, and moles	
5	represent chemical reactions with balanced chemical equations; predict whether a reaction occurs from a net ionic equation	
6	perform chemical calculations, e.g., mass to moles, for compounds and reactions, such as empirical formula and stoichiometry	
7	distinguish between and describe the different states of matter, including the chemical forces that hold them together	
8	describe and calculate heat transfer calculations in physical and chemical processes; calculate the heat of reaction using Hess' law	
9	describe the atomic and electronic structure of atoms using quantum theory; describe the role of light in understanding atoms and molecules	
10	describe bonding in ionic and molecular compounds, draw molecular (Lewis) structures, determine molecular geometry using VSEPR theory to predict properties, such as polarity and solubility	
11	perform basic lab techniques and measurements	
12	design experiments, analyze and interpret data and results, draw conclusions	
	Overall Chem 1A Grade	

Name: _____

Chem 1A, Instructor: L. Yee
December 17, 2008

FINAL EXAM
Show all work!

The In Class part of the Final Exam is worth 10% of your grade (50 points). For full credit, show all work in a logical and legible sequence. Clearly underline or circle your final answer. Include units where needed. You may use your text book, notes, and a calculator. You may ask me for a hint; however, each hint will cost you 1 point.
Constants: c = 3.00 x 10^{8} m/sec, h = 6.63x10^{-34} J sec, R_H = 2.18x10^{-18} J, N_A = 6.02x10^{23} /mole, $R = 0.082 \frac{\text{L atm}}{\text{mole K}}$

1. (4 points) Agree or disagree with the following statements. Support your answer with chemical reasoning, calculations, analogies, examples, etc.
a. Tripling the amount of reactants in an endothermic reaction triples the amount of heat released by the reaction.
b. The most abundant isotope of carbon has 8 neutrons, 4 valence electrons; the quantum numbers for one of these valence electrons are n = 2, l = 1, m_l = 0, and m_s = -1/2.

2. (10 points) a. Your pet dog, Ralph, is relaxing on a hot summer day in the pool and a radio playing cool music that is plugged into a 120V outlet accidentally drops into the pool. Although you've heard of people (or animals) getting electrocuted when this happens, Ralph is safe and unharmed. Did the pool contain champagne (alcohol, C_2H_5OH) or did it contain mineral water (water with various salts in it)? Give reasons.
b. During your astronaut training, your helmet pops off. Explain why the spit on your tongue and sweat on your body boils away.
c. If hot air rises, then why are there snow-capped mountains? Use gas laws to explain this statement. (Remember that pressure decreases as altitude (elevation) increases.)

3. (6 points) According to Care2.com (The Source for Natural Solutions to a NonToxic Lifestyle), some green eco-friendly cleaning agents are baking soda and vinegar.
a. Drains are often clogged by grease, which consists of fatty acids, or hair, which consists of proteins which are chains of amino acids. One way to unclog a drain is to pour 1 cup of baking soda followed by 3 cups of boiling water down the drain. How do you think this works to unclog a clogged drain? Identify the reaction type (a reaction that we studied in Chem 1A this semester).
b. Tap water, which contains various minerals and ions, that is left in a glass often leaves discolored rings and residue called scale. Scrubbing (the mechanical way) often doesn't work. One green eco-solution is to use vinegar. Since vinegar works, what type of substance (be specific) do you think scale is? Give reasons. Identify the reaction type (a reaction that we studies in Chem 1A this semester).

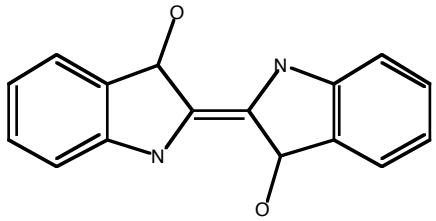
4. (8 points) The world is full of givers and takers. So is the chemistry world. The first column in the table below lists some chemical givers and takers. In the second column, identify which one is the taker. In the third column, identify what the taker is taking. In the fourth column, give the name and chemical formula of one example of that taker.

Givers and takers	Taker	What it takes	One example
Acids and bases			
Oxidizing agents and reducing agents			
Endothermic and exothermic			
Emission and absorption			

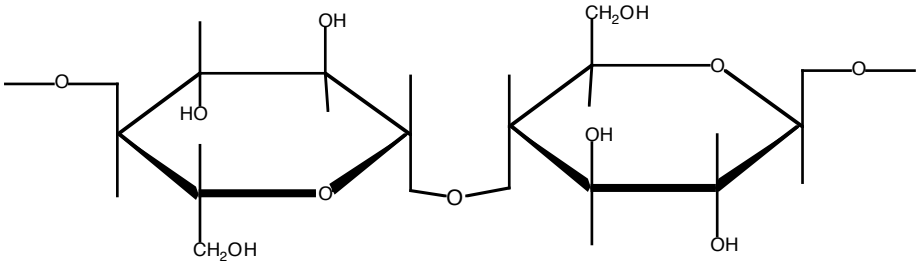
5. (8 points) You make two observations:
(i) A tube filled with gas that is connected to two electrodes in an electrical circuit emits red light.
(ii) A food coloring solution is red.
a. Draw an emission spectrum or absorption spectrum of each substance. Label the axes. Use wavelength on the x axis. **Label the approximate wavelength and color for each peak or line.**
b. Explain how you can use an emission spectrum or absorption spectrum to identify a substance.

6. (7 points) In a car engine, the air-fuel mixture is adjusted so all of the fuel burns with the O_2 in the air. 8 g of octane (C_8H_{18}) is burned in 400 ml of air (air = 80% N_2 + 20% O_2) at T = 1000°C and P = 10 atm. Determine the limiting reactant. Show your calculations for full credit. Will this car engine run well under these conditions? Give reasons.

7. (7 points) Indigo ($C_{16}H_{10}N_2O_2$, partial structure shown below) is the blue dye used for blue jeans. The complete structure cotton is also shown below.
a. For indigo only, draw in the double bonds, lone pairs of electrons, and the hydrogens to complete the Lewis structure of indigo. For one of the nitrogens in indigo, determine the molecular geometry at the N.



Indigo



Cotton

b. Identify the chemical forces between the dye and fabric. If H bonds exist, use a dashed line to show the H bond between the dye and fabric.
Extra credit: 2 points. Indigo is soluble in water but cotton is not. Give reasons.