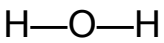
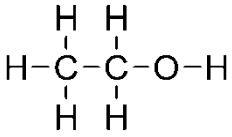
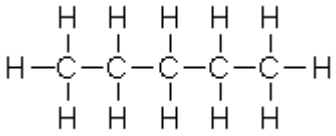
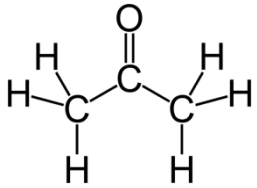
Vaporization Lab **Name: _____ Hour: _____**

Nova Chemistry 2018-2019

Mr. Lyman-Buttler

Substance	Uses	Formula	Structure
water	drinking, solvent, heating & cooling	H_2O	
ethanol	biofuels, disinfectant, liquor	CH_3CH_2OH	
pentane	solvent, fuel	C_5H_{12}	
acetone	nail polish remover	CH_3COCH_3	

Research question:

What determines a substance's heat of vaporization, ΔH_{vap}? (Heat of vaporization is a measure of the amount of energy needed to transform a mole of a particular liquid into a gas.)

Hypothesis: In this experiment, we will test two alternative hypotheses:

1) The amount of energy needed to vaporize a substance depends on its molecular mass.
2) The amount of energy needed to vaporize a substance depends on the strength of its intermolecular forces.

Prediction: If a hypothesis is correct, you should expect certain results. Fill in the table to make predictions based on each hypothesis.

1) Hint for Hypothesis 1: Which do you think would vaporize faster, a heavy molecule or a lighter one?
2) Hint for Hypothesis 2: Which do you think would vaporize faster, a molecule with strong or weak intermolecular forces?

Substance	Mol. mass* (g/mol)	% of bonds that are polar*: # of polar bonds / # total bonds	Strongest intermolecular force (hydrogen bond, dipole-dipole, or dispersion) USE THE CHEAT SHEET	Rank polarity 1 = least 4 = most	Hyp. #1 prediction 1 = fastest 4 = slowest	Hyp. #2 prediction 1 = fastest 4 = slowest
water						
ethanol						
pentane						
acetone						

*To calculate molar mass, add up the atomic mass of every atom in the molecule, e.g. H_2O = 1.01 + 1.01 + 16.00 = 18.02 g/mol

*Count up how many polar bonds the molecule has; then, divide by the total number of bonds in the molecule. Remember a double bond still counts as only one bond. e.g H_2O has 2 bonds and both of them are polar; 2 polar bonds ÷ 2 total bonds = 1 x 100 = 100%

Methods and Materials:

1. You need: **goggles,** stopwatch, aluminum foil, hot plate, pipettes, pentane, distilled water, acetone, ethylene glycol, ethanol
2. Cover the top of the hot plate with aluminum foil. Crimp the edges so that the foil is secured to the top of the hot plate. Turn the hot plate to 5 (note: this setting isn't guaranteed to work well; it depends on your hot plate…) and wait 5 minutes for the

hot plate to warm up. Each hot plate can be used by multiple groups, as long as each group picks a different spot on the foil to place their drops.

3. Have one group member place one drop of the chemical you are testing on the foil. (Hint: some of the liquids have very little *surface tension*, so they tend to run out of the dropper even if you don't squeeze it. Be careful with these.) Have a different group member use a stopwatch to time how many seconds it takes for the drop to evaporate completely.
4. Cleanup: Make sure all the containers are completely closed. Return the vials and pipettes to where you picked them up. Turn off the hot plates and unplug them. Leave the hot plates on the lab tables with the foil on them.

Results:

Copy your predictions from the previous page. For "Actual," rank order the molecules according to your actual evaporation times.

stamp

Substance	Seconds to evaporate (actual)	Hyp. #1 prediction 1 = fastest 4 = slowest	Hyp. #2 prediction 1 = fastest 4 = slowest	Actual 1 = fastest 4 = slowest
water				
ethanol				
pentane				
acetone				

Discussion:

On a separate sheet of paper, using paragraph form and complete sentences, write a discussion of your results. Use the rubric below as a guide. You might consider addressing questions like: does your data support one hypothesis more than it supports the other? Does either hypothesis fit your data perfectly? If not, which molecule(s) did not fit? Discuss the validity of your experiment. Do you believe your results? Why or why not? How did your results compare with those of other groups? (i.e. did you get your molecules in the same order as others?) How good were your lab techniques and your following of directions? What were the strengths and weaknesses of your method? What sources of measurement error may have affected your results, and to what extent? etc.

Key vocabulary words you should consider including in your writing: heat of vaporization, intermolecular forces, dispersion force, hydrogen bonding, dipole-dipole interaction, polar covalent bond, polar molecule, nonpolar molecule

	Communication	Prediction	Conclusion	Evaluation
0 Didn't do it	No key vocabulary from unit is used.	Missing or plagiarized	Missing, plagiarized, or entirely incorrect	Missing, plagiarized, or entirely incorrect
1-2 Didn't get it	Vocabulary is used mostly or entirely incorrectly, out of context, or appears only in phrases copied from notes. Writing is unclear, incoherent, or disorganized. Poor penmanship hinders readability.	Prediction contradicts hypothesis.	Decision to accept/reject hypothesis contradicts results or is not connected to outcome of experiment.	No claim is made as to validity of experiment, or claim is made with no support/explanation. No specific strengths or weaknesses identified.
3-4 Kinda got it	Vocabulary from the unit is used but some terms are used incorrectly, or does not clarify discussion, or phrases are unoriginal.	Prediction does not logically follow from hypothesis.	Decision to accept or reject hypothesis is consistent with results, but direct logical connection is not made.	Explains why student thinks experiment is valid/believable, but does not provide specific support for claim. Some strengths or weaknesses may be identified but not outlined.
5-6 Got it	Key vocab. from the unit is used accurately and appropriately to clarify discussion and to explain why data is meaningful. Presentation is well structured; spelling and grammatical errors do not hinder readability.	Prediction does not logically follow from hypothesis.	Accepts or rejects each hypothesis by comparing predicted results with actual results.	Evaluates if experiment is valid or believable; includes one good reason for claim. Strengths/weaknesses are outlined; practical & procedural issues are discussed in brief.
7-8 Nailed it	Key vocabulary from the unit is used in the student's own voice in such a way as to reveal deep conceptual understanding. Presentation is well structured and clear with no obvious errors.	Specific prediction logically follows from hypothesis.	Thoroughly evaluates each hypothesis; explains logic behind evaluations. Specific data and appropriate scientific knowledge cited to justify conclusion.	Evaluates if experiment is valid or believable; includes several good reasons for claim. Strengths/weaknesses (e.g. limitations of data, sources of error) are discussed thoroughly.