CHEM106 Section 002 Test #1
February 9, 2019

Name: Key

Use the answer sheet to record your answer for all questions. The test is broken into two parts: A multiple guess part (Fun!) and a short answer part (Games!). The Fun! questions are worth 3 points a piece and the Games! Questions are worth varying amounts. If you answer all of the questions on this test correctly, you will earn 133 points, all of which will count into your grade (which counts every Test as 100 points). Write clearly, neatly and large enough for a human being to read. Make sure you box your answers on your scratch paper, carefully transfer your answers to the answer sheet. Write your name on every piece of paper you turn in. Jumbled, confusing, illogical and disorganized work will not be accepted. Relax, trust in yourself and do your best.

Fun! (3 points each. Maximum Possible = 60 points)

1) Which of the following functional groups contain oxygen?
   a) Hydroxyl
   b) Amides
   c) Ether
   d) All of them contain oxygen

2) A spontaneous reaction
   a) has $\Delta S > 0$ and $\Delta H < 0$
   b) has $\Delta S < 0$ and $\Delta H > 0$
   c) at equilibrium
   d) none of the above

3) The tendency for an atom to attract electrons to itself in a chemical bond is called
   a) electronegativity
   b) coulombic attraction
   c) hydrophilicity
   d) electron deficiency

4) If atoms with greatly differing electronegativities form a bond, that bond will be
   a) hydrophilic
   b) nonpolar
   c) sigma bond
   d) neutral

5) Which of the following molecules is polar?
   a) ortho-dichlorobenzene
   b) carbon dioxide
   c) ethane
   d) ammonium
   e) None of these molecules is polar

6) A non-polar molecule cannot have any polar bonds.
   a) True
   b) False

7) Ionic compounds and polar covalent compounds tend to dissolve in water because of
   a) van der Waals interactions
   b) dipole-induced dipole interactions
   c) ion-dipole and dipole-dipole interactions
   d) Odin commands it to be so

8) How do hydrogen bonds tend to affect the melting and boiling points of substances?
   a) They tend to decrease both melting and boiling points.
   b) They tend to increase both melting and boiling points.
   c) They tend to decrease melting points and increase boiling points.
   d) They tend to increase melting points and decrease boiling points.
   e) They do not have any affect on either melting or boiling points.

9) Which of the following molecules will not form hydrogen bonds?
   a) H_2O
   b) NH_3
   c) CH_4
   d) HF

10) How does the strength of hydrogen bonds compare with covalent bonds?
   a) Hydrogen bonds are much weaker than covalent bonds.
   b) Hydrogen bonds are much stronger than covalent bonds.
   c) Hydrogen bonds and covalent bonds have similar strengths.

11) The pH of a solution of 0.025 M HCl is:
   a) 6
   b) 1.6
   c) 0.6
   d) 0.06
   e) The pH cannot be determined without the volume of the acid

12) An HCl solution has a pH = 4. If you dilute 10 mL of the solution to 1000mL, the final pH will be:
   a) 3.0
   b) 4.0
   c) The pH does not change.
   d) 5.0
   e) 6.0

13) A solution at pH 6 contains a weak acid, HA. The pKa of the acid is 5.5. What is the ratio of [A-]:[HA]?

a) 1:2
b) 1:1
c) 2:1
d) 5:1

Should be 3:1 but I accepted 2:1 or 5:1

14) The pH of a solution where the A^- to HA ratio is 1 has a pH = pK_a.

a) True
b) False

15) If the interaction between two species is proportional to $1/r^3$, which of the following is likely involved?

a) chloromethane molecules in the liquid phase
b) Na^+ and H_2O
c) bromine molecules in the liquid phase
d) water molecules in the liquid phase

Dipole-Dipole interactions

16) If the interaction between two species is proportional to $1/r^2$, which of the following is likely involved?

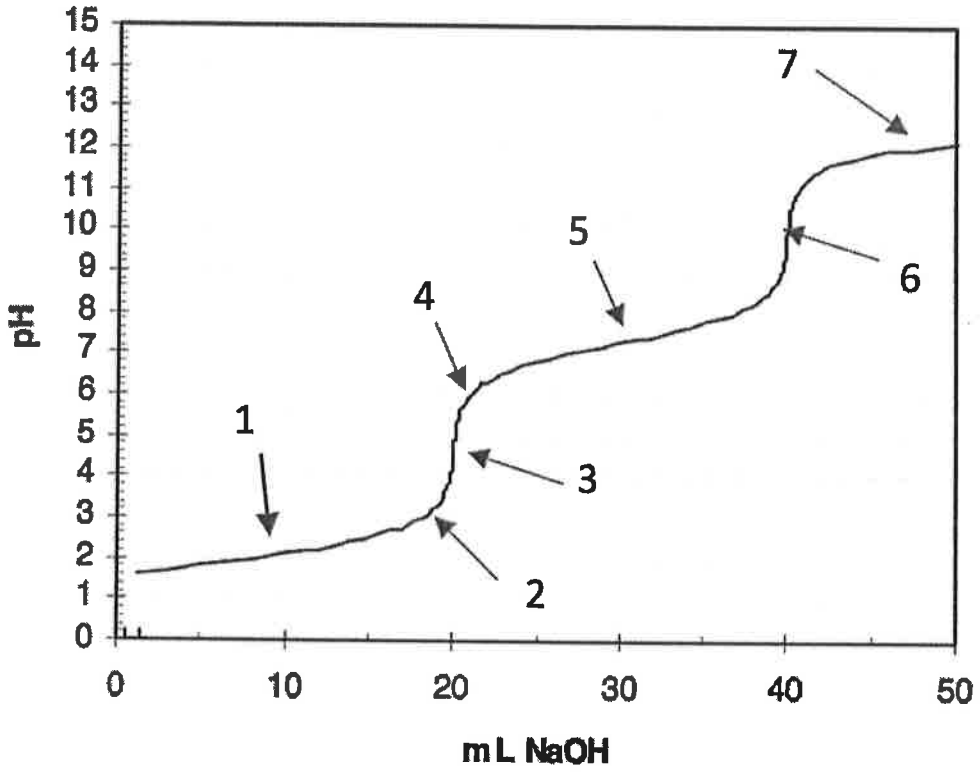
a) chloromethane molecules in the liquid phase
b) HF molecules in the liquid phase
c) bromine molecules in the liquid phase
d) Na^+ and H_2O

Ion-Dipole

17) Alcohols are not normally considered acidic. However, a carboxylic acid functional group is responsible for the weak acidic behavior of organic acids. What makes the carboxylic acid an acid, whereas an alcohol is not?

a) The hydroxyl-bonded carbon of an alcohol is less electronegative than the carbon bonded to the OH group of the carboxylic acid
b) The acid proton of the carboxylic acid is smaller than the hydrogen atom of an alcohol.
c) The hydrogen of the alcohol group is passed out and can't go anywhere.
d) The carbonyl oxygen of the carboxylic acid is pulling on the electrons of the oxygen of the OH group.

Figure 1



18) How many acidic protons does this acid have?

a) 1
b) 2
c) 3
d) None

19) Referring to Figure 1: Which points on the graph represent pK's?

a) 1 and 5
b) 2, 4 and 6
c) 3 and 5
d) 2, 3, 4, 5 and 6
e) The pKs cannot be determined without more information .

20) What is the pH at the first endpoint?

a) 2
b) 3.25
c) 4.5
d) 7.3

Games! And now the adventure begins...

1) (5 points) For the titration of 65.0 mL of 0.020 M aqueous holymolic acid (a monoprotic acid) with 0.020 M NaOH(aq), calculate the pH after the addition of 36.0 mL of NaOH(aq). The pKa of holymolic acid is 3.62.

$0.065\,L \times \frac{0.02\ \text{mole Holymolic acid}}{L} = 1.3\times10^{-3}\ \text{moles HM @ start}$

We add:

$0.036\,L \times \frac{0.02\ \text{mole } \bar{O}H}{L} = 7.2\times10^{-4}\ \text{moles } \bar{O}H \text{ added}$

New Volume is 101mL after OH addition

$HM + \bar{O}H \rightarrow H_2O + M^-$

This means 7.2×10^{-4} moles of HM were reacted, leaving:

$1.3\times10^{-3}\ \text{moles HM} - 7.2\times10^{-4}\ \text{moles HM} = 5.8\times10^{-4}\ \text{moles HM remaining}$

$K_A = \frac{[H_3O^+][M^-]}{[HM]}$ restructuring to solve for $[H_3O^+] = \frac{K_A[HM]}{[M^-]}$

$[H_3O^+] = \frac{(2.4\times10^{-4})(5.8\times10^{-3})}{7.12\times10^{-3}} = 1.93\times10^{-4}$

$pH = -\log[H_3O^+] = 3.71$

2) (10 points) Answer the following questions about dilutions.

a) What volume of 0.43 M $NaHCO_3$ (aq) should be diluted to 150.0 mL with water to reduce its concentration to 0.086 M $NaHCO_3$ (aq)?

The original $NaHCO_3$ solution has to be diluted 5 times (0.43M / 0.086M)

30mL of 0.43M $NaHCO_3$
120 mL of H_2O

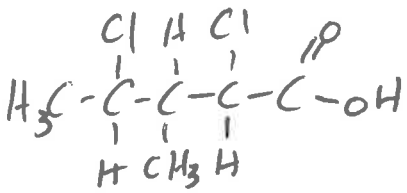
b) An experiment requires the use of 10.0 mL of 0.30 M $BeCl_2$ (aq). The stockroom assistant can only find a bottle of 5.0 M $BeCl_2$ (aq). How can the 0.30 M $BeCl_2$ be prepared without wasting reagents (Be specific)?

$\frac{5\,M\,BeCl_2}{0.3\,M\,BeCl_2} = 16.67$ times dilution

$\frac{10\,mL}{16.67} =$ 0.6mL 5M $BeCl_2$
9.4mL H_2O

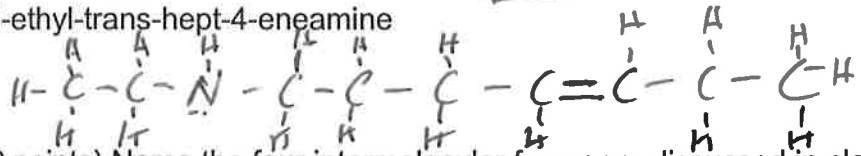
3) (6 points) Draw the following organic compounds:

a) 2,4-dichloro-3-methyl-pentanoic acid



b) Ortho-bromo-chlorobenzene

c) N-ethyl-trans-hept-4-eneamine



4) (12 points) Name the four intermolecular forces we discussed in class, give an example of each in aqueous solution (NOT THE GAS PHASE) and list them in order from highest energy (Number 1) to lowest energy (Number 4).

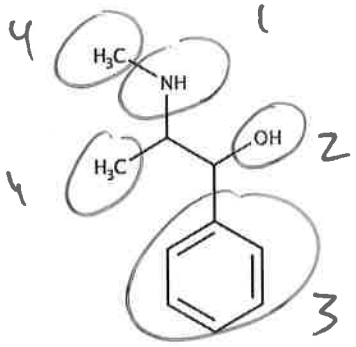
1) Ion – Dipole : Na^+ and H_2O

2) Dipole – Dipole : H_2O and H_2O

3) Dipole - Induced Dipole: H_2O and Octane

4) London Dispersion Forces : Octane and Octane

5) (6 points) Pseudoephedrine was a common over the counter decongestant available for purchase at any drug store until the early 2000's when people discovered that it could be used to synthesize methamphetamine. Circle and name the functional groups of pseudoephedrine.



1: Amino

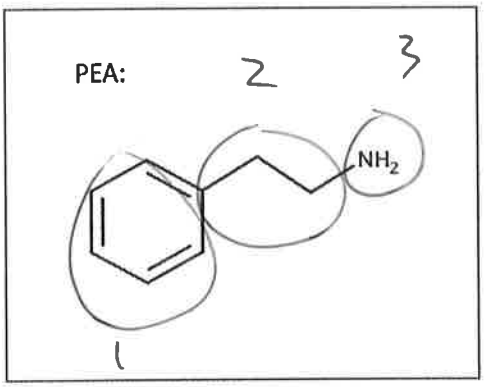
2: Hydroxyl

3: Aryl

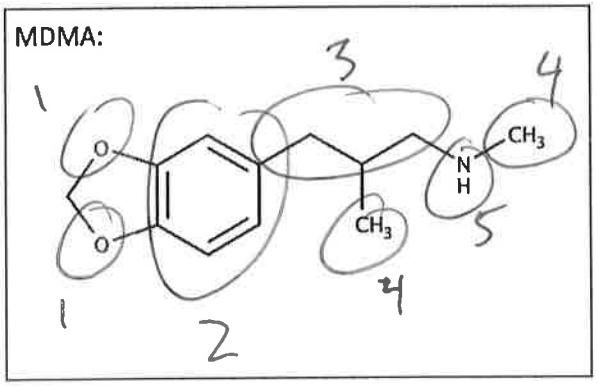
4: Methyl

6) (12 points) PEA is a compound that the brain produces when we fall in love (seriously!). During the initial period of a romantic relationship, the brain is awash in PEA, causing strong feelings of attachment, happiness and a desire to be near the focus of our affection at all times. In the early 1980's chemists decided to try and modify PEA in hopes of producing drugs that would elicit the same effects for brief periods of time. PEA and two of its derivatives (MDMA, commonly referred to as "Ecstasy" and DOI, a psychedelic amphetamine) are shown below. Circle the functional group in each molecule and give it a number, then in the space to the bottom of the chemical figures, give the number of the circled functional group and its name.

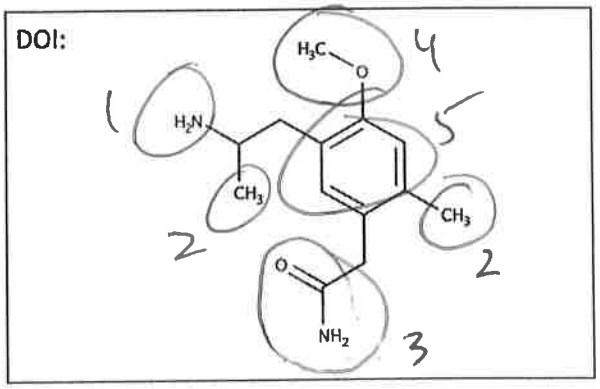
PEA:



MDMA:



DOI:



Functional Groups in PEA:

1: Aryl , 2: Alkyl , 3: Amino

Functional Groups in MDMA:

1: Ether , 2: Aryl , 3: Alkyl , 4: Methyl , 5: Amino

Functional Groups in DOI:

1: Amino , 2: Methyl , 3: Amide , 4: Ether , 5: Aryl