Name:_____ Recitation #1 CHE 106 Review

1.) A strong acid is a good electrolyte because it will _____ completely in water.

2.) A reaction that releases energy is said to be _____ and have a _____ΔH.

3.) Perform the following unit conversions:

a. If a marathon is 26.2 miles and there are 1.609 kilometers in 1.00 mile, how many kilometers in a marathon?

b. The men's world record pace for the marathon is 21.1 kilometers per hour, how many meters per second is this?

4.) Assign the ideal ionic charge to Ca, Li, and Al. Then, complete the following table:

| Ion | $(OH)^{1-}$ | $(PO_4)^{3-}$ | $(CO_3)^{2-}$ |
|---|---|---|---|
| Ca | | | |
| Li | | | |
| Al | | | |

5.) Name the compounds formed in the first row of the table above:

6.) There are approximately 980. grams of calcium (AW Ca = 40.0 g/mol.) in the average human body, how many moles of calcium does this represent?

7.) The molecular formula of the artificial sweetener sucralose is $C_{12}H_{19}Cl_3O_8$. Given the atomic weight of C is 12.0 g/mol., H is 1.00 g/mol., Cl is 35.45 g/mol., and O is 16.0 g/mol., what is the molecular weight of sucralose?

8.) Please balance the following equations:

a. ___$C_4H_{10}$ (*g*) + ___$O_2$ (*g*) → ___$H_2O$ (*g*) + ___$CO_2$ (*g*)

b. ___ Fe (*s*) + ___ $O_2$ (*g*) → ___$Fe_2O_3$ (*s*)

9.) Given the following balanced thermochemical equation for the oxidation of glucose, if 3.2 moles of glucose are oxidized, what is the absolute value of the total energy released?

$C_6H_{12}O_6$ (*s*) + 6 $O_2$ (*g*) → 6 $CO_2$ (*g*) + 6 $H_2O$ (*g*) $\Delta H° = -2816$ kJ/mol

10.) Given the following balanced equation for the oxidation of glucose, if 65 grams of glucose (180 g/mol) go through the reaction, how many grams of carbon dioxide (44 g/mol) will be formed?

$C_6H_{12}O_6$ (*s*) + 6 $O_2$ (*g*) → 6 $CO_2$ (*g*) + 6 $H_2O$ (*g*) $\Delta H° = -2816$ kJ/mol

Name:_____ Problem Set #2 V1 Rate Laws

1) What are the four variables we talked about in class that can be changed to influence the rate of a reaction:

2) Pick one of the four variables discussed and describe how and why it can be used to increase the rate of a reaction?

Use the data table below to answer questions 3 – 7 of this quiz. The data in the table below were obtained for the reaction: **A + B → Product**

| Experiment | [**A**] (M) | [**B**] (M) | Initial Rate (M/s) |
|---|---|---|---|
| 1 | 0.152 | 0.323 | 2.83 |
| 2 | 0.304 | 0.323 | 11.32 |
| 3 | 0.152 | 0.646 | 2.83 |

3) The rate law for this reaction is rate = _____.

A) $k[A]^1[B]^1$

B) k[P]

C) $k[A][B]^2$

D) $k[A]^2[B]^1$

E) $k[A]^2$

4) The overall order for this reaction is _____.

A) $1^{st}$

B) $2^{nd}$

C) $3^{rd}$

D) zero order

E) can't be determined

5) The rate constant (k) for the reaction above is _____. (Don't forget UNITS!)

6) Using your calculated rate constant, what would the rate for this reaction be when the starting concentration of the reactants are [A] = 1.15 M and [B] = 0.65 M.

7) What effect would adding a catalyst have on the rate of this reaction?

*The reaction* A → B *is first order in* [A]. *Consider the following data for question 8 and 9:*

| Time (s) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| [A] (M) | 0.10 | 0.091 | 0.082 | 0.073 | 0.068 | 0.061 | 0.055 | 0.049 | 0.046 |

8) Using the integrated rate law for the first order reaction, the rate constant for this reaction is _____ $s^{-1}$. ( $\ln[A]_t = -kt + \ln[A]_0$ )

9) The concentration of A is _____ M after 20.0 s.

10) Using the data from question 8, what would a graph of ln[A] vs time yield compared to a graph of [A] vs time?

Name:_____ Problem Set #3 Quiz V2 (10 pts)

1.) Once a reaction has reached equilibrium, what happens to the concentration of reactants and products? (1 pts)

2.) Is a reaction still taking place at equilibrium? (1 pt)

3.) What is the assumed rate law for the forward reaction for the following process? (1 pts)

$$PCl_3\ (g) + Cl_2\ (g) \rightleftharpoons PCl_5\ (g)$$

4.) What is the equilibrium expression for the reaction outlined in question 3? (1 pt)

5.) Given the equilibrium expression for the reaction outlined above, determine $K_c$ if the equilibrium concentrations are 0.15 M $PCl_3$, 0.23 M $Cl_2$, and 0.37 M $PCl_5$? (2 pts)

6.) You set up a new reaction with 1.2 M $PCl_5$, 0.016 M $Cl_2$, and 0.34 M $PCl_3$, what is the value of the reaction quotient (Q) for the reaction under these new conditions? (2 pts)

7.) Explain what it means for a reaction to have $K_c >> 1$ and $K_c << 1$. You can use the generic equation for equilibrium constant to help explain your answer. (1 pts)

8.) Apply Le Chatelier's Principle to the following exothermic reaction and determine three (3) changes that could be applied the reaction to shift the equilibrium to the right, favoring the formation of the product. (1 pts)

$$PCl_3\ (g) + Cl_2\ (g) \rightleftharpoons PCl_5\ (g)$$

Name:_____ Problem Set #4

1.) What is the definition of a strong acid?

2.) What is the definition of a weak acid?

3.) Identify the appropriate acid and conjugate base pair in each reaction:

$$A^-(aq) + H_3O^+(aq) \rightleftharpoons HA(aq) + H_2O(l)$$

$$HPO_4^{2-}(aq) + NH_4^+(aq) \rightleftharpoons H_2PO_4^-(aq) + NH_3(aq)$$

$$HS^-(aq) + HF(aq) \rightleftharpoons F^-(aq) + H_2S(aq)$$

4.) Water is one of the unique molecules that is amphiprotic, it can act like an acid or a base depending on the conditions. What are **ALL** the products if water reacts with generic base A- (arrow to the left) or with the generic acid HA (arrow to the right).

$$A^- \longleftarrow H_2O \longrightarrow HA$$

5.) What is the equilibrium expression for the autoionization of water?

$$H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$$

6.) What is the pH of a 0.050 M solution of Nitric Acid?

7.) What is the pH of a 1.5 L aqueous solution that contains 5.20 grams of hydrochloric acid (MW: 36.46 g/mol)?

8.) The pH of Coca-Cola is 3.80, what is the hydronium ion concentration in Coca-Cola?

9.) What is the pOH of the solution?

10.) The pH of Drano is 11.5, what is the hydroxide concentration of the solution?

**Equations:**

$$[H_3O^+][OH^-] = 1.0\ x\ 10^{-14} \qquad pH + pOH = 14$$

$$pH = -log[H_3O^+] \qquad pOH = -log[OH^-]$$

$$[H_3O^+] = 10^{-pH} \qquad [OH^-] = 10^{-pOH}$$

Name:_____ Problem Set #5

PLEASE SHOW YOUR WORK FOR ALL STEPS

1.) What is the pH of a 0.5 M solution of lactic acid at 25 °C given that lactic acid has $K_a$ of $8.3 \times 10^{-4}$?

2.) What is the percent ionization of lactic acid under these conditions?

3.) What is the pH of this solution after 0.3 M of sodium lactate (a strong electrolyte) is added to the solution (assuming no change in volume)?

4.) You prepare a 1.0 L buffer solution that is composed of 0.3 M sodium ascorbate and 0.3 M ascorbic acid. What is the pH of that buffer when equal concentrations of sodium ascorbate and ascorbic acid are present? Given the $K_{a1}$ of ascorbic acid is $8.0 \times 10^{-5}$ and the Henderson-Hasselbalch equation: $pH = pK_a + \log\frac{[base]}{[acid]}$.

5.) To the buffered solution in question 4, you add 0.075 moles of the strong base, sodium hydroxide (NaOH). What is the new pH of this solution? (Again, assume no change in volume)

6.) What would the pH be of an unbuffered 0.075 M sodium hydroxide solution? How does that compare to the buffered solution above?

Name:_____ Problem Set #6 (100 points)

PLEASE SHOW YOUR WORK FOR PARTIAL CREDIT

Indicate the ion products of the following salts and the corresponding $K_{sp}$ expression (5 pts each):

1.) $LaF_3$ (s)→

$K_{sp}$ =

2.) $Ca_3(PO_4)_2$ (s) →

$K_{sp}$ =

3.) $FeCO_3$ (s) →

$K_{sp}$ =

4.) Which of the following ions would have the largest impact on the pH of a solution? Assuming all solutions have equal ion concentration. (5 pts)
   a. $NO_3^-$
   b. $Cl^-$
   c. $Br^-$
   d. $I^-$
   e. $F^-$

5.) Based on the $K_a$ table, which of the following is the strongest acid? (10 pts)

| Acid | Ka |
|---|---|
| Acetic acid | $1.8 \times 10^{-5}$ |
| Benzoic acid | $6.5 \times 10^{-5}$ |
| Formic acid | $1.8 \times 10^{-4}$ |
| Tartaric acid | $9.2 \times 10^{-4}$ |
| Lactic acid | $1.4 \times 10^{-4}$ |

6.) Based on the $K_a$ table above, which of the following has the strongest conjugate base? (10 pts)

7.) What is the concentration of lead in a saturated solution of $PbSO_4$, given the $K_{sp}$ of $PbSO_4$ is $6.3 \times 10^{-7}$? (10 pts)

8.) What is the solubility (M) of lead from lead sulfate ($PbSO_4$) in a 0.017 M solution of the strong electrolyte sodium sulfate ($Na_2SO_4$)? The $K_{sp}$ of $PbSO_4$ is $6.3 \times 10^{-7}$. (10 pts)

9.) True or False: According to Le Châtelier's Principle, adding the strong electrolyte sodium sulfate to a saturated solution of the weak electrolyte, lead sulfate, would cause the lead sulfate to precipitate. (10 pt)

10.) What is the concentration (M) of silver in a saturated solution of $Ag_2SO_4$, given the $K_{sp}$ of $Ag_2SO_4$ is $1.5 \times 10^{-5}$? (10 pts)

11.) A saturated solution of barium fluoride, $BaF_2$, was prepared by dissolving solid $BaF_2$ in water. The concentration of $Ba^{2+}$ ion in the solution was found to be $7.52 \times 10^{-3}$ *M* . Calculate $K_{sp}$ for $BaF_2$. (10 pts)

12.) A buffer contains 0.65 M benzoic acid and 0.78 M sodium benzoate. What is the pH of the solution after the addition of 0.03 M of the strong base sodium hydroxide? Given the $K_a$ of benzoic acid is $6.50 \times 10^{-5}$. (10 pts)

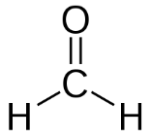
Name:_____ Problem Set #7

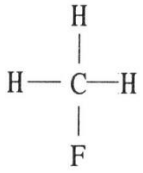
1) When NaCl dissolves in water, aqueous $Na^+$ and $Cl^-$ ions result. The force of attraction that exists between $Na^+$ and $H_2O$ is called a(n) _____ interaction.

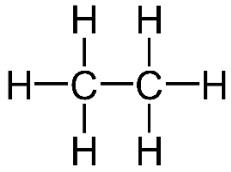
2) Draw those interactions named in the previous question between a water molecule and $Na^+$ cation and between a water molecule and the $Cl^-$ anion. Be sure to indicate what part of the water molecule interacts with each ion.

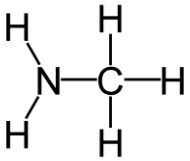
$Na^+$ $Cl^-$

3) Please list **ALL** the intermolecular forces available next to each of the following molecules. Possible forces are London dispersion forces, ion – dipole, dipole – dipole, and hydrogen bonding.

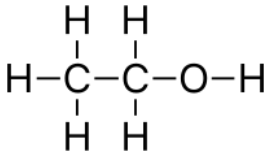
A) 

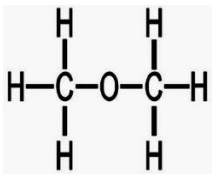
B) 

C) 

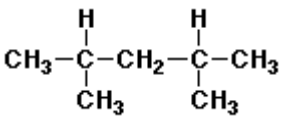
D) 

4) Given the structure of ethanol on the left and methoxy methane on the right, circle the compound with the higher boiling point **AND** explain why.



vs. 

5) Given the structure of 2,4-dimethylpentane on the left and heptane on the right, both compounds have the same chemical formula ($C_7H_{16}$), the same molecular weight (100 g/mol), circle the compound with the higher boiling point **AND** explain why.



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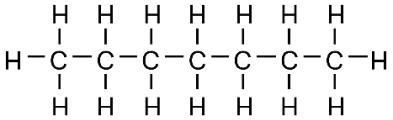
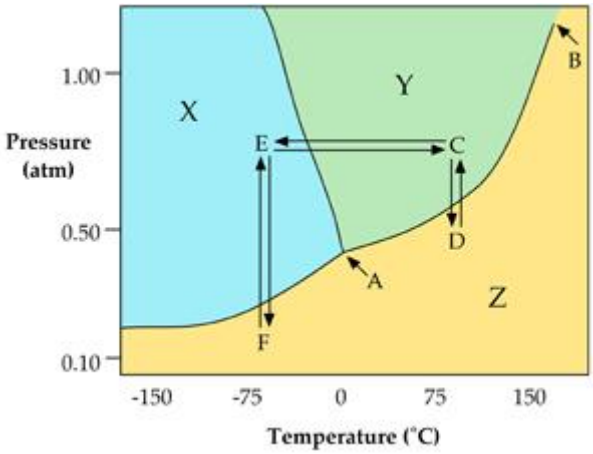


6) Given the phase diagram below, answer the following questions.




What phase is represented by area Z:_____

What is beyond point B:_____

Transition E → C represents:_____

Transition E → F represents:_____

If you took a sample that was solid at 1 atm and heated it at constant pressure, what temperature would you find the boiling point? _____

Name:_____ Problem Set #8

1.) What are the four variables discussed in class that will lead to an increase in entropy?

2.) Consider the processes or reactions, indicate which side of the reaction will have the greatest entropy **AND** explain why.

a. $CO_2$ (s) → $CO_2$ (g)

b. $CaCO_3$ (s) → CaO (s) + $CO_2$ (g)

c. 2 $NO_2$ (g) → $N_2O_4$ (g)

d. $H_2O$ (l) at 25 °C heated to 52 °C

e. NaCl (s) → $Na^+$ (aq) + $Cl^-$(aq)

Oxygen was first prepared by heating mercury(II) oxide, HgO. Given the following data collected at 25 °C, please answer the following questions:

2HgO (s) → 2Hg (g) + $O_2$ (g)

$$\Delta H^\circ = \sum n\,\Delta H°(products) - \sum m\,\Delta H°(reactants)$$

$$\Delta S^\circ = \sum n\,\Delta S°(products) - \sum m\,\Delta S°(reactants)$$

| Molecule | $\Delta H_f^\circ$ (kJ/mol) | ΔS° (J/mol·K) |
|---|---|---|
| HgO (s) | -90.79 | 70.27 |
| Hg (g) | 61.38 | 174.9 |
| $O_2$ (g) | 0.00 | 205.0 |

3.) What is the $\Delta H^\circ$ for this reaction?

4.) What is the ΔS° for this reaction (**in kJ/K**)?

5.) What is the free energy at 25 °C for the reaction outlined above, and is the reaction spontaneous at this temperature given: ΔG°= ΔH° - TΔS°.

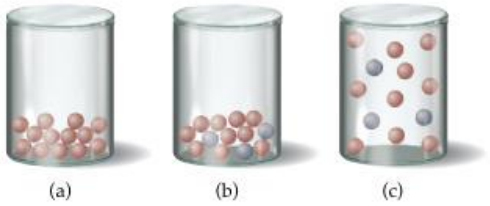
6.) The hydrogenation of ethene gas at 298 K shows a decrease in disorder ($\Delta S^\circ$ = -120.7 J/(mol•K)) during an exothermic reaction ($\Delta H^\circ$ = -136.9 kJ/mol). Determine whether the reaction is spontaneous or nonspontaneous by calculating $\Delta G^\circ$. (ΔG°= ΔH° - TΔS°)

$C_2H_4$ (g) + $H_2$ (g) → $C_2H_6$ (g)

Name:_____ Recitation #9 (10 points)

1) Arrange the following beakers in order of increasing entropy. (0.5 pts)

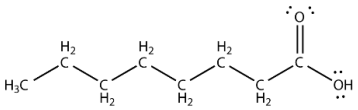
a) A < C < B
b) A = B < C
c) A < B < C
d) C < B < A



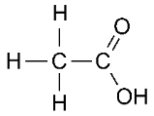

2) When ammonium chloride dissolves in water, the solution becomes colder. What must be true about the formation of this solution if it happens spontaneously? (0.5 pts)

a) Solution formation is exothermic and causes an increase in entropy
b) Solution formation is endothermic and causes a decrease in entropy
c) Solution formation is exothermic and causes a decrease in entropy
d) Solution formation is endothermic and causes an increase in entropy
e) More information is needed to answer the question

3) When comparing octanoic acid to acetic acid, which one should be more soluble in hexane ($CH_3CH_2CH_2CH_2CH_2CH_3$) and why? (0.5 pts)

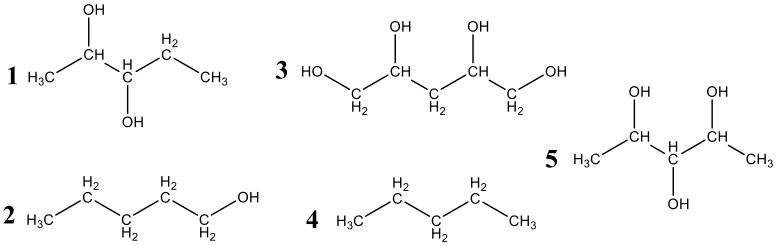


Octanoic acid



Acetic Acid

4) Using the above figure containing 5 different molecules, please rank the molecules in order of lowest to highest solubility in water. (0.5 pts)




a) 4 < 2 < 5 < 1 < 3
b) 2 < 4 < 1 < 5 < 3
c) 3 < 5 < 1 < 2 < 4
d) 4 < 2 < 1 < 5 < 3
e) it can't be determined without more information about these molecules

5) Consider a pure crystalline solid that is heated from absolute zero to a temperature above the boiling point of the liquid. Which of the following processes produces the greatest increase in the entropy of the substance? (1.0 pt)
   a) melting the solid
   b) heating the liquid
   c) heating the gas
   d) heating the solid
   e) vaporizing the liquid

6) Determine the change in entropy for the following reaction: $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$ (1.0 pt)
   a) 146.8 J/K
   b) 263.6 J/K
   c) -146.8 J/K
   d) -151.4 J/K

| Substance | S° (J/mol·K) |
|---|---|
| $NO_2$ | 240.0 |
| $O_2$ | 205.2 |
| NO | 210.8 |

7) What is the free energy of formation of glucose from carbon dioxide and water:
   $6\ CO_2\ (g) + 6\ H_2O\ (g) \rightarrow C_6H_{12}O_6\ (s) + 6\ O_2\ (g)$ (1.0 pt)
   a) -2827 kJ
   b) 2827 kJ
   c) -4648.6 kJ
   d) -287.6 kJ

| Substance | ΔH° (kJ/mol) |
|---|---|
| $C_6H_{12}O_6$ (s) | -910.6 |
| $O_2$ (g) | 0 |
| $CO_2$ (g) | -394.4 |
| $H_2O$ (g) | -228.6 |

8) If a reaction is endothermic and has a positive change in entropy, which of the following statements is true? (1.0 pt)
   a) The reaction is non-spontaneous as all temperatures
   b) The reaction is spontaneous at all temperatures
   c) The reaction is non-spontaneous at high temperatures and spontaneous at low temperatures
   d) The reaction is non-spontaneous at low temperatures and spontaneous at high temperatures
   e) More information is needed about the reaction to determine spontaneity

9) Given the following information, what is the melting point of phenol in degrees Celsius (°C)? Given $\Delta H°_{fusion}$=11.514 kJ/mol and $\Delta S°_{fusion}$=36.66 J/mol·K. (1.0 pt)
   a) 314 °C
   b) 41 °C
   c) 587 °C
   d) 0.314 °C

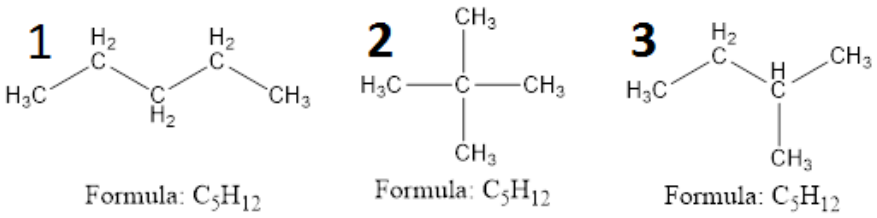
10) Match the intermolecular force that is most important to the two molecules listed forming a solution. (London dispersion forces, hydrogen bonding, dipole-dipole, or ion-dipole) (1.0 pt)

Heptane ($CH_3CH_2CH_2CH_2CH_2CH_2CH_3$) and decanol ($CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2OH$)

Potassium nitrate ($KNO_3$) and water

Acetone ($CH_3COCH_3$) and acetic acid ($CH_3COOH$)

Ethanol ($CH_3CH_2OH$) and acetic acid ($CH_3COOH$)

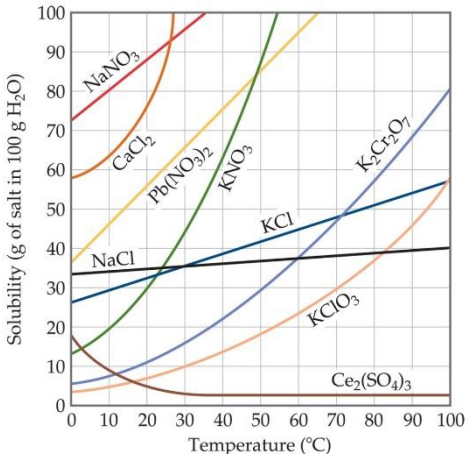



11) The figure above demonstrates three different isomers of pentane. Please rank the isomers in order of increasing boiling point. (1.0 pt)

a) 2 < 3 < 1
b) 1 < 3 < 2
c) 3 < 1 < 2
d) The trend can not be determined without more information
e) Equal boiling points because all structures have identical molecular weight and formula

12) Given the following solubility diagram, if a 150 mL of water contains 50 grams of KCl at 90 °C and is cooled to 40 °C, what happens to the solution? (0.5 pt)

a) The solution becomes super saturated
b) Potassium chloride precipitates from solution
c) Potassium chloride remains in solution
d) The solution becomes saturated



13) As the strength of intermolecular forces increases, what happens to the following physical properties: viscosity, boiling point, vapor pressure, melting point, and surface tension.(0.5 pt)

a) The value of all listed physical properties increases as the strength of intermolecular forces increase.

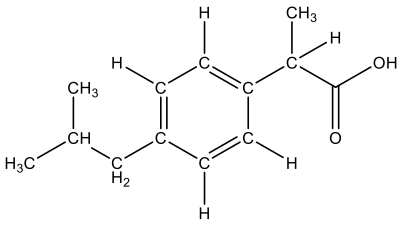
b) As the strength of intermolecular forces increases, boiling point, vapor pressure, and surface tension increase while viscosity and melting point decrease.

c) As the strength of intermolecular forces increases, boiling point, viscosity, and surface tension increase while vapor pressure and melting point decrease.

d) As the strength of intermolecular forces increase, boiling point, melting point, viscosity, and surface tension increase while vapor pressure decreases.

e) As the strength of intermolecular forces increases, viscosity, surface tension, and vapor pressure increase while boiling point, melting point remain the same because they are constants

14) The commonly used pain reliever Ibuprofen is slightly soluble in water (1 mg/mL), indicate which part of the molecule aids the solubility in water and what parts of the molecule hinder the solubility in water. (0.5 pt)

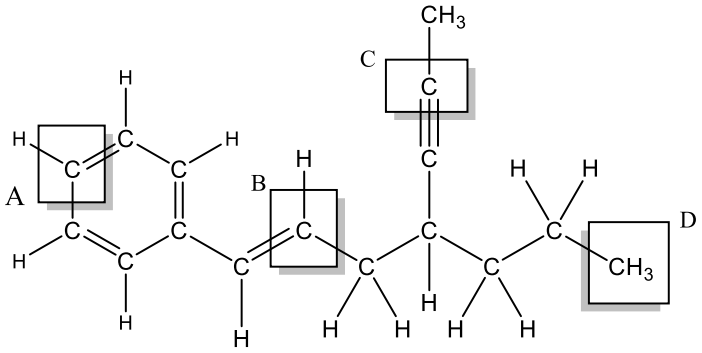


Name:_____ Problem Set #9

1) Name the first 10 hydrocarbons we covered in class and provide the condensed structural formula. The first one is provided as a guide

| **Name:** | **Condensed Structure:** |
|---|---|
| a) Methane | $CH_4$ |
| b) | |
| c) | |
| d) | |
| e) | |
| f) | |
| g) | |
| h) | |
| i) | |
| j) | |

Please use the following structure to answer question 2




2) Please indicate the hybridization and bond angles of the carbon atoms in box A – D:

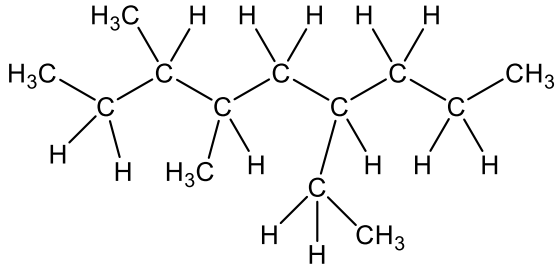
A. =

B. =

C. =

D. =

Please use the structure below to answer the following questions.




3) Circle the longest carbon chain in the molecule above.

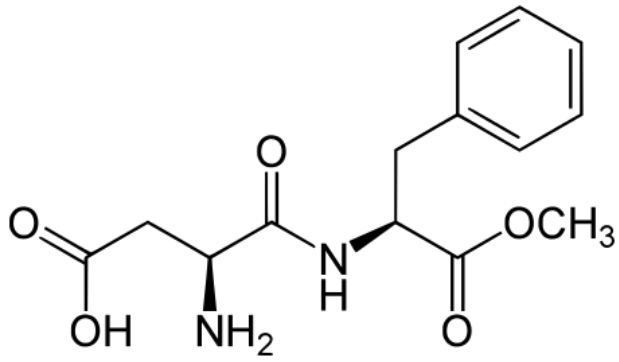
4) Name the longest carbon chain in the molecule above:

5) Name and number any substituents (branches) off the main chain of the molecule:

6) Provide the full name for this molecule:

Name:_____ Problem set 11

1.) Aspartame is used as an artificial sweetener, circle and name 4 functional groups present in the molecule below:




a.)

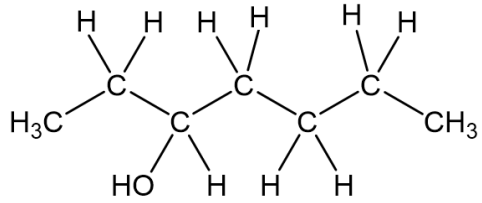
b.)

c.)

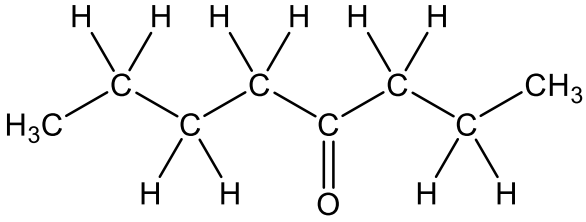
d.)

2.) Following standard IUPAC rules, name all of the structures below:

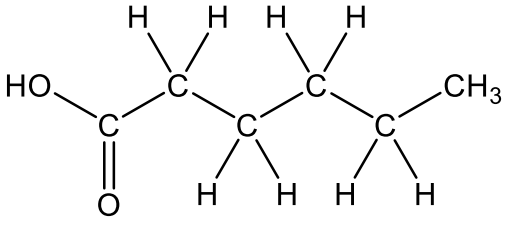
a.




b.




c.



3.) Draw any alkane or alkene structure following the general rules and then name that structure
    a. The longest chain must be 5-10 carbons in length
    b. There must be at least 2 branches that are 1-3 carbons in length
    c. You could also include a double bond (alkene) in the structure
    d. Once you have drawn and named your structure, exchange the structure with the group next to you and ask them to come up with the name following IUPAC rules.
    e. A few of the best structures will be added to the final exam

Name:_____ Problem set 12

1.) Draw the generic structure of an amino acid (where R can be any side chain). (1 pt)

2.) Draw a generic dipeptide (again using R to indicate any side chain), and indicate the peptide bond linking each amino acid together. (2 pt)

3.) What is the primary, secondary, and tertiary structure of a peptide? (3 pts)
   a. Primary structure:

   b. Secondary structure (provide two examples):

   c. Tertiary structure:

4.) We talked about four different materials last week in class, provide a few characteristics of each material. (2 pts)
   a. Metals:

   b. Ionic solids:

c. Covalent network solids:

d. Molecular solids:

5.) What is the difference between a substitutional alloy and an interstitial alloy? Provide an example of each. (2 pts)