

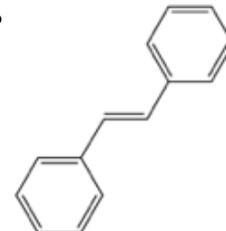
Part One: Multiple choice questions**(2 pt each)**

- Which of the following does not describe a **solution**?
a) soda pop b) a 15 karat gold/nickle bracelet c) atmospheric air d) chocolate chip cookies
- Percent (%) concentration** is based on which of the following units x 100%
a) g/mol b) mol/L c) mL/mol d) g/mL e) mg/L
- Calculations of concentration typically involve dividing the _____ or _____ of the solute by the _____ of the solvent.

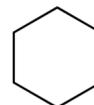
$\text{Concentration} = \frac{\text{(} \underline{\hspace{1cm}} \text{ or } \underline{\hspace{1cm}} \text{) of solute}}{\text{(} \underline{\hspace{1cm}} \text{) of solvent}}$
--

- | | | |
|--------------------------|----------------------------|--------------------------|
| a) mass or moles; mass | b) mass or moles; volume | c) volume or mass; moles |
| d) moles or volume; mass | e) volume or moles; volume | |
- Which of the following molecules would you expect to be the most hydrophobic?
a) butanone b) butane c) butanol d) butanal e) butanoic acid
- Which of the following ionic compounds produces the most equivalents of cation in aqueous solution?
a) NH₄Cl b) MgSO₄ c) NaBr d) LiNO₃ e) KCN
- Which of the following bonds are rotationally 'constrained' with regards to the two carbons involved?
a) Alkenes b) Alkanes c) Alkynes d) a & b e) a & c f) all of them
- What is the relationship between the two molecules shown below & to the right?

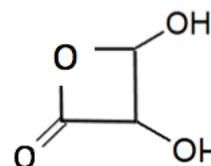
- Rotational isomers
- Structural isomers
- Geometric isomers
- none of the above (same molecule)



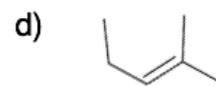
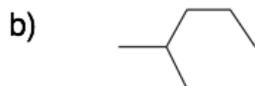
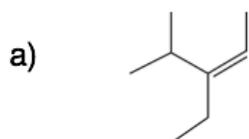
- What molecular geometry describes each of the carbons involved in a molecule of *cyclohexane*?
a) Tetrahedral d) Trigonal planar
b) Bent e) Trigonal pyramidal
c) Linear



- Why would the molecule below be unlikely to exist in a natural biomolecule?
a) cyclic hydrocarbons can't contain oxygen atoms
b) it contains an ester bond
c) it has too much ring strain
d) it has a carbonyl and alcohol groups
e) it has too many oxygens



- Which of the following molecules requires *cis* or *trans* in its name to identify which geometric isomer it represents?

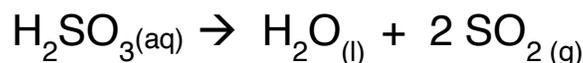


e) a & d

11. Aromatic hydrocarbons are unusual molecules in that their structures are flat due to the carbons being in the _____ geometry:
- a) tetrahedral c) linear e) trigonal pyramidal
b) bent d) trigonal planar

12. What is wrong with the reaction shown below?

- a) It is missing a product
b) It is missing a reactant
c) It has the wrong coefficients
d) Physical states are missing
e) The arrow points the wrong way



For the questions below, refer to the energy diagram shown to the right. **CIRCLE** the correct letter.

13. Which letter represents the total quantity of bond energy left in the products of the reaction?

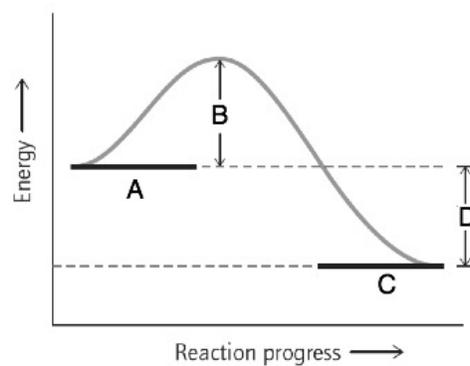
- A. B. C. D.

14. Which letter represents the change in bond energy over the course of the reaction?

- A. B. C. D.

15. Which quantity would you expect to change if a catalyst were added to this reaction?

- A. B. C. D.



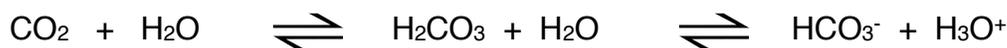
16. Which of the following would not increase the rate of a reaction?

- a) increasing temperature c) adding a catalyst e) they all would increase the rate
b) increasing [reactant] d) increasing [product]

17. What is the **pH** of a solution that contains a hydronium ion concentration $[\text{H}_3\text{O}^+] = 2.73 \times 10^{-4} \text{ M}$?

- a) 3.56 b) 2.73 c) 11.37 d) 1.74 e) 5.37

18. The reaction shown below describes the role of carbon dioxide and breathing in the blood buffer system. What would happen if a strong base were added to this system?



- a) $[\text{CO}_2]$ would increase c) $[\text{HCO}_3^-]$ would increase
b) $[\text{H}_2\text{CO}_3]$ would increase d) all components except H_2O would increase

19. Which of the following functional groups is likely to be *ionized* in aqueous solution?

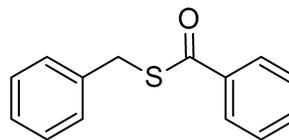
- a) $\text{R}-\text{C}(=\text{O})-\text{H}$ b) $\text{R}-\text{C}(=\text{O})-\text{OH}$ c) $\text{R}-\text{C}(=\text{O})-\text{NH}_2$ d) $\text{R}-\text{C}(=\text{O})-\text{O}-\text{R}'$ e) $\text{R}-\text{C}(=\text{O})-\text{SH}$

20. What is the relative difference in $[\text{H}_3\text{O}^+]$ between water (pH 7.2) and ammonia (pH 11.2)?

- a) 4x b) 100x c) 40x d) 10,000x e) 40,000x

21. What functional group is shown in the molecule to the right?

- a) Ether b) Ester
c) Amide d) Sulfhydryl
e) Thioester e) Ketothione



22. Which of the following functional groups has the most negative charge at physiological pH (7.2)?

- a) b) c) d) e)

23. Which of the following is always a product of an acid-base neutralization reaction?

- a) H_3O^+ b) OH^- c) H_2O d) a & b e) all three

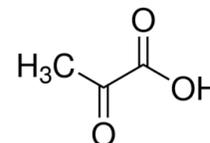
24. Which of the following pairs of molecules would compose a good buffer system?

- a) CH_3COOH & CH_3COO^- c) CH_3CHO & CH_3CO^-
b) CH_3NH_2 & CH_3NH^- d) CH_3OH & CH_3O^-

Part Two: Organic Structures & Nomenclature

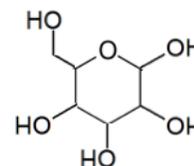
25. Pyruvic acid (CH_3COCOOH) is shown to the right. It is an important intermediate in human metabolism that we will study later this semester. (6 pts)

a. **Write out the equilibrium reaction** for pyruvic acid and its conjugate base when it is dissolved in aqueous solution.

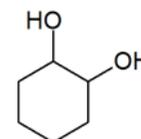


b. If the strong base sodium hydroxide (NaOH) were added to a solution of pyruvic acid at equilibrium, **which direction**—left (toward reactants) or right (toward products)—would the reaction shift?

26. Briefly explain in simple terms why **glucose** (shown below) is highly soluble in water, whereas a similar organic molecule, **cyclohexane-1,2-diol**, is not. (3 pts)



glucose

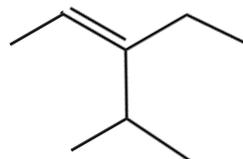


cyclohexane-1,2-diol

27. Provide proper IUPAC **names** or **structures** for the following organic molecules

(12 pts, 3 pts ea)

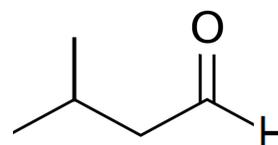
a) _____
(provide name)



b) **propyl 2-butenyl ether**

(draw the structure →)

c) _____
(provide name)



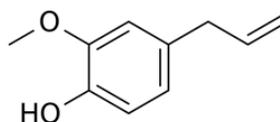
d) **N,N-dimethyl-hexanamine**

(draw the structure →)

28. Eugenol and zingerone are two similar aromatic compounds found in a variety of “essential oils”. Both are based on a similar core aromatic group, but have different functional groups that decorate this structure.

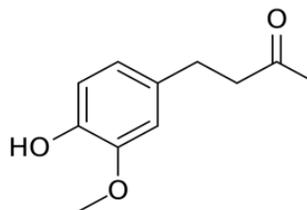
(6 pts)

a. **Identify the name** of the core aromatic structure that is common to both compounds.



eugenol (clove oil)

b. **Circle** and **name** all of the other functional groups found on each of these compounds.



zingerone (ginger extract)

Part Three: Problem Solving Calculations*(Make sure that you keep track of significant figures!)*

The nutritional label for **chocolate milk** is shown to the right. Answer the following questions based on this label.

29. Based on the caloric density of fat (9 Cal/gram), **calculate the number of Joules** of energy that are derived from fat a single serving of chocolate milk.

(4 pts)

Nutrition Facts	
Serving Size 1 cup (249g)	
Servings Per Container 8	
Amount Per Serving	
Calories 210	Calories from Fat 80
% Daily Value*	
Total Fat 8g	13%
Saturated Fat 5g	26%
Trans Fat 0g	
Cholesterol 30mg	10%
Sodium 200mg	9%
Total Carbohydrate 27g	9%
Dietary Fiber 1g	5%
Sugars 25g	
Protein 9g	
Vitamin A 6%	• Vitamin C 0%
Calcium 30%	• Iron 6%
Vitamin D 30%	
<small>*Percent Daily Values are based on a 2,000 calorie diet.</small>	

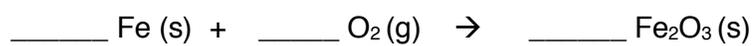
30. Drinking a glass of milk is a good treatment for heartburn, which is caused by excess stomach acid leaking into the esophagus. If drinking a glass of milk changed your stomach pH from 2.37 to 6.21 in a volume of 1.25 liters, **how many moles of acid** would be getting neutralized?

(6 pts)

31. A single serving of chocolate milk is 1 cup (= 237 mL). Given this volume and information from the nutritional label, **calculate the molarity (M)** of cholesterol (386.7 g/mol) in chocolate milk.

(6 pts)

32. Balance the reaction shown below & calculate the mass of iron (III) oxide (159.69 g/mol) produced from the oxidation of 50.0 grams of pure iron (55.85 g/mol) with oxygen. **(9 pts)**



Reference Materials

Periodic Table

1												13					14	15	16	17	18
Hydrogen 1 H 1.01 2.1												Boron 5 B 10.81 2.0	Carbon 6 C 12.01 2.5	Nitrogen 7 N 14.01 3.0	Oxygen 8 O 16.00 3.5	Fluorine 9 F 19.00 4.0	Neon 10 Ne 20.18 ...				
Lithium 3 Li 6.94 1.0	Beryllium 4 Be 9.01 1.5											Aluminum 13 Al 26.98 1.5	Silicon 14 Si 28.09 1.8	Phosphorus 15 P 30.97 2.1	Sulfur 16 S 32.07 2.5	Chlorine 17 Cl 35.45 3.0	Argon 18 Ar 39.95 ...				
Sodium 11 Na 22.99 0.9	Magnesium 12 Mg 24.31 1.2	3	4	5	6	7	8	9	10	11	12	Gallium 31 Ga 69.72 1.6	Germanium 32 Ge 72.61 1.8	Arsenic 33 As 74.92 2.0	Selenium 34 Se 78.96 2.4	Bromine 35 Br 79.90 2.8	Krypton 36 Kr 83.80 3.0				
Potassium 19 K 39.10 0.8	Calcium 20 Ca 40.08 1.0	Scandium 21 Sc 44.96 1.3	Titanium 22 Ti 47.88 1.5	Vanadium 23 V 50.94 1.6	Chromium 24 Cr 52.00 1.6	Manganese 25 Mn 54.94 1.5	Iron 26 Fe 55.85 1.8	Cobalt 27 Co 58.93 1.8	Nickel 28 Ni 58.69 1.8	Copper 29 Cu 63.55 1.9	Zinc 30 Zn 65.39 1.6	Indium 49 In 114.82 1.7	Tin 50 Sn 118.71 1.8	Antimony 51 Sb 121.76 1.9	Tellurium 52 Te 127.60 2.1	Iodine 53 I 126.90 2.5	Xenon 54 Xe 131.29 2.6				
Rubidium 37 Rb 85.47 0.8	Strontium 38 Sr 87.62 1.0	Yttrium 39 Y 88.91 1.2	Zirconium 40 Zr 91.22 1.4	Niobium 41 Nb 92.91 1.6	Molybdenum 42 Mo 95.94 1.8	Technetium 43 Tc (98) 1.9	Ruthenium 44 Ru 101.07 2.2	Rhodium 45 Rh 102.91 2.2	Palladium 46 Pd 106.42 2.2	Silver 47 Ag 107.87 1.9	Cadmium 48 Cd 112.41 1.7	Thallium 81 Tl 204.38 1.8	Lead 82 Pb 207.20 1.8	Bismuth 83 Bi 208.98 1.9	Polonium 84 Po (209) 2.0	Astatine 85 At (210) 2.2	Radon 86 Rn (222) 2.4				
Cesium 55 Cs 132.91 0.7	Barium 56 Ba 137.33 0.9	57-70 *	Lutetium 71 Lu 174.97 1.1	Hafnium 72 Hf 178.49 1.3	Tantalum 73 Ta 180.95 1.5	Tungsten 74 W 183.84 1.7	Rhenium 75 Re 186.21 1.9	Osmium 76 Os 190.23 2.2	Iridium 77 Ir 192.22 2.2	Platinum 78 Pt 195.08 2.2	Gold 79 Au 196.97 2.4	Mercury 80 Hg 200.59 1.9	Ununbium 110 Uun (271) ---	Ununium 111 Uuu (272) ---	Ununium 112 Uub (277) ---	Ununquadium 114 Uuq (289) ---					
Francium 87 Fr (223) 0.7	Radium 88 Ra (226) 0.9	89-102 **	Lanthanum 57 La 138.91 1.1	Cerium 58 Ce 140.12 1.1	Praseodymium 59 Pr 140.91 1.1	Neodymium 60 Nd 144.24 1.1	Promethium 61 Pm (145) 1.1	Samarium 62 Sm 150.36 1.2	Europium 63 Eu 151.97 1.1	Gadolinium 64 Gd 157.25 1.2	Terbium 65 Tb 158.93 1.1	Dysprosium 66 Dy 162.50 1.2	Holmium 67 Ho 164.93 1.2	Erbium 68 Er 167.26 1.2	Thulium 69 Tm 168.93 1.3	Ytterbium 70 Yb 173.04 1.1					
			Actinium 89 Ac (227) 1.1	Thorium 90 Th 232.04 1.3	Protactinium 91 Pa 231.04 1.5	Uranium 92 U 238.03 1.4	Neptunium 93 Np (237) 1.4	Plutonium 94 Pu (244) 1.3	Americium 95 Am (243) 1.3	Curium 96 Cm (247) 1.3	Berkelium 97 Bk (247) 1.3	Californium 98 Cf (251) 1.3	Einsteinium 99 Es (252) 1.3	Fermium 100 Fm (257) 1.3	Mendelevium 101 Md (258) 1.3	Nobelium 102 No (259) 1.3					

Element name
Atomic #
Symbol
Average mass
Electronegativity value

Table 8-1 Common Units of Energy and Their Conversions

Unit	Conversion
calorie (cal)	1 cal = 4.184 J (exact)
Calorie (Cal) (note capital C)	1 Cal = 1 kcal
kilocalorie (kcal)	1 kcal = 10 ³ cal

$$pH = -\log_{10}[H_3O^+]$$

$$[H_3O^+] = 10^{-pH}$$

Polyatomic Ions

- Acetate: CH₃CO₂⁻
- Hydrogen carbonate: HCO₃⁻ (also termed bicarbonate)
- Carbonate: CO₃²⁻
- Cyanide: CN⁻
- Hydroxide: OH⁻
- Hypochlorite: OCl⁻
- Nitrate: NO₃⁻
- Nitrite: NO₂⁻
- Phosphate: PO₄³⁻
- Hydrogen phosphate: HPO₄²⁻
- Dihydrogen phosphate: H₂PO₄⁻
- Sulfate: SO₄²⁻
- Sulfite: SO₃²⁻
- Hydronium: H₃O⁺
- Ammonium: NH₄⁺