

SHOW ALL OF YOUR CALCULATIONS AND PROPER UNITS FOR FULL CREDIT**Molecular Shapes (32 pts)**

1. Consider the molecule $\text{CH}_3\text{CO}_2\text{H}$ (skeletal structure is H_3CCOOH where **both O atoms are attached to the C – ask me if you have trouble**). The H is attached to one of the O atoms.
 - a. Draw the structure of the molecule. (5 pts) Label the carbons so you know which is which
 - b. What is the electron geometry of the atoms listed below? Show number of electron groups and lone pairs for each as well. (6 pts)
 - 1) C
 - 2) C
 - 3) O (interior)
 - c. What is the molecular geometry of the atoms listed below? Show number of electron groups and lone pairs for each as well. (6 pts)
 - 1) C
 - 2) C
 - 3) O (interior)

2. Determine the hybridization about each interior atom in the following molecule. Draw the Lewis structure, label the bonds as pi or sigma, and list the interior atoms with their corresponding hybridization. **NOTE: The oxygen does not undergo hybridization.** I suggest numbering the carbons. Remember the carbons attach to one another forming a chain with an oxygen in between the last 2 – ask me if you are unsure (15 pts).

$\text{CH}_3\text{CO}_2\text{CH}_3$ ($\text{H}_3\text{C}\text{C}\text{OOCH}_3$ One O atom is attached to 2nd C atom; the other O atom is bonded to the 2nd and 3rd C atom $\text{H}_3\text{C}\text{C}\text{O}\text{OCH}_3$)

Solutions (38 pts)

3. Determine the freezing point of a solution that contains 30.7 g glycerin ($\text{C}_3\text{H}_8\text{O}_3$, molar mass = 92.09 g/mol) in 376 mL of water. Some possibly useful constants for water are: freezing point 0.0°C , $K_f = 1.86^\circ\text{C}/m$, density 1g/1ml. (15 pts)

4. A 150.0 mL sample of an aqueous solution at 25°C contains 15.2 mg of an unknown nonelectrolyte compound. If the solution has an osmotic pressure of 8.44 torr, what is the molar mass of the unknown compound? (15 pts)
5. Which of the following compounds will be most soluble in nonane (C₉H₂₀)? **Tell me WHY and LIST THE INTERACTIONS that will occur between the solute and solvent. (8 pts)**
- pentanol (CH₃CH₂CH₂CH₂CH₂OH)
 - benzene (C₆H₆)
 - acetic acid (CH₃CO₂H)
 - ethyl methyl ketone (CH₃CH₂COCH₃)

$$m = \frac{\text{moles of solute}}{\text{mass solvent (Kg)}}$$
$$\frac{\text{mass solute}}{\text{mass solution}} \times 100\%$$
$$\Delta T_f = m \times K_f$$
$$\Delta T_b = m \times K_b$$
$$\Pi = MRT$$
$$R = 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$$
$$1 \text{ atm} = 760 \text{ torr}$$
$$M = \frac{\text{moles of solute}}{\text{Liter of solution}}$$
$$C \rightarrow K : +273$$

1

H

hydrogen

1.008

[1.0078, 1.0082]

2

He

helium

4.0026

3

Li

lithium

6.94

[6.938, 6.997]

4

Be

beryllium

9.0122

11

Na

sodium

22.990

[24.304, 24.307]

12

Mg

magnesium

24.305

[24.304, 24.307]

13

B

boron

10.81

[10.806, 10.821]

14

C

carbon

12.011

[12.009, 12.012]

15

N

nitrogen

14.007

[14.005, 14.008]

16

O

oxygen

15.999

[15.998, 16.000]

17

F

fluorine

18.998

[18.997, 18.999]

18

Ne

neon

20.180

[20.179, 20.181]

19

K

potassium

39.098

[39.096, 39.100]

20

Ca

calcium

40.078(4)

[40.078, 40.078]

21

Sc

scandium

44.956

[44.955, 44.957]

22

Ti

titanium

47.867

[47.867, 47.867]

23

V

vanadium

50.942

[50.941, 50.943]

24

Cr

chromium

51.996

[51.996, 51.996]

25

Mn

manganese

54.938

[54.938, 54.938]

26

Fe

iron

55.845(2)

[55.845, 55.845]

27

Co

cobalt

58.933

[58.933, 58.933]

28

Ni

nickel

58.693

[58.693, 58.693]

29

Cu

copper

63.546(3)

[63.546, 63.546]

30

Zn

zinc

65.382(2)

[65.382, 65.382]

31

Ga

gallium

69.723

[69.723, 69.723]

32

Ge

germanium

72.630(8)

[72.630, 72.630]

33

As

arsenic

74.922

[74.922, 74.922]

34

Se

selenium

78.971(8)

[78.971, 78.971]

35

Br

bromine

79.904

[79.904, 79.904]

36

Kr

krypton

83.798(2)

[83.798, 83.798]

37

Rb

rubidium

85.468

[85.468, 85.468]

38

Sr

strontium

87.62

[87.62, 87.62]

39

Y

yttrium

88.906

[88.906, 88.906]

40

Zr

zirconium

91.224(2)

[91.224, 91.224]

41

Nb

niobium

92.906

[92.906, 92.906]

42

Mo

molybdenum

95.95

[95.95, 95.95]

43

Tc

technetium

98.906

[98.906, 98.906]

44

Ru

ruthenium

101.07(2)

[101.07, 101.07]

45

Rh

rhodium

102.91

[102.91, 102.91]

46

Pd

palladium

106.42

[106.42, 106.42]

47

Ag

silver

107.87

[107.87, 107.87]

48

Cd

cadmium

112.41

[112.41, 112.41]

49

In

indium

114.82

[114.82, 114.82]

50

Sn

tin

118.71

[118.71, 118.71]

51

Sb

antimony

121.76

[121.76, 121.76]

52

Te

tellurium

127.60(3)

[127.60, 127.60]

53

I

iodine

126.90

[126.90, 126.90]

54

Xe

xenon

131.29

[131.29, 131.29]

55

Cs

caesium

132.91

[132.91, 132.91]

56

Ba

barium

137.33

[137.33, 137.33]

57-71

lanthanoids

72

Hf

hafnium

178.49(2)

[178.49, 178.49]

73

Ta

tantalum

180.95

[180.95, 180.95]

74

W

tungsten

183.84

[183.84, 183.84]

75

Re

rhenium

186.21

[186.21, 186.21]

76

Os

osmium

190.23(3)

[190.23, 190.23]

77

Ir

iridium

192.22

[192.22, 192.22]

78

Pt

platinum

195.08

[195.08, 195.08]

79

Au

gold

196.97

[196.97, 196.97]

80

Hg

mercury

200.59

[200.59, 200.59]

81

Tl

thallium

204.38

[204.38, 204.38]

82

Pb

lead

207.2

[207.2, 207.2]

83

Bi

bismuth

208.98

[208.98, 208.98]

84

Po

polonium

85

At

astatine

86

Rn

radon

87

Fr

francium

88

Ra

radium

89-103

actinoids

104

Rf

rutherfordium

105

Db

dubnium

106

Sg

seaborgium

107

Bh

bohrium

108

Hs

hassium

109

Mt

meitnerium

110

Ds

darmstadtium

111

Rg

roentgenium

112

Cn

copernicium

113

Nh

nihonium

114

Fl

flerovium

115

Mc

moscovium

116

Lv

livermorium

117

Ts

tennessine

118

Og

oganeson

Key:

atomic number

Symbol

name

conventional atomic weight

standard atomic weight

57 La lanthanum	58 Ce cerium	59 Pr praseodymium	60 Nd neodymium	61 Pm promethium	62 Sm samarium	63 Eu europium	64 Gd gadolinium	65 Tb terbium	66 Dy dysprosium	67 Ho holmium	68 Er erbium	69 Tm thulium	70 Yb ytterbium	71 Lu lutetium
138.91	140.12	140.91	144.24		150.36(3)	151.96	157.25(3)	158.93	162.50	164.93	167.26	168.93	173.05	174.97
89 Ac actinium	90 Th thorium	91 Pa protactinium	92 U uranium	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium
	232.04	231.04	238.03		239.04	247.07	247.07	247.07	251.08	252.08	253.08	258.10	259.10	262.10