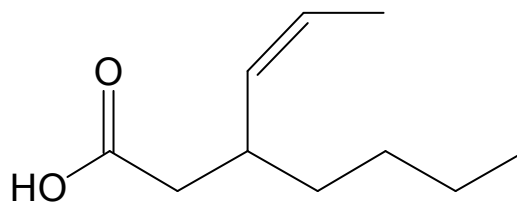


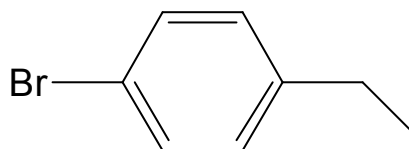
1) Give the systematic name of the compound at right. (4 pts)

- a) *trans*-3-butyl-4-hexenoic acid
- b) *cis*-3-propylheptanoic acid
- c) ***cis*-3-butyl-4-hexenoic acid**
- d) *trans*-3-propylheptanoic acid
- e) *cis*-3-butyl-4-pentenoic acid



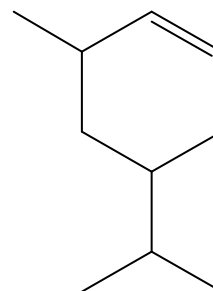
2) Give the systematic name of the compound at right. (4 pts)

- a) *o*-bromomethylbenzene
- b) ***p*-bromoethylbenzene**
- c) *o*-ethylbromobenzene
- d) *p*-methylbromobenzene
- e) *m*-bromoethylbenzene



3) Give the systematic name of the compound at right. (4 pts)

- a) **5-isopropyl-3-methylcyclohexene**
- b) 4-isopropyl-2-methyl-1-cyclohexene
- c) 4-isopropyl-2-methylcyclohexene
- d) 1-isopropyl-3-methyl-4-cyclohexene
- e) 4-isopropyl-6-methylcyclohexene



4) Which of the following is not a structural isomer of 1-pentanol? (5 pts)

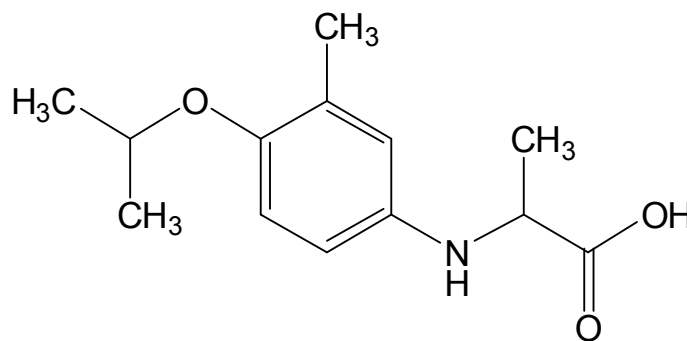
- a) 2,2-dimethyl-1-propanol
- b) 3-pentanol
- c) 3-methyl-1-butanol
- d) **2-methylbutanal**
- e) **2-methyl-1-propanol** **both answers are correct.**

5) Draw the structure of 2-propyl-4,4-dimethylhexane. Is there a better name for this compound? (5 pts)

- a) no, 2-propyl-4,4-dimethylhexane is correct
- b) yes, 4,6,6-trimethyloctane - keep this one second or third
- c) yes, 2-ethyl-2,4-dimethylheptane
- d) **yes, 3,3,5-trimethyloctane**
- e) yes, 3,3,5-trimethylheptane

6) Which functional groups are present in the molecule at right? (5 pts)

- a) ester, aldehyde
- b) ester, amine, carboxylic acid
- c) **ether, amine, carboxylic acid**
- d) phenol, amine, carboxylic acid
- e) amine, aldehyde



7) How many chiral carbons are present in the molecule given in problem 6 above? (5 pts)

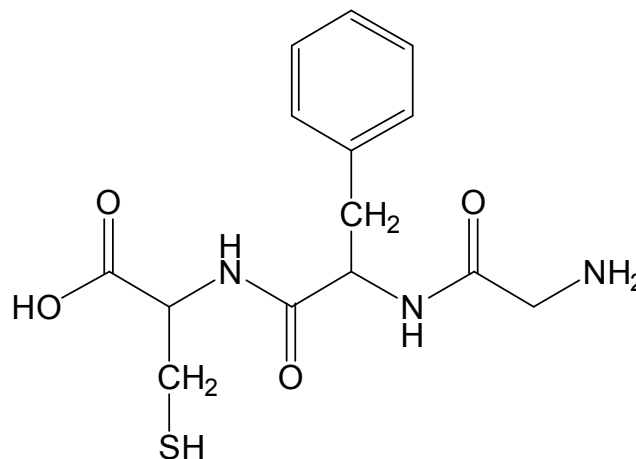
- a) 0
- b) **1**
- c) 2
- d) 3
- e) 4

8) What is the amino acid sequence of the following tripeptide? (5 pts)

- a) asn-phe-ser
- b) **cys-phe-gly** This answer 3pts
- c) ser-phe-gly
- d) **gly-phe-cys**
- e) cys-phe-asn

For Reference:

- Gly -H
- Ala -CH₃
- Phe -CH₂-phenyl
- Asn -CH₂-(C=O)-NH₂
- Cys -CH₂-SH
- Leu -CH₂-CH-(CH₃)₂
- Ser -CH₂-OH



9) Select the amino acid that will not rotate plane-polarized light. The R groups of are listed above. (4 pts)

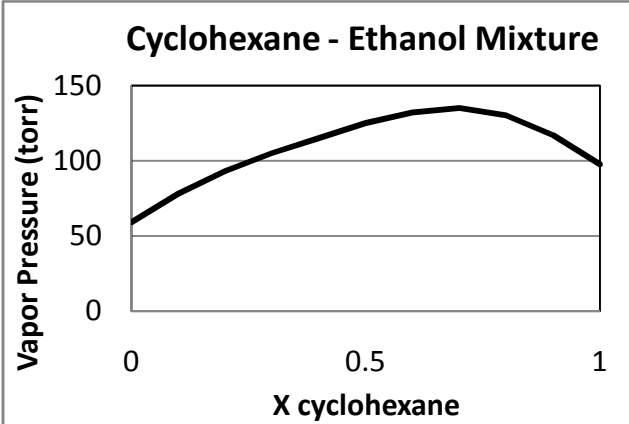
- a) Cysteine (cys)
- b) Glutamic acid (gln)
- c) Alanine (ala)
- d) **Glycine (gly)**
- e) Serine (ser)

- 10) Which of the following will have the highest boiling point at 1.0 atm? (5 pts)
- a) pure water
 - b) a 0.10 m solution of potassium phosphate (K_3PO_4) in water
 - c) a 0.10 m solution of calcium chloride (CaCl_2) in water
 - d) a 0.30 m solution of acetone (CH_3COCH_3) in water
 - e) **a 0.25 m solution of sodium permanganate (NaMnO_4) in water**
- 11) What is the boiling point of a 2.5 molal aqueous solution of $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_2$?
The boiling point elevation constant for water is $0.51^\circ\text{C kg mol}^{-1}$.
Assume complete dissociation of any soluble salts. (5 pts)
- a) 111.5°C
 - b) **103.8°C**
 - c) 3.8°C
 - d) 101.3°C
 - e) 102.6°C
- 12) A mixture of benzene and an unknown volatile liquid has a vapor pressure of 143 torr at 25°C when the mole fraction of benzene is 0.25. What is the vapor pressure of the pure unknown compound? At 25°C , the vapor pressure of pure benzene is 100.84 torr. Assume the solution is ideal. (5 pts)
- a) 186 torr
 - b) 122 torr
 - c) **269 torr** this answer worth 2 pts
 - d) **157 torr**
 - e) 89.8 torr

- 13) Which molecule has the highest melting point? (4 pts)
- 2-methylpentanal
 - 2-pentene
 - 3-chloropentanoic acid**
 - 3-chloro-2-pentanone
 - 4-chloro-2-pentene
- 14) What is the dominant intermolecular force present in propanal? (4 pts)
- Dispersion forces
 - Hydrogen bonding
 - Dipole-dipole forces**
 - No intermolecular forces are present

- 15) The vapor pressures of several solutions of cyclohexane and ethanol were determined at various compositions at 25°C. A plot of vapor pressure vs. mole fraction of cyclohexane is shown at right. (4 pts)

Does this solution follow Raoult's Law?

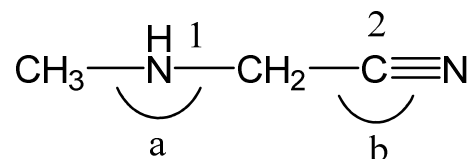
- Yes
 - No, it has a negative deviation
 - No, it has a positive deviation**
- 
- 16) Consider the cyclohexane-ethanol mixture described in the previous problem. As you mix cyclohexane and ethanol together, will you notice a temperature change? (4 pts)
- No, there will be no temperature change
 - Yes, the mixture will feel colder than before mixing**
 - Yes, the mixture will feel warmer than before mixing.
- 17) Consider the cyclohexane-ethanol mixture described in the previous problems. Which would be the strongest? (4 pts)
- The interactions between cyclohexane molecules in the pure solvent
 - The interactions between ethanol molecules in the pure solvent**
 - The interactions between cyclohexane and ethanol molecules in the mixture

- 18) A 2.29 Molar aqueous solution of glucose was prepared by adding 100mL of water to 50g of glucose, which had a final volume of 121mL. What is the molality of this solution? Assume the density of pure water is 1.00 g/mL. (5 pts)
- a) **2.77 m**
 - b) 1.89 m
 - c) 18.9 m
 - d) 0.227 m
 - e) 2.29 m
- 19) The normal boiling point of acetone is 56.2°C and the molar heat of vaporization is 32.0 kJ/mol. At what temperature will acetone boil when it is held under a pressure of 50.0 torr? (5 pts)
- a) -173°C
 - b) 54.1°C
 - c) 1.41°C
 - d) **-6.01°C**
 - e) 0.0037°C
- 20) The solubility of N₂ in blood is 5.2×10^{-4} mol/L at 37°C and normal atmospheric pressure (where the partial pressure of N₂ is 0.80 atm). Deep-sea divers experience a condition called nitrogen narcosis when the partial pressure of N₂ in the compressed air they're breathing reaches 4.0 atm, which results in the divers feeling like they're tipsy. What is the concentration of dissolved nitrogen in the blood when a diver begins to experience nitrogen narcosis? (6 pts)
- a) 5.2×10^{-4} mol/L
 - b) 3.0×10^{-3} mol/L
 - c) 1.6×10^{-4} mol/L
 - d) **2.6×10^{-3} mol/L**
 - e) 1.0×10^{-4} mol/L

- 21) Which molecule would you expect to have the lowest boiling point? (3 pts)
- a) H₂O
 - b) HOCH₂OH
 - c) **pentane**
 - d) hexane
 - e) acetone (CH₃COCH₃)
- 22) Which molecule would you expect to have the highest ΔH_{vap} ? (3 pts)
- a) H₂O
 - b) **HOCH₂OH**
 - c) pentane
 - d) hexane
 - e) acetone (CH₃COCH₃)
- 23) Which molecule would you expect to have the highest vapor pressure? (3 pts)
- a) H₂O
 - b) HOCH₂OH
 - c) **pentane**
 - d) hexane
 - e) acetone (CH₃COCH₃)
- 24) Select the molecule which forms a molecular solid. (3 pts)
- a) **H₂CO** b) Ne c) Ca₂[Cr(Cl)₆] d) MgCl₂
- 25) The triple point on the phase diagram for an unknown compound is located at 0.53atm and 15.0°C, and the critical point is located at 156atm and 230°C. At which constant temperature could both a solid→liquid and liquid→gas phase change occur as the pressure is decreased?
- Assume that the density of the solid state is greater than the liquid state for unknown compound, and that there are only three phases represented on the diagram. (5 pts)
- a) 0°C
 - b) 15.0°C
 - c) **20°C**
 - d) 260°C
 - e) There is no such temperature where both phase changes could occur.

- 26) What is the electron configuration of the molecular orbitals in the carbide ion, C_2^{2-} ? List the molecular orbitals in order of increasing energy. (4pts)
- a) $(\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\sigma_{2p})^2 (\pi_{2p})^4$
- b) $(\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\sigma_{2p})^4$
- c) $(\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\pi_{2p})^4 (\sigma_{2p})^1$
- d) $(\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\pi_{2p})^4$
- e) $(\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\pi_{2p})^4 (\sigma_{2p})^2$
- 27) Based on molecular orbital theory, which would have the stronger bond, C_2^{2-} or N_2 ? (3 pts)
- a) C_2^{2-} will have the stronger bond
- b) N_2 will have the stronger bond
- c) **The bond strengths will be equal**
- 28) Based on molecular orbital theory, which of the following is paramagnetic? (3 pts)
- a) C_2^{2-} b) N_2 c) N_2^{2-} d) CN^-
- 29) Based on molecular orbital theory, which has the lowest bond order? (3 pts)
- a) C_2^{2-} b) N_2 c) N_2^{2-} d) CN^-
- 30) Select the molecule with the longest nitrogen-nitrogen bond. Hint: all molecules actually contain a nitrogen-nitrogen bond. (5 pts)
- a) N_2
- b) N_2O
- c) **N_2H_4**
- d) N_3^-

The following four questions concern the following molecule:

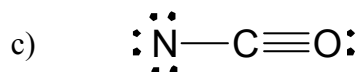
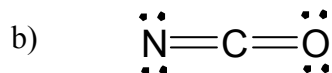
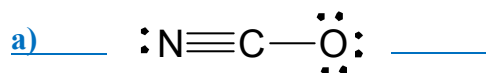


- 31) What is the hybridization of the nitrogen atom present as NH, labeled (1) in the diagram above? (3 pts)
- a) sp b) sp^2 c) sp^3 d) dsp^3 e) d^2sp^3
- 32) What is the hybridization of the carbon atom participating in the triple bond, labeled (2) in the diagram above? (3 pts)
- a) sp b) sp^2 c) sp^3 d) dsp^3 e) d^2sp^3
- 33) What is the angle labeled (a)? (3 pts)
- a) 90° **b) 107°** c) 109.5° d) 120° e) 180°
- 34) What is the angle labeled (b)? (3 pts)
- a) 90° b) 107° c) 109.5° d) 120° e) **180°**

The next four questions are all about the same molecules, SO_3 , XeF_4 , PCl_3 and PH_3 .

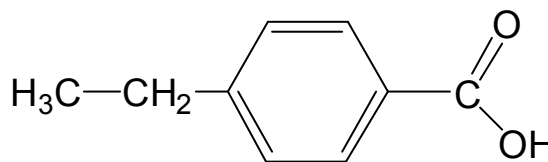
- 35) Which of the following is a polar molecule? (4 pts)
- a) SO_3 b) XeF_4 c) **PCl_3** d) PH_3 worth 2 pts
- 36) Which of the following has a trigonal planar geometry? (4 pts)
- a) **SO_3** b) XeF_4 c) PCl_3 d) PH_3
- 37) Which of the following has a square planar geometry? (4 pts)
- a) SO_3 b) **XeF_4** c) PCl_3 d) PH_3
- 38) Which of the following has a central atom that is d^2sp^3 hybridized? (4 pts)
- a) SO_3 b) **XeF_4** c) PCl_3 d) PH_3

- 39) Three possible Lewis structures for the molecule NCO^- are shown below. Which is the best / most stable structure? (4 pts)



- 40) Consider the molecule shown below. How many atoms lie in the same plane? (4 pts)

- a) 6
b) 8
c) 10
d) **12**
e) 14



- 41) If the complex ion $\text{Cr}(\text{H}_2\text{O})_6^{3+}$ appears violet, what color could $\text{Cr}(\text{OH})_6^{3-}$ appear? (4 pts)

- a) **blue**
b) orange
c) red

- 42) Select the complex ion that will not absorb light. (4 pts)

- a) $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$
b) $[\text{Co}(\text{en})_2(\text{H}_2\text{O})_2]^{2+}$
c) $[\text{Fe}(\text{CO})_4]^{2+}$
d) **$[\text{Zn}(\text{H}_2\text{O})_6]^{2+}$**

- 43) Give the name for the compound $[\text{Cr}(\text{en})_2(\text{NH}_3)_2]\text{Cl}_3$ (3 pts)
- diamminebis(ethylenediamine)chromium(V) chloride
 - diamminedi(ethylenediamine)chromium(III) chloride
 - diamminebis(ethylenediamine)chromium(II) chloride
 - diamminedi(ethylenediamine)chromium(V) chloride
 - diamminebis(ethylenediamine)chromium(III) chloride**
- 44) Give the name for the compound $\text{Na}[\text{Cu}(\text{OH})_3(\text{CO})]$ (3 pts)
- sodium carbonyltrihydroxocuprate(II)**
 - sodium carbonyltrihydroxocopper(II)
 - sodium triaquacarbonylcopper(III)
 - sodium triaquacarbonylcuprate(III)
 - sodium triaquacarbonylcopper(II)
- 45) What types of isomerism could the compound $[\text{Cr}(\text{en})_2(\text{Cl})_2]\text{Br}$ display? Assume the compound has an octahedral or tetrahedral geometry. (3 pts)
- geometrical, optical
 - coordination, geometrical
 - coordination, geometrical, linkage
 - coordination, geometrical, optical**
 - linkage, geometrical, coordination, optical
- 46) What types of isomerism could the compound $\text{Mn}(\text{NH}_3)_2(\text{Cl})_2$ display? Assume the compound has an octahedral or tetrahedral geometry. (3 pts)
- geometrical
 - coordination
 - geometrical, optical
 - coordination, geometrical, optical
 - no isomerism is present**
- 47) What types of isomerism could the square planar compound $\text{Pt}(\text{NH}_3)_2(\text{SCN})(\text{Cl})$ display? (3 pts)
- geometrical, linkage**
 - geometrical, linkage, optical
 - coordination, linkage
 - geometrical, optical
 - coordination, geometrical, linkage, optical

- 48) How many unpaired electrons does the compound $\text{Fe}(\text{en})_2(\text{CN})_2$ have? Assume the compound has an octahedral or tetrahedral geometry. (4 pts)
- a) 0
 - b) 1
 - c) 2
 - d) 3
 - e) 4
- 49) Choose the complex ion with two unpaired electrons. All complex ions have an octahedral or tetrahedral geometry. (6 pts)
- a) $\text{Fe}(\text{CN})_4^{2-}$
 - b) $\text{Cr}(\text{Br})_6^{4-}$
 - c) $\text{Cr}(\text{CO})_6^{2+}$
 - d) None of the above
- 50) Of the following complex ions, two appear violet in aqueous solution, one appears red, one appears blue-green, and one appears yellow. Which of the following appears yellow? (4 pts)
- a) $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$
 - b) $[\text{Cr}(\text{NH}_3)_6]^{3+}$
 - c) $[\text{Cr}(\text{NH}_3)_5\text{Cl}]^{2+}$
 - d) $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]^{2+}$
 - e) $[\text{Cr}(\text{NH}_3)_4\text{Cl}_2]^+$