

Chemistry 1C Final  
June 10, 2009  
Mark Lingwood  
13 Pages, 50 Questions

**Form A**

First letter of your last name:

Name: \_\_\_\_\_  
Last First

Perm # \_\_\_\_\_

**DO NOT TURN THE PAGE UNTIL TOLD TO BEGIN**

You will have 3 hours for this exam. No notes are allowed.  
No sharing of calculators, no hats/hoods, no phones / iPods / etc.

**BEFORE YOU BEGIN**

Write your name and perm number at the top of this page.

On your Scantron answer sheet:

- Fill in the “test form”. This yellow exam is **Form A**.
  - Fill in your perm number. Seven digits only.
  - Write your name on the Scantron answer sheet.

Completely fill bubbles



Completely fill answers



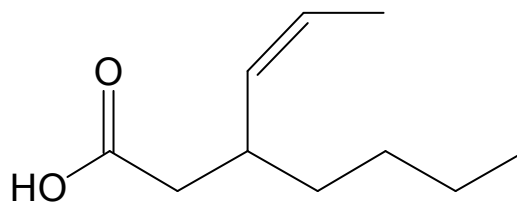
**Show your work in this booklet.** Your grade will be calculated from the answers you mark on the scantron, but this booklet will be used if any questions arise.

At the end of the exam, turn in **both** the scantron and this exam booklet.

The last page of the exam is an info sheet that you can carefully tear off if you wish.

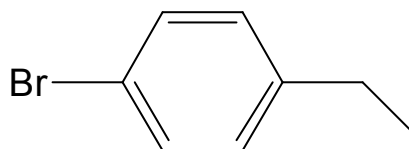
1) Give the systematic name of the compound at right. (4 pts)

- 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



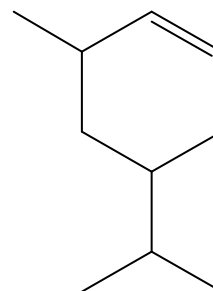
2) Give the systematic name of the compound at right. (4 pts)

- 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)

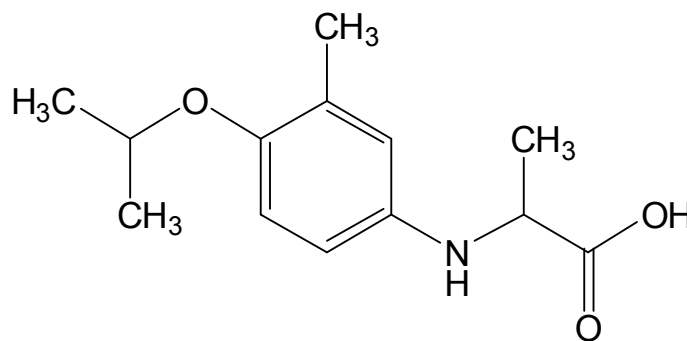
- a) 2,2-dimethyl-1-propanol
- b) 3-pentanol
- c) 3-methyl-1-butanol
- d) 2-methylbutanal
- e) 2-methyl-1-propanol

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
- 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
- c) ser-phe-gly
- d) gly-phe-cys
- e) cys-phe-asn

For Reference:

Gly -H

Ala -CH<sub>3</sub>

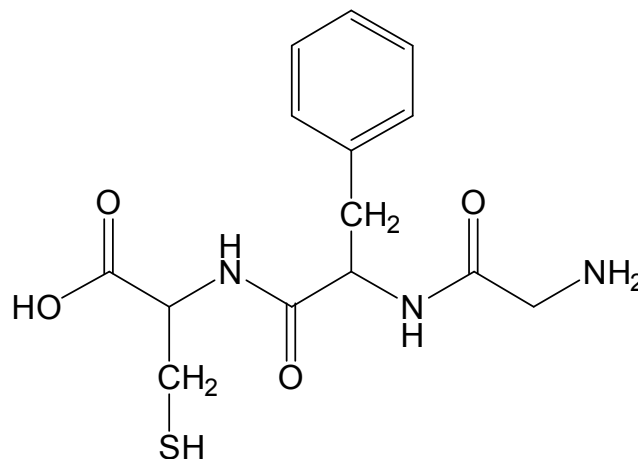
Phe -CH<sub>2</sub>-phenyl

Asn -CH<sub>2</sub>-(C=O)-NH<sub>2</sub>

Cys -CH<sub>2</sub>-SH

Leu -CH<sub>2</sub>-CH-(CH<sub>3</sub>)<sub>2</sub>

Ser -CH<sub>2</sub>-OH



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

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

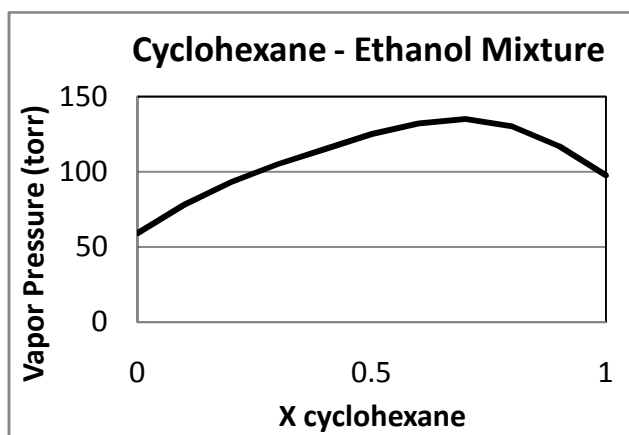
- 10) Which of the following will have the highest boiling point at 1.0 atm? (5 pts)
- a) pure water
  - b) a 0.10 m solution of potassium phosphate ( $\text{K}_3\text{PO}_4$ ) in water
  - c) a 0.10 m solution of calcium chloride ( $\text{CaCl}_2$ ) in water
  - d) a 0.30 m solution of acetone ( $\text{CH}_3\text{COCH}_3$ ) in water
  - e) a 0.25 m solution of sodium permanganate ( $\text{NaMnO}_4$ ) 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)  $111.5^\circ\text{C}$
  - b)  $103.8^\circ\text{C}$
  - c)  $3.8^\circ\text{C}$
  - d)  $101.3^\circ\text{C}$
  - e)  $102.6^\circ\text{C}$
- 12) A mixture of benzene and an unknown volatile liquid has a vapor pressure of 143 torr at  $25^\circ\text{C}$  when the mole fraction of benzene is 0.25. What is the vapor pressure of the pure unknown compound? At  $25^\circ\text{C}$ , 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
  - d) 157 torr
  - e) 89.8 torr

- 13) Which molecule has the highest melting point? (4 pts)
- a) 2-methylpentanal
  - b) 2-pentene
  - c) 3-chloropentanoic acid
  - d) 3-chloro-2-pentanone
  - e) 4-chloro-2-pentene
- 14) What is the dominant intermolecular force present in propanal? (4 pts)
- a) Dispersion forces
  - b) Hydrogen bonding
  - c) Dipole-dipole forces
  - d) 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?

- a) Yes
  - b) No, it has a negative deviation
  - c) 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)
- a) No, there will be no temperature change
  - b) Yes, the mixture will feel colder than before mixing
  - c) 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)
- a) The interactions between cyclohexane molecules in the pure solvent
  - b) The interactions between ethanol molecules in the pure solvent
  - c) The interactions between cyclohexane and ethanol molecules in the mixture

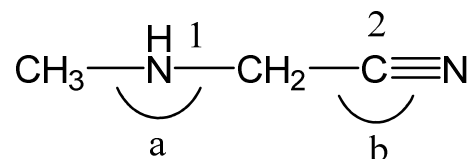


- 18) A 2.29 Molar aqueous solution of glucose was prepared by adding 100mL of water to 50g of glucose, which had a final volume of 121mL. What is the molality of this solution? Assume the density of pure water is 1.00 g/mL. (5 pts)
- a) 2.77 m
  - b) 1.89 m
  - c) 18.9 m
  - d) 0.227 m
  - e) 2.29 m
- 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 N<sub>2</sub> in blood is  $5.2 \times 10^{-4}$  mol/L at 37°C and normal atmospheric pressure (where the partial pressure of N<sub>2</sub> is 0.80 atm). Deep-sea divers experience a condition called nitrogen narcosis when the partial pressure of N<sub>2</sub> 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)  $5.2 \times 10^{-4}$  mol/L
  - b)  $3.0 \times 10^{-3}$  mol/L
  - c)  $1.6 \times 10^{-4}$  mol/L
  - d)  $2.6 \times 10^{-3}$  mol/L
  - e)  $1.0 \times 10^{-4}$  mol/L

- 21) Which molecule would you expect to have the lowest boiling point? (3 pts)
- a) H<sub>2</sub>O
  - b) HOCH<sub>2</sub>OH
  - c) pentane
  - d) hexane
  - e) acetone (CH<sub>3</sub>COCH<sub>3</sub>)
- 22) Which molecule would you expect to have the highest  $\Delta H_{\text{vap}}$ ? (3 pts)
- a) H<sub>2</sub>O
  - b) HOCH<sub>2</sub>OH
  - c) pentane
  - d) hexane
  - e) acetone (CH<sub>3</sub>COCH<sub>3</sub>)
- 23) Which molecule would you expect to have the highest vapor pressure? (3 pts)
- a) H<sub>2</sub>O
  - b) HOCH<sub>2</sub>OH
  - c) pentane
  - d) hexane
  - e) acetone (CH<sub>3</sub>COCH<sub>3</sub>)
- 24) Select the molecule which forms a molecular solid. (3 pts)
- a) H<sub>2</sub>CO                      b) Ne                      c) Ca<sub>2</sub>[Cr(Cl)<sub>6</sub>]                      d) MgCl<sub>2</sub>
- 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)
- $(\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\sigma_{2p})^2 (\pi_{2p})^4$
  - $(\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\sigma_{2p})^4$
  - $(\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\pi_{2p})^4 (\sigma_{2p})^1$
  - $(\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\pi_{2p})^4$
  - $(\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\pi_{2p})^4 (\sigma_{2p})^2$
- 27) Based on molecular orbital theory, which would have the stronger bond,  $C_2^{2-}$  or  $N_2$ ? (3 pts)
- $C_2^{2-}$  will have the stronger bond
  - $N_2$  will have the stronger bond
  - The bond strengths will be equal
- 28) Based on molecular orbital theory, which of the following is paramagnetic? (3 pts)
- $C_2^{2-}$
  - $N_2$
  - $N_2^{2-}$
  - $CN^-$
- 29) Based on molecular orbital theory, which has the lowest bond order? (3 pts)
- $C_2^{2-}$
  - $N_2$
  - $N_2^{2-}$
  - $CN^-$
- 30) Select the molecule with the longest nitrogen-nitrogen bond. Hint: all molecules actually contain a nitrogen-nitrogen bond. (5 pts)
- $N_2$
  - $N_2O$
  - $N_2H_4$
  - $N_3^-$

The following four questions concern the following molecule:

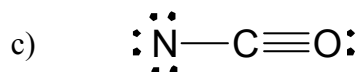
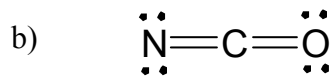
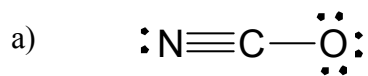


- 31) What is the hybridization of the nitrogen atom present as NH, labeled (1) in the diagram above? (3 pts)
- a)  $sp$       b)  $sp^2$       c)  $sp^3$       d)  $dsp^3$       e)  $d^2sp^3$
- 32) What is the hybridization of the carbon atom participating in the triple bond, labeled (2) in the diagram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

The next four questions are all about the same molecules, SO<sub>3</sub>, XeF<sub>4</sub>, PCl<sub>3</sub> and PH<sub>3</sub>.

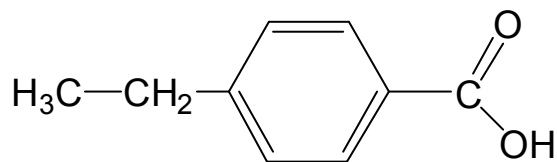
- 35) Which of the following is a polar molecule? (4 pts)
- a) SO<sub>3</sub>      b) XeF<sub>4</sub>      c) PCl<sub>3</sub>      d) PH<sub>3</sub>
- 36) Which of the following has a trigonal planar geometry? (4 pts)
- a) SO<sub>3</sub>      b) XeF<sub>4</sub>      c) PCl<sub>3</sub>      d) PH<sub>3</sub>
- 37) Which of the following has a square planar geometry? (4 pts)
- a) SO<sub>3</sub>      b) XeF<sub>4</sub>      c) PCl<sub>3</sub>      d) PH<sub>3</sub>
- 38) Which of the following has a central atom that is  $d^2sp^3$  hybridized? (4 pts)
- a) SO<sub>3</sub>      b) XeF<sub>4</sub>      c) PCl<sub>3</sub>      d) PH<sub>3</sub>

- 39) Three possible Lewis structures for the molecule  $\text{NCO}^-$  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)  $[\text{Cr}(\text{NH}_3)_4\text{Cl}_2]^+$