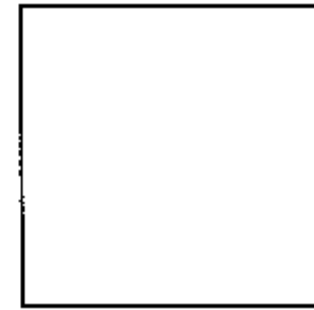


# Exam 3B

Chem 960  
Fall 2009  
Maleckar  
100 points



Initial of last name

NAME KEY

Multiple Choice \_\_\_\_\_ (45)

Circle / FGs \_\_\_\_\_ (24)

Naming & #13 \_\_\_\_\_ (21)

Problem #14 \_\_\_\_\_ (10)

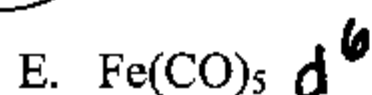
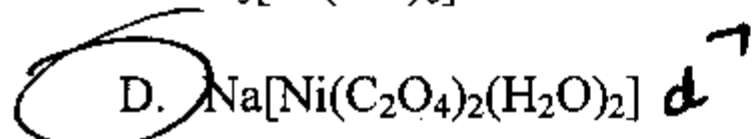
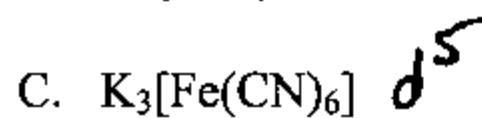
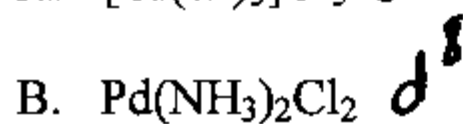
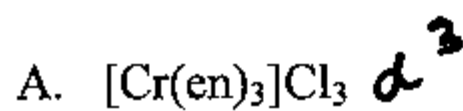
TOTAL \_\_\_\_\_ (100)

Spts. each

B

**Multiple Choice** Circle the letter of the correct answer. Not all of the questions are worth the same point value.

1. Which of the following complexes contains a metal that is  $d^7$ ?



2. Which of the following rankings of average molecular speed is correct for the following gases at the same temperature?

A.  $\text{Cl}_2 > \text{Ar} > \text{Kr} > \text{Xe}$

B.  $\text{Ar} > \text{Cl}_2 > \text{Kr} > \text{Xe}$

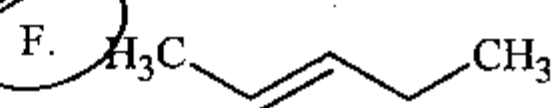
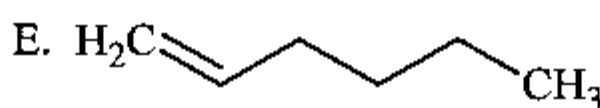
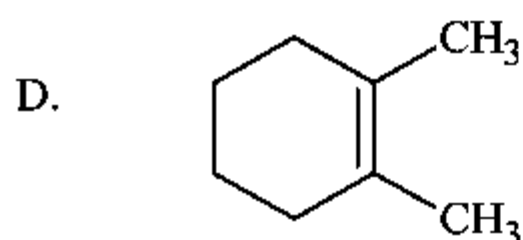
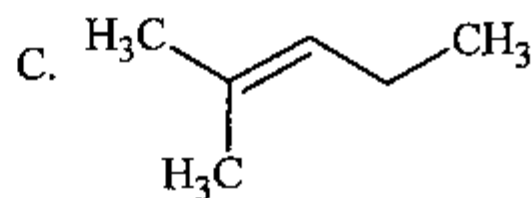
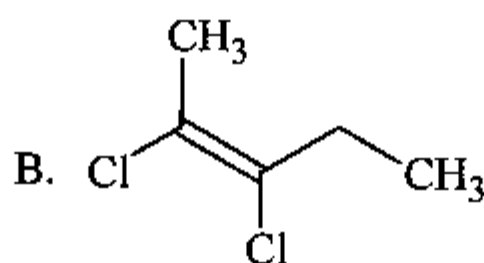
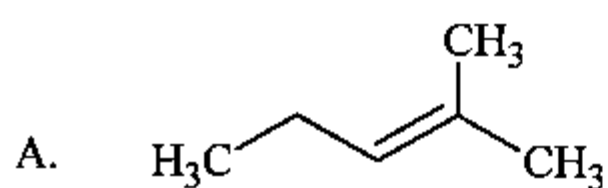
C.  $\text{Cl}_2 > \text{Kr} > \text{Xe} > \text{Ar}$

D.  $\text{Xe} > \text{Kr} > \text{Cl}_2 > \text{Ar}$

E.  $\text{Ar} > \text{Xe} > \text{Kr} > \text{Cl}_2$

	MW
$\text{Cl}_2$	71
Ar	40
Xe	131
Kr	84

3. Which of the following compounds is trans as drawn below?



4. In  $[\text{Cr}(\text{NH}_3)_2(\text{C}_2\text{O}_4)]^-$ , the coordination number is \_\_\_\_\_ and the oxidation number of the ~~Cr~~ <sup>Cr</sup> is \_\_\_\_\_.

- A. 3, +2
- B. 4, +2
- C. 3, +3
- D. 4, +3
- E. 3, +1
- F. 4, +1

5. How many seconds would it take one molecule of HCl to diffuse 120yd, the length of a football field including end zones, on a 25°C (77°F) day, assuming that it travels along a linear path?

*360 ft/mile*

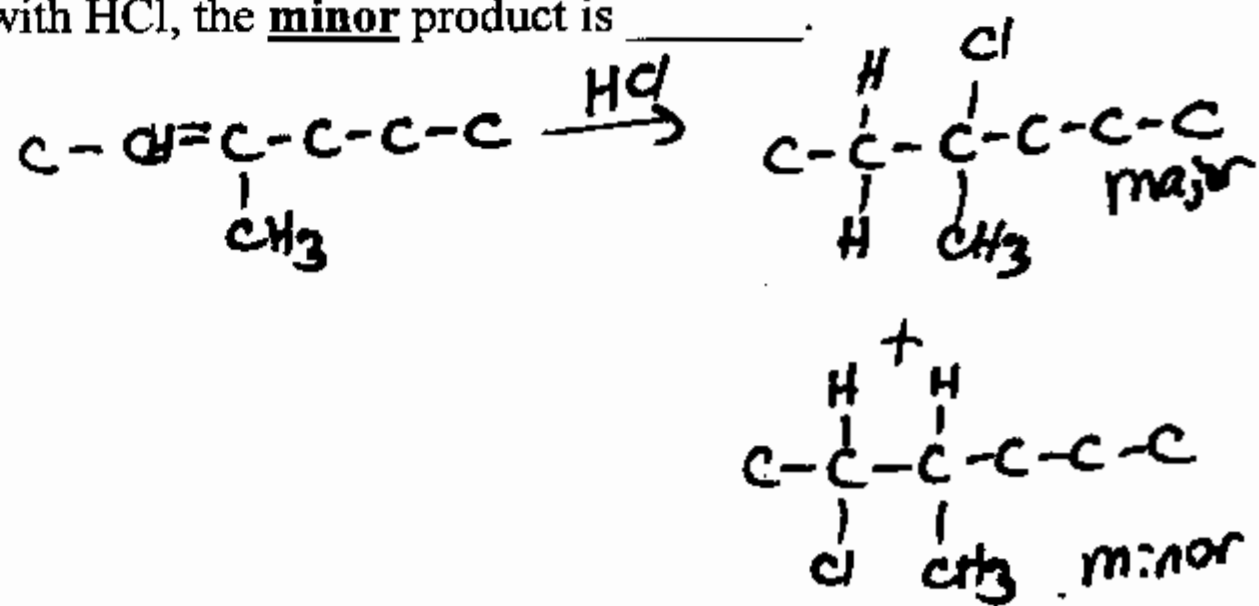
$$u = \sqrt{\frac{2(8.314)(298)}{.036}} = 459.4 \text{ m/s}$$

- A. 2.43 sec
- B. 14.4 sec
- C. 0.241 sec
- D. 7.63 sec
- E. 45.1 sec

$$(120 \text{ yd}) \left( \frac{\text{m}}{1.094 \text{ yd}} \right) \left( \frac{\text{sec}}{459.4 \text{ m}} \right) = 0.241 \text{ sec}$$

6. When you react 3-methyl-2-hexene with HCl, the minor product is \_\_\_\_\_.

- A. 4-chloro-4-methylhexane
- B. 3-chloro-3-methylhexane
- C. 5-chloro-4-methylhexane
- D. 2-chloro-3-methylhexane
- E. there is no reaction



7. Nickel forms a gaseous compound of the formula Ni(CO)<sub>x</sub>. What is the value of x given the fact that under the same conditions of temperature and pressure, methane (CH<sub>4</sub>) effuses 3.3 times faster than the compound?

- A. 0
- B. 1
- C. 2
- D. 3
- E. 4**
- F. none of these

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

$$\frac{3.3}{1} = \sqrt{\frac{M}{16}}$$

$$10.89 = \frac{M}{16}$$

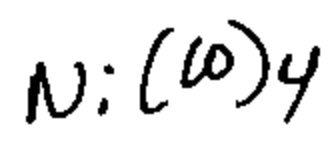
$$M = 174.24 \text{ g/mole}$$

$$\frac{174.24}{58.6} \text{ (Ni)}$$

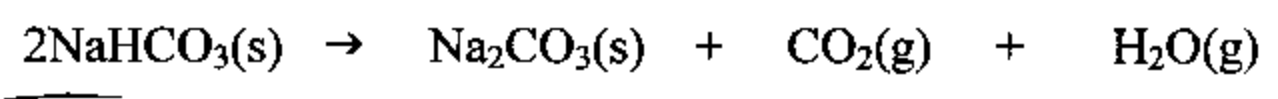
$$115.64$$

$$\text{CO: MW} = 28$$

$$\frac{115.6}{28} = 4$$



8. Sodium hydrogen carbonate, NaHCO<sub>3</sub>, is also known as baking soda. When this compound is heated, it decomposes to sodium carbonate, carbon dioxide, and water vapor. You add 2 teaspoons (11.4g) of baking soda to your cake batter. What volume (in liters) of carbon dioxide will be produced at 350°F (177°C) and 740 mm Hg?



- A. 2.58L**
- B. 5.14L
- C. 2.02L
- D. 10.3L
- E. 1.01L

$$(11.4\text{g}) \left( \frac{\text{mole}}{84\text{g}} \right) \left( \frac{1}{2} \right) = .06786 \text{ moles CO}_2$$

$$\frac{740}{760} = .9737 \text{ atm}$$

$$V = \frac{(.06786)(.08206)(350)}{.9737}$$

$$= 2.58 \text{ L}$$

9. A piece of sodium metal undergoes complete reaction with water as follows:



The hydrogen gas, collected over water at 25°C, is 327 ml, measured at 745 mm Hg. How many grams of Na were used in the reaction?  $P_{\text{H}_2\text{O}} @ 25^\circ\text{C} = 23.78 \text{ mm Hg}$

$$745 - 23.78 = \frac{721.22 \text{ mm}}{760} = 0.9489 \text{ atm}$$

$$n = \frac{(0.9489)(0.327)}{(0.08206)(298)} = 0.0127 \text{ moles } \text{H}_2$$

$$(0.0127 \text{ moles}) \left( \frac{2 \text{ Na}}{1 \text{ H}_2} \right) = 0.0254 \text{ moles Na}$$

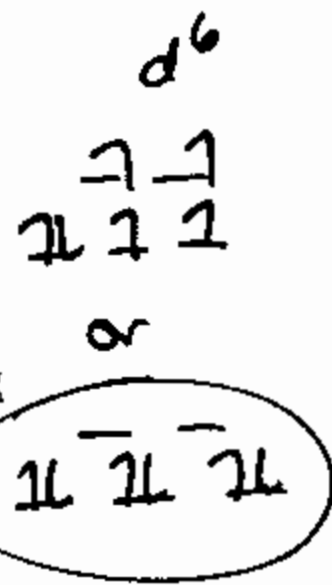
$$(0.0254 \text{ moles}) \left( \frac{23 \text{ g}}{\text{mole}} \right) = 0.584 \text{ g}$$

- A. 0.584g
- B. 0.301g
- C. 0.292g
- D. 0.603g

**Circle It!**

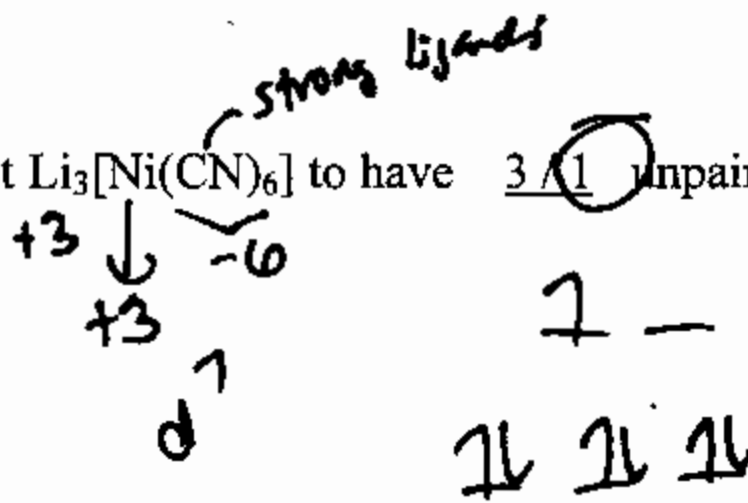
Circle the correct answer in every underlined set of words to complete the sentences.

10a. If you were told that  $[\text{Ir}(\text{NH}_3)_6]\text{PO}_4$  is diamagnetic, you could conclude that it has ligands that bind strongly / weakly. It will be labeled as high-spin / low-spin. This corresponds to a small / large  $\Delta$  value, and this complex absorbs light of a short / long wavelength.



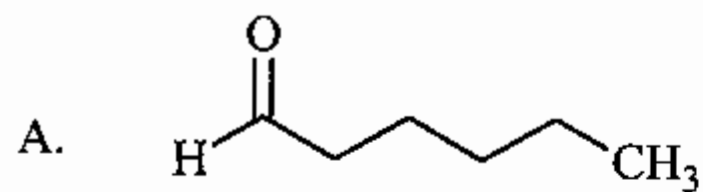
10b. If you react an alkyne with one equivalent of hydrogen and a catalyst, the product will be an alkane / alkene / alkyne.

10c. You would expect  $\text{Li}_3[\text{Ni}(\text{CN})_6]$  to have 3 / 1 unpaired electrons in its d orbitals.

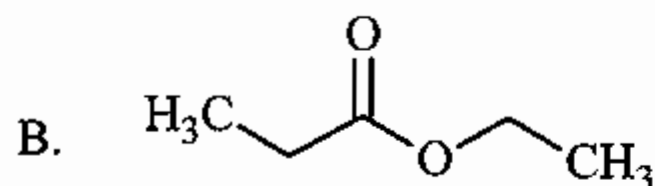


2 pts. for each circled item  
12 pts. total

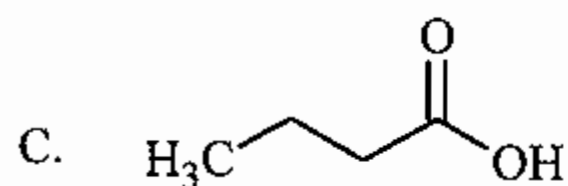
**Functional Groups** Write the name of the functional group on the line beside the structure. Your choices are: alcohol, aldehyde, amide, amine, carboxylic acid, ether, ester, and ketone.



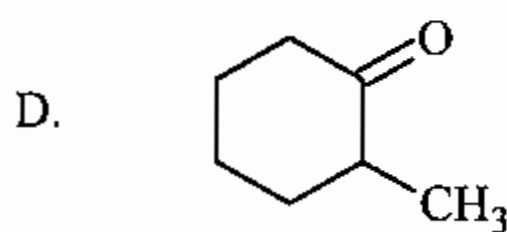
aldehyde



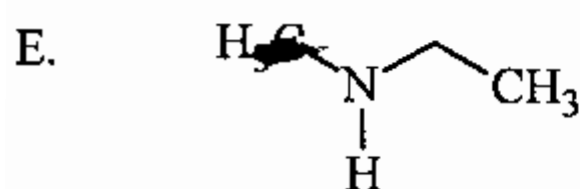
ester



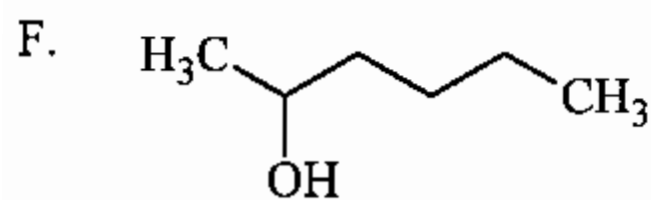
carboxylic acids



ketone



amine

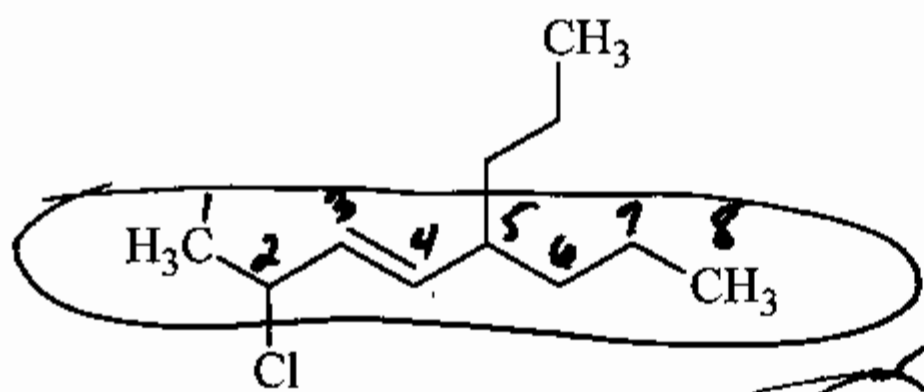


alcohol

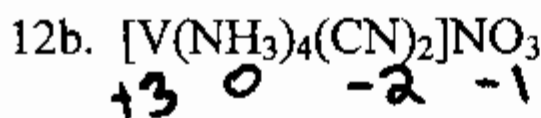
2pts. each  
12pts. total

**Naming** Name the following compounds. Use cis/trans where warranted.

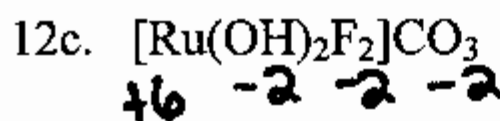
12a.



1 pt.  
trans - 2-chloro - 5-n-propyl - 3-octene



tetraammine dicyano vanadium (III) nitrate



difluoro dihydroxy ruthenium (III) carbonate

**Miscellaneous Problems**

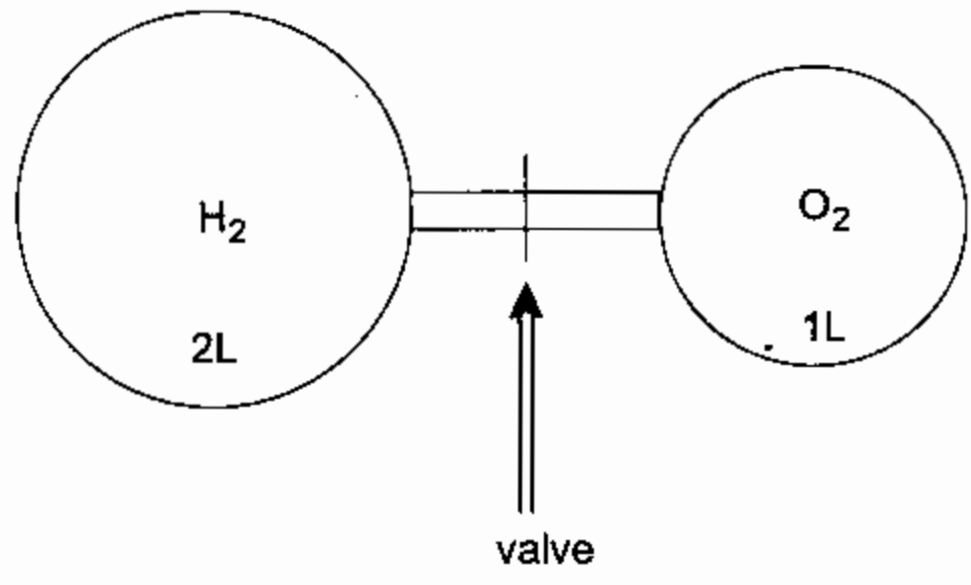
13. Three complexes of cobalt,  $[Co(NH_3)_6]^{3+}$ ,  $[Co(CN)_6]^{3-}$ , and  $[CoF_6]^{3-}$ , absorb light of 410nm, 520nm, and 630nm. Match the correct complex to the correct wavelength, then give the expected color that each complex would appear to be.

<u>Complex</u>	<u>Absorbed Wavelength</u>	<u>Observed Color</u>
$[Co(NH_3)_6]^{3+}$ red.	520 nm	red
$[Co(CN)_6]^{3-}$ str	410 nm	yellow
$[CoF_6]^{3-}$ wk	630 nm	blue

1 pt each

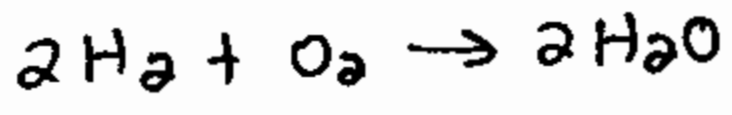
wk ligands =  $\Delta$  small  
 $= \log \lambda$

14. You have the apparatus below, with one side containing H<sub>2</sub> at 0.65 atm and the other side containing O<sub>2</sub> at 0.50 atm. You open the valve, allowing the two gases to mix and react, forming only H<sub>2</sub>O (g). The temperature is fixed at 533K.



100%

After the reaction has gone to 100% completion, what is the overall pressure in the vessel? What are the partial pressures of H<sub>2</sub>, O<sub>2</sub>, and H<sub>2</sub>O? Assume the volume of the tube connecting the two spherical chambers is negligible.



$$n = \frac{PV}{RT} = \frac{(0.65)(2)}{(0.08206)(533)} = .0297 \text{ moles } H_2$$

$$n = \frac{(0.50)(1)}{(0.08206)(533)} = 0.0114 \text{ moles } O_2$$

$$(.0297 \text{ moles } H_2) \left( \frac{1 O_2}{2 H_2} \right) = .01485 \text{ moles } O_2 \text{ needed}$$

have less  
∴ O<sub>2</sub> is LR

∴ have no O<sub>2</sub> left after rxn.

$$P_{O_2} = 0 \text{ (2pb)}$$

$$(.0114 \text{ moles } O_2) \left( \frac{2 \text{ moles } H_2}{1 \text{ mole } O_2} \right) = .0228 \text{ moles } H_2$$

$$\begin{array}{r} .0297 \\ - .0228 \\ \hline .0069 \text{ moles } H_2 \text{ left over} \end{array}$$

$$P = \frac{(.0069)(.08206)(533)}{3L} = 0.1006 \text{ atm} = P_{H_2} \text{ (2pb)}$$

also make .0228 moles H<sub>2</sub>O

$$P_{H_2O} = \frac{(.0228)(.08206)(533)}{3L} = 0.332 \text{ atm} = P_{H_2O} \text{ (2pb)}$$

$$P_{\text{total}} = P_{H_2O} + P_{H_2} = 0.332 + 0.1006 = 0.433 \text{ atm} \text{ (1pt)}$$

3pt work

## Equations and Constants

$$PV = nRT$$

$$u = (3RT/M)^{1/2}$$

$$\frac{r_1}{r_2} = (M_2/M_1)^{1/2}$$

$$\begin{aligned} R &= 0.08206 \text{ atm-L/mole-K} \\ &= 8.314 \text{ J/mole-K} \\ &= 8.314 \text{ kg-m}^2/\text{s}^2\text{-mole-K} \end{aligned}$$

$$1 \text{ atm} = 760 \text{ mm Hg} = 760 \text{ torr}$$

$$K = ^\circ\text{C} + 273$$

$$100 \text{ cm} = 1 \text{ m}$$

$$1000 \text{ ml} = 1 \text{ L}$$

$$1 \text{ cm}^3 = 1 \text{ ml}$$

$$E = \Delta E = \frac{hc}{\lambda}$$

