MC, Chem1B, Fall 11, LecExam1 Name KEY

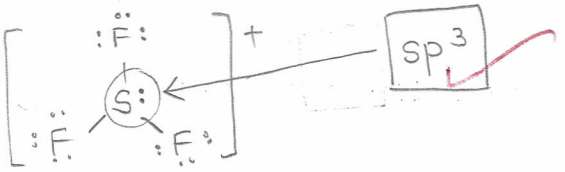
Read questions carefully to understand what is being asked. If you have doubt, do ask your instructor. Use the reverse side of your answer paper as scratch. Use attached periodic table and important constants chart. On your scantron, please start from number 10 to answer the multiple choice questions. (Total pts. = ~~78~~ 74 + 27 + ~~8~~ 12 = 113)

SHORT ANSWER: Show all your calcualtions using appropriate set up and units.

1) Identify the hybridization of the central atom in the following compounds (3 pts. each; Total 12 pts.): 1) _____

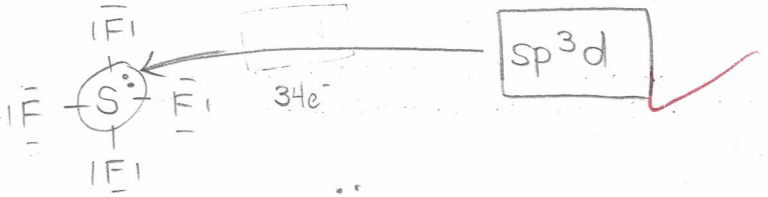
(a) SF_3^+

$6+3(7)-1=26e^-$



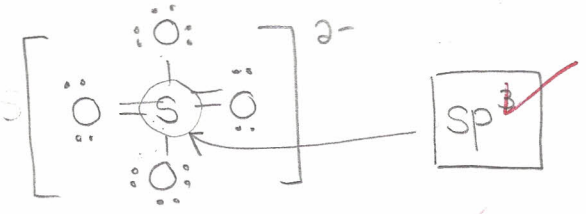
(b) SF_4

$6+4(7)=34$



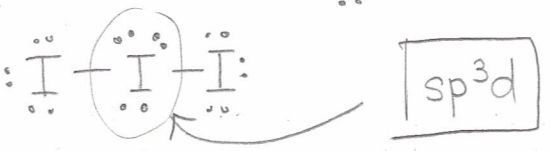
(c) SO_4^{2-}

$6+4(6)+2=32e^-$

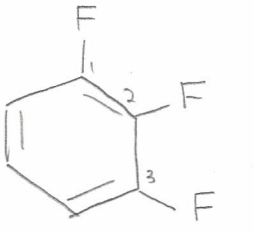


(d) I_3^-

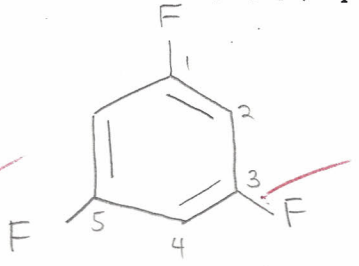
$3(7)+1=22e^-$



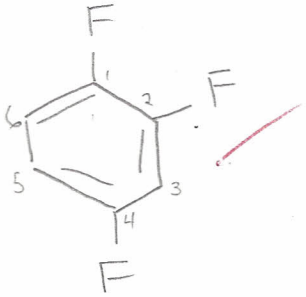
2) Draw the structures and name the isomers of $C_6H_3F_3$ (~~12~~ 8 pts.) 2) _____



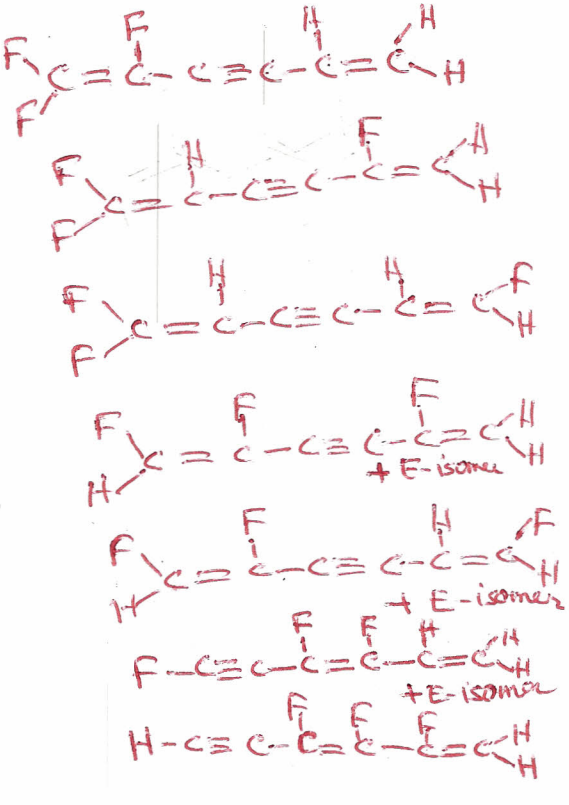
1,2,3-trifluoro benzene



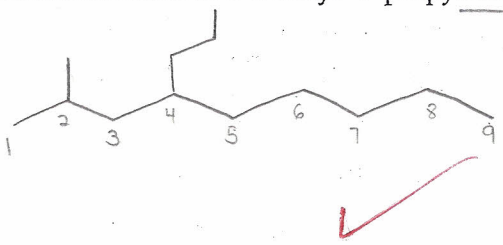
1,3,5-trifluorobenzene



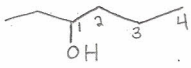
1,2,~~4~~ 3-trifluorobenzene



3) Write the condensed structure of 2-methyl-4-propylnonane (4 pts.). 3) _____



4) What is the name of the compound $CH_3CH_2CH(OH)CH_2CH_2CH_3$? (4 pts.) 4) _____



1-ethyl-1-butanol ✗

3-hexanol

5) Draw the condensed structures of the reactants and product(s) of the reaction between propionic acid and 1-propanol (8 pts.) and name the major product (2 pts.) and the functional group it conatins (2 pts.). 5) _____

propionic acid

1-propanol

ethyl propanoate ✗

propylpropionate

6) Draw the structures of the reactants and major product of the reaction between 2-methyl propene and hydrochloric acid (6 pts.) and name the major product (4 pts.) 6) _____

2-chloro-2-methyl propane ✓

7) The following experimental data were obtained at constant temperature for the reaction: 7) _____

$$2NO(g) + O_2(g) \text{ -----> } 2NO_2(g)$$

Experiment	Initial Concentrations [NO]	[O2]	Initial Rate (M s^{-1})
1	0.0010	0.0010	7.0×10^{-6}
2	0.0010	0.0020	1.4×10^{-5}
3	0.0010	0.0030	2.1×10^{-5}
4	0.0020	0.0030	8.4×10^{-5}
5	0.0030	0.0030	1.9×10^{-4}

a. Calculate the order of the reaction with respect to each reactant (6 pts.).

Rate = $K[NO]^m[O_2]^n$

$$\frac{1.4\times10^{-5}}{7.0\times10^{-6}} = \frac{K(0.0010)^m(0.0020)^n}{K(0.0010)^m(0.0010)^n} = \left(\frac{0.002}{0.001}\right)^n$$

$2 = 2^n$

$n = 1$

Order of reaction with respect to O_2 is 1st order.

$$\frac{8.4\times10^{-5}}{2.1\times10^{-5}} = \frac{K(0.002)^m(0.003)^n}{K(0.001)^m(0.003)^n}$$

$4 = 2^m$

$2^2 = 2^m$

$m = 2$

Order of reaction with respect to NO is 2nd order.

b. Write the rate law for the reaction (2 pts.).

$7.0\times10^{-6} = K(0.001)^2(0.001)$

$K = 7000$

Rate = $7000[NO]^2[O_2]$

c. Calculate rate of NO_2 formation when [NO] = [O_2] = 0.005 M (4 pts.)

Rate = $7000(0.005)^2(0.005) = 8.75 \times 10^{-4} \frac{M}{S}$

8) If the rate of foramtion of oxygen gas is 6.0×10^{-5} M/s in the following conversion: 8) _____
$2\ O_3\ (g) \text{ --------> } 3\ O2$, then calculate the rate of disappearance of O_3 (g) at that same time. (4 pts.)

$$-\frac{1}{2}\left(\frac{\Delta O_3}{\Delta t}\right) = \frac{1}{3}\left(\frac{\Delta O_2}{\Delta t}\right)$$

$$-\frac{1}{2}\left(\frac{\Delta O_3}{\Delta t}\right) = \frac{1}{3}\left(6.0\times10^{-5}\frac{M}{s}\right)$$

$$-\frac{\Delta O_3}{\Delta t} = \frac{2}{3}\left(6.0\times10^{-5}\frac{M}{s}\right) = \boxed{4\times10^{-5}\frac{M}{s}}$$ O_3 disappearing

9) Carbon dating may be used to date (once living) materials that are between 100 and 40,000 years old. The half-life of the **first-order** decomposition of carbon-14 is 5730 years. What percentage of carbon-14 remains (ratio of final to initial concentrations multiplied by 100) in a sample after 40,000 years (8 pts.). 9) _____

$K = \frac{0.693}{t_{\frac{1}{2}}}$

$t = 40{,}000\ yr$

$\frac{A_t}{A_0} = ?$

$t_{\frac{1}{2}} = 5730\ yr$

$K = \frac{0.693}{5730} = 1.2094\times10^{-4}$

$$\ln\left(\frac{A_t}{A_0}\right) = -kt$$

$$\ln\left(\frac{A_t}{A_0}\right) = -\frac{0.693}{5730}(40{,}000)$$

$$\frac{A_t}{A_0} = e^{-\left(\frac{0.693}{5730}\right)(40{,}000)} = 0.0079$$

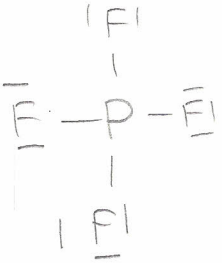
$\frac{A_t}{A_0} \times 100 = 0.0079 \times 100 = \boxed{0.79\%}$ C^{14} remains

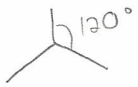
MULTIPLE CHOICE. Start on line 7 of your scantron paper. Select the one alternative that best completes the statement or answers the question (3 pts each).

10) The molecular geometry of the PF_4^+ ion is _____. 10) _____

A) trigonal pyramidal
B) octahedral 6
C) trigonal bipyramidal 5
D) tetrahedral
E) trigonal planar 3

$5+4(7)-1 = 32e^-$



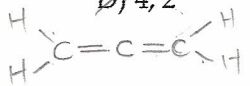


11) The angles between sp^2 orbitals are _____. 11) _____

A) 90° B) 120° C) 180° D) 45° E) 109.5°

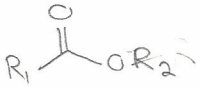
12) There are _____ σ and _____ π bonds in the $H_2C{=}C{=}CH_2$ molecule. 12) _____

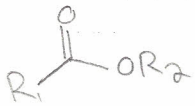
A) 2, 6 B) 6, 4 C) 6, 2 D) 4, 2 E) 2, 2



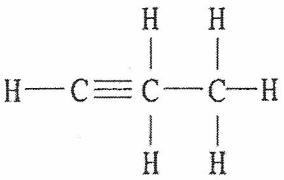
13) The general formula of an ester is _____. 13) _____

A) R–O–R' ether
B) R–CO–OR' ester
C) R–OH alcohol
D) R–CO–R' ketone
E) R–CO–OH acid





14) The compound below is an _____. 14) _____



A) aromatic compound
B) alkyne
C) olefin
D) alkene
E) alkane

15) The addition of HBr to 2-butene produces _____. 15) _____

A) no reaction
B) 2-bromobutane
C) 2,3-dibromobutane
D) 1-bromobutane
E) 1,2-dibromobutane

16) The rate law for a reaction is 16) _____

$$\text{rate} = k\,[A][B]^2$$

Which one of the following statements is false?

A) The reaction is second order overall.
B) k is the reaction rate constant
C) If [B] is doubled, the reaction rate will increase by a factor of 4.
D) The reaction is second order in B.
E) The reaction is first order in A.

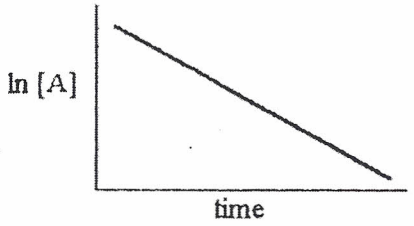
$K = \frac{0.693}{t_{\frac{1}{2}}}$ $t_{\frac{1}{2}} = \frac{0.693}{K}$

17) Under constant conditions, the half-life of a first-order reaction _____. 17) _____

A) is constant
B) does not depend on the initial reactant concentration
C) is the time necessary for the reactant concentration to drop to half its original value
D) can be calculated from the reaction rate constant
E) All of the above are correct.

18) The graph shown below depicts the relationship between concentration and time for the following chemical reaction. 18) _____

$2A \longrightarrow C$



$\ln A_t = (-k)t + \ln A_0$

The slope of this line is equal to _____.

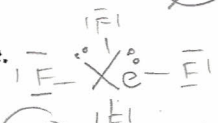
A) -k B) k C) $\ln[A]_0$ D) -1/k E) 1/k

TRUE/FALSE. In your scantron, fill up bubble A for true and bubble B for false answers (2 pts./question).

19) Possible shapes of AB_3 molecules are linear, trigonal planar, and T-shaped. F 19) _____

20) XeF_4 is a polar molecule. 20) _____

$8+4(7)=36e^-$



F nonpolar

21) Rates of reaction can be positive or negative. F 21) _____

22) The half-life for a first order rate law depends on the starting concentration. 22) _____

F