Chemistry 1110 R10 Fall 2023 Test 2

Thursday, October 26, 2023 Time: 1 hour 50 minutes

Name: ANSWERS Student #: _____

*This test consists of **nine** pages of questions, a page containing useful constants and conversions, a page containing functional group information, and a periodic table. Please ensure that you have a complete test and, if you do not, obtain one from me **immediately**. There are **76** marks available. Good luck!*

1) **[4 marks]** The following apparatus was assembled:

Flask 1:
Volume: 6 litres
Filled with: C_4H_{10}
At a pressure of: 2000 torr

Flask 2:
Volume: 4 litres
Filled with: O_2
At a pressure of: 6500 torr

The two flasks were kept at a temperature of 528.6°C. The flasks were connected to one another by a valve (of no significant volume). When the valve was opened, the reaction

$$2C_4H_{10}(g) + 13O_2(g) \longrightarrow 8CO_2(g) + 10H_2O(g)$$

occurred. Calculate the partial pressures of all species after reaction. Give your answers in torr.

$n_{C_4} = \frac{2000 \times 6}{RT} = \frac{12000}{RT}$; $n_{O_2} = \frac{6500 \times 4}{RT} = \frac{26000}{RT}$

LR check: $\frac{12000}{RT}$ mol $C_4 \times \frac{1\ rxn}{2C_4} = \frac{6000}{RT}$ mol rxn

LR

$\frac{26000}{RT}$ mol $O_2 \times \frac{1\ rxn}{13O_2} = \frac{2000}{RT}$ mol rxn

C_4 L.O. = $\frac{12000}{RT}$ mol $C_4 - \frac{26000}{RT}$ mol $O_2 \times \frac{2C_4}{13O_2} = \frac{8000}{RT}$

CO_2: $\frac{26000}{RT}$ mol $O_2 \times \frac{8CO_2}{13O_2} = \frac{16000}{RT}$ mol CO_2

H_2O: $\frac{26000}{RT}$ mol $O_2 \times \frac{10H_2O}{13O_2} = \frac{20000}{RT}$ mol H_2O

$P = \frac{nRT}{V} = \frac{8000}{RT} \times \frac{RT}{10L}$

800 torr	1600 torr	2000 torr	0
(C_4H_{10})	CO_2	H_2O	O_2

2) **[4 marks]** Helium effuses 5.0512 times faster than a gas of formula S_nF_m, and 5.8084 times faster than a gas of formula S_nCl_m. What are the formulas of the two gases?

$M_1 = 4.0026(5.0512)^2 = 102.12488238$

$M_2 = 4.0026(5.8084)^2 = 136.0377598$

So:

$32.065n + 18.998m = 102.124\ldots$ (1)

$32.065n + 35.453m = 136.0377\ldots$ (2)

(2) − (1) gives:

$16.455m = 32.9129\ldots$

$m = 2$

$32.065n + 2(18.998) = 102.124\ldots$

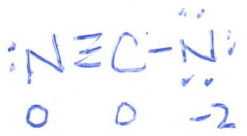
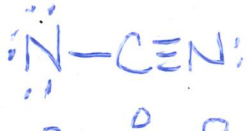
$\Rightarrow n = 2$

So the gases are $\boxed{S_2F_2 + S_2Cl_2}$

3) **[4 marks]** For the CN_2^{2-} ion (C the centre atom):

a) Draw three resonance forms.
b) Assign formal charges to all atoms in each resonance form.
c) Circle the "worst" of the resonance forms you've drawn.
d) Which of the structures you drew are equivalent resonance forms? Label them as equivalent resonance forms.

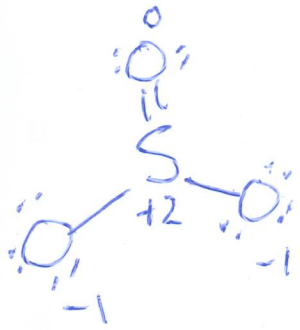
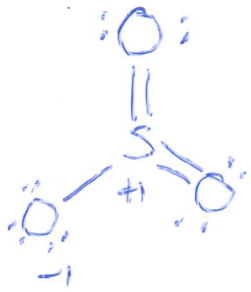
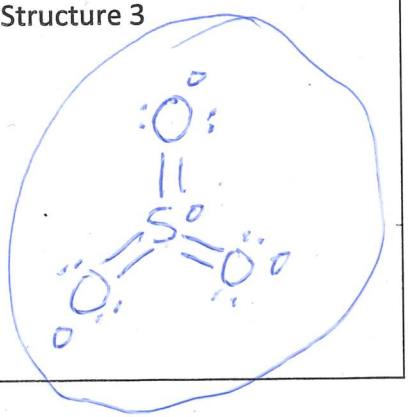
Draw your structures in the boxes provided; only structures drawn in those boxes will be marked. (You may use the rest of the page for rough work; it will not be marked.)

Structure 1	Structure 2	Structure 3
 equiv		 equiv

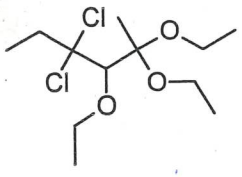
4) **[4 marks]** For the SO_3 molecule (S the centre atom):

a) **[2 marks]** Draw three non-equivalent resonance forms. The three forms you draw must include the "best" one.
b) **[1 mark]** Assign formal charges to all atoms in each of your resonance forms.
c) **[1 mark]** Circle the "best" resonance form.

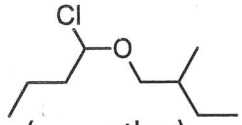
Draw your structures in the boxes provided; only structures drawn in those boxes will be marked. (You may use the rest of the page for rough work; it will not be marked.)

Structure 1	Structure 2	Structure 3
		

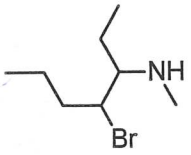
5) **[24 marks]** Give IUPAC (or other acceptable) names for the following structures.

a) 

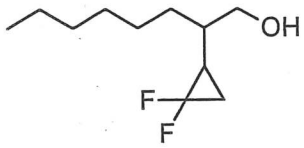
4,4-dichloro-2,2,3-triethoxyhexane

b) 
(as an ether)

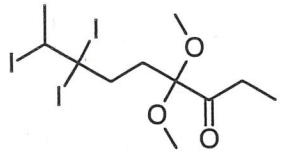
1-chlorobutyl 2-methylbutyl ether

c) 

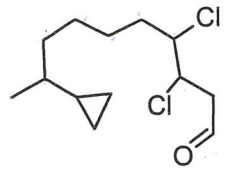
4-bromo-N-methylheptan-3-amine

d) 

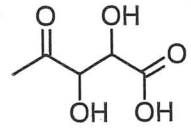
2-(2,2-difluorocyclopropyl)octan-1-ol

e) 

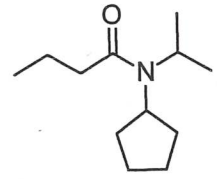
7,7,8-triiodo-4,4-dimethoxynonan-3-one

f) 

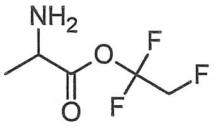
3,4-dichloro-9-cyclopropyldecanal

g) 

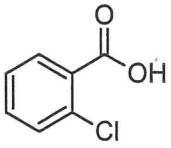
2,3-dihydroxy-4-oxopentanoic acid

h) 

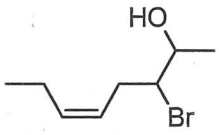
N-isopropyl-N-cyclopentylbutanamide

i) 

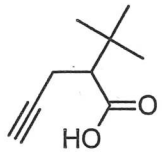
1,1,2-trifluoroethyl 2-aminopropanoate

j) 

o-chlorobenzoic acid

k) 

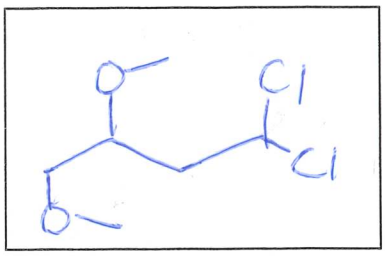
cis-3-bromooct-5-en-2-ol

l) 

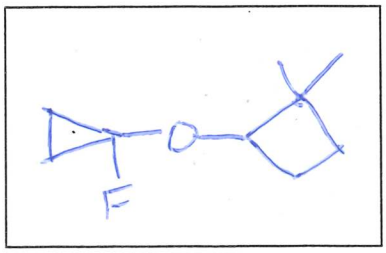
2-t-butylpent-4-ynoic acid

6) **[24 marks]** Draw structures to correspond with the names given below. For those structures, you may use either the shorthand (as was used in the previous question), or you may draw Lewis-compliant structures showing all atoms and all bonds between atoms (you need not show lone pairs). You may switch between the two styles for different structures.

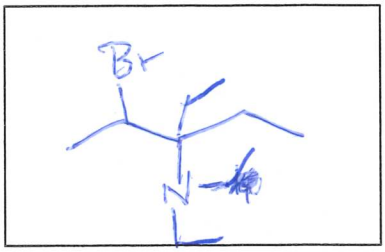
a) 1,1-dichloro-3,4-dimethoxybutane



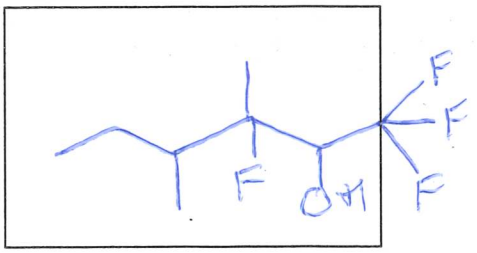
b) 1-fluorocyclopropyl 2,2-dimethylcyclobutyl ether



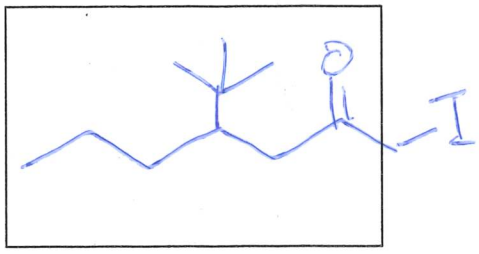
c) 2-bromo-N,N,3-triethylpentan-3-amine



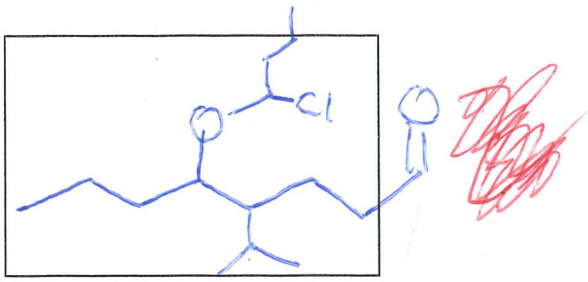
d) 1,1,1,3-tetrafluoro-3,4-dimethylhexan-2-ol



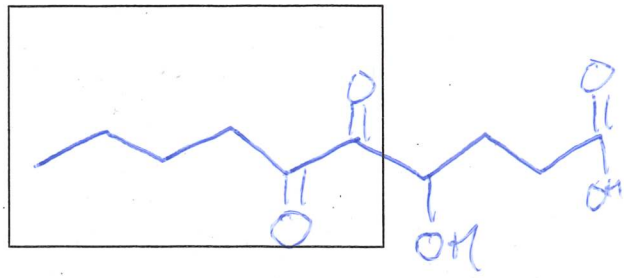
e) 4-tert-butyl-1-iodoheptan-2-one



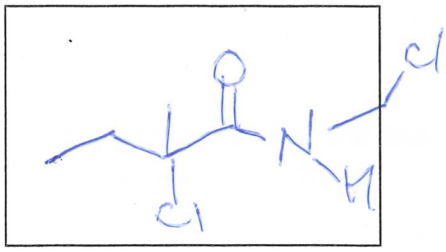
f) 5-(1-chlorobutoxy)-4-isopropyloctanal



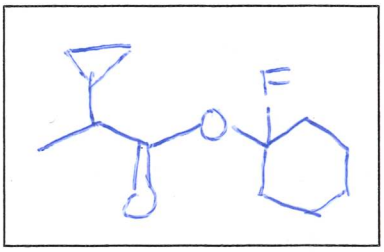
g) 4-hydroxy-5,6-dioxodecanoic acid



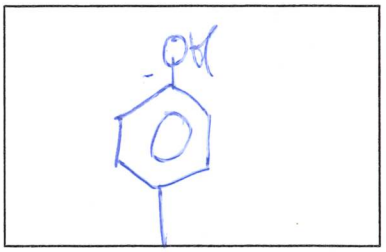
h) 2-chloro-N-(chloromethyl)-2-methylbutanamide



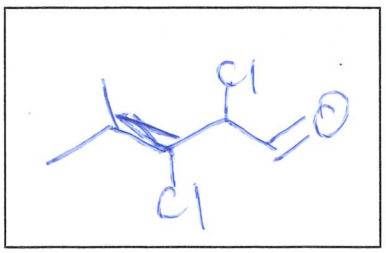
i) 1-fluorocyclohexyl 2-cyclopropylpropanoate



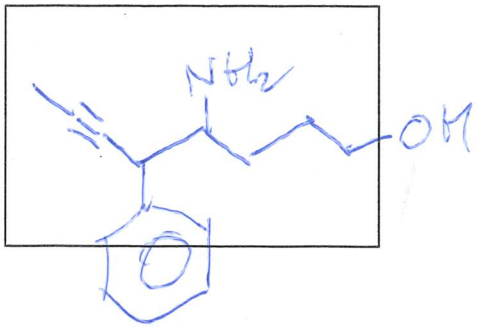
j) p-methylphenol



k) 2,3-dichloro-4-methylpent-3-enal



l) 4-amino-5-phenyloct-6-yn-1-ol



7) **[3 marks]** Draw two compounds of formula C_3H_6O that are functional isomers of each other. Name the compounds you draw.

propanone (or acetone)

propanal

8) **[3 marks]** Draw two compounds of formula $C_4H_{11}N$. One must be a primary amine, and one must be a tertiary amine. Name the compounds you draw, and indicate which is the primary amine, and which is the tertiary amine.

butan-1-amine (1°)

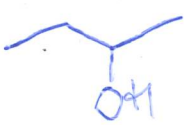
N,N-dimethylethanamine (3°)

9) **[3 marks]** Draw two compounds of formula C_4H_8 that are geometric isomers of each other. Name the compounds you draw.

trans-2-butene

cis-2-butene

10) **[3 marks]** Draw two compounds of formula $C_4H_{10}O$. One must be a secondary alcohol, and one must be a tertiary alcohol. Name the compounds you draw, and indicate which alcohol is secondary and which is tertiary.



butan-2-ol (2°)

2-methylpropan-2-ol (3°)