1) 10pts
What is a fluorocarbon?

A compound that contains a carbon-fluorine bond.

What are the three characteristics that make fluorine such a special and unique substituent?

a) F is the most electronegative element
b) Next smallest substituent after hydrogen
c) It forms a stronger bond to carbon than hydrogen does.

Name two famous fluorine chemists and state what area of fluorine chemistry they each contributed to.

- Scheele (HF), Noding (F2), Svedberg (anhydrous fluoride)
- Simon (fluorine), Dobson (F in organic molecules), O’Hara (natural occurring fluoroalkanes, fluorine), Pake (fluorine)

2) 10pts
Draw a Lewis structure with lone pairs for:

- Tetrabutylammonium fluoride
- A Fluorine atom

3) 5pts
State and briefly explain one historical reason why organofluorine chemistry grew rapidly during the 1900’s.

- Research into CFC’s for cooling agents
- F2 heating for UF6 and related materials for atomic bomb research

Give one possible reason why nature finds it (almost) impossible to synthesize organofluorine compounds?

- Natural fluoride ion sources are heavily water insoluble.
- Aqueous fluoride is very well solvated, & is a poor nucleophile.
- $F^-$ & $F_2$ are too difficult to generate biologically.
4) 22 pts
Circle which bond is longer
C-H or C-F
Circle which bond is stronger
C-H or C-F
Circle which bond is more polar
C-H or C-F
Circle the molecule with the stronger σ bond:

- CF₄
- CBr₄
- CF₄
- CF₂H₂
- BBr₃
- BCl₃
- F-F
- Cl-Cl

State two similarities between H and F
Both are: small, unipolar; Nucleus spin I = \( \frac{1}{2} \); form strong bonds to carbon; form stable polyatomic molecules, need le for full outer shell ...

State two similarities between F and Cl
Both are: halogens, 7 valence electrons; electronegative; leaving groups; O/P directors for E.A.S. ...

5) 10 pts Match the reagents with the correct process:

- SF₄, HF → Nucleophilic Trifluoromethylation
- Ni electrodes in HF → Electrophilic Fluorination
- Electrophilic Trifluoromethylation
- E.C.F./ Simon’s Cell
- Chiral Cartman Fluorination
- Nucleophilic Fluorination
- F₂, Sulphuric Acid → DeoxoFluorination
- KF, crown ether, sulpholane → Radical Trifluoromethylation
- Uneven Poptart Sugarnation
- Radical Fluorination
6) 8pts Explain how CFC's are detrimental to the Ozone layer.

CFC's are ChloroFluorocarbons, which when rise up into the stratosphere and react with the powerful UV rays. This generates Cl⁻ which destroys the ozone layer.

\[ \text{Cl} \cdot + \text{O}_3 \rightarrow \text{ClO} \cdot + \text{O}_2 \]
\[ \text{ClO} \cdot + \text{O}_3 \rightarrow 2\text{O}_2 + \text{Cl}^- \]

Regenerated & carries on the chain process.

Overall \[ 2\text{O}_3 \rightarrow 3\text{O}_2 \]

catalyzed by Cl⁻ radicals.

7) 5 pts. Name and draw (correct Lewis structure, including lone pairs) a polar, aprotic solvent suitable for fluoride ion Halex reactions.

Eg: Sulpholane

N-Methylpyrrolidinone

\( \text{H}_3\text{C} - \text{N} - \text{C} - \text{CH}_3 \)

\( \text{H}_3\text{C} - \text{O} - \text{CH}_3 \)

\( \text{H}_3\text{C} - \text{O} - \text{CH}_3 \)

\( \text{H}_3\text{C} - \text{O} - \text{CH}_3 \)

\( \text{H}_3\text{C} - \text{O} - \text{CH}_3 \)

\( \text{H}_3\text{C} - \text{O} - \text{CH}_3 \)

\( \text{H}_3\text{C} - \text{O} - \text{CH}_3 \)

\( \text{H}_3\text{C} - \text{O} - \text{CH}_3 \)

\( \text{H}_3\text{C} - \text{O} - \text{CH}_3 \)
8) 10pts Draw in the products:

\[
\begin{align*}
&\text{CH}_3 \quad \text{F}_2/N_2 \quad \text{H}_2\text{SO}_4 \\
&\xrightarrow{\text{CoF}_3} \\
&\text{CF}_3 \\
&\text{F}
\end{align*}
\]

9) 15pts Draw in the products:

\[
\begin{align*}
&\text{HO} \quad \text{CF}_3 \\
&\xrightarrow{\text{1) KOH}} \\
&\xrightarrow{\text{2) CF}_3\text{Si(CH}_3)_3, \text{CsF, THF}} \\
&\xrightarrow{\text{3) H}_2\text{O}} \\
&\xrightarrow{\text{DAST, hexane}} \\
&\text{CF}_2 \quad \text{CF}_3 \\
&\text{F} \\
&\text{CF}_2 \quad \text{CF}_3 \\
&\text{OH}
\end{align*}
\]

10) 15pts Draw in the products:

\[
\begin{align*}
&\text{I} \\
&\xrightarrow{\text{SelectFluor, CH}_3\text{CN}} \\
&\xrightarrow{\text{CF}_3\text{I, heat}} \\
&\xrightarrow{\text{FSO}_2\text{CF}_2\text{CO}_2\text{CH}_3, \text{Cul, heat}} \\
&\text{+ para}
\end{align*}
\]
11) 10pts  Draw in the products:

12) 20pts
10 True and False questions:

BAST and DAST reagents are safer alternatives to SF₄.  T
A Fluorine atom has 10 neutrons.  F
Fluorine prefers to be bound to atoms of high p character.  T
A Fluorine atom has 9 valence electrons.  T
Perfluorocarbons are normally more dense than hydrocarbons.  T
Perfluorocarbons can dissolve large amounts of oxygen and carbon dioxide.  T
The Fluorinase enzyme can make a C-F bond.  F
Fluoride ion is a worse nucleophile in ethanol than in THF.  T
Prakash was the first chemist to prepare CF₃-TMS.  F
All compounds containing a C-F bond are very toxic.  F
13) 3 x 20 pts
Write the mechanism (no words) for three of the following fluorinating agents. (If you do all 4 I will just grade the first 3)