Refrigerators

- Refrigerants are gases at room temperature; they are compressed at room temperature to liquids (takes energy, makes heat) then evaporated quickly then (gets cold)

Early Refrigerants

- \( \text{SO}_2 \) bp -10°C - smells bad, toxic
- \( \text{NH}_3 \) bp -34°C - smells bad, toxic
- \( \text{CF}_2\text{H}_2 \) bp -30°C - non-toxic, chloro-fluorocarbons

But there's a problem:

- \( \text{O}_3 \) - Bad at our level
- \( \text{O}_3 \) - Protects us from UV in the upper atmosphere
- \( \text{CF}_2\text{Cl}_2 \xrightarrow{hv} \text{Cl}^* \) in upper atmosphere & a chlorine atom

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$\text{Cl}_2\text{Cl}_2 \xrightarrow{\text{hr}} \text{Cl}^\circ + \text{Cl}_2\text{Cl}_2$  

$\text{O}_3 \xrightarrow{\text{Cl}^\circ} \text{O}_2$  

$\text{Cl}^\circ$ is a catalyst for decomposition of ozone to molecular oxygen  

$\text{Cl}^\circ + \text{O}_2 \xrightarrow{\text{Cl}^\circ} \text{Cl}_2\text{O}_2$  

$\text{Cl}_2\text{O}_2 \xrightarrow{\text{Cl}^\circ} \text{Cl}^\circ + \text{O}_3$  

$2 \text{Cl}^\circ \leftrightarrow \text{Cl}_2\text{O}_2$  

$\text{Cl}_2\text{O}_2 \xrightarrow{\text{Cl}^\circ} \text{Cl}^\circ \cdot \text{O}_3$  

$\text{Cl}^\circ + \text{O}_3 \xrightarrow{\text{Cl}^\circ} \text{Cl}^\circ$  

So we need something new  

$\text{Cl}^\circ + \text{CF}_2\text{Cl}_2$ - destroyed in the lower atmosphere  

$\text{CF}_3\cdot\text{CH}_2\text{F}$ - no Cl - can't produce $\text{Cl}^\circ$  

Long life  

- But, it's a very "good" greenhouse gas.
The Greenhouse effect

Sunlight $\downarrow$ radiation $\rightarrow$ $\frac{\circ}{\circ}$ radiated light $\rightarrow$ $\frac{\circ}{\circ}$ absorbs some $\rightarrow$ enters $\rightarrow$ it into heat.

$F_2C=CHF$ has far more IR stretching modes than $\frac{\circ}{\circ}$ and is much worse as $\rightarrow$ a greenhouse gas.

Other alternatives may be pentane - but it’s flammable, or $\frac{\circ}{\circ}$ which requires higher pressure.

$F_2C=CF_2$ Tetrafluoro ethylene

Petel polymerized $\rightarrow (CF_2-CF_2)_n$ Teflon

Oil + Water don’t stick to it.

$H_2C=CH_2$ $\rightarrow (CH_2-CH_2)_n$ Polyvinyl Chloride PVC - most plumbing pipes.
$\text{F}_3\text{C} - \text{c}^\ddagger\text{H} \quad \text{Halothane - an anesthetic}$

$\text{Br} \quad \text{- it's chiral! - which enantiomer works? - both about the same which is uncommon for drugs}$

$\text{very good for killing mosquitoes and thus controlling malaria}$

$\text{But... it's now banned worldwide because the Elimination Pander}$

$\text{Causes very fragile egg shells in Raptors.}$
Elimination Reactions:
- The opposite of addition to double bonds
- Requires strong base.

\[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{Br} & \quad \xrightarrow{\text{NaOH}} & \quad \text{H} & \quad \text{Br} \\
\text{H} & \quad \text{H} & \quad \xrightarrow{\text{CH}_3\text{OH}} & \quad \text{H} & \quad \text{Br} \\
\text{H} & \quad \text{H} & \quad \xrightarrow{\text{H}_2\text{O}} & \quad \text{H} & \quad \text{Br}
\end{align*}
\]

90% + 10%

\[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{O} & \quad \xrightarrow{\text{H}_2\text{O}} & \quad \text{H} & \quad \text{O} \\
\text{H} & \quad \text{H} & \quad \xrightarrow{\text{Na}} & \quad \text{H} & \quad \text{O} \\
\text{H} & \quad \text{H} & \quad \xrightarrow{\text{H}_3\text{O}^+} & \quad \text{H} & \quad \text{O}
\end{align*}
\]

15% + 85%

Bulkier Base - it's harder to fit in for back-side attack

\[
\text{Rate} = k[B_{\text{RBr}}][B_{\text{RO}}^2]
\]

Second order.

This is E2.
More crowded R-Br - Slower SN2

Depending on which H is taken off,

What is the Stereochimetry of Elimination?

Only product seen
The other possible conformation is:

This is an eclipsed conformation.

Almost flat like in the future alkene.
E1 Elimination - Non-basic Conditions

Side Reaction of SN1

\[ \text{H}_3\text{C} - \text{CH}_2\text{Br} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{C} - \text{CH}_3 + \text{CH}_3\text{O} \]

\[ \text{H}_3\text{C} - \text{CH}_3 + \text{CH}_3\text{OH} \rightarrow \text{H}_3\text{C} - \text{CH}_3 + \text{CH}_3\text{O} \]

We've seen lots of reactions of carbocations,