

# Expand your Chemical Universe Construct a Molecule!



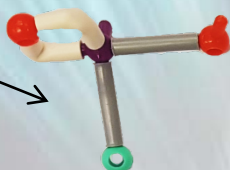
You are in possession of the  
"O-Alkyl ( $\leq C_{10}$ , incl. cycloalkyl) alkyl (Me, Et, n-Pr or i-Pr)-phosphonofluoridates" Construction Kit

## Instructions:

### Your kit contains:

- 1 phosphonofluoridate moiety. This is a phosphorus center (P ●) bonded to two oxygen atoms (O ●) and one fluorine atom (F ●)
- 13 carbon atoms (C ●) without bonds
- 28 hydrogen atoms (H ○), each attached to a 2 cm length bonds
- 23 loose 2.5 cm length bonds

Phosphonofluoridate moiety



Carbon atoms (C)



2.5 cm length bonds

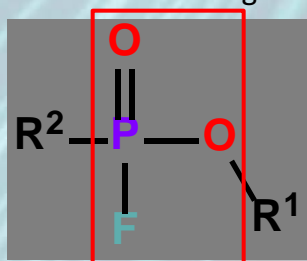


Hydrogen atoms (H) (with bonds)

Your task is to construct alkyl and/or cycloalkyl groups and build a member of the "O-Alkyl ( $\leq C_{10}$ , incl. cycloalkyl) alkyl (Me, Et, n-Pr or i-Pr)-phosphonofluoridate" family of chemicals. Points will be rewarded and prizes given for getting the right structure.

## What is an 'O-Alkyl ( $\leq C_{10}$ , incl. cycloalkyl) alkyl (Me, Et, n-Pr or i-Pr)-phosphonofluoridate'?

An "O-Alkyl ( $\leq C_{10}$ , incl. cycloalkyl) alkyl (Me, Et, n-Pr or i-Pr)-phosphonofluoridate" is a molecule with the following structural features:



Phosphonofluoridate moiety

- A phosphonatefluoridate moiety as the core of the structure and two alkyl groups;  $R^1$  and  $R^2$
- $R^1$  = any alkyl/cycloalkyl group from 1 to 10 C atoms in size attached to the P atom through a bridging O atom
- $R^2$  = Methyl (Me), Ethyl (Et), Isopropyl (i-Pr) or n-propyl (n-Pr) (these are specific alkyl groups of 1, 2 or 3 C atoms in size) attached directly to the P atom

## Constructing an alkyl group (R):

### Step 1: build the parent “alkane” or “cycloalkane”

#### Follow these rules...

- An alkane is the parent molecule of an alkyl group. Alkanes consist exclusively of H and C atoms. Alkanes are commonly referred to as hydrocarbons
- The alkanes related to this construction kit (up to 10 C atoms in size) can exist in all possible structures allowed by connecting the atoms and bonds as follows:
  - C atoms always have four bonds. Each is attached to an H atom or another C atom
  - All C-C connections use a 2.5 cm length bond
  - H atoms always have one bond. They are always attached to a C atom through a 2 cm length bond
  - If the C atoms are connected in the form of rings, you have constructed a “cycloalkane”

### Step 2: create the alkyl or cycloalkyl group by replacing one H atom and its 2 cm length bond with a 2.5 cm length bond

### Step 3: construct one more parent molecule by repeating steps 1 and 2

### Step 4: construct an “O-Alkyl ( $\leq$ C10, incl. cycloalkyl) alkyl (Me, Et, n-Pr or i-Pr)-phosphonofluoridate” by attaching alkyl or cycloalkyl groups to the free pegs of the O and P atoms of the phosphonofluoridate moiety. Pay attention to the rules for what groups can or cannot be attached to each peg.

## Congratulations!

You have constructed an “O-Alkyl ( $\leq$  C10, incl. cycloalkyl) alkyl (Me, Et, n-Pr or i-Pr)-phosphonofluoridate”, which is a member of the Schedule 1.A.D1 family of the Chemical Weapons Convention Annex on Chemicals.

Confused by all these atoms and molecules? Don't worry! The use of this kit follows “open book”, “open mobile device” and “talk to your neighbor” rules.

