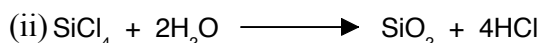


## Chemguide – answers

### GROUP 4: CHLORIDES

1. a) Both are bonded covalently with a single shared pair of electrons between the chlorine and the carbon or silicon.
- b) (i) It reacts with moisture in the air to form silicon dioxide and hydrogen chloride gas. The fumes you see are mainly the hydrogen chloride.

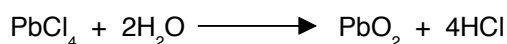


(iii) In order for a reaction to happen, a lone pair on a water molecule would have to approach and attach to the carbon or silicon atom, begin to form a bond, and a chlorine atom would be pushed off to make room around the central atom.

In the case of  $\text{CCl}_4$ , the carbon is a small atom surrounded by large chlorine atoms with lone pairs of electrons, and the water can't easily approach it. If it did approach, there aren't any empty orbitals at the bonding level to accept the lone pair from the water.

In the case of  $\text{SiCl}_4$ , the silicon is bigger and the space around it is less crowded. The silicon also has 3d orbitals available at the 3-level (the bonding level) which the lone pair on the water can use to form a coordinate (dative covalent) bond. The energy released as the new bond forms helps to supply the energy needed to break a silicon-chlorine bond. There is no similar mechanism available in the carbon case.

2. a)  $\text{PbCl}_4$  is bonded covalently with a single shared pair of electrons between each chlorine and the lead atom.  $\text{PbCl}_2$  can be thought of as ionic and is held together by attractions between  $\text{Pb}^{2+}$  ions and  $\text{Cl}^-$  ions. ("can be thought of as ionic": It isn't going to be pure ionic, but will be ionic with a fair degree of covalent character. However, in its properties it behaves as if it was essentially ionic.)
- b)  $\text{PbCl}_2$ .  $\text{PbCl}_4$  decomposes to give  $\text{PbCl}_2$  and chlorine at room temperature.
- c)  $\text{PbCl}_4$ : A colourless fuming liquid reacting violently with water to give a brown precipitate and steamy fumes of hydrogen chloride (which might all dissolve in the water if you use a very large excess of water and very little lead(IV) chloride).



$\text{PbCl}_2$ : A white solid which doesn't seem to dissolve in cold water (although a little will), but dissolves in hot water (to give a colourless solution).