How to safely work with PH_3

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Phosphane PH_3 is the well-known analogue to ammonia NH_3. However, these derivatives show completely different properties. The E-H bonds of ammonia are best described using sp^3 hybridized orbitals at the nitrogen center. On the contrary, phosphorous belongs to the "hybridization-reluctant" elements and the P-H bonds in PH_3 have a significantly higher p-orbital contribution which results in narrow H-P-H angles close to 90°.[1] Another important difference is the ability to engage in E-H···A hydrogen bonding (A = hydrogen acceptor). While ammonia is highly soluble in water (up to 25 wt%) due to a high solvation energy caused by strong N-H···O bonds, phosphane is only soluble with 0.39 g L^{-1}.[1] The aqueous solution of ammonia is safe to handle in the laboratory. Also, NH_3 gas can be liquified by the use of a dry ice bath. Handling phosphane on a laboratory scale is much more challenging.

Phosphane gas is toxic and is immediately dangerous to life and health (IDLH) at 50 ppm. It acts on the central nervous system and lungs, leading to pulmonary oedema.[2] Ultra-pure phosphane is odorless, though it is mostly known for its garlic or rotten-fish smell, which originates from the dimer P_2H_4.[2] Phosphane is spontaneously flammable at air. The boiling point of phosphane is at -87.7°C, which is below the one of commonly used cooling baths.[1]

We build a setup for the safe handling of PH_3 in our laboratory at ETHZ. This setup was improved over the years in order to gain a safe and easy way in handling phosphane. The setup is shown in Fig. 1 and 2 and will be explained in detail in the presentation.

Figure 2: PH_3 setup in the fume hood including the quenching system.

Figure 1: PH_3 cupboard.

[1] D. Corbridge, *in Studies in Inorganic Chemistry, Vol. 20,* Elsevier, **1995**, p. 1172.
[2] Md. S. Khan, *Chem Phys. Lett.,* **2015**, 636, 103-109.