

Chemguide – questions

HALOGENOALKANES: MAKING

1. Halogenoalkanes can be made from alcohols using a reaction with hydrogen halides. The general equation is



where R is any alkyl group, and X is a halogen.

a) In the case of chloroalkanes, only tertiary ones can be made easily this way. Tertiary alcohols react readily with concentrated hydrochloric acid.

(i) Draw a structure for a tertiary chloroalkane.

(ii) Draw the structure of the alcohol it would be made from.

(iii) Why aren't primary or secondary chloroalkanes usually made in this way?

b) Bromoalkanes and iodoalkanes aren't usually made using HBr or HI directly because hydrobromic acid and hydriodic acid aren't commonly available in the lab.

(i) What would you react together to make a sample of bromoethane in the same sort of way? (In this and any further questions, if you aren't confident about naming alcohols, write the structural formula instead.)

(ii) What would you react together to make a sample of 1-iodopropane in the same sort of way?

(iii) Explain how each of these cases relates to the equation at the top of this page.

2. Halogenoalkanes can also be made from alcohols using phosphorus compounds, particularly the phosphorus(III) halides, PX_3 , where X is chlorine, bromine or iodine.

a) Write the equation for the reaction of ethanol, $\text{CH}_3\text{CH}_2\text{OH}$, with PCl_3 .

b) In the bromine and iodine case, you don't actually start with PBr_3 or PI_3 . Instead, you use a mixture of red phosphorus and either bromine or iodine which first react to make these compounds. Write the equation for the reaction between red phosphorus and bromine to produce PBr_3 .

c) Phosphorus(V) chloride also reacts with alcohols to give chloroalkanes, but isn't normally used to make them in the lab. Why not?

3. This question is about making bromoethane in the lab from ethanol, potassium bromide and concentrated sulphuric acid.
- a) Great care has to be taken when the concentrated sulphuric acid and ethanol are mixed. Why?
 - b) The mixture is heated and the bromoethane is distilled off and collected. How is it collected?
 - c) The bromoethane will contain several impurities which have to be removed, including unreacted ethanol, hydrogen bromide, bromine, sulphur dioxide and ethoxyethane (diethyl ether).
 - (i) Explain where the bromine and sulphur dioxide come from.
 - (ii) Explain where the ethoxyethane comes from.
 - d) The product from the distillation is shaken with water in a separating funnel. Which impurities does this help to remove?
 - e) After shaking, there are two layers in the separating funnel. Which one do you collect and save?
 - f) The product from this is shaken with sodium carbonate or sodium hydrogencarbonate solution. What does this do?
 - g) The bromoethane layer is again separated and saved. It is returned to a clean funnel and this time shaken again with water. Why?
 - h) The bromoethane layer is now run into a tube containing solid anhydrous calcium chloride, and allowed to stand. Which impurities does this remove?
 - i) The resulting liquid layer is finally fractionally distilled, collecting the fraction which boils between 35 and 40°C. There is one impurity which this entire process may well not completely remove. Which one?