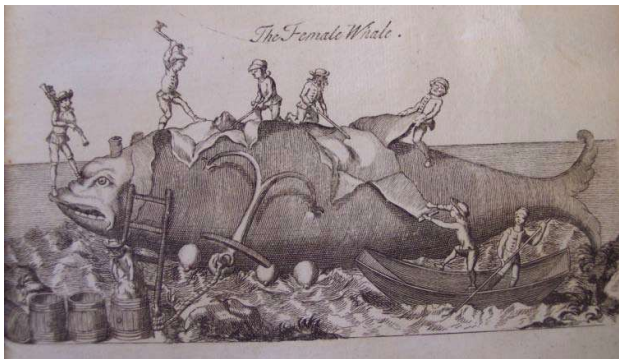
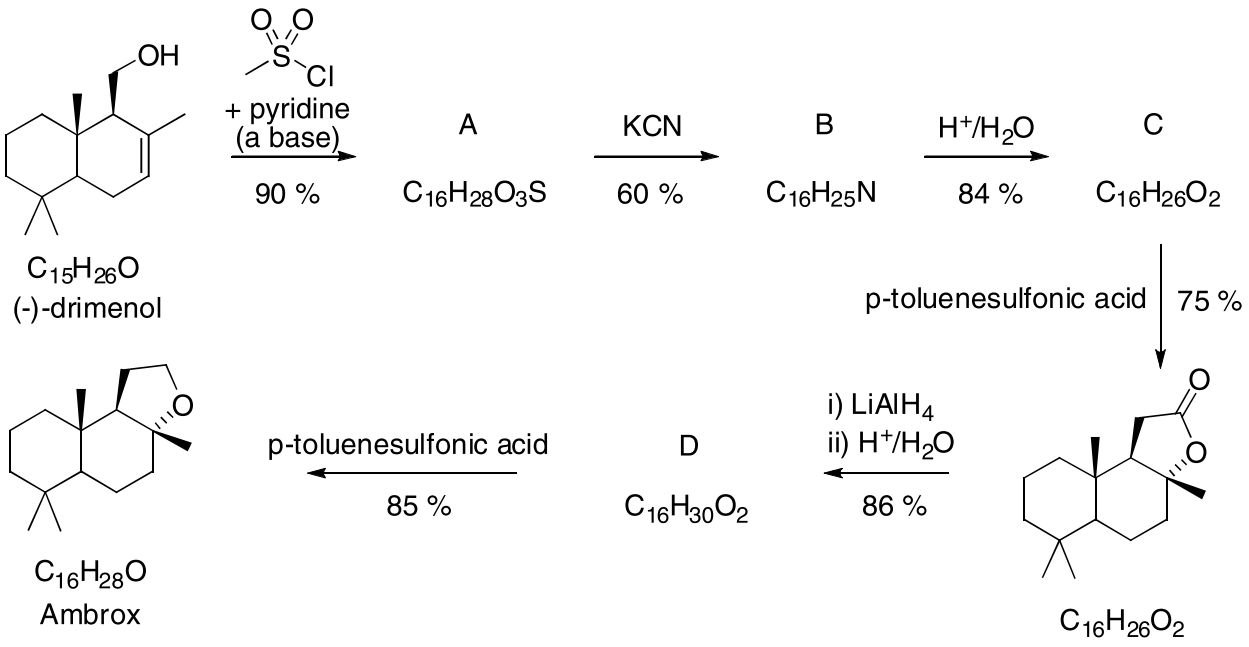
1. This question is about a substitute for the perfume ingredient ambergris

Ambergris, a metabolic product of the sperm whale, was for many years one of the most valuable ingredients in fine fragrances. Recently, it has been replaced with synthetic equivalents such as Ambrox® which possesses a powerful amber-type fragrance. Many different research groups have proposed methods for synthesising Ambrox from natural products found in plants. A synthesis starting with (–)-drimenol extracted from the bark of the Chilean tree *Drimys winteri* is outlined below:





(a) Given that ten tonnes of Ambrox are produced every year, calculate the number of moles produced per year.

(b) Draw the structures of compounds **A** to **D**.

The yield of each step in the synthesis is shown beside the arrows in the scheme.

(c) **(i)** What is the overall percentage yield of Ambrox in this synthesis?

(ii) What mass of (–)-drimenol would be needed each year if all of the commercially synthesised Ambrox was made using this method?

(iii) Given that *Drimys winteri* bark contains 0.5 % by mass of (–)-drimenol calculate the mass of bark that would be needed each year if all of the commercially synthesised Ambrox was made using this method.