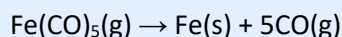


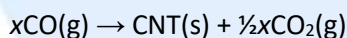
## Paper 3 Section A Data Response (4)

At 25 °C iron pentacarbonyl,  $\text{Fe}(\text{CO})_5$ , is a, straw-coloured liquid with a pungent odour. It can react with chlorine to give  $\text{Fe}(\text{CO})_4\text{Cl}_2$ .

One of the uses of iron pentacarbonyl is to make nanotubes. When  $\text{Fe}(\text{CO})_5$  is heated at 1400 K in the presence of carbon monoxide at high pressure it reacts to form nanoparticles of iron.



These iron nanoparticles provide a nucleation surface for the transformation of carbon monoxide into carbon during the growth of the nanotubes (CNT).



where  $x$  is typically 6000 giving a carbon nanotube containing 3000 carbon atoms.

- (a)** Comment on the fact that iron pentacarbonyl is a liquid under standard conditions (its melting point is - 21 °C and its boiling point is 103 °C). **[1]**
- (b)** Deduce the geometric shape of a molecule of iron pentacarbonyl. **[1]**
- (c) (i)** Draw the Lewis structure of carbon monoxide. **[1]**
- (ii)** Use the concept of formal charge to explain why iron bonds to the carbon atom of the carbon monoxide molecules rather than the oxygen atom. **[2]**
- (d) (i)** Use oxidation states to show whether iron pentacarbonyl is oxidized or reduced when it reacts with chlorine. **[1]**
- (ii)** Deduce all the possible structures for  $\text{Fe}(\text{CO})_4\text{Cl}_2$ . **[2]**
- (e)** Assuming the carbon dioxide in the above process is lost to the atmosphere and the iron produced is discarded, calculate the atom economy of the reaction assuming it gives 100% yield of carbon nanotubes. **[2]**