SL & HL Answers to Alkanes questions

1. $C_5H_{12}(l) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l)$

$2C_6H_{14}(l) + 19O_2(g) \rightarrow 12CO_2(g) + 14H_2O(l)$

$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(l)$

2. The two pollutants are carbon monoxide and particles of solid carbon (particulates). They are formed as there is insufficient oxygen (present in the air inside the combustion chamber in the car) to bring about complete combustion of the gasoline.

3. i. During *homolytic fission* the bond breaks symmetrically so that one electron forming the bond between two atoms becomes attached to one of the atoms and the other electron becomes attached to the other atom resulting in the formation of two radicals.

ii. The ultraviolet light provides the energy to break the Cl-Cl bond homolytically. This energy, 242 kJ mol^{-1}, is much less than the 414 kJ mol^{-1} of energy required to break a C-H bond.

iii. The product is a chlorine (free) radical. The electron configuration is $1s^2 2s^2 2p^6 3s^2 3p^5$.

iv. Once a chlorine free radical is formed it reacts with a methane molecule to produce hydrogen chloride and a methyl radical. This methyl radical can react with another chlorine molecule to form chloromethane and generate a new chlorine radical which can then repeat the process. This is a propagation step. The formation of new radicals will only stop when a termination reaction occurs. (A termination step may be between two radicals or between a radical and an impurity or the walls of the reaction vessel).

4. i. The ultraviolet light provides the energy to break the Br-Br bond in bromine homolytically.

ii. *Initiation*: $Br_2(g) +$ ultraviolet light $\rightarrow 2Br^{\bullet}(g)$

Propagation: $Br^{\bullet}(g) + C_2H_6(g) \rightarrow C_2H_5^{\bullet}(g) + HBr(g)$

Propagation: $C_2H_5^{\bullet}(g) + Br_2(g) \rightarrow C_2H_5Br(g) + Br^{\bullet}(g)$

Termination: $C_2H_5^{\bullet}(g) + Br^{\bullet}(g) \rightarrow C_2H_5Br(g)$ (there are other possible termination reactions)

iii. React ethane with excess bromine in the presence of ultraviolet light. This would give a mixture of brominated products. For example, 1,1-dibromoethane, 1,2- dibromoethane, 1,1,1-tribromoethane etc. The desired product, 1,2-dibromoethane, would need to be separated from the mixture using fractional distillation (as they all have different boiling points) or by using some form of chromatography, e.g. HPLC, GC or GLC, (as they will all have different retention times).