C.2 Fossil Fuels

1. The following table gives some RON values for some of the individual components that can be found in gasoline (petrol).

Organic compound	RON
heptane	0
2-methylheptane	23
2,2,4-trimethylpentane	100
methylbenzene	121

(a) Explain why the value for methylbenzene is greater than 100.

(b) Deduce the octane rating for a fuel that consists of 87% 2,2,4-trimethylpentane, 8% 2-methylheptane and 5% methylbenzene by volume.

2. Pure octane has a density of 0.703 g cm^{-3}. A typical car gasoline tank holds 55 dm^3 of fuel. If a driver uses one full tank of gasoline each week, calculate how much it contributes to his or her carbon footprint in tonnes* per year. (Assume that that the driver carries no passengers and that gasoline has the same chemical and physical properties as pure octane).

* 1 tonne ("metric ton") = 1000 kg

3. During the process of cracking long chain hydrocarbons are broken down into smaller more usable compounds. State the equation for the cracking of decane, $C_{10}H_{22}$ to produce octane and state the main use for the other organic product formed.

4. Catalytic reforming of straight chain alkanes can be used to make branched alkanes in a process known as isomerization and to make aromatic compounds in a process known as aromatization.

(a) Deduce the equations for the isomerization of heptane to make 2,2-dimethylpentane and the aromatization of heptane to make methylbenzene.

(**b)** Explain why isomerization and aromatization are important processes.

5. Butane and methanol are being compared as two possible fuels for a camping stove. Which has the highest carbon footprint given that the enthalpy of combustion of butane is -2,877 $kJmol^{-1}$ and the enthalpy of combustion of methanol is -726 $kJmol^{-1}$?

What ***assumptions*** do you need to make?

6. **a)** ***Explain*** what is meant by '*octane number*'.

b) ***Why*** do heptane and 2,2,4-trimethylpentane have a similar boiling point?

c) ***Explain*** how cracking and reforming can improve the yield of high quality gasoline from an oil refinery. Give ***example equations*** as part of your answer

7. ***Outline*** with equations how coal can be converted into gasoline.