AS LEVEL CHEMISTRY

2.4.1 CHEMISTRY OF THE AIR

2.4.2 GREEN CHEMISTRY

ASSESSED HOMEWORK

Answer all questions

Max 44 marks

Name	……..
Mark	……../44 ……....% Grade ……

1. Concern about the consumption of fossil fuels and excessive emissions of carbon dioxide from cars has led to moves to cut down on car usage.

(i) Heptane, C_7H_{16}, is a component in petrol. Construct a balanced equation for the complete combustion of heptane.

.....

[2]

(ii) Gases such as CO_2 contribute towards the 'Greenhouse Effect'.

What happens to CO_2 molecules in this process?

.....

.....

[2]

[Total 4 marks]

2. Two workers decide to car-share on a 25 mile journey to work and back. On this journey, each of their cars uses petrol equivalent to 2.0 kg of heptane.

(i) calculate the amount, in mol, of heptane, C_7H_{16}, saved;

[2]

(ii) calculate the energy saved ($\Delta H_c^{\ominus}$ [C_7H_{16}] = – 4817 kJ mol^{-1});

[1]

(iii) calculate the decrease in volume of CO_2(g) emitted into the atmosphere.

Assume that the conditions are the same as room temperature and pressure.

[2]

[Total 5 marks]

3. CFCs and carbon dioxide affect the Earth's atmosphere.

CFCs form chlorine radicals, C*l*, in the atmosphere. Chlorine radicals are one of the factors responsible for depleting the ozone layer in the stratosphere. The equations below represent two steps that occur during this process. Complete these equations and construct an overall equation for the reaction.

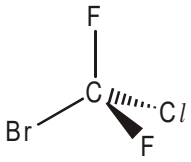
$Cl + O_3 \rightarrow ClO +$ .....

..... $+ O \rightarrow Cl + O_2$

.....overall equation

[Total 2 marks]

4.



Bromochlorodifluoromethane has been used as a flame retardant.

When exposed to high temperatures, one of the C–halogen bonds undergoes homolytic fission to produce free radicals.

Suggest, with a reason, which C–halogen bond is most likely to be broken.

The C–halogen bond most likely to be broken is ..... because .....

.....

.....

[Total 1 marks]

5. In the upper atmosphere, reactions occur involving chlorine free radicals, C*l*.

Equations for two such processes are given below.

$C\mathit{l} + O_3 \rightarrow C\mathit{l}O + O_2$ **equation 1**

$C\mathit{l}O + ... \rightarrow C\mathit{l} + O_2$ **equation 2**

(i) Complete **equation 2.**

[1]

(ii) Write the overall equation for the two processes shown in **equations 1 and 2.**

.....

[1]

(iii) Describe how the chlorine free radicals, C*l*, are formed in the upper atmosphere.

.....

.....

.....

[2]

(iv) State **one** undesirable result of ozone depletion in the upper atmosphere for life on Earth.

.....

[1]

[Total 5 marks]

6. There are two types of catalysis, homogeneous and heterogeneous.

CFCs form chlorine free radicals, C*l*, in the atmosphere. Chlorine free radicals are one of the factors responsible for depleting the ozone layer in the stratosphere. This is an example of homogeneous catalysis.

(i) Equations 1 and 2 represent two possible steps that occur during this process. Complete these equations and construct an overall equation for the reaction.

$$Cl + O_3 \rightarrow ClO + \text{.....} \qquad \text{equation 3.1}$$

$$\text{.....} + O \rightarrow Cl + O_2 \qquad \text{equation 3.2}$$

$$\text{.....} + \text{.....} \rightarrow \text{.....} \qquad \text{overall equation}$$

[3]

(ii) Use the equations above to identify a catalyst in the reaction scheme.

Explain your answer.

.....

.....

.....

[2]

[Total 5 marks]

7. A catalytic converter contains a heterogeneous catalyst. One of the reactions catalysed is shown below.

$$2NO(g) + 2CO(g) \rightarrow N_2(g) + 2CO_2(g)$$

Outline the way that this type of catalyst works in a catalytic converter.

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[Total 3 marks]

8. Many chemical reactions occur in the atmosphere.

Car engines produce carbon monoxide and nitrogen monoxide near to the Earth's surface.

Explain how carbon monoxide and nitrogen monoxide are formed in the car engine.

carbon monoxide .....

.....

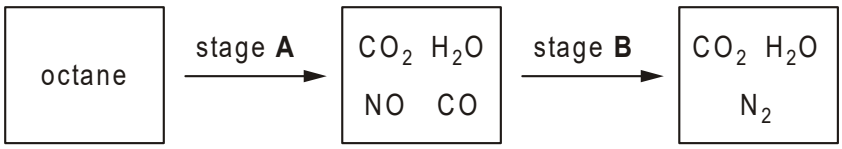
nitrogen monoxide .....

.....

[Total 2 marks]

9. This question looks at some aspects of the use of petrol as a fuel for cars.

Petrol contains octane, C_8H_{18}. Two of the stages that occur when petrol, containing octane, is used in a car engine are shown below.



(a) Stage **A** includes the complete combustion of octane.

(i) Write the equation for this reaction.

.....

[2]

(ii) Suggest how NO is produced.

.....

[1]

(b) Stage **B** requires a catalyst.

(i) Name **two** metals generally present in the catalyst.

.....

[1]

(ii) The catalyst is a heterogeneous catalyst. Describe how it works.

.....

.....

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.....

[3]

(iii) Using the substances shown above, write the equation for the reaction that occurs in stage **B**.

.....

[2]

(c) If stage **B** does not happen, further reactions occur and pollution levels rise.

Suggest **one** pollutant whose level in the atmosphere would rise.

.....

[1]

[Total 10 marks]

10. Ethanol, C_2H_5OH, is manufactured on a large scale for a wide range of uses such as alcoholic drinks, as an industrial solvent and as a raw material for the synthesis of many organic compounds.

Ethanol, C_2H_5OH, is manufactured on a large scale by two methods:

- Fermentation, using yeast, of sugars, such as glucose, $C_6H_{12}O_6$.

  $$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

  The ethanol is then distilled off.

- Hydration of ethene, C_2H_4, with steam in the presence of an acid catalyst.

  $$C_2H_4(g) + H_2O(g) \rightarrow C_2H_5OH(g)$$

Compare the sustainability of these methods of manufacturing ethanol in terms of:

- availability of starting materials and energy requirements;
- atom economy.

In your answer, you should make clear how the atom economy of the processes links with chemical theory.

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[Total 7 marks]