AS LEVEL CHEMISTRY

PAPER 2

PRACTICE PAPER 21

(structured questions only)

Answer all questions

Max 80 marks

Name	
Mark ……../80 ……....% Grade ………	

Note – this paper only contains structured questions

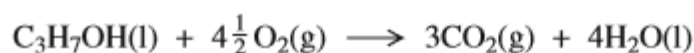**1.** (a) Define the term *standard enthalpy of combustion*.

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(3 marks)

(b) Write an equation for the complete combustion of ethanol, C_2H_5OH

....

(1 mark)

(c) The following table gives some standard enthalpies of formation.

	$C_3H_7OH(l)$	$O_2(g)$	$CO_2(g)$	$H_2O(l)$
$\Delta H_f^{\ominus} / kJ\,mol^{-1}$	−315	0	−394	−286

Use these data to calculate a value for the enthalpy of combustion, $\Delta H_c^{\ominus}$, of propan-1-ol, C_3H_7OH

$$C_3H_7OH(l) + 4\tfrac{1}{2}O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(l)$$

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(3 marks)

(d) State how you would expect the value obtained in part (c) to differ if gaseous water, rather than liquid water, is formed.

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(1 mark)

(e)   In an experiment 0.92 g of propan-1-ol, C_3H_7OH, was burned and the heat given off used to raise the temperature of 250 g of water. The temperature rise was 16 °C. The specific heat capacity of water is $4.2 \, J \, K^{-1} \, g^{-1}$.

Calculate a value for the enthalpy of combustion of one mole of propan-1-ol.

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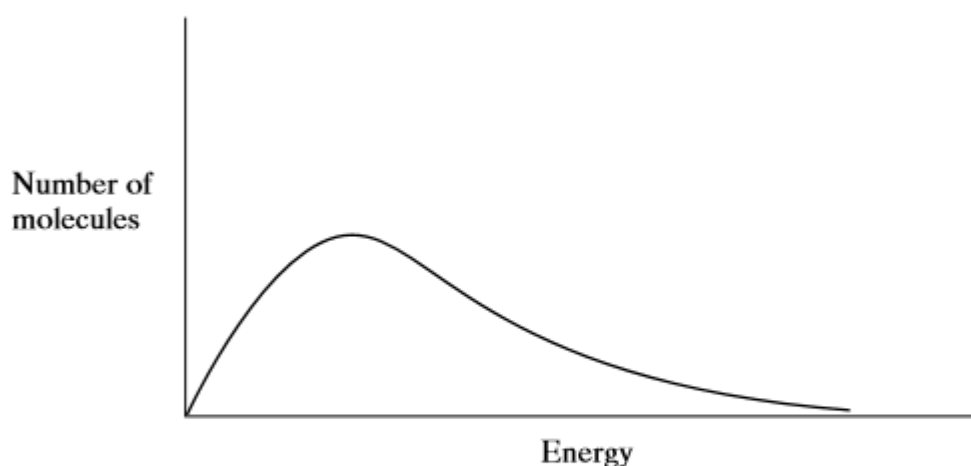
(4 marks)

(f)   Suggest why the experimental value of the enthalpy of combustion obtained in part (e) is less reliable than the value obtained in part (c).

....

(1 mark)

(Total 13 marks)

2.   (a)   A sample of a gas was sealed into a flask at temperature T and pressure P. The Maxwell–Boltzmann distribution of energies for the molecules in this sample is shown below.

(i)   Using the axes above, sketch the curve that you would expect if this sample of gas at pressure P had been cooled. Label this curve **X**.

(ii) Using the axes above, sketch the curve that you would expect if another sample of the same gas was sealed in the same flask at the original temperature, T, but at a higher pressure. Label this curve **Y**.

(b) Gas **A** decomposes slowly to form gases **B** and **C**. An equilibrium is established as shown by the following equation.

$$A(g) \rightleftharpoons B(g) + C(g) \qquad \Delta H \text{ is positive}$$
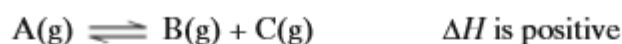
(i) In terms of the behaviour of molecules, state what must happen before molecules of **A** can react to form **B** and **C**.

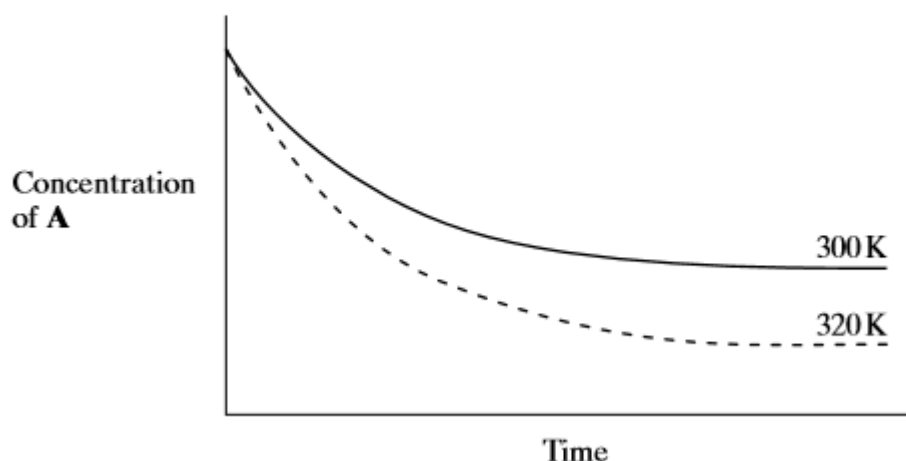..

....

(ii) Explain why the decomposition of **A** is faster at higher temperatures.

....

....

(4 marks)

(c) The graphs below show how, starting from **A** alone, the concentration of **A** varies with time at temperatures of 300 K and 320 K for the reversible reaction given in part (b).

(i) Suggest why, as shown on the graphs, the concentration of **A** remains constant after a time.

....

(ii) Explain why, at 320 K, the concentration of **A** falls to a lower value compared with the reaction at 300 K.

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(3 marks)

(Total 11 marks)

3. Alkanes are used as fuels. A student burned some octane (C_8H_{18}) in air and found that the combustion was incomplete.

(a) (i) Write an equation for the incomplete combustion of octane to produce carbon monoxide as the only carbon-containing product.

....

(1)

(ii) Suggest **one** reason why the combustion was incomplete.

....

....

(1)

(b) Catalytic converters are used to remove the toxic gases NO and CO that are produced when alkane fuels are burned in petrol engines.

(i) Write an equation for a reaction between these two toxic gases that occurs in a catalytic converter when these gases are removed.

....

(1)

(ii) Identify a metal used as a catalyst in a catalytic converter.
Suggest **one** reason, other than cost, why the catalyst is coated on a ceramic honeycomb.

Metal ....

Reason ....

....

(2)

(c) If a sample of fuel for a power station is contaminated with an organic sulfur compound, a toxic gas is formed by complete combustion of this sulfur compound.

(i) State **one** environmental problem that can be caused by the release of this gas.

....

....

(1)

(ii) Identify **one** substance that could be used to remove this gas.
Suggest **one** reason, other than cost, why this substance is used.

Substance ....

Reason why used ....

....

(2)
(Total 8 marks)

4. (a) The empirical formula and the molecular formula of undecane are both $C_{11}H_{24}$

(a) (i) State what is meant by the term *empirical formula*.

....

....
(1 mark)

(a) (ii) Give the molecular formula of an alkane with 15 carbon atoms.

....
(1 mark)

(a) (iii) State what is meant by the term *fuel*.

....

....
(1 mark)

(a) (iv) Write an equation for the complete combustion of undecane ($C_{11}H_{24}$).

....
(1 mark)

(b) Ethanol can also be used as a fuel in the engine of a motor car.

Write an equation for the incomplete combustion of ethanol to form carbon monoxide and water only.

....
(1 mark)

(Total 5 marks)

5. The cracking of alkanes gives useful products such as motor fuels and alkenes.

(a) (i) Identify a catalyst used in catalytic cracking.

....

(ii) Write an equation for the thermal cracking of one molecule of the alkane $C_{10}H_{22}$ to produce a different alkane and propene only.

....
(2 marks)

(b)   Motor fuels contain cyclohexane, C_6H_{12}

(i)   State which of the two types of cracking is more likely to produce cyclohexane as one of the products.

....

(ii)   State the conditions necessary for cyclohexane to undergo complete combustion.

....

(iii)   Draw the structure of cyclohexane.

(iv)   Write an equation for the incomplete combustion of C_6H_{12} to form carbon and water only.

....
(4 marks)

(c)   The burning of fuels in a petrol engine produces some carbon monoxide and some nitrogen monoxide.
These two gases are atmospheric pollutants which can be removed by the use of a catalytic converter.

(i)   Write an equation for the reaction in which nitrogen monoxide is formed in a petrol engine. State **one** essential condition for this reaction to occur.

Equation ....

Condition ....

(ii)   Identify **one** of the metals used as a catalyst in a catalytic converter.

....

(iii)   Write an equation to show how carbon monoxide and nitrogen monoxide react together in a catalytic converter.

....
(4 marks)
(Total 10 marks)

6. The first four members of the homologous series of alkenes are shown below.

ethene	$H_2C=CH_2$
propene	$H_2C=CHCH_3$
but-1-ene	$H_2C=CHCH_2CH_3$
pent-1-ene	$H_2C=CHCH_2CH_2CH_3$

(a) One characteristic of an homologous series is that it can be represented by a general formula.

 (i) Give the general formula for these alkenes.

 ....
 (1 mark)

 (ii) State **two** other characteristics of an homologous series.

 Characteristic 1 ....

 ....

 Characteristic 2 ....

 ....
 (2 marks)

(b) Give the molecular formula for the next member of this homologous series.

 ....
 (1 mark)

(c) Draw the structure of the position isomer of pent-1-ene.

 (1 mark)

(d) Buta-1,3-diene has the formula

$$H_2C=CH-CH=CH_2$$
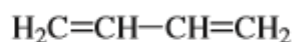
 (i) State what is meant by the term *empirical formula*.

 ....

 ....
 (1 mark)

 (ii) Give the empirical formula of buta-1,3-diene.

 ....
 (1 mark)

(e) Alkenes are able to react with bromine even though bromine is a non-polar molecule.

   (i) Explain why non-polar bromine molecules are able to react with the double
        bonds in alkenes.

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        ....

        ....

        ....
        (2 marks)

   (ii) Name the type of mechanism involved in this reaction.

        ....
        (1 mark)

   (iii) Draw the structure of the compound with $M_r = 373.6$, formed when
         buta-1,3-diene reacts with an excess of bromine.

         (1 mark)
         (Total 11 marks)

7. Consider the following pairs of structural isomers.

Molecular formula	Structure	Structure
$C_4H_{10}O$	**Isomer A** $H_3C-\overset{\overset{\displaystyle CH_3}{\vert}}{\underset{\underset{\displaystyle OH}{\vert}}{C}}-CH_3$	**Isomer B** $CH_3CH_2CH_2CH_2OH$
	Isomer C $CH_3CH_2-\overset{}{\underset{\underset{\displaystyle H}{\vert}}{C}}=O$	**Isomer D** $H_3C-\overset{\overset{\displaystyle}{\underset{\underset{\displaystyle O}{\vert\vert}}{C}}}-CH_3$
C_6H_{12}	**Isomer E**	**Isomer F** $CH_3CH_2CH=CHCH_2CH_3$

(a)   (i)   Explain what is meant by the term *structural isomers*.

....

....

  (ii)   Complete the table to show the molecular formula of isomers **C** and **D**.

  (iii)   Give the empirical formula of isomers **E** and **F**.

....
(4 marks)

(b)   A simple chemical test can be used to distinguish between separate samples of isomer **A** and isomer **B**. Suggest a suitable test reagent and state what you would observe in each case.

Test reagent ....

Observation with isomer A ....

Observation with isomer B ....
(3 marks)

(c)   A simple chemical test can be used to distinguish between separate samples of isomer **C** and isomer **D**. Suggest a suitable test reagent and state what you would observe in each case.

Test reagent ....

Observation with isomer **C** ....

Observation with isomer **D** ....

(3 marks)

(d)   A simple chemical test can be used to distinguish between separate samples of isomer **E** and isomer **F**. Suggest a suitable test reagent and state what you would observe in each case.
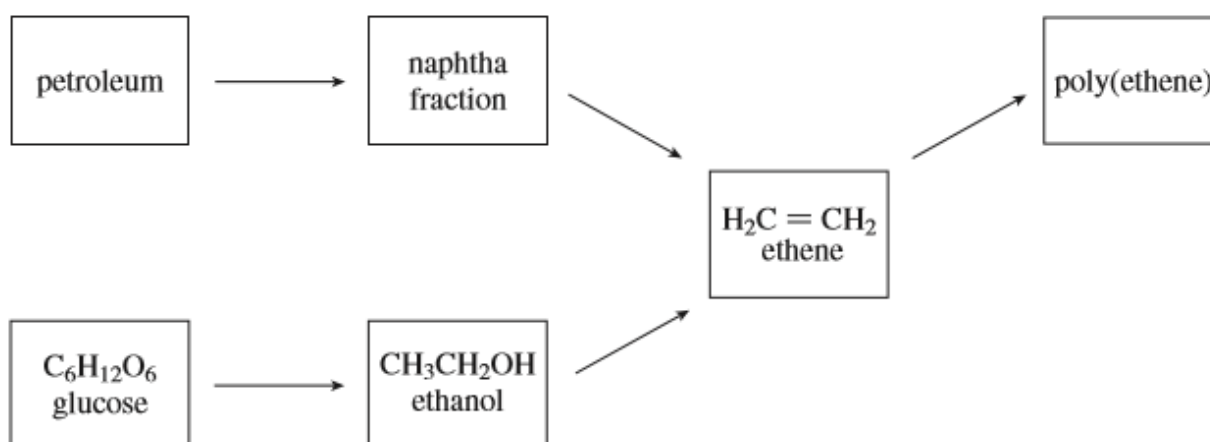
Test reagent ....

Observation with isomer **E** ....

Observation with isomer **F** ....

(3 marks)

(Total 13 marks)

8.   Ethene can be produced either from petroleum or from glucose. These processes and the formation of some useful products from ethene are illustrated in the following scheme.

(a)   Give the name of the process by which ethene is produced from the naphtha fraction. Give **one** essential condition for this process

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....

(2)

(b)   State what must be added to an aqueous solution of glucose to convert it into ethanol.
Name the process and write an equation for this reaction.

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(3)

(c)   The reaction of aqueous glucose to form ethanol produces a dilute aqueous solution.
Name the process used to separate ethanol from this dilute aqueous solution. Identify
a catalyst for the conversion of ethanol into ethene and state the type of reaction.

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....

(3)

(d)   Draw the structure of the repeating unit of poly(ethene)

(1)
(Total 9 marks)