AS LEVEL CHEMISTRY

PAPER 2

PRACTICE PAPER 22

(structured questions only)

Answer all questions

Max 80 marks

Name ……..
Mark ……../80 ……....% Grade ……

Note – this paper only contains structured questions

1. (a) Write an equation for the reaction in which the enthalpy change is the standard enthalpy of formation of gaseous methoxymethane, CH_3OCH_3

.....

(2 marks)

(b) Define the term *standard enthalpy of combustion*.

.....

.....

.....

.....

(3 marks)

(c) Methoxymethane burns completely in air according to the following equation.

$$CH_3OCH_3(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(l)$$

(c) (i) Use the standard enthalpies of formation given in the table below to calculate a value for the standard enthalpy of combustion of methoxymethane.

Substance	$CH_3OCH_3(g)$	$O_2(g)$	$CO_2(g)$	$H_2O(l)$
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	–185	0	–394	–286

.....

.....

.....

.....

.....

.....

(3 marks)

(c) (ii) State why the standard enthalpy of formation of oxygen is zero.

.....

(1 mark)

(d) (i) Use the information from the equation above and the mean bond enthalpies from the table below to calculate a value for the bond enthalpy of the O—H bond.

Bond	C—H	C—O	H—I	C—I
Mean bond enthalpy / kJ mol^{-1}	412	360	299	238

.....

.....

.....

.....

.....

.....

.....

(3 marks)

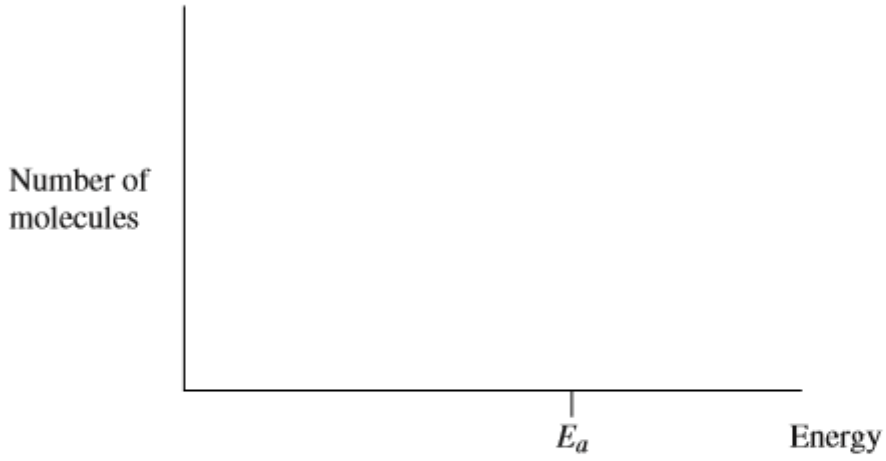
(d) (ii) Suggest which bond is most likely to break first in a collision between a methoxymethane molecule and a hydrogen iodide molecule.

.....

(1 mark)

(Total 13 marks)

2. (a) (i) On the axes below, draw a Maxwell-Boltzmann distribution of molecular energies for a gas at temperature T.
E_a is the activation energy for a reaction involving this gas.



(2 marks)

(ii) State the meaning of the term *activation energy*.

.....

.....

(2 marks)

(iii) Shade on the graph the area that represents the number of molecules which can react at temperature T.

(1 mark)

(b) (i) State the effect on the activation energy of increasing the temperature.

.....

(1 mark)

(ii) Explain why reactions involving gases become faster as the temperature increases.

.....

.....

(2 marks)

(c) A mixture of gases is allowed to react in the presence of a catalyst.
State and explain the effect of a catalyst on the rate of this reaction.

Effect .....

Explanation .....

.....

(3 marks)

(Total 11 marks)

3. Consider the following equations which show reversible reactions.

Reaction **1** $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$ $\Delta H^{\ominus} = -900\,kJ\,mol^{-1}$

Reaction **2** $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$ $\Delta H^{\ominus} = -91\,kJ\,mol^{-1}$

(a) In industry these reactions are carried out in the presence of catalysts. A platinum catalyst is used in Reaction **1** and a copper catalyst is used in Reaction **2**.

(a) (i) Give **one** reason why a metal catalyst is often used in the form of a gauze or a powder.

.....

(1 mark)

(a) (ii) State and explain the effect on the equilibrium yield of a reaction when a catalyst is used.

Effect on equilibrium yield .....

Explanation .....

.....

(2 marks)

(b) State and explain which of the above reactions will give an increase in the equilibrium yield of product when the overall pressure is increased at constant temperature.

Reaction .....

Explanation .....

.....

.....

(3 marks)

(c) State and explain the effect on the equilibrium yield of product when the temperature is increased in Reaction **1** at constant pressure.

Effect .....

Explanation .....

.....

.....

(3 marks)

(Total 9 marks)

4. Petroleum is separated into fractions by fractional distillation.
The petrol fraction (C_4 to C_{12}) is burned in internal combustion engines and the naphtha fraction (C_7 to C_{14}) is cracked.

(a) Petroleum is separated into fractions when it is heated and the vapour mixture is passed into a fractionating column.

(i) Explain what is meant by the term *fraction* as applied to fractional distillation.

.....

.....

(ii) State a property of the molecules in petroleum which allows the mixture to be separated into fractions.

.....

.....

(b) The fractions from petroleum contain alkane hydrocarbons.

(i) Write an equation for the incomplete combustion of the alkane C_8H_{18} to produce carbon monoxide and water only.

.....

(ii) One isomer of C_8H_{18} is 2,2,3-trimethylpentane. Draw the structure of this isomer.

(2 marks)

(c) State **one** economic reason for the cracking of petroleum fractions.

.....

(1 mark)

(d) Identify a catalyst used in catalytic cracking.

.....

(e) Identify the different type of hydrocarbon produced in a high percentage by the thermal cracking of alkanes.

.....

(Total 7 marks)

5. Three atmospheric pollutants which can be formed when fossil fuels are burned are shown below.

CO	NO	SO_2
carbon monoxide	nitrogen monoxide	sulphur dioxide

(a) The combustion of hydrocarbons in a petrol-engined car can lead to the formation of CO and NO

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

.....

.....

.....

(1 mark)

(a) (ii) Write an equation for the incomplete combustion of the hydrocarbon nonane (C_9H_{20}) to give CO and H_2O as the only products.

.....

.....

(1 mark)

(a) (iii) State **one** essential condition for the formation of NO from air in a petrol-engined car. Write an equation for the reaction in which NO is formed.

Essential condition .....

Equation .....

.....

(2 marks)

(b) Most petrol-engined cars are fitted with a catalytic converter.

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

.....

.....

(1 mark)

(b) (ii) Balance the following equation.

$$C_8H_{18} + \ldots\ldots NO \longrightarrow \ldots\ldots CO_2 + \ldots\ldots N_2 + \ldots\ldots H_2O$$

(1 mark)

(c) Natural gas is mainly methane and is burned as a fuel. State what is meant by the term *fuel*.

.....

.....

.....

(1 mark)

(d) Natural gas contains a small amount of hydrogen sulphide, H_2S
Write an equation for the combustion of H_2S in air to give SO_2 and H_2O as the only products.

.....

.....

(1 mark)

(Total 8 marks)

6. Crude oil is a mixture which can be separated into fractions. These fractions contain saturated hydrocarbons that belong to the homologous series of alkanes.

(a) (i) Name the process by which crude oil can be separated into fractions.

.....

(1 mark)

(a) (ii) State what is meant by the term *saturated*, as applied to a hydrocarbon.

.....

.....

(1 mark)

(b) Each homologous series can be represented by a general formula.

State **two** other characteristics of homologous series.

Characteristic 1 .....

.....

Characteristic 2 .....

.....

(2 marks)

(c) Fractions from crude oil can be converted into different substances by catalytic cracking or by thermal cracking.

(c) (i) Explain what is meant by the term *cracking*.

.....

.....

.....

(2 marks)

(c) (ii) Apart from the use of a catalyst, state how **one** of the conditions for catalytic cracking differs from that used for thermal cracking.

.....

.....

(1 mark)

(c) (iii) State **one** way in which the products formed by catalytic cracking differ from those formed by thermal cracking.

.....

.....

(1 mark)

(Total 8 marks)

7. The mechanism for the reaction of fluorine with difluoromethane (CH_2F_2) is a free-radical substitution similar to the reaction of chlorine with methane.

(a) Write an equation for each of the following steps in the mechanism for the reaction of fluorine with difluoromethane to form trifluoromethane (CHF_3).

Initiation step

.....

First propagation step

.....

Second propagation step

.....

A termination step in which $C_2H_2F_4$ is formed

.....

(4 marks)

(b) Heptafluoropropane (C_3HF_7) is used to extinguish fires that occur in electrical equipment.

(b) (i) Balance the following equation.

$$C_3H_8 + \ldots\ldots F_2 \longrightarrow C_3HF_7 + \ldots\ldots HF$$ *(1 mark)*

(b) (ii) Draw the structure of **one** of the possible isomers of C_3HF_7

(1 mark)

(c) Halon 1301 was used in fire extinguishers before the introduction of heptafluoropropane. Halon 1301 is a compound which contains 8.1 % carbon and 53.7 % bromine by mass. The remainder of the compound is fluorine.

Calculate the empirical formula of Halon 1301.

.....

.....

.....

.....

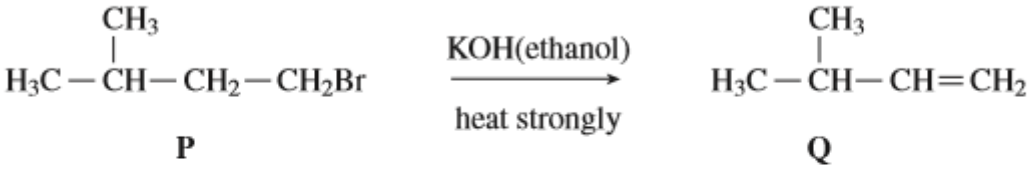
.....

.....

(3 marks)

(Total 9 marks)

8. Consider the following conversion of compound **P** into compound **Q**.



P **Q**

(a) Give the name of compound **Q**.

.....

.....

(1 mark)

(b) Name and outline a mechanism for the conversion of **P** into **Q**.

Name of mechanism .....

Mechanism

(4 marks)

(c) Hydrogen bromide reacts with **Q** to form compound **R**, which is a position isomer of **P**.

(c) (i) Identify compound **R**.

.....

(1 mark)

(c) (ii) Name the type of mechanism for the conversion of **Q** into **R**.

.....

.....

(1 mark)

(d) Draw the structure of an alkene which is an isomer of **Q** and which shows stereoisomerism. State the type of stereoisomerism shown by this isomer.

Structure of isomer

Type of stereoisomerism .....

(2 marks)

(Total 9 marks)

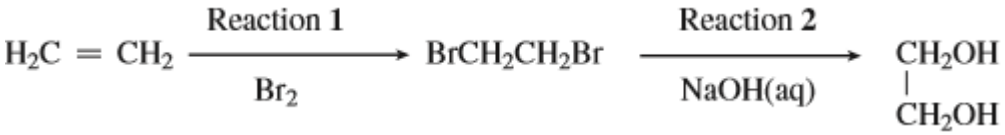
9. The reaction of acidified potassium dichromate(VI) with ethane-1,2-diol produces ethanedioic acid.

(a) (i) Balance the following equation for this reaction

(ii) An intermediate formed in this reaction is a compound with only aldehyde functional groups and an empirical formula of CHO
Draw the structure of this intermediate compound.

(2 marks)

(b) Ethane-1,2-diol can be made from ethene by the following route :

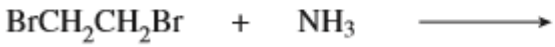


(i) State the type of mechanism in Reaction **1** and that in Reaction **2**.

Type of mechanism in Reaction 1 .....

Type of mechanism in Reaction 2 .....

(ii) The compound $BrCH_2CH_2Br$ can react with an excess of ammonia to produce a compound with $M_r = 60.0$
Complete and balance the equation for this reaction.



(4 marks)

(Total 6 marks)