

# AS LEVEL CHEMISTRY

## PAPER 2

### PRACTICE PAPER 23

#### (structured questions only)

Answer all questions

Max 80 marks

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

**Note – this paper only contains structured questions**

1. Enthalpy of combustion and bond enthalpy data can be used, with Hess's Law, to calculate enthalpy changes for other reactions.

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

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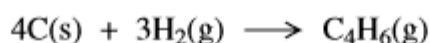
(3 marks)

(b) State *Hess's Law*.

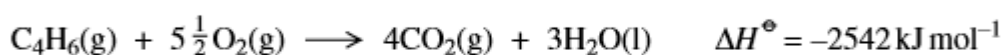
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(1 mark)

(c) The equation below shows the formation of buta-1,3-diene, C<sub>4</sub>H<sub>6</sub>



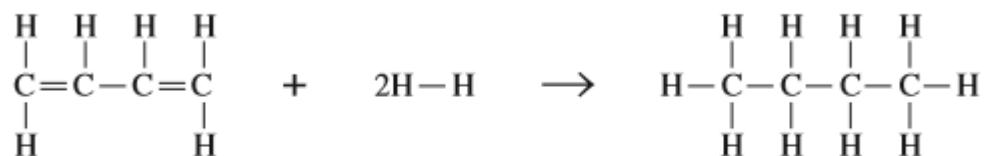
Use the following data to calculate the standard enthalpy of formation of buta-1,3-diene.



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(3 marks)

(d) Buta-1,3-diene reacts with hydrogen to form butane according to the following equation.



The standard enthalpy change for this reaction,  $\Delta H^\ominus = -240 \text{ kJ mol}^{-1}$

Bond	C-C	H-H	C-H
Mean bond enthalpy/ $\text{kJ mol}^{-1}$	348	436	412

Use the data given above to calculate a bond enthalpy value for the C=C bond.

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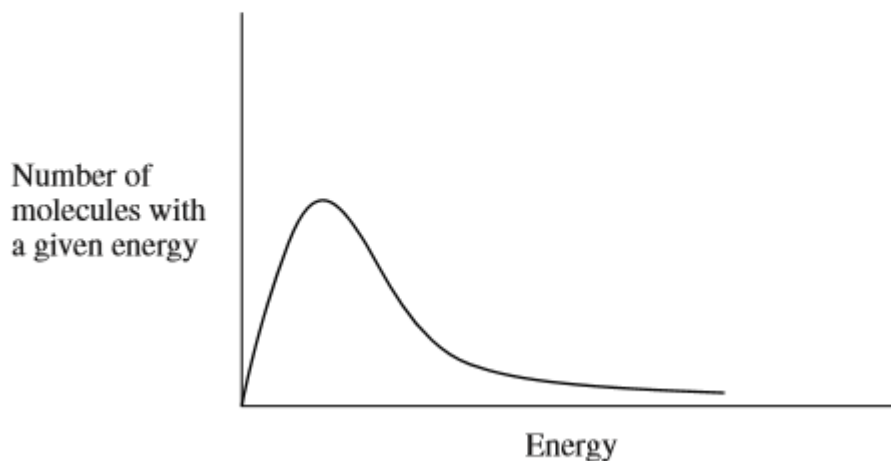
(3 marks)

(Total 10 marks)

2. The Figures below represent the distribution of molecular energies for one mole of gas at 300 K.

(a) On **Figure 1** below draw a curve to show the distribution of energies for one mole of gas at a higher temperature.

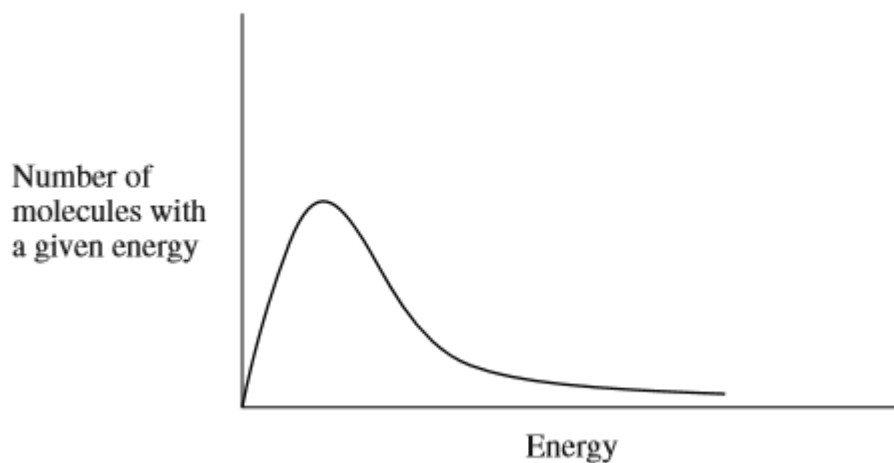
**Figure 1**



(2 marks)

(b) On **Figure 2** below draw a curve to show the distribution of energies for two moles of gas at 300 K.

**Figure 2**



(2 marks)

(c) Gases **A** and **B** react together.

(i) Explain why collisions between molecules of **A** and **B** do not always lead to a reaction.

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(ii) Explain why increasing the temperature by a small amount has a much bigger effect on the rate of reaction than increasing the pressure by a small amount.

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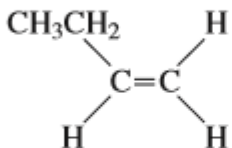
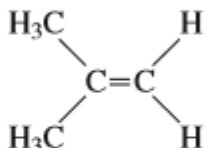
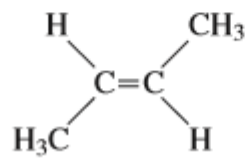
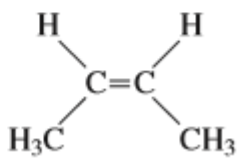
(iii) Explain why adding a catalyst will increase the rate of reaction between gases **A** and **B**.

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*(5 marks)*

**(Total 9 marks)**

3. The table below gives the structures of the four isomeric alkenes with molecular formula  $C_4H_8$

<p>Isomer 1</p> 	<p>Isomer 2</p> 
<p>Isomer 3</p> 	<p>Isomer 4</p> 

- (a) Name Isomer 1 and Isomer 2.

*Isomer 1* .....

*Isomer 2* .....

(2 marks)

- (b) (i) State what is meant by the term *stereoisomers*.

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- (ii) From the table, identify two isomers which are stereoisomers.

..... and .....

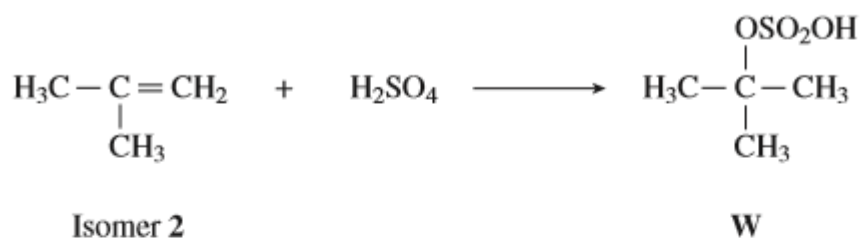
(3 marks)

- (c) From the table, identify the isomer which is a chain isomer of Isomer 1.

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(1 mark)

- (d) Isomer 2 reacts with concentrated sulphuric acid to form compound W as shown in the equation below. Name and outline a mechanism for this reaction.



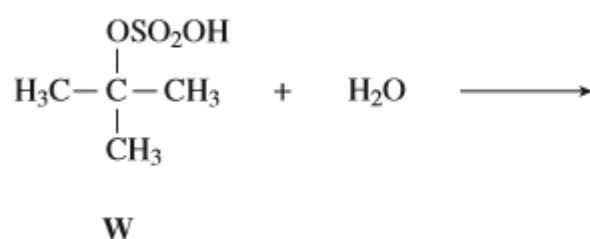
Name of mechanism .....

Mechanism

(5 marks)

- (e) Compound W reacts with water to form an alcohol and sulphuric acid.

- (i) Complete the equation for this reaction



- (ii) Name the alcohol produced in this reaction.

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(2 marks)

- (f) State the overall role of the sulphuric acid in the conversion of Isomer 2 into the alcohol formed in part (e).

.....  
(1 mark)

(Total 14 marks)

4. (a) Natural gas is mainly methane and has sulphur-containing impurities. Write equations to show the formation of all of the possible reaction products that result from the combustion of methane in both a limited and a plentiful supply of oxygen. Identify **two** pollutants formed in the combustion of natural gas and state why each is considered to be a pollutant.

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(7)

- (b) Chloromethane reacts with chlorine by a free-radical substitution mechanism to form dichloromethane. Give the conditions and outline the mechanism for the reaction, naming each step. Write an equation for a termination step in which 1,2-dichloroethane could be formed in this reaction.

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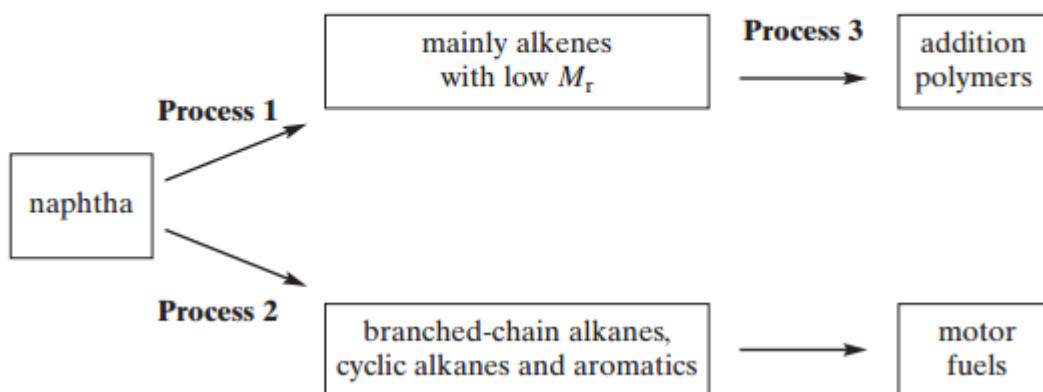
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(7)

(Total 14 marks)



5. Naphtha is one of the fractions obtained from crude oil and is a source of useful products.



- (a) Give a name for **Process 1**. State **one** essential condition in this process.  
Write an equation to show how one molecule of an alkane  $C_{13}H_{28}$  can be converted into two molecules of ethene, one molecule of propene and one molecule of an alkane.

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(4)

- (b) **Process 2** produces branched-chain alkanes and cyclic alkanes from larger alkanes. Give a name for **Process 2**.  
Draw **one** possible structure for each of the alkanes  $C_5H_{12}$  and  $C_6H_{12}$  which are produced in **Process 2**. Name the alkane  $C_5H_{12}$  which you have drawn.

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(4)

- (c) Write an equation to illustrate the formation of an addition polymer from propene in **Process 3**.

(1)  
(Total 9 marks)

6. (a) The fuels used most frequently in car engines are mixtures of alkanes obtained from petroleum. In car engines, fuels undergo combustion reactions, which can lead to the formation of pollutants.

(i) Write an equation for the complete combustion of pentane,  $C_5H_{12}$

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(ii) Identify a **solid** pollutant formed when pentane undergoes incomplete combustion.

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(iii) Give one reason why sulphur dioxide gas may be found in the exhaust gases of cars.

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(iv) Give one reason why sulphur dioxide is considered to be a pollutant.

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(4 marks)

(b) Ethanol is an alternative fuel for car engines. Ethanol can be made either by the hydration of ethene or by the fermentation of glucose.

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

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(ii) Write an equation for the hydration of ethene.

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(iii) Write an equation for the formation of ethanol from glucose,  $C_6H_{12}O_6$

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(iv) Write an equation for the incomplete combustion of ethanol to produce carbon monoxide and water only.

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(4 marks)

(Total 8 marks)

7. The naturally-occurring fragrances in rose oil contain unsaturated alcohols. Three of these alcohols are shown in the following table.

Geraniol	$\begin{array}{c} \text{H}_3\text{C} \quad \text{H} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \\ \text{H}_3\text{C} \quad \text{CH}_2-\text{CH}_2 \end{array} \quad \begin{array}{c} \text{H}_3\text{C} \quad \text{CH}_2\text{OH} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \\ \text{H} \end{array}$
Nerol	$\begin{array}{c} \text{H}_3\text{C} \quad \text{H} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \\ \text{H}_3\text{C} \quad \text{CH}_2-\text{CH}_2 \end{array} \quad \begin{array}{c} \text{H}_3\text{C} \quad \text{H} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \\ \text{CH}_2\text{OH} \end{array}$
Citronellol	$\begin{array}{c} \text{H}_3\text{C} \quad \text{H} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \\ \text{H}_3\text{C} \quad \text{CH}_2-\text{CH}_2 \end{array} \quad \begin{array}{c} \text{H}_3\text{C} \\   \\ \text{CH}-\text{CH}_2-\text{CH}_2\text{OH} \end{array}$

- (a) Geraniol and nerol are stereoisomers of each other.

- (i) State what is meant by the term *stereoisomers*.

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(2 marks)

- (ii) State the type of stereoisomerism shown by geraniol and nerol.

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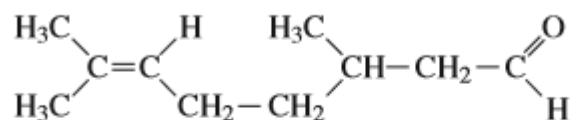
(1 mark)

- (b) State the class of alcohols to which citronellol belongs.

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(1 mark)

- (c) Citronellol can be converted into the aldehyde citronellal, which has the following structure.



State the type of reaction and a reagent or combination of reagents which could be used to convert citronellol into citronellal.

Type of reaction .....

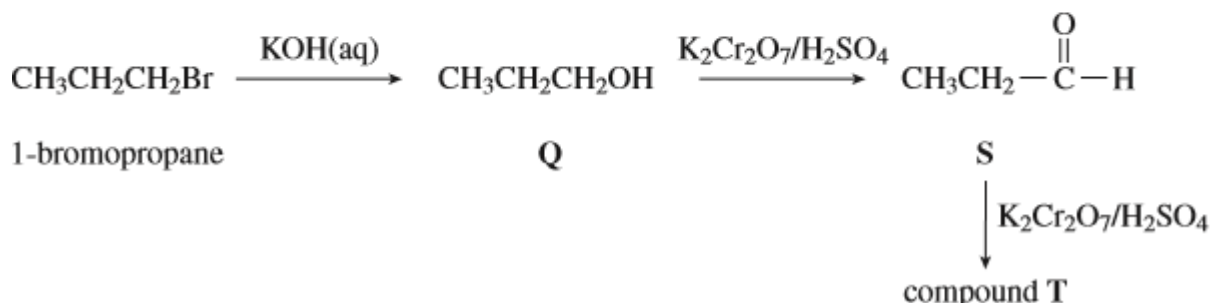
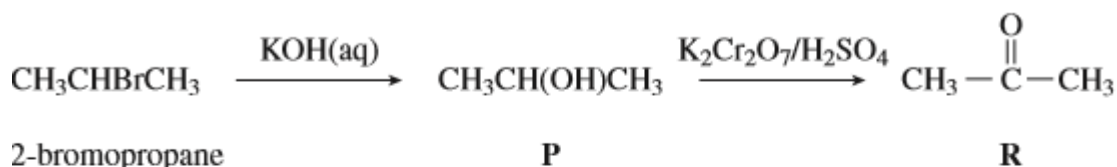
Reagent or combination of reagents

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(2 marks)

(Total 6 marks)

8. Consider the following two reaction sequences.



- (a) Name and outline a mechanism for the conversion of 2-bromopropane into compound P.

Name of mechanism .....

Mechanism

(3 marks)

- (b) State the class of alcohols to which compound **P** belongs and give the name of compound **R**.

*Class of alcohols* .....

*Name of R* .....

(2 marks)

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

*Test reagent* .....

*Observation with R* .....

*Observation with S* .....

(3 marks)

- (d) (i) Draw the structure of **T**.

(1 mark)

- (d) (ii) State the type of reaction that occurs in the conversion of **S** into **T**.

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(1 mark)

(Total 10 marks)