

OXFORD CAMBRIDGE AND RSA EXAMINATIONS Advanced Subsidiary GCE

CHEMISTRY 2813/01

How Far, How Fast?

Thursday

10 JUNE 2004

Morning

45 minutes

Candidates answer on the question paper.
Additional materials:

Data Sheet for Chemistry
Scientific calculator

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TIME 45 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer all the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- You may use a scientific calculator.
- You may use the Data Sheet for Chemistry.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE				
Qu.	Max.	Mark		
1	13			
2	10			
3	9			
4	5			
5	8			
TOTAL	45			

Answer all the questions.

(a)	Def	ine the term <i>t</i>	oond enthalpy.		
(b)	 Met	thane burns in	air according	to the following equation.	
(<i>)</i>			_	$O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$)
	(i)		rage bond ent	thalpies given in the table be inbustion of methane, $\Delta H_{\rm c}$.	
			bond	average bond enthalpy / kJ mol ⁻¹	
			C-H	+410	
			0Н	+465	
			O=O	+500	
			C=O	+805	
				$\Delta H_{c} = .$	kJ mol ⁻¹
	(ii)	The standar	d enthalpy cha	inge of combustion of metha	ne is –890 kJ mol ^{–1}
				ed value differs from this valu	

(c) Table 1.1 gives values for the standard enthalpy changes of combustion for the first three alkanes.

Table 1.1

alkane	formula	$\Delta H_{\rm c}^{\Phi}/{\rm kJ}{\rm mol}^{-1}$
methane	CH ₄	-890
ethane	C ₂ H ₆	-1560
propane	C ₃ H ₈	-2220

(i)	Write a balanced equation, including state symbols, illustrating the standard enthalpy change of combustion of propane gas.
	[2]
(ii)	As the chain length in the alkanes increases, the value of $\Delta H_{\rm c}^{\rm e}$ becomes more negative. Use your understanding of bond breaking and bond making to explain this trend.
	[2]
(iil)	Propane can be cracked to form ethene and methane.
	$C_3H_8(g) \rightarrow C_2H_4(g) + CH_4(g)$
	The standard enthalpy change of combustion of ethene, $\Delta H_c^{\theta} = -1410 \text{ kJ mol}^{-1}$.

Use this value together with relevant values in Table 1.1 to calculate the enthalpy change of this reaction.

$$\Delta H^{\Phi} = \dots kJ \, \text{mol}^{-1} \, [3]$$

[Total: 13]

2 Diamond and graphite are two allotropes of carbon. Allotropes are different forms of the same element. Diamonds are made industrially from the much cheaper graphite.

Under high pressure the following equilibrium exists.

$$\Delta H^{\bullet} = +1.8 \,\mathrm{kJ} \,\mathrm{mol}^{-1}$$

substance	density/gcm ⁻³
graphite	2.25
diamond	3.51

(a) Complete the following enthalpy profile diagram for the conversion of graphite into diamond, labelling ΔH^{Θ} .

enthalpy	<u>C(graphite)</u>
	progress of reaction

[2]

(b)	Suggest which allotrope of carbon is thermodynamically more stable. Give a reason for your choice.
	[1]
(c)	In which allotrope do the carbon atoms take up less space? Give a reason for your choice.
	[1]
(d)	State Le Chatelier's principle.
	[0]

Use Le Chatelier's principle and the information given at the start of the question to deduce the likely conditions of pressure and temperature needed to turn graphite into diamond. Explain your answer.	(e)
pressure	
[2]	
temperature	
[2]	
[Total: 10]	

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

(b)

(a) CFCs form chlorine free radicals, Cl, 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 3.1 and 3.2 represent two possible steps that occur during this process
	Complete these equations and construct an overall equation for the reaction.

equation 3.1	$Cl + O_3 \rightarrow ClO + \dots$	
equation 3.2	+ O \longrightarrow Cl + O ₂	
overall equation	+ →	

		[3]
(ii)	Use the equations above to identify a catalyst in the reaction scheme.	
	Explain your answer.	
		······
		[2]
	atalytic converter contains a heterogeneous catalyst. One of the reactions cataly hown below.	sed
	$2NO(g) + 2CO(g) \rightarrow N_2(g) + 2CO_2(g)$	

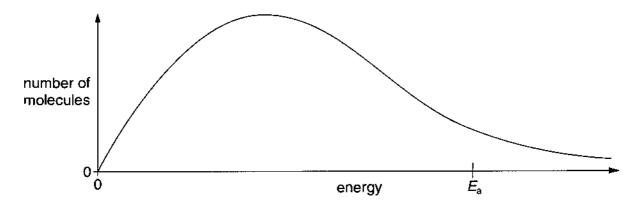
State what is meant by a *heterogeneous* catalyst and outline the way that this type of catalyst works in a catalytic converter.

[Total: 9]

4

(a)	Hyc	Irochloric acid is a strong acid.					
	(i)	What is meant by the term acid?					
		.,,	.[1]				
	(ii)	Explain the meaning of the term strong acid.					
		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,					
			.[1]				
(b)	(b) Hydrochloric acid reacts with a solution of sodium carbonate.						
	(i)	(i) Write appropriate state symbols in the equation for this reaction shown below.					
	2	2 HC l + Na $_2$ CO $_3$ \rightarrow 2NaC l + CO $_2$ + H $_2$ O	[1]				
	(ii)	State what you would see to indicate that the reaction was taking place.					
			.[1]				
+	(iil)	Construct an ionic equation for this reaction.					
			.[1]				
		Пotal	: 51				

5 (a) The diagram below shows the energy distribution of reactant molecules at a particular temperature. E_a represents the activation energy of the reaction.



(I) On the diagram, draw a second curve to represent the energy distribution of the same number of molecules at a higher temperature. [2]

(ii)	Use your completed diagram to explain how an increase in temperature can cause an increase in the rate of a reaction.
	[2]

(b) The rate of the reaction between hydrogen and oxygen depends on the pressure as well as the temperature.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$
 $\Delta H = -286 \text{ kJ mol}^{-1}$

(i) Describe and explain the effect of increasing the pressure on the rate of this reaction.

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***************************************	.,.,,	[2]

(ii) A sudden rapid increase in the rate of a reaction causes an explosion to occur.

Suggest why highly exotherr than other reactions.	nic reactions such	as this one are	more likely to explode
			[2]

[Total: 8]

END OF QUESTION PAPER