

Preliminary Examinations 2008

Pre-university 3

H2 CHEMISTRY

9746 / 02

Tuesday

9 Sep 2008

1h 30 min

Additional materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

- 1. Do not turn over this question paper until you are told to do so.
- 2. Write your name, class and index number in the spaces provided at the top of this page.
- 3. Write in *dark blue* or *black pen* in the spaces provided on the Question Paper.
- 4. You may use a soft pencil for any diagrams or graphs.
- 5. **DO NOT** use paper clips, highlighters, glue or correction fluid or tape.
- 6. Answer **ALL** the questions.
- 7. Give non-exact numerical answers correct to <u>3 significant figures</u>, or <u>1 decimal</u> <u>place</u> in the case of M_r and A_r , unless a different level of accuracy is specified in the question.
- 8. The number of marks is given in brackets [] at the end of each question or part question.
- 9. You are reminded of the need for <u>*clear presentation*</u> in your answers and to <u>*show*</u> <u>*all working*</u> in calculations.
- 10. The use of a calculator is expected, where appropriate.

Paper 2								
Question No	1	2	3	4	5	6	7	
Marks Obtained								60

 Electrical generating plants transport large amounts of hot water through copper pipes, and oxygen dissolved in the water can cause a major corrosion problem, Hydrazine (N₂H₄) is added to avoid the problem by reacting with the oxygen:

$$N_2H_4(aq) + O_2(g) \rightarrow N_2(g) + 2 H_2O(I)$$

 (a) Draw dot-and-cross diagram for hydrazine and determine the bond angle with respect to a nitrogen atom.
[2]

Bond angle:

(b) Explain the data below.

Compound	Melting point / °C
N_2H_4	1
P_2H_4	-134
CH ₃ CH ₂ NH ₂	-81

[3]

(c) With the use of the Data Booklet, draw an energy level diagram for the formation of N_2H_4 and determine the standard enthalpy change of formation of N_2H_4 . [3]

- (d) An alternative method suggested to prevent the copper pipes from corroding is to coat the copper pipes with a layer of aluminium oxide.
 - (i) Complete the diagram below, by filling in correct labels into the empty boxes, to illustrate the process. [1]



(ii) Write the half equations for reactions which occur at the anode and cathode.

	[2]
Cathode:	
Anode:	

[Total: 11m]

2. The following reaction is sometimes used to produce H₂ needed for production of ammonia in the Haber process.

214(g) + 202(g) + 200(g) + 212(g)

Temperature / K	K _p
1200	3.75
1300	7.74

- (a) (i) Write an expression for K_p for the reaction. Determine the units for K_p, given that the partial pressure is measured in atm.
 - (ii) What is the percentage yield of H₂ when an equimolar mixture of methane and carbon dioxide with a total pressure of 20.0 atm reaches equilibrium at 1200K?

(b) Van't Hoff equation shown below can be used to determine the enthalpy change of the reaction.

$$\ln \frac{K_2}{K_1} = -\frac{\Delta H_{rxn}^{\theta}}{R} (\frac{1}{T_2} - \frac{1}{T_1})$$

(i) Calculate the standard enthalpy change of reaction. [1]

(ii) Calculate the standard change in entropy for the reaction at equilibrium. [2]

(c) The rate equation for the reaction is found to $Rate = 1.2 \times 10^{\text{-18}} \, [CH_4] [CO_2]$

The backward reaction will have the rate equation as:

Rate =
$$2.6 \times 10^{-18} [CO]^2 [H_2]^2$$

What is the equilibrium constant, K_c, for the formation of carbon monoxide and hydrogen from methane and carbon dioxide? [2]

[Total: 9m]

 (a) A student carried out the following experiment involving silver chloride, silver iodide and copper (II) ions.

Step 1:	To the solid mixture of silver chloride and silver iodide, add excess
	aqueous ammonia and shake.
Step 2:	The solution is filtered and the residue is washed with distilled water.
	The filtrate is collected and labelled as Solution X.
Step 3:	Solution X is gradually added to a diluted solution containing copper
	(II) ions.

Predict and explain the observation for Step 2 and 3. Include chemical equations where possible. [6]

<u>Step 2</u>

Observation: Explanation:

<u>Step 3</u> Observation:

Explanation:

[Total: 6m]

(a) The curve below shows how the volume of oxygen evolved varies with time when 50 cm³ of a 2.0 moldm⁻³ solution of hydrogen peroxide, H₂O₂, decomposes at 298K.



(i) State how you could use the curve to find the rate of reaction at point A. [1]

- (ii) Using the same axes, sketch and label the following curves:
 - Curve X: 100 cm^3 of a 1.0 mol dm⁻³ solution of H₂O₂ at 298 K Curve Y: 25 cm^3 of a 2.0 mol dm⁻³ solution of H₂O₂ in the presence of a catalyst at 298 K [2]
- (iii) Hydrogen peroxide decomposes more rapidly in the presence of aqueous Fe³⁺. Write equations to shown how Fe³⁺ is able to catalyse the decomposition of hydrogen peroxide. [2]

(v) Explain, using the Maxwell Boltzmann distribution curve, how the presence of a catalyst leads to an increase in the rate of the reaction. [2]

[Total: 7m]

5. Laughing gas, N_2O , can be prepared from H_2 and NO:

$$H_2(g) + 2NO(g) \rightarrow N_2O(g) + H_2O(g)$$

A study of initial concentration versus initial rate at a certain temperature yields the following data for this reaction:

[H ₂] / mol dm ⁻³	[NO] / mol dm ⁻³	initial rate / mol dm ⁻³
0.1000	0.5000	2.560 x 10 ⁻⁶
0.2000	0.3000	1.843 x 10 ⁻⁶
0.2000	0.6000	7.373 x 10 ⁻⁶

(b) Hence determine the rate constant, k. Include the units of k in your answer. [2]

6. (a) (i) Suggest a 2-step procedure to form compound **P** from but–1–ene. [2]



Compound P

Step 1:	Reagents:
	Conditions:
Step 2:	Reagents:
	Conditions:

- (ii) What type/s of hybridization occur for C_x and C_y ? [1]
- (b) Aqueous iodine reacts with but-1-ene to produce C_4H_7OI .
 - (i) Suggest a structural formula for the major intermediate formed. [1]
 - (ii) Write equations to show how the product C_4H_7OI can be formed. [3]



7. (a) (i) Suggest a chemical test to differentiate the following compounds. Include observations. [2]
HOCH₂



	Reagent(s):		
	Condition:		
	Observations:		
	Compound M:		
	Compound N:		
(ii) (:::)	Indicate with an	asterisk the chiral centre(s) present on compound \mathbf{M} .	[1]
(111)	Compounds whi	ch have chiral centres are known to exhibit optical activi	ly.
	Explain the term	"optical activity".	[1]

(iv) Compound N also exhibit another type of stereoisomerism. Illustrate this type of stereoisomerism by drawing the isomers of compound N. [1]



Compound **G** is a flavouring agent in food. Draw the displayed formula of the product(s) when it reacts with the reagents.

(i) Tollen's reagent

[1]

(ii) aqueous NaOH

[2]

 (c) When compound G is added to ethanoic acid, no visible reaction is observed. However, when compound G is added to ethanoyl chloride, a sweet-smell evolves. Write an equation to illustrate the above reaction and hence account for the above observations. [2]



(d) Consider the four compounds listed below:

A :	C_6H_5OH	C :	CICH ₂ COOH
В:	CH₃COOH	D :	CH₃COCI

Arrange the compounds in order of increasing $\ensuremath{\mathsf{pK}}\xspace_a$ values. Explain your answer.

[5]

[Total: 15m]

-END OF PAPER-