IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

M07/4/CHEMI/SP2/ENG/TZ0/XX

22076105

CHEMISTRY
STANDARD LEVEL
PAPER 2

Thursday 10 May 2007 (afternoon)

1 hour 15 minutes

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

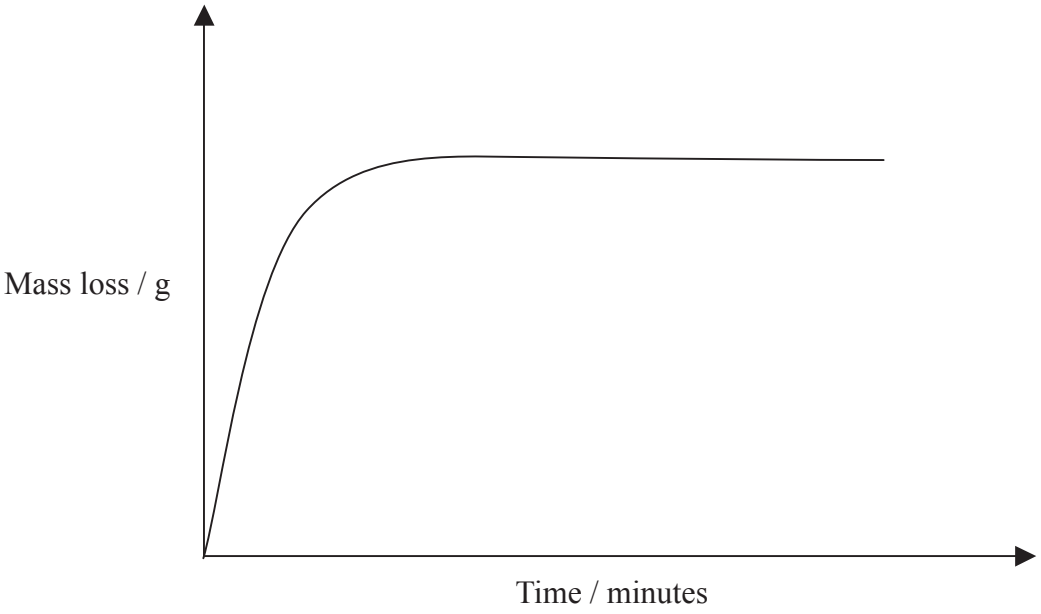
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all of Section A in the spaces provided.
- Section B: answer one question from Section B. Write your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the numbers of the questions answered in the candidate box on your cover sheet and indicate the number of sheets used in the appropriate box on your cover sheet.

SECTION A

*Answer **all** the questions in the spaces provided.*

1. Excess 0.100 mol dm^{-3} nitric acid is added to a certain mass of powdered calcium carbonate at 20 °C. The rate of reaction is monitored by measuring the change in mass over time due to the loss of carbon dioxide.

$$2HNO_3(aq) + CaCO_3(s) \rightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$$



(a) Define the term *rate of reaction*. *[1]*

. . . . . .

. . . . . .

(b) Explain why the mass loss remains constant after a certain time. *[1]*

. . . . . .

. . . . . .

(c) Draw a line on the graph above, to show what the graph would look like if the same mass of calcium carbonate in larger pieces were reacted with excess 0.100 mol dm^{-3} nitric acid. *[1]*

(This question continues on the following page)

(Question 1 continued)

(d) Explain in terms of the collision theory what would happen to the rate if the reaction was conducted at 50 °C. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(e) Determine the rate of formation of carbon dioxide when the nitric acid reacts at a rate of 2.00×10^{-3} mol cm^{-3} s^{-1}. *[1]*

. . . . . .

. . . . . .

(f) Calculate the volume of carbon dioxide produced at 1.01×10^5 Pa and 20.0 °C when 0.350 g of calcium carbonate reacts with excess 0.100 mol dm^{-3} nitric acid. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

2. (a) State the meaning of the term *electronegativity.* *[1]*

. . . . . .

. . . . . .

(b) State and explain the trend in electronegativity across period 3 from Na to Cl. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) Explain why Cl_2 rather than Br_2 would react more vigorously with a solution of I^-. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

3. (a) Define the term *average bond enthalpy.* *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) Use the information from Table 10 in the Data Booklet to calculate the enthalpy change for the complete combustion of but-1-ene according to the following equation. *[3]*

$$C_4H_8(g) + 6O_2(g) \rightarrow 4CO_2(g) + 4H_2O(g)$$

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) Predict, giving a reason, how the enthalpy change for the complete combustion of but-2-ene would compare with that of but-1-ene based on average bond enthalpies. *[1]*

. . . . . .

. . . . . .

(d) Predict, giving a reason, whether the entropy change, ΔS, for the reaction in (b) would be positive or negative. *[1]*

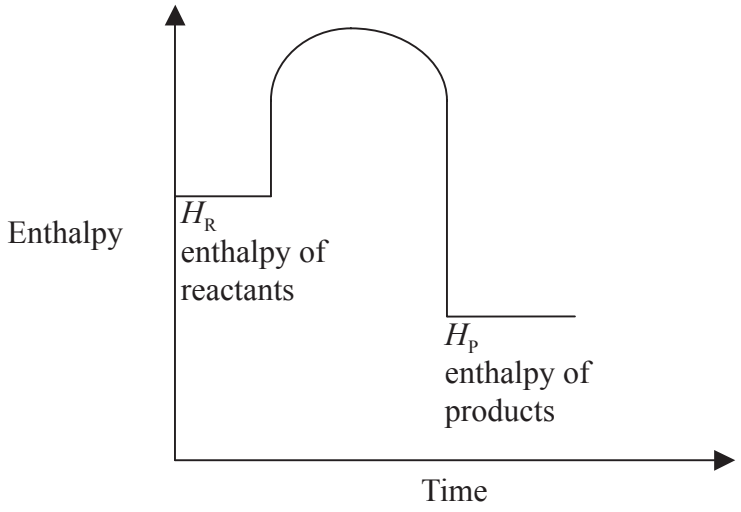
. . . . . .

. . . . . .

(This question continues on the following page)

(Question 3 continued)

(e) The enthalpy level diagram for a certain reaction is shown below.



State and explain the relative stabilities of the reactants and products. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

4. Ammonia is produced by the Haber process according to the following reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H \text{ is negative}$$

(a) State the equilibrium constant expression for the above reaction. *[1]*

. . . . . .

. . . . . .

(b) Predict, giving a reason, the effect on the position of equilibrium when the pressure in the reaction vessel is increased. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) State and explain the effect on the value of K_c when the temperature is increased. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(d) Explain why a catalyst has no effect on the position of equilibrium. *[1]*

. . . . . .

. . . . . .

SECTION B

*Answer **one** question. Write your answers on the answer sheets provided. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

5. Ethene is an unsaturated hydrocarbon used as a starting material for many organic chemicals.

(a) Draw the structural formula of ethene and state the meaning of the term *unsaturated hydrocarbon*. *[2]*

(b) State an equation for the conversion of ethene to ethanol and identify the type of reaction. *[2]*

(c) Describe the complete oxidation of ethanol and name the product. Include the conditions, reagents required and any colour changes. *[4]*

(d) State an equation for the reaction between ethanol and the product of complete oxidation in (c). Include any other reagent required for this reaction. Name the organic product and state **one** possible use of this product. *[4]*

(e) Explain why ethene undergoes addition polymerisation but not condensation polymerisation. *[2]*

(f) (i) State the meaning of the term *isomers*. *[1]*

(ii) Draw the functional group isomers of C_3H_6O. *[2]*

(iii) State the meaning of the term *optical isomers*. Draw the alcohol with the molecular formula $C_4H_{10}O$ which exhibits optical isomerism and identify the chiral carbon atom. *[3]*

6. (a) State the electron arrangement for atoms of aluminium, nitrogen and fluorine. *[2]*

(b) Describe the bonding present in samples of solid aluminium and nitrogen gas. *[4]*

(c) Aluminium fluoride, AlF_3, is a solid up to a temperature of 1250 °C whereas nitrogen trifluoride, NF_3, is a gas above −129 °C. Describe the bonding and structure in samples of each of these substances. *[5]*

(d) Explain why

(i) aluminium conducts electricity in both the solid and liquid state. *[1]*

(ii) aluminium fluoride conducts electricity in the liquid state but not in the solid state. *[2]*

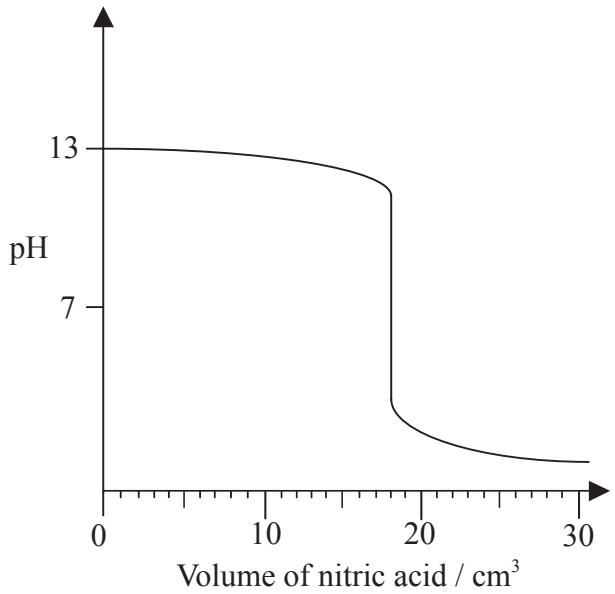
(iii) nitrogen trifluoride does not conduct in either the liquid or solid states. *[1]*

(e) Draw the Lewis structure of NCl_3. Predict, giving a reason, the Cl – N – Cl bond angle in NCl_3. *[3]*

(f) The relative atomic mass of chlorine is 35.45. Calculate the percentage abundance of the two isotopes of chlorine, ^{35}Cl and ^{37}Cl in a sample of chlorine gas. *[2]*

7. (a) Explain why a 1.0 mol dm^{-3} solution of sodium hydroxide has a pH of 14 whereas 1.0 mol dm^{-3} ammonia solution has a pH of about 12. Use equations in your answer. *[5]*

(b) 20.0 cm^3 of a known concentration of sodium hydroxide is titrated with a solution of nitric acid. The graph for this titration is given below.



(i) State an equation for the reaction between sodium hydroxide and nitric acid. *[1]*

(ii) Calculate the concentration of the sodium hydroxide solution before the titration. *[2]*

(iii) From the graph determine the volume of nitric acid required to neutralize the sodium hydroxide and calculate the concentration of the nitric acid. *[2]*

(iv) Predict the volume of ethanoic acid of the same concentration as the nitric acid in (b) (iii), required to neutralize 20.0 cm^3 of this sodium hydroxide solution. *[1]*

(c) State and explain **two** methods, other than measuring pH, which could be used to distinguish between 1.0 mol dm^{-3} solutions of nitric acid and ethanoic acid. *[4]*

(d) Nitric acid and ammonia may be used to make a buffer solution.

(i) Describe the behaviour of a buffer solution. *[2]*

(ii) Describe how you could prepare a buffer solution using 0.100 mol dm^{-3} solutions of nitric acid and ammonia. *[3]*