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

N07/4/CHEMI/SP2/ENG/TZ0/XX

88076105

CHEMISTRY
STANDARD LEVEL
PAPER 2

Wednesday 14 November 2007 (afternoon)

1 hour 15 minutes

Candidate session number

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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** question in the spaces provided.*

1. 0.502 g of an alkali metal sulfate is dissolved in water and excess barium chloride solution, $BaCl_2(aq)$, is added to precipitate all the sulfate ions as barium sulfate, $BaSO_4(s)$. The precipitate is filtered and dried and weighs 0.672 g.

(a) Calculate the amount (in mol) of barium sulfate formed. *[2]*

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(b) Determine the amount (in mol) of the alkali metal sulfate present. *[1]*

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(c) Determine the molar mass of the alkali metal sulfate and state its units. *[2]*

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(d) Deduce the identity of the alkali metal, showing your working. *[2]*

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(e) Write an equation for the precipitation reaction, including state symbols. *[2]*

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2. Naturally occurring copper has a *relative atomic mass* (A_r) of 63.55 and consists of two isotopes ^{63}Cu and ^{65}Cu.

(a) Define the term *relative atomic mass*, A_r. *[1]*

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(b) State and explain which is the more abundant isotope. *[1]*

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(c) Describe and explain how the physical and chemical properties of the two isotopes compare. *[4]*

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3. (a) (i) A solution of hydrochloric acid has a concentration of 0.10 mol dm^{-3} and a pH value of 1. The solution is diluted by a factor of 100. Determine the concentration of the acid **and** the pH value in the diluted solution. *[2]*

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(ii) Explain why 0.10 mol dm^{-3} ethanoic acid solution and the diluted solution in (a) (i) have similar $[H^+]$ values. *[3]*

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(b) Suggest **one** method, other than measuring pH, which could be used to distinguish between solutions of a strong acid and a weak acid of the same concentration. State the expected results. *[2]*

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4. (a) Iodide ions, $I^-(aq)$, react with iodate ions, $IO_3^-(aq)$, in an acidic solution to form molecular iodine and water.

(i) Determine the oxidation number of iodine in each iodine-containing species in the reaction. *[2]*

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(ii) Identify, with a reason, the species that undergoes: *[2]*

oxidation . . . . . .

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reduction . . . . . .

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(b) Describe how electrolysis is used to plate an object with copper. Write an equation for the reaction occurring at the negative electrode (cathode). *[4]*

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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. (a) The reaction between ethene and hydrogen gas is exothermic.

(i) Write an equation for this reaction. *[1]*

(ii) Deduce the relative stabilities and energies of the reactants and products. *[2]*

(iii) Explain, by referring to the bonds in the molecules, why the reaction is exothermic. *[2]*

(b) (i) Predict and explain, the sign of ΔS for the reaction in part (a). *[3]*

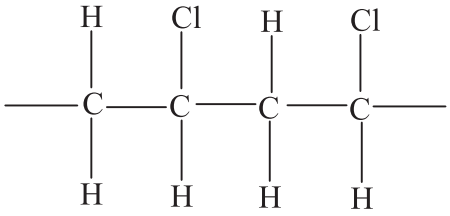
(ii) Predict and explain whether the reaction will be more spontaneous or less spontaneous as the temperature is increased. *[2]*

(c) Ethene reacts with steam to form a compound X. X reacts with acidified potassium manganate(VII) to form compound Y of molecular formula $C_2H_4O_2$. Y reacts with X to form a sweet-smelling compound Z.

(i) State the type of reaction that occurs when X is converted to Y. Deduce the names of the compounds X, Y and Z. Write an equation for the formation of Z, and draw its structural formula. *[5]*

(ii) Suggest a use of compound Z in the food industry. *[1]*

(iii) A section of a polymer is shown below:



Draw the structural formula and state the name of the monomer used to make this polymer. *[2]*

(iv) State, giving a reason, whether the polymer is made by addition or condensation polymerization. *[2]*

6. (a) (i) Define the term *ionization energy.* *[1]*

(ii) Write an equation for the reaction of lithium with water. *[1]*

(iii) State and explain the trend in the ionization energy of alkali metals down the group. *[3]*

(iv) Explain why the electronegativity of phosphorus is greater than that of aluminium. *[2]*

(v) Table 8 in the Data Booklet contains two values for the ionic radius of silicon. Explain, by reference to atomic structure and electron arrangements, why the two values are very different. *[4]*

(b) The boiling points of the hydrides of the group 5 elements are shown below:

Hydride	NH_3	PH_3	AsH_3	SbH_3
Boiling point / K	240	186	218	248

(i) Explain the trend in the boiling points from PH_3 to SbH_3. *[2]*

(ii) Explain why the boiling point of NH_3 does not fit this trend. *[2]*

(c) Arrange the following in **decreasing** order of bond angle (largest one first), and explain your reasoning. *[5]*

$$NH_2^-, NH_3, NH_4^+$$

7. (a) The equation for the exothermic reaction in the Contact process is given below:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

(i) Write the equilibrium constant expression for the reaction. *[1]*

(ii) State and explain qualitatively the pressure and temperature conditions that will give the highest yield of sulfur trioxide. *[4]*

(iii) In practice, conditions used commercially in the Contact process are 450 °C and 2 atmospheres of pressure. Explain why these conditions are used rather than those that give the highest yield. *[3]*

(iv) Name a catalyst used in the Contact process. State and explain its effect on the value of the equilibrium constant. *[3]*

(b) (i) Draw a graph that shows the distribution of molecular energies in a sample of a gas at two different temperatures, T_1 and T_2 such that T_2 is greater than T_1. *[2]*

(ii) Define the term *activation energy*. *[1]*

(iii) State and explain the effect of a catalyst on the rate of an endothermic reaction. *[2]*

(c) (i) Magnesium is added to a solution of hydrochloric acid. Sketch a graph of acid concentration on the y-axis against time on the x-axis to illustrate the progress of the reaction. *[1]*

(ii) Describe how the slope of the line changes with time. *[1]*

(iii) Use the collision theory to state and explain the effect of decreasing concentration on the rate of the reaction. *[2]*