



Student Number	
Mark / 39	

Chemistry

Preliminary Course

Final Examination • 2006

General Instructions

- Reading time – 5 minutes
- Working time – 45 minutes
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A Data Sheet and a Periodic Table are provided
- Write your Student Number at the top of this page

Total Marks – 39

Part A – 10 marks

- Attempt Questions 1 – 10
- Allow about 10 minutes for this part

Part B – 29 marks

- Attempt Questions 11 – 19
- Allow about 35 minutes for this part

► Mark your answers for Questions 1 – 10 in the Answer Box on page 2.

- 1 The law of combining volumes states that the ratio of gases involved in a chemical reaction can be expressed in simple whole number ratios.

Identify who proposed this law?

- (A) Dalton
- (B) Gay–Lussac
- (C) Avogadro
- (D) Mendeleev

- 2 Which statement is correct for NO₂ gas?

- (A) One molecule has a mass of 46 g.
- (B) One molecule occupies a volume of 24.79 L at 0°C and 100 kPa.
- (C) One mole contains 6.02×10^{23} atoms of oxygen.
- (D) One mole contains 6.02×10^{23} molecules.

- 3 The extraction of a metal from its ore involves a series of steps as shown...

mine ore → concentrate ore → extract metal via smelting → purify the metal

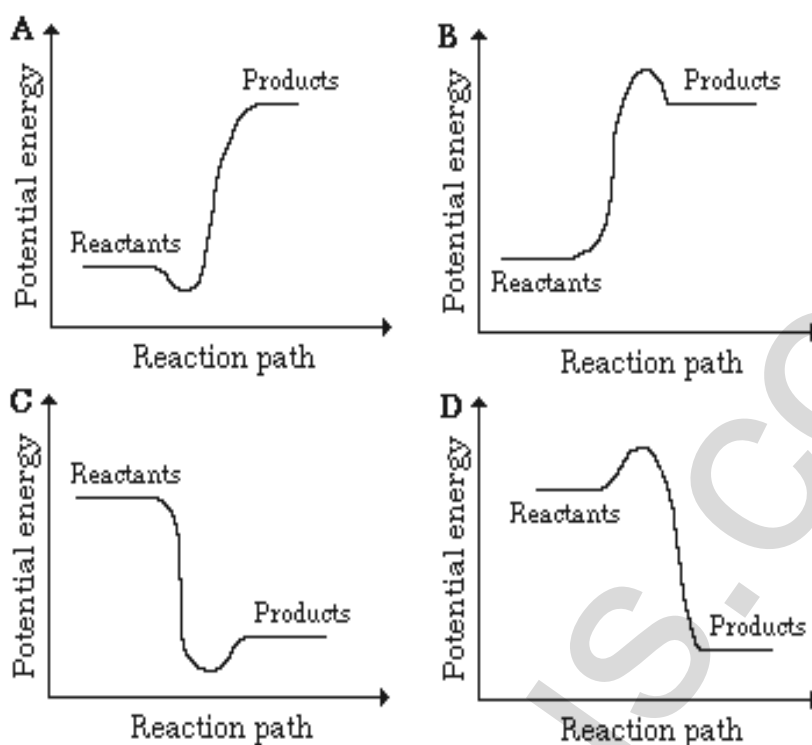
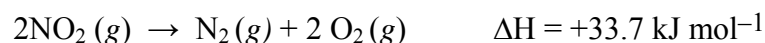
Which chemical equation represents a reaction that would be appropriate for the metal extraction step for copper from its ore?

- (A) $\text{FeO (s)} + \text{SiO}_2 \text{ (s)} \rightarrow \text{FeSiO}_3 \text{ (l)}$
- (B) $2\text{CuFeS}_2 \text{ (s)} + 5\text{O}_2 \text{ (g)} \rightarrow 2\text{Cu (l)} + 2\text{FeO (s)} + 4\text{SO}_2 \text{ (g)}$
- (C) $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$
- (D) $\text{CuO (s)} + \text{Mg (s)} \rightarrow \text{MgO (s)} + \text{Cu (s)}$

- 4 Which of these processes is endothermic?

- (A) decomposition of silver chloride to silver and chlorine
- (B) burning methane
- (C) condensing steam
- (D) adding sodium metal to water

- 5 Which graph represents the change in potential energy for the reaction...



- (A) Graph A
(B) Graph B
(C) Graph C
(D) Graph D
- 6 A compound contains potassium, sulfur and oxygen only. A sample of the compound is found to contain 41.1 mg of potassium, 33.8 mg of sulfur and 25.2 mg of oxygen.
- Which of the following represents the empirical formula of the compound?
- (A) K_2SO_4
(B) K_2SO_3
(C) $\text{K}_2\text{S}_2\text{O}_3$
(D) K_2SO_2
- 7 In a calorimeter, a 1.000 g sample of magnesium is burned to form MgO , and in so doing, releases 6.075 kJ of energy. What is the heat of combustion, in kJ, of one mole of magnesium?
- (A) 6.075
(B) 72.90
(C) 147.7
(D) 3.65×10^{25}

- 8 10 mL of hydrogen fluoride gas reacts with 5 mL of dinitrogen difluoride gas to form 10 mL of a gas. All gas volumes are measured at the same temperature and pressure.

Which of the following is the most likely equation for the reaction?

- (A) $\text{HF (g)} + \text{N}_2\text{F}_2 \text{ (g)} \rightarrow \text{N}_2\text{HF}_3 \text{ (g)}$
 (B) $2\text{HF (g)} + \text{N}_2\text{F}_2 \text{ (g)} \rightarrow \text{N}_2\text{H}_2\text{F}_4 \text{ (g)}$
 (C) $2\text{HF (g)} + \text{N}_2\text{F}_2 \text{ (g)} \rightarrow 2\text{NHF}_2 \text{ (g)}$
 (D) $\text{HF (g)} + 2\text{N}_2\text{F}_2 \text{ (g)} \rightarrow \text{N}_4\text{HF}_5 \text{ (g)}$

- 9 The table shows the solubility of salts in water at 25°C.

ANION	CATION	COMPOUND
All	Group I metals	soluble
All	Ammonium, NH_4^+	soluble
Nitrate, NO_3^-	All	soluble
Acetate/ethanoate CH_3COO^-	All except Ag^+	soluble
Chloride, Cl^- Bromide, Br^- Iodide, I^-	Ag^+ , Pb^{2+} , Hg_2^{2+} , Cu^+	insoluble
	All others	soluble
Sulfate, SO_4^{2-}	Ca^{2+} , Sr^{2+} , Ba^{2+} , Pb^{2+} , Ag^+ , Hg_2^{2+}	insoluble
	All others	soluble
Sulfide, S^{2-}	Group I and II metals, NH_4^+	soluble
	All others	insoluble
Hydroxide, OH^-	Group I metals, NH_4^+ , Sr^{2+} , Ba^{2+}	soluble
	All others	insoluble
Carbonate, CO_3^{2-} Phosphate, PO_4^{3-} Sulfite, SO_3^{2-}	Group I metals, NH_4^+	soluble
	All others	insoluble

A student mixed several salt solutions as described in the table.

Mixture number	Salt solutions mixed
1	sodium sulfate + magnesium nitrate
2	sodium chloride + magnesium iodide
3	calcium nitrate + ammonium sulfate

In which mixture(s) will a precipitate occur?

- (A) 1 only
 (B) 1 and 3
 (C) 1 and 2
 (D) 3 only

- 10 A single piece of zinc was put into 2 mol L⁻¹ hydrochloric acid. It was observed that the rate of production of hydrogen gas soon reached a maximum and then decreased.

The following reasons were put forward for the decrease in the rate of formation of hydrogen...

- I The concentration of the acid decreased as the reaction proceeded.
- II The surface area of the zinc decreased as the reaction proceeded.
- III The reaction was exothermic.

Which of the above three suggestions explains the decreasing reaction rate?

- (A) I, II and III
- (B) I and II only
- (C) I only
- (D) II only

Part B – 29 marks
Attempt Questions 11 – 19
Allow about 35 minutes for this part

► *Show all relevant working in questions involving calculations.*

Question 11 (2 marks)

Describe the energy changes involved in the dissolving of copper(II) sulfate crystals in water.

Question 12 (3 marks)

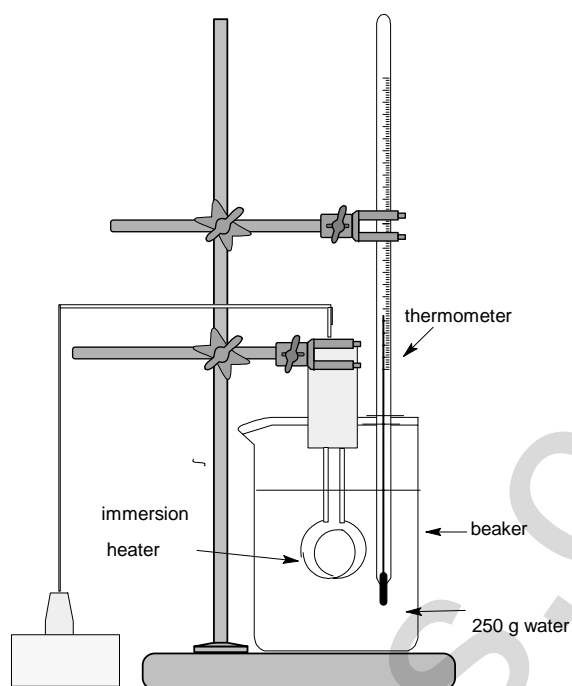
During a chemical reaction, chemical bonds are broken and then reformed.

(a) Outline the role of activation energy in this process. **(1 mark)**

(b) Compare the overall energy involved in breaking and reforming bonds in the combustion of methane. **(2 marks)**

Question 13 (6 marks)

A group of students were assigned to verify the value of the specific heat capacity of water. The diagram shows their experimental set-up...



The immersion heater provided 75.7 kJ of heat which raised the temperature of the water in the beaker from 25°C to 85°C.

- (a) Calculate the experimental value of the specific heat capacity of water. **(2 marks)**

- (b) Compare the experimental value calculated above with the reference value for the specific heat of water. Explain any difference in the values. **(2 marks)**

- (c) Outline ways to improve the experimental set-up to obtain a more valid result. **(2 marks)**

Question 14 (2 marks)

Explain why ethanol $\left(\begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ | \quad | \\ \text{H} \quad \text{H} \end{array} \right)$ totally dissolves in water. **(2 marks)**

Question 15 (4 marks)

Identify the molecular shapes and draw the Lewis electron dot structures of water and hydrogen sulfide.

water	hydrogen sulfide

Question 16 (3 marks)

Hydrogen gas can be generated by reacting an acid with an active metal.

- (a) Write an equation for the reaction between magnesium and hydrochloric acid. **(1 mark)**

- (b) Calculate the volume of hydrogen gas generated at 25°C and 100 kPa when 4.86 g of magnesium are reacted with excess 1.00 mol L⁻¹ hydrochloric acid. **(2 marks)**

Question 17 (2 marks)

Lead is a toxic heavy metal that is carefully monitored in waterways.

An electric probe measured the concentration of lead ions (Pb²⁺) in a creek as 0.07 ppm.

Calculate the mass of lead ions that would be found in 3 L of the creek water.

Question 18 (3 marks)

A student prepared a sugar solution by dissolving 1.71 g of sucrose ($C_{12}H_{22}O_{11}$) in water and making the volume up to 100 mL.

- (a) Calculate the concentration of the sucrose solution in moles per litre. **(2 marks)**

- (b) The student then diluted the sucrose solution to 250 mL.

Calculate the concentration of the new sucrose solution in moles per litre. **(1 mark)**

Question 19 (4 marks)

$BaSO_4$ is frequently used as a radiocontrast agent for X-ray imaging. It can be prepared using precipitation reactions.

2.08 g of barium chloride was dissolved in water to make 50 mL of solution and then added to 50 mL of a solution containing 2.84 g of sodium sulfate. A white precipitate formed.

- (a) Write a net ionic equation for the reaction forming the precipitate. **(1 mark)**

- (b) What is the mass of the precipitate formed? **(2 marks)**

- (c) Calculate the concentration, in moles per litre, of the sulfate ions in the final solution. **(1 mark)**
