962/2

PERCUBAAN STPM 2009

CHEMISTRY (KIMIA)

PAPER 2 (KERTAS 2)

Two hours and thirty minutes (Dua jam tiga puluh minit)

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Instructions to candidates:

Answer **all** *the questions in Section A in the spaces provided. All working* **must** *be shown. For numerical answers, unit* **must** *be quoted wherever they are appropriate.*

Answer any **four** *questions from section B. For this section, write your answers on the answer sheets. Begin each answer on a fresh sheet of paper and arrange your answers in numerical order. Tie your answer sheets to this booklet.*

Answers may be written in either English or Malay.

A Data Booklet is provided.

For Examiner's use (Untuk kegunaan pemeriksa)	
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Total (Jumlah)	

This question paper consists of 33 printed pages.

Section A [40 *marks*]

Answer **all** *the questions in this section.*

1. (a) Iodine, I_2, crystallizes in a face-centred cubic lattice.

(i) Draw a unit cell for the iodine crystal lattice. [1 mark]

(ii) Calculate the number of iodine atoms in one unit cell. [1 mark]

(b) The triple point of carbon dioxide is at -57°C and 5 kPa, while its critical point is at 31°C and 73 kPa.

(i) Define *triple point*. [1 mark]

.....

.....

(ii) Sketch the phase diagram of carbon dioxide based on the information above. [3 marks]

(iii) Based on your diagram in b(ii), explain why solid carbon dioxide sublimes at room temperature. [1 mark]

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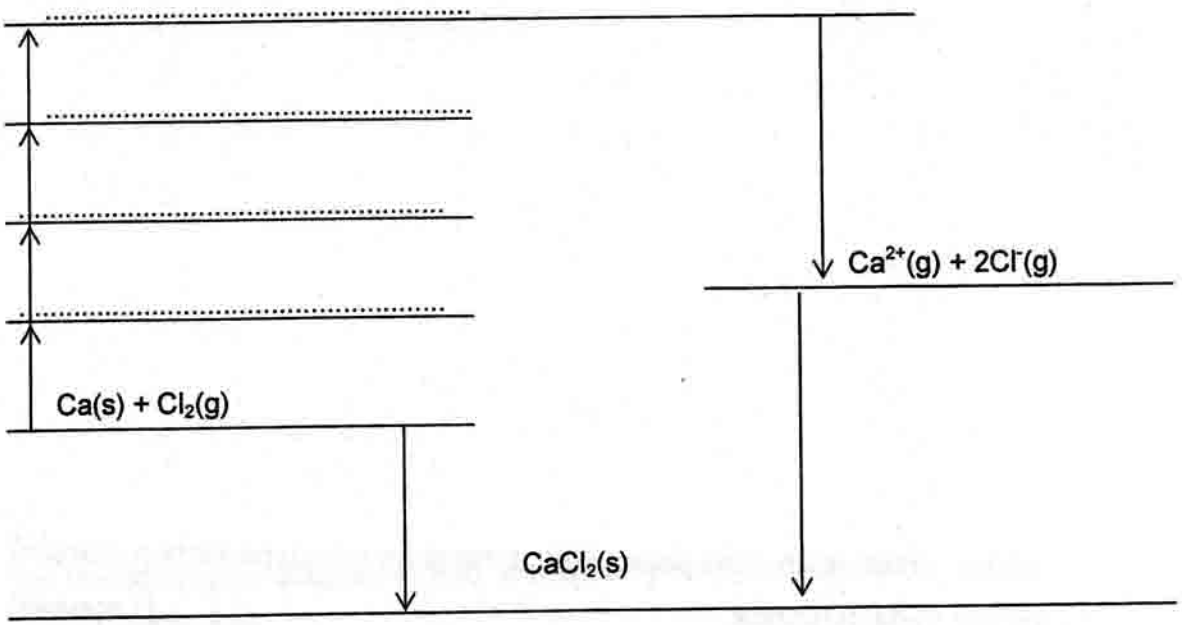
.....

.....

(iv) A piece of solid carbon dioxide with a mass of 5.50 g is placed in a 10.0 dm^3 vessel that already contains air at 93.7 kPa and 24.0°C. After the carbon dioxide has totally vaporized, calculate the total pressure in the container at 24.0°C.

[3 marks]

2. Consider the incomplete Born–Haber cycle and the table of data below.



Standard enthalpy change	Value of enthalpy change/kJmol^{-1}
Enthalpy of atomization of chlorine	+121
Enthalpy of atomization of calcium	+178
First ionization energy of calcium	+590
Second ionization energy of calcium	+1145
Electron affinity of chlorine	-364
Lattice energy of calcium chloride	-2237

(a) Complete the Born-Haber cycle above by writing the appropriate chemical formulae, with state symbols, on the dotted lines. [3 marks]

(b) Use the cycle and the values given in the table to calculate the standard enthalpy of formation of calcium chloride. [2 marks]

(c) The standard enthalpies of hydration of the Ca^{2+} and the Cl^- ions are –1650 kJ mol^{-1} and –364 kJ mol^{-1} respectively. Use this information and data from the table in part (a) to calculate the enthalpy of solution of calcium chloride. [2 marks]

(d) The standard enthalpy of solution of ammonium chloride, NH_4Cl, is +15 kJ mol^{-1}.

A 2.0 g sample of ammonium chloride is dissolved in 50 g of water. Both substances are initially at 20 °C.

Calculate the temperature change and the final temperature of the solution.

Assume that the specific heat capacity of the solution is 4.2 JK^{-1} g^{-1}.

[3 marks]

3. Aluminium is the first element of Group 13 in the Periodic Table.

(a) State the valence electronic configuration of aluminium [1 mark]

.....

(b) When aqueous sodium hydroxide is added to an aqueous solution of aluminium chloride, a white precipitate, P, is formed. This precipitate dissolves in excess sodium hydroxide, forming an ion, Q.

(i) Name the precipitate P. [1 mark]

.....

(ii) What is the formula of ion Q ? [1 mark]

.....

(c) An aqueous solution of aluminium salt is acidic.

(i) Describe what you would observe when aqueous sodium carbonate is added to aqueous aluminium chloride. [2 marks]

.....

.....

(ii) Write an ionic equation for the reaction in (c) [1 mark]

.....

(d) Aluminium chloride can be used as a catalyst in Friedal Crafts alkylation of benzene.

(i) Write an equation for the reaction between aluminium chloride and chloromethane to form an electrophile. [1 mark]

.....

(ii) Use your understanding of acids and bases to explain the role of aluminium chloride in the reaction above. [2 marks]

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.....

.....

(e) State one property which enables aluminium to be used in overhead electric cables. [1 mark]

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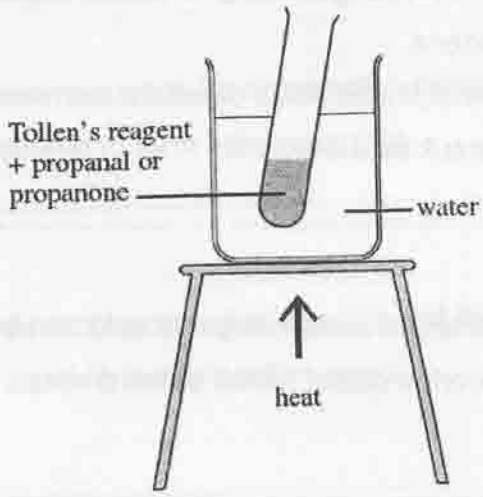
4. (a) The diagram shows how to distinguish between propanal and propanone.



(i) State the metal ion present in Tollen's reagent.

.....[1 mark]

(ii) State the functional group present in both propanal and propanone.

..... [1 mark]

(iii) Explain why hot water is used.

.....

..... [1 mark]

(iv) State what is observed in separate experiments with propanal and propanone.

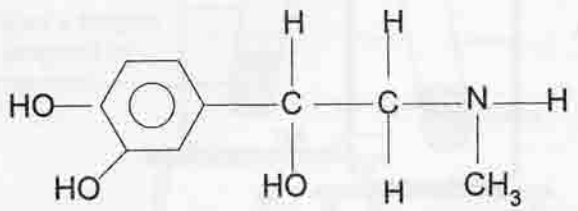
Propanal.....

..... [1 mark]

Propanone.....

..... [1 mark]

(b) *Adrenaline* is a hormone that acts as a stimulant. It has the structural formula shown below.



(i) State the type of isomerism that can exist in the adrenaline molecule.

[1 mark]

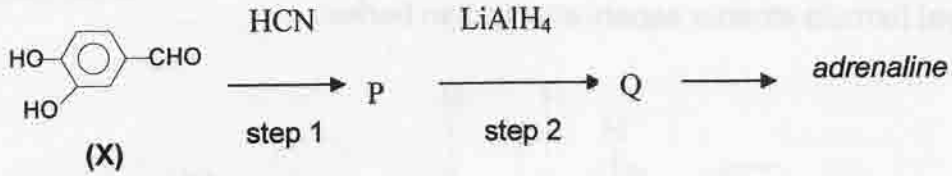
.....

(ii) Draw the structural formula of the product formed when adrenaline reacts with

$NaOH_{(aq)}$	Dilute HCl
Structural formula	*Structural formula*

[2 marks]

(c) *Adrenaline* can be synthesized from **X** via the following steps :



(X)

(i) State the type of reaction that is involved in step 1 [1 mark]

.....

(ii) State the condition(s) required for step 2. [1 mark]

.....

.....

Section B [60 *marks*]

Answer any **four** *questions in this section.*

5. (a) The equation below shows the reaction between ammonia and a hydrogen ion.

$$NH_3 + H^+ \rightarrow NH_4^+$$

In terms of the electrons involved, explain how the bond between the NH_3 molecule and the H^+ ions is formed.

Name the type of bond formed in this reaction. [3 marks]

(b) Boiling point data for three hydrides are given in the table below.

Hydride	Relative molecular mass, M_r	Boiling point/ °C
Methane	16	-182
Ammonia	17	- 33
Water	18	100

Explain why these three hydrides have very different boiling points.

[4 marks]

(c) (i) A reaction of nitrogen monoxide is shown below.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

The rate of reaction can be found by measuring the concentration of NO_2 at different times.

Define the term *rate of reaction*.

Sketch a graph to show how the concentration of NO_2 changes with time.

Indicate how the initial rate of reaction could be obtained from your graph.

[4 marks]

(ii) In the manufacture of sulphur trioxide from sulphur dioxide, nitrogen monoxide can be used in a two-stage process to increase the rate of production.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

$$NO_2(g) + SO_2(g) \rightarrow NO(g) + SO_3(g)$$

Construct an overall equation for the production of SO_3 from SO_2.

State and explain fully the role of NO in this process.

[4 marks]

6. (a) (i) Using a solution of ammonium chloride and ammonia as example, explain what is meant by a *buffer solution*. [5 marks]

(ii) Calculate the mass of ammonium chloride that needs to be added to 450 cm^3 of 0.10 mol dm^{-3} ammonia to produce a solution with pH = 9.0
[K_b of NH_3 = 1.7 x 10^{-5} mol dm^{-3}] [4 marks]

(b) The pK_a values of four carboxylic acids are listed in the table below.

Acid	Formula of acid	pK_a
1	CH_3CH_2COOH	4.9
2.	$CH_3CHClCO_2H$	2.8
3	CH_3CCl_2COOH	1.4
4	CH_2ClCH_2COOH	4.1

(i) Describe and explain the trend in acidic strength shown by acids 1, 2 and 3.

(ii) Give an explanation for the difference in the p*K*a values for acids 2 and 4.

(iii) Calculate the pH of a 0.010 mol dm^{-3} solution of propanoic acid (acid 1).

[6 marks]

7. (a) (i) State the trend in the *reducing ability* of the halide ions from fluoride to iodide.

[1 mark]

(ii) State what you would observe when chlorine water reacts with a solution of potassium iodide. Write an equation for the reaction.
State the role of chlorine in the reaction.

[3 marks]

(iii) Give a reagent which could be used to distinguish between separate solutions of potassium bromide and potassium iodide. State what would be observed when this reagent is added to each of the separate solutions of potassium bromide and potassium iodide. Write an equation for **one** of the reactions.

Identify a reagent which could be added to the mixtures from the first test to confirm the identity of the halide ions. State what would be observed in each case.

[6 marks]

(b) Carbon tetrachloride and silicon tetrachloride behave in different ways when added to water. State how each chloride behaves and explain the difference.

[5 marks]

8. (a) An aqueous solution of magnesium nitrate and barium nitrate can be differentiated by the addition of dilute sulphuric acid.

State what you would observe when the above reaction is carried out.

[3 marks]

(b) Compare and explain the solubility in water, for the solid sulphates formed in 8(a). [7 marks]

(c) The solubility product, K_{sp}, of magnesium hydroxide has a numerical value of 2.0×10^{-11}.

(i) Write an expression for the K_{sp} of magnesium hydroxide, stating its units.

(ii) Use the value of K_{sp} given to calculate the concentration of $Mg(OH)_2$ in a saturated solution.

(iii) Explain whether magnesium hydroxide would be more soluble or less soluble in 0.1 mol dm^{-3} $MgSO_4(aq)$ than in water.

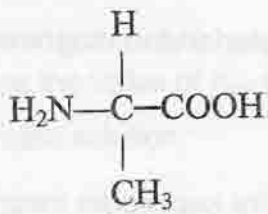
[5 marks]

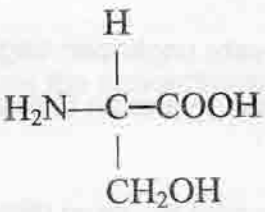
9. (a) (i) Write the mechanism of the reaction when 1-chloropropane is refluxed with aqueous sodium hydroxide. Name of the type of reaction involved [3 marks]

(ii) State and explain how the rate of this reaction changes when 1-chloropropane is replaced by 1-bromopropane. [3 marks]

(iii) Write equations to show how you would change 1-chloropropane to 2-chloropropane [5 marks]

(b) The amino acids *alanine* and *serine* are shown below.


alanine


serine

(i) Draw the structures of the **two** dipeptides formed by the reaction of *alanine* with *serine*.

(ii) Name **one** of the dipeptides formed in b(i).

(iii) Draw the structure of the organic compound formed when one molecule of *serine* reacts with two molecules of ethanoyl chloride. [4 marks]

10. Five organic compounds, **A** to **E**, has the molecular formula $C_5H_{10}O$.

Compounds **A, B** and **C** can react with 2,4-dinitrophenylhydrazine, but not with Fehling's solution. Only **A** and **B** gives a positive iodoform test. **A** has a higher boiling point than **B**.

Compounds **D** and **E** give a brick red precipitate, **P** , with Fehling's solution. **D** is optically active. Reduction of **E** gives a straight chain compound, **F**.

Based on the information above, identify compounds **A** to **F**. Give reasons for your choice.

Name compound **P**.

Write any **three** chemical equations for the reactions above, involving different reagents.

[15 marks]