1997

Part A — Structured Essay

Answer all four questions. Each question carries 10 marks

1. (*a*) (i) Present briefly and clearly a simple experiment to demonstrate that gases are non-continuous.

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(ii) Present briefly and clearly a simple experiment to demonstrate that liquds are non-continuous.

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(b) Name the chemical compounds shown below, **appropriately.**

Compound	Name
Cu_3N	
Li_2O_2	

(c) (i) The relative atomic mass of the element, **X** is between 50 and 70. The hydrated crystals of XSO_4 are colourless, while **XS** is a white precipitate. A dioxide of **X** does not exist. Identify **X**.

(ii) Write the electronic configuration of the element of atomic number 28 in the usual form, $1s^2 2s^2$ . . . .etc.

(iii) **Apart from the temperature changes that occur**, predict **three** important changes that could occur when an excess of dilute $FeSO_4$ is gradually added to an aqueous solution of Br_2/KBr.

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(iv) **Apart from the temperature changes that occur,** predict **three** important changes that could occur when a small amount of $Fe(OH)_3$ is added to an aqueous solution of hydroiodic acid.

2. (*a*) Balance the following chemical changes with respect to the various atoms and electrical charges.

(i) $C_2O_4^{2-} \longrightarrow CO_2$

(ii) $CrO_4^{2-} + H^+ \longrightarrow Cr^{3+} + H_2O$

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(b) Using the balanced equations obtained above, **or using another method**, write a balanced chemical equation for the reaction that could occur when K_2CrO_4, $K_2C_2O_4$ and aqueous H_2SO_4 are heated together.

(c) Explain qualitatively the nature of the three physical states of matter on the basis of the motion and arrangement of molecules. **N.B. It is sufficient to consider two properties for each of the physical states.**

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(d) Indicate how you would show that the equilibrium reaction pertaining to the $Cr_2O_7^{2-} / CrO_4^{2-}$ system in aqueous solution is reversible.

3. (a) The organic compound, **P** contains 47·4% carbon, 2·63% hydrogen, 18·4% nitrogen and oxygen only. The relative molecular mass of **P** is about 150. Determine the molecular formula of **P**. (H = 1; N = 14; O = 16; C = 12)

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(*b*) Consider the C_2H_4 molecule.

(i) Name **specifically** the orbitals that are being used by the carbon atoms for bond formation in this molecule.

(ii) Indicate in a diagram the orbitals that are being used by a carbon atom for bond formation in this molecule. Indicate clearly in your diagram the angles between the directions of orientation of the above orbitals. **N.B. These angles should be specified in degrees.**

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(iii) Describe clearly the nature of the double bond between the two carbon atoms in the C_2H_4 molecule.

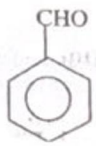
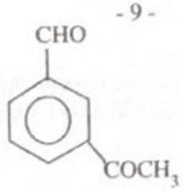
(c) Indicate how you would chemically distinguish between the two compounds in the following pairs.

(i) $CH_3CH_2CH=CH_2$ and $CH_3CH=CHCH_3$

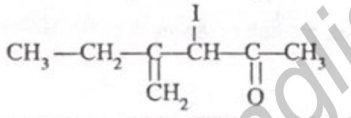
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(ii)  and 

4. (*a*) Name the compound having the structure



in accordance with IUPAC nomenclature.

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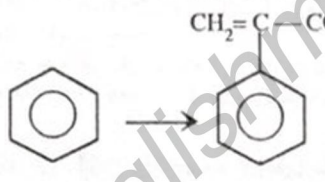
(*b*) Give the mechanism of the addition reaction that occurs between $CH_2=CH_2$ and HBr under polar conditions.

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(*c*) Indicate how the following conversions could be effected. The necessary reagents and reaction conditions should be clearly given at the appropriate places. **N.B. If the method of conversion proposed by you is unnecessarily long, you will not be awarded maximum marks.**

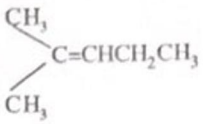
(i)



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(ii) $(CH_3)_2CHOH \longrightarrow$ 

N.B. For this conversion, you are supplied with only $(CH_3)_2CHOH$ as an organic compound.

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අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 1997 අගෝස්තු (නව නිර්දේශය)
கல்விப் பொதுத் தராதரப்பத்திர(உயர் தர)ப் பரீட்சை, 1997 ஒகஸ்ற் (புதிய பாடத்திட்டம்)
General Certificate of Education (Adv. Level) Examination, August 1997 (New Syllabus)

රසායන විද්‍යාව II
இரசாயனவியல் II
Chemistry II

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Part B — Essay

*Answer **two** questions only. Each question carries **15** marks.*

5. (*a*) State Boyle's law and Charles' law **in words.** Using these two laws derive the ideal gas equation.

(*b*) A closed vessel of volume 7.76 dm^3 contains a mixture of helium and oxygen. The pressure inside the vessel at 280 K was 1.50×10^5 N m^{-2}. Inside the vessel there is a strip of magnesium which can be ignited by an electrical method. When this strip of magnesium was ignited, the oxygen completely combined chemically with the magnesium. After this reaction, the pressure inside the vessel at 327.5 K was 0.702×10^5 N m^{-2}.

(i) Assuming that the total volume of magnesium and magnesium oxide is neglegible, calculate the mass of helium present in the vessel.

(ii) Calculate the mass of magnesium oxide formed in the vessel.
(He = 4; O = 16; Mg = 24)
N.B. Assume that under the above conditions helium and oxygen behave as ideal gases, and that the volume of the vessel remains constant.

(*c*) Ammonium dichromate(VI) solid undergoes complete thermal decomposition as follows:

$$(NH_4)_2Cr_2O_7 \rightarrow N_2 + 4H_2O + Cr_2O_3$$

You are supplied with pure ammo....m dichromate(VI) solid. Describe clearly how you would attempt to determine experimentally the **gas constant,** *R*, using this substance.

6. (*a*) (i) State Hess's law.

(ii) Explain how the **standard enthalpy of formation** of the hypothetical ionic compound 'KBr_2' could be determined.

(*b*) (i) Assume that **Y** is a trivalent metal while **Z** is a non-metal. Assume that the ionic solid YZ_3 is slightly soluble in water. At a certain temperature the concentration of Z^- in an aqueous solution saturated with YZ_3 is *C* mol dm^{-3}. Derive the relationship between the K_{sp} of YZ_3 and *C* at this temperature.
N.B. In this derivation, the essential steps should be clearly indicated.

(ii) The water-solubility of the compund, $Y(MnO_4)_3$ is small. Assume that this solubility cannot be determined accurately **by weighing**. However, assume that $Y(MnO_4)_3$ dissolves slightly in water at 25 °C giving a considerably prominent purple colour. Describe clearly how you would attempt to determine experimentally the K_{sp} of $Y(MnO_4)_3$ at 25 °C.

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7. (*a*) (i) Derive the equation pertaining to Ostwald's dilution law.

(ii) The dissociation constant of the weak mono-basic acid, RCOOH is $2{\cdot}5 \times 10^{-5}$ mol dm^{-3} at 25 °C. Calculate the pH value and the OH^- ion concentration of a 0.16 mol dm^{-3} aqueous solution of RCOOH at 25 °C.
$K_w = 1{\cdot}0 \times 10^{-14}$ mol^2 dm^{-6} at 25 °C

(*b*) (i) Using a **specific**, simple chemical reaction of your choice, present an experiment to demonstrate clearly that temperature influences the rate of a chemical reaction.

(ii) Using a **specific**, simple chemical reaction of your choice, present an experiment to demonstrate clearly that light influences the rate of a chemical reaction.

(*c*) Assume that a certain water-soluble chloro-compound **QCl**, undergoes hydrolysis slowly in aqueous medium. Assume also that the rate of this reaction can be expressed as follows:

$$\text{Rate} = k[QCl]^n$$

Describe clearly an experimental method which might be suitable for the determination of the value of n above.

8. (*a*) (i) State **in words** Raoult's law as applicable to a mixture consisting of two liquids **A** and **B** which are completely miscible.

(ii) Give **two specific examples** of instances which show positive deviations from Raoult's law. Explain how these deviations occur.

(*b*) Present the theory pertaining to the separation of the constituents of a binary solution consisting of two liquids by fractional distillation.

(*c*) (i) A zinc rod is partially immersed in a 1·0 mol dm^{-3} aqueous solution of $ZnSO_4$ at 25 °C. Explain how an electrical potential difference arises between the zinc rod and the $ZnSO_4$ solution.

(ii) The value of the above electrical potential difference cannot be measured simply and directly by a voltmeter. Explain why this is so.

Part C — Essay

Answer two questions only. Each question carries 15 marks.

9. (*a*) (i) Write the chemical formulae of the oxides derived from the highest oxidation states of boron, magnesium, aluminium, sulphur, chlorine, rubidium and barium.

(ii) Using **appropriately only one or two** of the terms, **'strongly acidic', 'weakly acidic', 'weakly basic'** and **'strongly basic'** indicate clearly the acid-base nature of each of those oxides.

(*b*) (i) Give **four** reasons that led to the classification of hydrogen along with the alkali metals in the Periodic Table.

(ii) Give **four** reasons that led to the classification of hydrogen along with the halogens in the Periodic Table.

(*c*) You are provided with a mixture consisting of barium carbonate, magnesium carbonate, potassium chloride and silicon dioxide. Explain how you would attempt to determine the mass percentage of each of these constituents in the mixture.

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10. (*a*) (i) Indicate **clearly and separately** the various conditions employed in the manufacture of sulphuric acid by the **Contact Process.**

(ii) Explain as fully as you can, **appropriately and separately,** how each one of the conditions indicated by you, increases the efficiency of the above manufacturing process.

(*b*) (i) How and under what conditions will sulphuric acid react with ammonium iodide?
N.B. The relevant balanced chemical equation should also be written.

(ii) Predict how and under what conditions methanoic acid (HCOOH) is likely to react with sulphuric acid. **N.B. The relevant balanced chemical equation should also be written.**

(*c*) You are provided with an aqueous solution containing Fe^{3+} ions and Fe^{2+} ions. Propose a method to determine the concentration of Fe^{3+} and the concentration of Fe^{2+} in this solution.

11. (*a*) Explain how the environment is polluted by a factory that produces nitric acid using the **Ostwald Process.**
N.B. It is sufficient to consider four important points.

(*b*) Indicate briefly how and under what conditions the following pairs of substances would react.

(i) $NH_3(g)$ and $Cl_2(g)$

(ii) $NH_3(g)$ and $K(s)$

(iii) $NH_3(aq)$ and $Cu(NO_3)_2(aq)$

(iv) $NH_3(aq)$ and $FeSO_4(aq)$

(*c*) Assume that the molecular formula of a certain monobasic acid is $H_4P_2O_4$. If two oxyacids are obtained when this compound is hydrolysed, draw the most likely structural formula that will correspond to $H_4P_2O_4$.

12. (*a*) (i) We can assume that natural rubber is formed by the polymerization of a certain molecule. Draw the structure of this molecule.

(ii) Draw the structure of natural rubber.

(iii) Indicate briefly how you would show that sulphur is present in a sample of vulcanized rubber.

(*b*) Describe briefly how calcium carbide is manufactured.

(*c*) Consider following statement:

"We can circumvent the fuel crisis in Sri Lanka by producing ethyne from calcium carbide and utilizing that ethyne in large quantities."

Show that the proposal pertaining to the above statement is not an appropriate one.
N.B. It is sufficient to consider five important points.

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