B. The numerical value of the equilibrium constant Kc of the reaction if the temperature of the reaction is increased? ----------

(iv). Write the equilibrium constant expression (Kc) giving units, for the reaction above. ----------

(8 marks)

(b) In an experiment, 15.5g of PCl_5 were allowed to dissociate in a 250 cm^3 flask at 25°C. At equilibrium, the flask was analysed and found to contain 0.25 moles of the chlorine gas. (RAM: Cl=35.5; P=31). Calculate:

(i). The initial concentration of PCl_5 in the flask----------

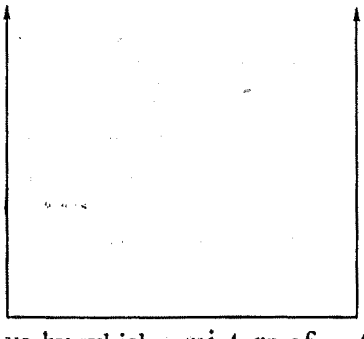
(ii). The value of the equilibrium constant Kc----------

3 marks

(c) (i) State Raoult's law ----------

(ii). A mixture of methylbenzene and benzene is an ideal solution. Explain why the mixture constitutes an ideal solution ----------

(iii). Use the diagram below to sketch a well labelled graph to show the variation of vapour against composition for the mixture in c(ii) above.



(iv). Suggest a practical technique by which a mixture of methylbenzene and benzene could be separated into its components ----------

7 marks

(d) (i) Give an example of a solution which deviates positively from Raoult's law ----------

(ii). Explain why this solution exhibits a positive deviation from Raoult's law----------

2 marks
Total =20 marks

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3. The question is on reaction kinetics and bonding.

(a) What is meant by:

(i). Activation complex of a reaction? ----------

(ii). Molecularity of a reaction? ----------

2 marks

(b) What would be the effect on

(i). The rate constant if the temperature is increased?----------

---

(ii). The collision frequency if the concentration of a reactant is increased?----------

---

2 marks

(c) A study of the reaction $2X + Y \longrightarrow Z$ yielded the data given in the table below.

Experiment	Initial concentration /mol dm^{-3}		Initial rate /mol $dm^{-3}s^{-1}$
	[X]	[Y]	
1	0.100	0.100	0.18
2	0.100	0.200	0.36
3	0.200	0.200	1.44

(i). Distinguish between **initial rate of a reaction** and **rate of a reaction** ----------

---

(ii). Determine the order of the reaction with respect to

A. X ----------

B. Y ----------

(iii). Write the rate expression ----------

(iv). Calculate the value of the rate constant, giving its units ----------

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(v). Explain whether or not the reaction can take place in a single step----------

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6 marks

(d) This part of the question is on the hydrides CH_4; NH_3; H_2O; and ammonium ion NH_4^+

(i). Draw dot and cross diagrams to show the structures of the ammonia molecule and the ammonium ion ----------

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(ii). Draw the shape of each of the hydrides listed below. Suggest values for the bond angles.

CH_4; NH_3; H_2O ----------

(iii). State the type of intermolecular forces present in each of the hydrides CH_4 and NH_3 ---

---

(iv). Account for the variation in bond angles in the hydrides CH_4; NH_3 and H_2O ----------

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(v). In which of the hydrides CH_4, NH_3 and H_2O are the intermolecular forces strongest? Explain. ----------

10 marks
Total = 20 marks

SET 4 : SECTION A (CGCEB 2012)

General and Physical Chemistry

1. This question concerns, bonding, intermolecular forces and energetics.

(a) Various forces of attraction are encountered in strontium and ammonium chloride

(i). Identify the forces present in

A. Strontium----------

B. Ammonium chloride. ----------

5 marks

(b) Complete the table below by giving the shapes and bond angles of the species given.

species	shape	Bond angles
Cl_2O		
$AlCl_3$		

2 marks

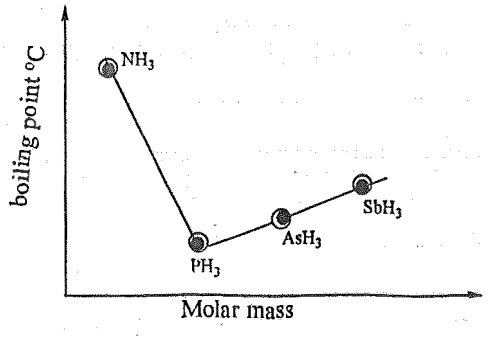
(c) Aluminium trichloride ($AlCl_3$) exists as a dimer (Al_2Cl_6) in the gas phase.

(i). What is a dimer? ----------

(ii). Draw the dot-and-cross diagram of this dimer? ----------

2 marks

(d) The graph below shows the variation in boiling point of the hydrides of Group V elements.



(i). Account for the regular increase in boiling point from PH_3 to SbH_3 ----------

(ii). Why is the boiling point of NH_3 exceptionally high?----------

2 marks

(e) With reference to specific examples, define:

(i). Lattice energy ----------

(ii). Standard enthalpy of atomisation ----------

4 marks

(f) The standard enthalpy change for the reaction between sodium hydroxide and hydrochloric acid can be determined experimentally.

(i). What is the name given to the enthalpy change for this type of reaction?----------

(ii). In one such experiment 25 cm^3 each of solutions of sodium hydroxide and hydrochloric acid of concentration 1 mol dm^{-3} were mixed. The temperature rose from 27 °C to 34.5 °C. Calculate the standard enthalpy change for the reaction in kJ mol^{-1} (assume that the specific heat capacity of the solution is 4.2 $kJkg^{-1}K^{-1}$ and no heat is lost to the calorimeter) ----------

3 marks

(g) Given the following standard enthalpies.

$H_{2(g)} \longrightarrow 2H_{(g)}$ $\quad \Delta H^{\theta} = +436kJ$

$O_{2(g)} \longrightarrow 2O_{(g)}$ $\quad \Delta H^{\theta} = +498kJ$

$\Delta H_f^{\theta}(H_2O) = -285.8kJ$

Calculate the O-H bond enthalpy in water----------

2 marks

Total= 20 marks

2. (a)The table below gives the standard electrode potential values of some electrodes

	Electrode	E^{θ}/V
I.	$MnO^-_{4(aq)} + 8H^+_{(aq)} + 5e^- \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$	+1.51V
II.	$Cl_{2(g)} + 2e^- \rightarrow 2Cl^-_{(aq)}$	+1.36V
III.	$Cr_2O^{2-}_{7(aq)} + 14H^+_{(aq)} + 6e^- \rightarrow 2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$	+1.33V
IV.	$Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)}$	+0.78V

(i). A. What standard reference electrode could be used to obtain the values in the table?----------

B Under what condition is the standard electrode used? ----------

(ii). Under what four (4) conditions will the standard e.m.f of electrode IV be obtained? ---

(iii). A salt bridge is used when a cell is set up to obtain an e.m.f.

A. What is the function of the salt bridge?----------

B. What substance could be used as a salt bridge? ----------

(iv). The electrodes III and IV are linked to form an electrochemical cell.

A. Which species is reduced? ----------

B. Write the equation for the redox process----------

8 marks

(b) A 25.0 cm^3 sample of a 0.1 $moldm^{-3}$ solution of ethanoic acid ($ka = 1.8 \times 10^{-5}$) was titrated with 0.1 $moldm^{-3}$ sodium hydroxide.

(i). Calculate the pH of ethanoic acid ----------

(ii). The table below gives the names and the pH ranges for some acid/base indicators

Name of indicator	pH range
Bromophenol blue	2.8-4.6
bromothymol blue	6.0-7.6
phenophthalein	8.2-10.0

Which of the above indicators would you use for the titration in (b) above? Explain.

Indicator: ----------

Explanation: ----------

2marks

*Kinetics

(c) Rates of reactions are found to increase with temperature.

(i). In the space below, sketch a labelled diagram that shows the distribution of molecular energies at two difference temperatures----------

(ii). State two theories that explain the effect of temperature increase on the rate of reaction. ----------

(iii). This part concerns a kinetic study on a reaction of your choice.

A. Reaction chosen ----------

B. State the property (parameter) that could be used for the kinetic study of the reaction -

C. Give the method that will be used to measure the chosen property, and the instruments/apparatus to be used

Method ----------

Apparatus ----------

8 marks

Total =20 marks

3. This question is on atomic structure, mole concept and phase equilibrium

(a) The isotopes of bromine have the following relative abundances $^{79}Br = 50.5\%$, $^{81}Br = 49.5\%$

(i). State one way in which the isotopes are similar ----------

(ii). What instrument is used to detect the isotopes in the laboratory? ----------

(iii). Calculate the relative atomic mass of bromine from the data. ----------

4 marks

(b) Write the electronic configuration of the element of the atomic number 12, and sketch a labelled energy level diagram of the electrons ----------

---------- **3 marks**

(c) Some miscible liquids show negative deviation from Raoult's law and others show positive deviation.

(i). State Raoult's law. ----------

(ii). Give two experimental evidence for negative deviation from Raoult's law.----------

---------- **3 marks**

(d) An ethanol/ water mixture forms an azeotropic mixture.

(i). Why is it not possible to obtain a pure sample of the ethanol from the mixture by fractional distillation? ----------

(ii). How would you obtain pure ethanol from the azeotropic mixture? ----------

3 marks

(e) (i) Draw a well labelled diagram of the experimental set-up (apparatus) that would be used to determine the molar mass of a volatile compound such as liquid hexane.

(ii). Using the ideal gas equation, derive the expression that could be used to obtain the molar mass of the liquid.

(iii). In one such experiment carried out at a temperature of 470 °C and a pressure of 100 atmospheres, 4.3 g of the volatile liquid produced 30.6 cm3 of the gas. Calculate the molar mass of the liquid. (molar gas constant, R = 8.314 $JK^{-1}mol^{-1}$, molar gas volume at s.t.p =22400 cm^{-3} 1 atmosphere=1.0x10^5 Nm^{-2})

7 marks
Total 20 marks

SET 5 : SECTION A (CGCEB 2013)

General and Physical Chemistry

1. (a) What do you understand by,

(i). Avogadro's number

(ii). Amount of a substance

2 marks

(b) A solution was made by dissolving 9.0g of hydrated aluminium sulphate ($Al_2(SO_4)_3.6H_2O$) in 250 cm^3 of solution. (RAM: Al= 27; O =16; S = 32; H = 1). Calculate:

(i). The number of moles of hydrated aluminium sulphate solution.

(ii). The number of moles of sulphate ions in this solution.

(iii). The concentration (mol dm^{-3}) of the hydrated aluminium sulphate.

3 marks

(c) (i) What is a nuclear reaction? Give a suitable example of a nuclear reaction.

(ii). In a transformation $^{238}_{92}U$ decays to $^{226}_{88}Ra$. How many alpha and beta particles are emitted?

A. Alpha particles: ----------

B. Beta particles: ----------

3 marks

(d) Iron burns in chlorine to form a chloride. An experiment showed that 5.60g of iron combined with 10.65g of the chlorine to form a chloride. (RAM: Fe=56, Cl=35.5). Determine:

(i). The number of moles of chlorine used. ----------

(ii). The number of moles of iron used. ----------

(iii). The equation for the reaction. ----------

3 marks

(e) (i) Define bond energy term. ----------

(ii). Write an equation to represent the lattice energy of calcium chloride. ----------

2 marks

(f) Given the following data:

$\Delta H^{\theta}_{at}[C_{(s)}] = +717\ kJmol^{-1}$

$\Delta H^{\theta}_{at}[H_{2(g)}] = +218\ kJmol^{-1}$ of gaseous hydrogen atoms

$\Delta H^{\theta}_{f}[CH_{4(g)}] = -75\ kJmol^{-1}$

Determine the C-H bond energy in methane. ----------

3 marks

(g) Theoretical and experimental values of lattice energy of a compound may differ.

(i). Explain why the values may differ. ----------

(ii). Give an example of a halide in each case where the values of the lattice energies

A. Are different: ----------

B. Are similar: ----------

(iii). Why is the Born Haber cycle used to determine the lattice energies of ionic compound? ----------

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4 marks
Total = 20 marks

2. (a) what do you understand by

(i). Initial rate of reaction. ----------

(ii). Order of reaction. ----------

---

2 marks

(b) Why is the order of reaction important in the study of rate of reaction? ----------

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1 mark

(c) The data below was obtained for the reaction between iodine and propanone in the presence of an acid catalyst

$$CH_3COCH_{3(aq)} + I_{2(aq)} \xrightarrow{H^+} CH_3COCH_2I_{(aq)} + HI_{(aq)}$$

Experiment	Concentration			Rate/mol dm^{-3} s^{-1}
	$[CH_3COCH_{3(aq)}]$/ (mol dm^{-3})	$[I_{2(aq)}]$/ (mol dm^{-3})	$[H^+_{(aq)}]$/ mol dm^{-3}	
1	0.30	0.05	0.05	5.7×10^{-5}
2	0.30	0.10	0.05	5.7×10^{-5}
3	0.30	0.05	0.10	1.2×10^{-4}
4	0.40	0.05	0.20	3.1×10^{-4}
5	0.36	0.05	0.05	7.1×10^{-5}

(i). Deduce the order of the reaction with respect to:

$[CH_3COCH_{3(aq)}]$. ----------

$[I_2(aq)]$ ----------

$[H^+_{(aq)}]$. ----------

(ii). What is the overall order of the reaction?----------

(iii). Write the rate expression for the reaction. ----------

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(iv). Calculate the value of the rate constant indicating its units. ----------

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(v). State a method you would use to measure the rate of the reaction above without quenching the reaction. ----------

7 marks

(d) What is an ideal solution? ----------.1mark

(e) Methanol and ethanol form an ideal solution. The vapour pressure of pure ethanol and pure methanol at 20 °C is 44 mmHg and 94 mmHg respectively. A mixture of 30 g of methanol (CH_3OH) and 45 g of ethanol (CH_3CH_2OH) is prepared. (RAM: C = 12; O = 16; H = 1). Calculate

(i). The mole fraction of methanol in the solution. ----------

(ii). The total pressure of the vapour above the solution at 20 °C. ----------

(iii). The mole fraction of methanol in the vapour above the solution. ----------

3 marks

(f) (i) Suggest a method of separating the components of a solution containing methanol and ethanol. ----------1 mark

(ii). Sketch and label a diagram of boiling point against composition for the mixture of trichloromethane (b.pt 334 K) and propanone (b.pt 329 K). ----------

(iii). Can a mixture of trichloromethane and propanone be separated into the pure components by fractional distillation? ----------

Explain. ----------

5 marks

Total = 20 marks

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3. (a) State the equilibrium law. ----------

1 mark

(b) The equilibrium constant for the reaction $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ is 1.0×10^{-1} at 500K, 8.0×10^{-5} at 700K and 5.0×10^{-8} at 1100K

(i). From the data, predict and explain whether the reaction is endothermic or exothermic. ----------

(ii). Predict and explain the shift of equilibrium position of the reaction above in response to the following changes. -

A. Increasing the temperature at constant pressure. ----------