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

C. Adding a catalyst at constant temperature and pressure. ----------

(iii). What is the effect of increase in temperature at constant pressure on the value of the equilibrium constant? ----------

6 marks

(c) Define 'standard electrode potential' of an electrode system. ----------

----------**1 mark**

(d) Given the following redox potentials

$I_{2(aq)} + 2e^- \rightleftharpoons 2I^-_{(aq)}$ $E^\theta = +0.54\ V$

$S_2O^{2-}_{6(aq)} + 2e^- \rightleftharpoons 2S_2O^{2-}_{3(aq)}$ $E^\theta = +0.10\ V$

(i). Select the species which is the strongest

A. Reducing agent. ----------

B. Oxidising agent. ----------

(ii). Write the cell diagram when the half cells are coupled and calculate the emf of the cell.----------

4 marks

(e) Explain the following observations:

(i). The bond dissociation energy of the hydrogen molecule (H_2) is greater than that of the hydrogen molecule ion (H_2^+) ----------

(ii). Both aluminium and carbon are solid, aluminium forms sheets whereas carbon breaks into pieces when hammered. ----------

(iii). Ammonia boils at -33.3°C while phosphine boils at -87.7°C. ----------

3 marks

(f) (i) state and briefly explain the shapes of the following substances:

Substance	Shape	Explanation
NH_3		
BF_3		

(ii). Draw the electron density map for the hydrogen chloride molecule. ----------

5 marks
Total = 20marks

SET 6 : SECTION A (CGCEB 2014)

General and Physical Chemistry

1. (a) Oxidation and reduction take place simultaneously in many chemical processes. Define oxidation in terms of electron transfer. ----------
---------- 1 mark

(b) Given the following half cell reactions and their standard electrode potentials:
Half reaction

	Half reactions	E^0/V
A	$Cu^{2+} + 2e^- \rightleftharpoons Cu_{(s)}$	+0.34
B	$Zn^{2+}_{(aq)} + 2e^- \rightleftharpoons Zn_{(s)}$	-0.76
C	$Cr_2O^{2-}_{7(aq)} + 14H^+_{(aq)} + 6e^- \rightleftharpoons 2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$	+1.33
D	$I_{2(aq)} + 2e^- \rightleftharpoons 2I^-_{(aq)}$	+0.54
E	$Fe^{3+}_{(aq)} + e^- \rightleftharpoons Fe^{2+}_{(aq)}$	+0.77

(i). Which of the species in A-Eis the most powerful oxidising agent? Give a reason for your choice. ----------
---

(ii). Which is the strongest reducing agent? Give reason for your choice. ----------
---

(iii). Write the cell diagram and calculate the e.m.f of a cell made by coupling D and E. ----
---
---

6 marks

(c) Urea $[(NH_2)_2CO]$ is prepared by reacting ammonia with carbon dioxide according to the equation.

$$2NH_{3(g)} + CO_{2(g)} \longrightarrow (NH_2)_2CO_{(s)} + H_2O_{(l)}$$

In one process 632.2 g of NH_3 react with 1142 g of CO_2

(i). Calculate the mass of urea formed ----------

(ii). How many grams of CO_2 were left at end of the reaction?----------
---

(iii). Suggest a structure for $(NH_2)_2CO$ ----------

(iv). Calculate the percentage of nitrogen in urea.----------
---

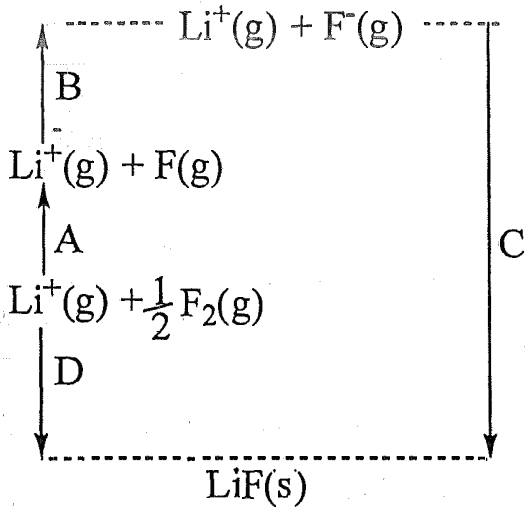
(v). Will urea be soluble in water? ----------

(vi). Suggest a possible use of urea. ----------

---

10 marks

(d) At the end of an investigative research to determine $\Delta H_f^{\theta}(LiF_{(s)})$, a student came out with the following energy cycle.



(i). What are the energy changes represented by B and C?

B----------

C----------

(ii). From a book of data, A = +230.5 kJ mol^{-1}, B = +192 kJ mol^{-1} and C = -1017 kJ mol^{-1}. Calculate the value of D ----------

---

---

3 marks

Total= 20 marks

2. This question is on bonding, chemical equilibrium and phase equilibrium.

(a) (i) What is the difference between a simple covalent bond and a dative covalent bond?----------

---

(ii). Draw the dot-and-cross diagram as well as the shape of NI_3 molecule. Give the bond angle. ----------

---

(iii). Identify and account for the bonding in sodium bromide (NaBr) ----------

---

---

5 marks

(b) The equilibrium constant for the reaction given below can be determined experimentally when known amounts of hydrogen iodide in a sealed tube are heated until equilibrium is attained.

$2HI(g) \rightleftharpoons H_{2(g)} + I_{2(g)}$ $\Delta H = -63.0 kJ\ mol^{-1}$

(i). State the equilibrium law. ----------

(ii). Write the equilibrium constant expression for the reaction. ----------

---

(iii). What parameter or property must be measured to enable the calculation of the equilibrium constant? ----------

(iv). How is the value of the equilibrium constant affected by?

A decrease in pressure? Explain. ----------

A decrease in temperature? Explain. ----------

5 marks

(c) Explain the following:

(i). Saturated vapour pressure of a liquid. ----------

(ii). An azeotropic mixture. ----------

2 marks

(d) A mixture of hexane and heptane forms an ideal solution. Given that their saturated vapour pressures at 100 °Care respectively 790 mmHg and 350 mmHg. Calculate:

(i). The mole fraction of each component in a mixture containing 50.0 g of hexane and 70.0g of heptane. ----------

(ii). The partial pressure of each component in the mixture. ----------

(e) Draw well labelled vapour pressure/composition and boiling point/ composition curves for the mixture above. ----------

4 marks

Total = 20 marks

---

3. This question is on atomic structure, acid-base equilibria and chemical kinetics.

(a) The emission spectrum gives information on the electronic configuration of atoms. For most elements the emission spectrum consists of a series of lines of different energies

(i). What does each series of lines represent? ----------

(ii). Why are there several lines in each series? ----------

(iii). How can the ionisation energy of an element be determined from its emission spectrum? ----------

(iv). What other method could be used to determined ionisation energies? How can this method be used to obtain information on electronic structure? ----------

5 marks

(b) (i) Give the Bronsted-Lawry definition of acids and bases.

(ii). For acid-base equilibrium below indicate the acid-base conjugate pairs

$NH^{+}_{4(aq)} + OH^{-}_{(aq)} \rightleftharpoons NH_{3(aq)} + H_2O_{(l)}$

(c) (i) Calculate the pH of a solution containing 0.05 mol dm^{-3} benzoic acid C_6H_5COOH and 0.05 mol dm^{-3} of potassium benzoate C_6H_5COOK (Ka for benzoic acid is 6.4×10^{-5})

(ii). How does the addition of a few drops of molar nitric acid affect the pH of this solution?

(iii). What general name is given to such a solution?

3 marks

(d) Phenolphthalein indicator is a weak acid with ka = 10^{-9} mol dm^{-3}. It is colourless while it conjugate base is pink in solution

(i). Define the term "weak acid"

(ii). Calculate the ratio to the number of pink particles to the number colourless particles of this indicator in a solution of pH = 9

3 marks

(e) The progress of the reaction between iodide ions and potassium iodate(V) can be followed by withdrawing samples of the reaction mixture at various times, quenching and then titrating with standard thiosuphate solution. The reaction equation is

$$I^{-}_{(aq)} + IO^{-}_{3(aq)} + 6H^{+}_{(aq)} + 4e^{-} \longrightarrow I_{2(aq)} + 3H_2O_{(l)}$$

(i). What other method can be used to follow up this reaction?

(ii). How would you quench the reaction?

(iii). In one sueh experiment the following data were obtained

	Initial concentration (mol dm^{-3})of		Initial reaction
	$I^{-}(aq)$	$KIO_3(aq)$	Rate/mol $dm^{-3}s^{-1}$
1	0.019	0.015	3.5×10^{-6}
2	0.038	0.015	7.0×10^{-6}
3	0.038	0.030	28.0×10^{-6}

A. Determine the order of the reaction with respect to $I^{-}_{(aq)}$ and $IO^{-}_{3(aq)}$ ions

B. Write the rate expression for the reaction. ----------

---

5 marks

Total = 20 marks

SET 7 : SECTION A (CGCEB 2015)

General and Physical Chemistry

1. (a) What do you understand by the term first ionization energy?----------

---

----------**1 mark**

(b) The hydrogen spectrum shows different series of lines known as the Lyman, Balmer, Paschen etc

(i). What do the lines represent?

(ii). What is the difference between the Lyman and the Balmer series of lines?

(iii). State one important information about the structure of the atom that can be obtained from the emission spectrum of the element.

---

3 marks

(c) The first 8 successive ionization energies in kJ/mol of an element M (where M is not the usual symbol of the element) are:

789,1 577,3232,4356,16091, 19755,23789,29253

(i). Write the electronic configuration of the outermost shell of M.

(ii). Predict the group of the periodic table to which M belongs.

Explain your reasoning ----

---

3 marks

(d) Briefly explain the shape of ammonia (NH_3) molecule.

---------- **2 marks**

(e)(i) What is the difference between a covalent bond and an intermolecular force?

(ii). Using a suitable example, explain how an intermolecular force can affect the molecular mass of a substance

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4 marks

(f) A mixture of ethanoic acid (CH_3COOH) and sodium ethanoate (CH_3COONa) is an acid buffer.

(i). What is an acid buffer?

(ii) Using equations only, show how the acid buffer will react in the presence of

A: Excess acid----

B: Excess base (alkali) ----------

(iii) A solution contains 0.02 M CH_3COOH and 0.2 M CH_3COONa. Calculate the pH of the solution which results from the addition of 50 cm^3 of 0.04 M NaOH to the solution. (K_a= 1.7×10^{-5} mol $dm^{-3} CH_3COOH$)

---

7 marks

Total = 20 marks

---

2. (a) (i) Define "mole of a substance"

---

ii) Calculate the mass of iron (in grams) contained in 250 cm^3 of 0.1 M iron(III) chloride solution. (RAM: Fe= 56, Cl= 35.5)

---

3 marks

b) When NaOH is dissolved in water, the temperature of the solution rises, but when NH_4NO_3 is dissolved in water, the temperature of the solution falls, explain the difference in the behaviour.

---**2 marks**

c) **The standard** lattice enthalpy of NaBr is -735kJ/mol and its heat of solution is -0.06kJ/mol.

i) Sketch an energy diagram that can be used to determine its heat of solvation (hydration energy).

---

ii) Calculate the solvation energy.

---

d) (i) What do you understand by "order of a reaction"?

---

ii) Given the following data for the reaction: $A + 2B \rightarrow C$

Experiment	Initial [A] mol dm^{-3}	Initial [B] mol dm^{-3}	Rate of formation of C mol $dm^{-3}s^{-1}$
1	0.10	0.10	0.001
2	0.10	0.20	0.004
3	0.20	0.10	0.001
4	0.20	0.30	0.009

A. Determine the overall order of the reaction

B. Write the rate expression and calculate the value of the rate constant and give its units.

C. Based on the rate expression, suggest a mechanism for the reaction.

6 marks

e) Trichloromethane ($CHCl_3$) and ethylethanoate ($CH_3CO_2C_2H_5$) form a completely miscible solution which does not obey Raoult's law.

i) State Raoult's law

ii) Explain why the liquid mixture would deviate from Raoult's law

iii) Predict and explain the change in temperature when the two liquid are mixed

iv) Draw a well-labelled diagram of the variation of the total vapour pressure against composition for the mixture.

6 marks
Total=20 marks

SET 8 : SECTION A (CGCEB 2016)

General and Physical Chemistry

1. (a) (i) Define the second ionisation energy of fluorine

(ii) Write an equation to represent the second ionisation energy of fluorine

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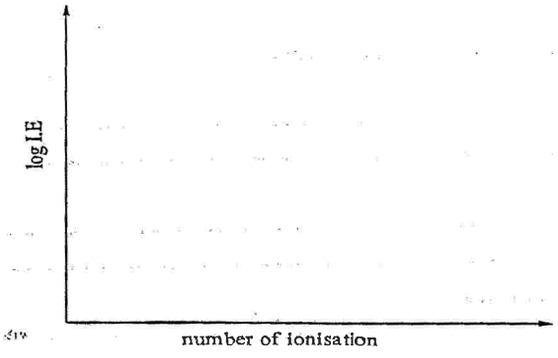
(iii) Using the axis below, sketch a graph to show the successive ionisation energies of fluorine



(iv) Give reasons for the shape of your graph

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6 marks

(b) (i) Draw the "dot and cross" diagram of carbonic acid H_2CO_3.

(ii) Draw the resonance structures of the HCO_3^- anion.

(iii) Complete the table below by stating the molecular shapes and bond angles of the following species.

Species	Molecular shape	Bond angles
CF_4		
NF_3		
CH_2Cl_2		
H_3O^+		

7 marks

(c) The following reaction occurs at 450°C. $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

Experiment	Initial $[H_2]$ mol dm^{-3}	Initial $[I_2]$ mol dm^{-3}	Initial rate of production of HI mol $dm^{-3}s^{-1}$
1	0.0113	0.0011	1.9×10^{-23}.
2	0.0220	0.0033	1.1×10^{-22}
3	0.0550	0.0011	9.3×10^{-23}
4	0.0220	0.0056	1.9×10^{-22}

(i) Determine the order of the reaction with respect to H_2 and I_2.

(A) Order with respect to H_2

(B) Order with respect to I_2

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

(iii) Write an expression for the rate law.

(iv) Determine the value of the rate constant and state its units.

---7 marks

2. (a) (i) Explain how positive and negative deviations from Raoult's law arise when liquids are mixed.

Negative deviation ----------

Positive deviation----------

(ii) If a solution shows positive deviation from Raoult's law, would you expect it to have a higher or lower boiling point? Explain ----------

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4 marks

(b) (i) Define the "mole of a substance" ----------

(ii) How many moles of carbon atoms are there in 1.0 mole of sucrose, $C_{12}H_{22}O_{11}$?
(RAM H=1.0, C=12.0, O=16.0) ----------

(iii) How many carbon atoms are there in 1.0 mole of sucrose? (Avogadro's number= 6.022×10^{23})