SET 2 : SECTION B (CGCEB 2010)

Inorganic (Mineral) Chemistry

(4). (a) The group IV elements, C, Si, Ge, Sn and Pd form compounds in either the +2 or the +4 oxidation states.

(i). State the trend and explain the stability of the +2 and +4 oxidation states among the elements.

Trend ----------

Explanation ----------

(ii). The group IV elements have the ability to catenate. What is meant by catenation? ----

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Arrange the elements in order of increasing ability to catenate ----------

(iii). State one way in which the element carbon is chemically:

- similar to the rest of the elements ----------

- different from the rest of the elements ----------

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6 marks

(b) The d-block elements characteristically form complex ions and show variable oxidation states in their compounds

(i). What is a d-block element? ----------

(ii). Give one reason in each case to explain why d-block elements

- Form complexes ----------
- Show variable oxidation states ----------

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3 marks

(c) Given the following complex compound: $[Cr(H_2O)_6]Cl_3$

(i). Identify the ligands in the complex compound ----------

(ii). Give the structural formulae of two isomers of the compound and state their systematic names.

ISOMER	NAME

(iii). What is the coordination number and oxidation state of chromium in the complex?

Coordination number	
Oxidation state	

(iv). State the electron configuration of chromium in the complex using s.p.d notation (atomic number–24)

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6 marks

(d) (i) Complete the following table that concerns the halogens

Elements	Physical state at 25°C
Fluorine	
Chlorine	
Bromine	
iodine	

(ii). Explain the change in the physical states of the substances----------
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(iii). Write an equation in each case to show how HCl and HI couldbe prepared from solid NaCl and NaI respectively ----------
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5 marks Total: 20 marks

5. These questions concern some elements of group I and II and periods 2 and 3 of the **Periodic Table**

(a) Give the formulae ofthe simple oxides of the elements in the table

Elements	sodium	phosphorus	sulphur	aluminium
oxides				

(b) Write an equation in each case to show how

(i). The oxide of sodium reacts with an acid ----------

(ii). The oxide of phosphorus reacts with a base ----------

(iii). The oxide of aluminium reacts with

(A). An acid----------

(B). A base----------

4 marks

(c) Give the reaction of the following chlorides with water

(i). PCl_5 ----------

(ii). $MgCl_2$ ----------

(iii). $AlCl_3$ ----------

3 marks

(d) From the following groups I and II elements Li, Na, K, Mg, Ca, Sr, Ba; choose the element

(i). With the smallest first ionisation energy ----------

(ii). With the smallest atomic radius ----------

(iii). With the highest melting point ----------

(e) Write an equation in which lithium

(i). Behaves like magnesium: ----------

(ii). Behaves like sodium: ----------

2 marks

(f) Explain how a pure sample of $AlCl_3$ can be prepared in the laboratory from pure Al metal. ----------

4 marks

Total: 20 marks

6. This question concerns the chemistry of nitrogen.

(a) Ammonia is manufactured by the Haber process

$$N_2(g) + 3H_2(g) \xrightleftharpoons{\text{catalyst}} 2NH_3(g) \quad \Delta H = -90 \text{ kJ}$$

(i). Name the catalyst used in this process (reaction)----------

(ii). What is the role of the catalyst?----------

(iii). State Le Chatetier's principle ----------

(iv). Briefly explain how a change in temperature and pressure would affect the yield of NH_3 in the reaction

(A). Temperature----------

(B). Pressure ----------

(v) How is ammonia useful in agriculture? ----------

6 marks

(b) The principal oxidation states of nitrogen are -3, +3, +4, and +5

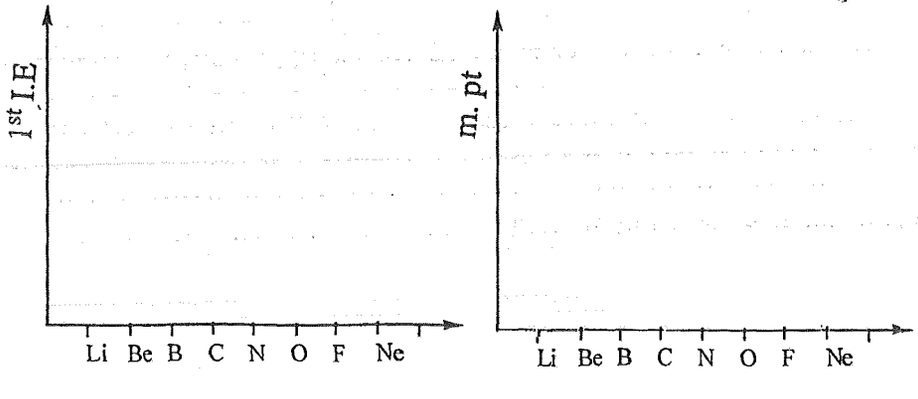
For each oxidation state, give the formula and name of one compound of nitrogen

Oxidation state	Formula of compound	Name
-3		
+3		
+4		
+5		

4 marks

(c) For the elements of period 2: (Li–Ne) sketch a graph to show the variation of first ionisation energy and melting point.

(i) 1st ionization energy and (ii) melting point with atomic number



4 marks

(d) You are given the following data

Chloride	Lattice energy (kJ/mol)
$MgCl_2$	-2526
$CaCl_2$	-2258
$SrCl_2$	-2156
$BaCl_2$	-2056

Which chloride is likely to be:

(i). Most soluble? ----------

(ii). Most stable? ----------

(iii). Suggest an explanation for the trend in the lattice energies ----------
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(iv). From electronic configuration consideration, which of these chlorides would you expect to be most stable: MgCl, $MgCl_2$, $MgCl_3$, (atomic number Mg=12, Cl=17) ----------
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6 marks

Total: 20 marks

SET 3 : SECTION B (CGCEB 2011)

Inorganic (Mineral) Chemistry

4. (a) The following table shows the first ionisation energies of the element in the period, Na to Ar

Element	Na	Mg	Al	Si	P	S	Cl	Ar
First ionisation energy /KJ mol^{-1}	496	738	578	786	1012	1000	1251	1521

(i). Define the team ionisation energy of an element ----------
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(ii). Write an equation to illustrate the first ionisation energy of magnesium ----------
---

(iii). Briefly explain the trend in the first ionisation energies of the elements ----------
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(iv). Complete the table below by writing the outer electron configuration of the elements shown

Element	Na	Mg	Al	Si	P	Ar
Electronic configuration	$3s^1$					

(v). Explain why the first ionisation energy of aluminium is lower that of magnesium. -----
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7 marks

(b) (i) State and explain the trend in atomic radius across the period, Na-Ar
Trends ----------
Explanation----------

(ii). Write the symbols of two isoelectronic ions of elements in the period, Na-Ar. ----------
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(iii). Suggest stable oxidation states for aluminium and phosphorus.

Element	Al	P
Oxidation state		

5 marks

(c) (i) The element in groups I and II of the periodic table are called s-block elements. Explain the term "s-block" elements ----------
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(ii). How do the atomic radii of the elements vary down the groups I and II and between the two groups? ----------
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(iii). Explain why:

A. The melting points of the group II elements are generally higher than those of group I. ----------

B. The hydroxides of group I elements are more soluble than those of group II
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5 marks

(d) (i) Write an equation in each case to show the effect of heat on the carbonate of lithium and magnesium
Magnesium carbonate: ----------
Lithium carbonate: ----------

(ii). Why does lithium have a diagonal relationship with magnesium in its chemical properties? ----------

3 marks
Total = 20 marks

5. (a) The halogens are found in group VII(17) of the periodic table

(i). Give the names and physical states of the halogens.

Halogens	Physical state

(ii). The haloacids of chlorine are:

A	B	C	D
HOCl	$HClO_2$	$HClO_3$	$HClO_4$

Give the oxidation number of chlorine in A and C ----------

(iii). Give the balanced equation for the reaction of potassium iodate (KIO_3) with potassium iodide in acid solution ----------

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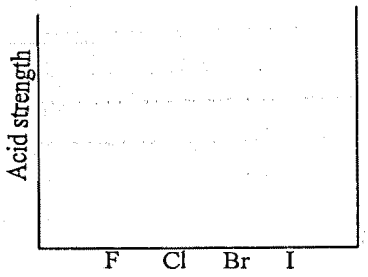
(iv). In the space below, sketch the trend of acid strength of 1 mol dm^{-3} of acid HX(aq) and give an explanation



Explanation of the trend: ----------

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11 marks

(b) (i) Give compounds of sulphur which are used in the laboratory for volumetric analysis and the corresponding equation for any one of them----------

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Equation of reaction of the sulphur compound in volumetric analysis:----------

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(ii). In the industrial preparation of sulphuric acid the following reaction occurs

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\Delta H = -197$ kJ mol^{-1}

Give three ways by which the yield of SO_3 (g) can be increased ----------

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6 marks

(c) In the table below, give a named nitrogen compound used in each of the following: nutrition, agriculture, and industry.

Nutrition	
Agriculture	
Industry	

3 marks

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6. This question is on the d-block elements and the group IV elements (C-Pb)

(a) (i) Differentiate between a transition metal and ad-block element----------

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(ii). Name two d-block elements which are not transition metals. ----------

(iii). List two typical properties of transition metals. ----------

4 marks

(b) (i) During the reaction of a transition metal ion, there could be a colour change. Give three reasons why there may be a change of colour. ----------

(ii). For each of the observations described below, state which change or changes you have given above is responsible for the change in colour.

A. A pale blue aqueous solution of copper(II) sulphate turns deep blue when added to an excess of **aqueous ammonia.** ----------

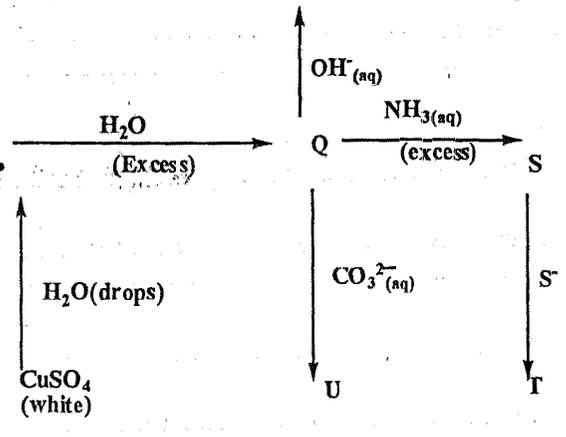
B. A pink aqueous solution of cobalt (II) chloride turns blue when excess of concentrated hydrochloric acid is added. ----------

5 marks

(c) (i) What are "chelating" ligands? ----------

(ii). Give an example each, of complex ions of copper and chromium containing chelating ligands ----------

(iii). Complexes undergo displacement reactions. Study the flow diagram below. Give the names or formulae of the substances represented by the letters P, Q, R, T and U



P. ----------

Q. ----------

R. ----------

S. ----------

T. ----------

U. ----------

5 marks

(d) From the compounds of group IV elements (C-Pb), choose an appropriate example for each of the following:

(i). A strong reducing oxide ----------

(ii). A giant covalent oxide ----------

(iii). A strong reducing chloride ----------

(iv). A covalent chloride which is NOT hydrolysed by water. ----------

4 marks

(e) Write an equation for the reaction of lead dioxide (PbO_2) with:
(i). A base----------
(ii). An acid ----------

2 marks

SET 4 : SECTION B (CGCEB 2012)
Inorganic (Mineral) Chemistry

4. The first part of this question concerns Group VII (halogens).
(a) (i) Give the colour and physical state of the elements bromine and iodine.

(ii). From your knowledge of halogens suggest the colour and physical state of astatine.
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3 marks

(b) (i) The iodate/iodide reaction is used in the laboratory for iodimetry. Complete the equation for the reaction below:

$$IO^-_{3(aq)} + I^-_{(aq)} + H^+_{(aq)} \rightarrow$$

(ii). What indicator is used in the titration of aqueous iodine with aqueous thiosulphate?

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2 marks

(c) What is observed when chlorine water s added separately to solutions of sodium chloride and sodium bromide?
A. Sodium chloride: ----------
B. Sodium bromide: ----------
3 marks

(d) The hydrides of the halogens dissolve in water forming acidic solutions. Arrange the following hydrides in order of decreasing strength: HF, HBr, HCl. ----------
1 mark

(e) State one problem caused by organo-halogen compounds in the society.----------
---------- **1mark**

This part of the question concerns the group IV elements (carbon to lead).

(f) (i) write:
A. The general outer shell electronic configuration of the elements. ----------
B. The principal oxidation states of the elements in their chlorides----------
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(ii). What is the trend in the stability of these oxidation states?----------
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3 marks

(g) (i) Using equations only, predict the reactions of silicon tetrachloride and carbon tetrachloride with water.
$SiCl_4$: ----------

CCl_4: ----------

(ii). Account for the similarities and difference in their reactions with water, if any.-------
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3 marks

(h) State the type of bonding in:
(i). Lead(II) oxide. ----------
(ii). Carbon dioxide----------2 marks

(i) State two ways in which carbon differs from the rest of the elements in the group. -------
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---2 marks

(5) This question is on periodicity and the s-block elements (groups I and II).
The elements in period 3 (sodium to argon) of the Periodic Table show 'periodic trends' in their properties.

(a) What is meant by the term "periodic trends"?----------1 mark

(b) In the space below, sketch a graph of the variation of the first ionisation energy for the elements sodium to argon. ----------
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2 marks

(c) Two oxides of elements **X and Y** in the period 3 have the formulae X_2O and YO_2. X_2O and YO_2 are very soluble in water producing solutions whose pH are more than 7 and less than 7 respectively.

(i). Identify the groups to which the elements X and Y belong.
X :----------
Y: ----------

(ii). Write the dot-and-cross diagram of both oxides
X_2O: ----------

YO_2: ----------

(iii). Give the formula of one other oxide of either X or Y and gives its acid/base properties. ----------
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5marks

(d) (i) In the table below, give the formulae of the chlorides of the elements.

Na	Mg	Al	Si	P	S	Cl

(ii). How does the nature of the bonding in the chlorides vary from left to right?----------
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4 marks

(e) (i) Write the electronic configurations of Na^+ and Mg^{2+}

Na^+: ----------

Mg^{2+}: ----------

(ii). How are these ions similar? ----------

(iii). Which of the two ions is bigger? Give reasons. ----------

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3 marks

(f) The atomic radii of Li, Na and Kare respectively 0.157 nm, 0.191 nm and 0.235 nm. Give a reason for this trend. ----------

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

(g) The melting points of group II metals are generally higher than those of the group I metals. Give a reason. ----------

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

(h) The hydroxides of Group I elements are more soluble than those of Group II elements. Why?----------

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

(i) Lithium shows a diagonal relationship with magnesium.

(a) Why are the two elements diagonally related? ----------

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

(b) Give one reaction in which Li and Mg show this relationship.----------

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

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(6). **This question** is on the elements of the d-block, nitrogen and sulphur, Cobalt, Nickel, Manganese, and Copper are both d-block and transition elements.

(a) Why are they considered as;

(i). D-block elements? ----------

(ii). Transition elements? ----------

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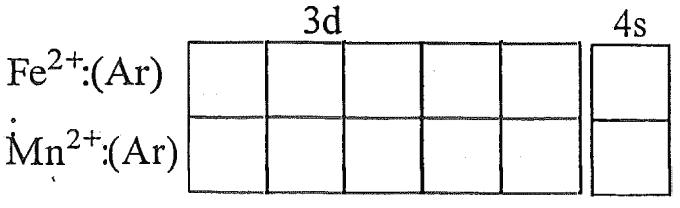
2 marks

(b) (i) In the space below insert the electronic configuration of Fe^{2+} and Mn^{2+}.



(ii). Explain in terms of their electronic configurations why Fe^{2+} ions are more readily oxidise to Fe^{3+} ions while Mn^{2+} are not readily oxidised to Mn^{3+} ions. ----------

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---------- **4 marks**

(c) Transition metal ions form complexes whose shape may be linear, tetrahedral square planar or octahedral.