UNIT 5 REVISION CHECKLIST

5.1 Thermodynamics

You must be able to:

a) Construct Born-Haber cycles using atomisation enthalpies, bond dissociation enthalpies, enthalpies of vaporisation, 1st and 2nd ionisation enthalpies, 1st and 2nd electron affinities, and lattice enthalpies, define all these terms, and calculate the missing value if all other values and the enthalpy of formation is given

b) Use mean bond dissociation enthalpy data to calculate approximate enthalpy changes, and understand why these enthalpy changes are approximate

c) Construct a cycle to show the enthalpy changes which occur when ionic compounds dissolve in water, using lattice enthalpies, enthalpies of hydration and enthalpies of solution, define all these terms, and calculate the missing value if all others are given

d) Calculate entropy changes given the entropy of the reactants and products, and predict qualitatively whether the entropy change in a reaction will be positive or negative

e) Use enthalpy changes (ΔH) and entropy changes (ΔS) to calculate free energy changes (ΔG), understand that reactions are only spontaneous when ΔG is negative, and calculate the critical temperature above or below which a reaction will or will not be spontaneous

5.2 Periodicity

You must be able to:

a) Write equations for the reactions of Na and Mg with water, including the conditions necessary for the reactions to take place and any observations

b) Write equations for the reactions of Na, Mg, Al, Si, P and S with oxygen to form Na_2O, MgO, Al_2O_3, SiO_2, P_4O_{10} and SO_2, and relate the boiling points of these compounds to the structure and bonding present

c) Relate the acid-base character of these oxides, and also SO_3, to the bonding present, write equations to show their reaction with water and give the pH of the resulting solutions, and write equations to show their reaction with simple acids and bases

5.3 Redox Equilibria

You must be able to:

a)   Deduce the oxidation number of an atom in an ion or compound, write half-equations to show oxidation or reduction processes, and write full ionic equations to show redox reactions in acidic and alkaline conditions

b)   Draw simple chemical cells, represent them using conventional IUPAC notation, know the standard conditions, use standard electrode potential data to predict the direction of the reaction in a cell, calculate the cell emf and predict how a change in the conditions will affect the emf

c)   Understand the use of the standard hydrogen electrode in measuring electrode potentials, and that secondary standard electrodes such as the calomel electrode are used in practice

d)   Use standard electrode potentials to predict whether a redox reaction will be spontaneous or not

e)   Know the reactions taking place in a hydrogen fuel cell and understand the advantages and limitations of fuel cells

5.4 Transition Metals

 You must be able to:

a)   Define a transition metal, and deduce the electronic configurations of the transition metals Ti – Cu and their ions

b)   Define the terms ligand, complex ion and co-ordination number, explain why transition metal ions can bond with ligands, recall two examples of bidentate ligands and one example of a hexadentate ligand

c)   Predict the likely co-ordination number and shape of a complex ion, and explain why larger ligands result in smaller co-ordination numbers

d)   Explain why transition metal ions are coloured, describe the factors which can lead to a change in colour, and explain how colour can be used to determine concentration

e)   Recall the structures and uses of haem and know why CO is toxic, and also recall the uses of cisplatin, $[Ag(NH_3)_2]^+$, $[Ag(CN)_2]^-$ and $[Ag(S_2O_3)_2]^{3-}$

f)   Explain why transition metals can form a variety of oxidation states, and write half-equations for the reduction of $Cr_2O_7^{2-}$ and VO_2^+ by zinc in acidic solution,

the oxidation of $[Cr(OH)_6]^{3-}$ and $Co(OH)_2$ by hydrogen peroxide in alkaline solution, and the oxidation of $[Co(NH_3)_6]^{2+}$ by air in ammonia solution, and recall the colours of all the species produced

g)   Write equations for the redox titrations involving manganate (VII) ions with Fe^{2+}, H_2O_2 and $C_2O_4^{2-}$ and involving $Cr_2O_7^{2-}$ with Fe^{2+}, describe how to carry out these titrations and perform calculations related to these calculations

h)   Distinguish between homogeneous and heterogeneous catalysis, explain how a catalyst works, write equations to show the catalytic action of Fe^{2+} and Fe^{3+} in the reaction between $S_2O_8^{2-}$ and I^-, and explain how the reaction between MnO_4^- and $C_2O_4^{2-}$ is autocatalysed

i)   Describe the stages of heterogeneous autocatalysis and explain catalytic activity in terms of a balance between adsorption and desorption, give examples of heterogeneous catalysis (Contact Process, Haber Process, hydrogenation of oils, catalytic converters), give equations to show how VO catalyses the Contact Process, explain the use of an inert ceramic support in catalytic converters and recall how Fe in the Haber process and Pt/Rh in catalytic converters can be poisoned

5.5 Reactions of Inorganic Compounds in Aqueous Solution

You must be able to:

a)   Define and recognise Lewis Acids and Bases

b)   Recall that most metal ions exist in aqueous solution as the hexaaqua complex, write equations to show why these complexes are acidic and explain why +3 complexes are more acidic than +2 complexes

c)   Write equations to show the deprotonation of hexaaqua complexes of Fe^{2+}, Cu^{2+} and Co^{2+} by hydroxide ions and ammonia, and of Fe^{3+}, Cr^{3+}, Al^{3+} by hydroxide ions, carbonate ions and ammonia to give hydroxide precipitates, know the colours of the precipitates formed and use equations to show how these deprotonation reactions can be reversed by the addition of acid

d)   Write equations to show the deprotonation of $Cr(H_2O)_3(OH)_3$ and $Al(H_2O)_3(OH)_3$ with excess hydroxide ions, recall the colours of the species formed and understand how this shows the amphoteric nature of these hydroxides

e)   Write equations to show the ligand exchange reactions of $Cu(H_2O)_4(OH)_2$ and $Co(H_2O)_4(OH)_2$ with excess ammonia, of $Cu(H_2O)_6^{2+}$ and $Co(H_2O)_6^{2+}$ with chloride ions, recall the oxidation of $Co(NH_3)_6^{2+}$ on standing and recall the colours of all the species formed

f)   Write equations to show ligand exchange reactions of other aqueous ions with other ligands, including multidentate ligands, explain why substitution by chloride ions causes the co-ordination number to decrease and explain why substitution by multidentate ligands leads to the formation of more stable complexes (the chelate effect)

g)   Write equations to show the precipitation reactions of the hexaaqua complexes of Fe^{2+}, Cu^{2+} and Co^{2+} with carbonate ions to form carbonates, recall the colours of the precipitates formed and explain why they do not form hydroxides

h)   Recall and write equations to show how $Cr_2O_7^{2-}$ and CrO_4^{2-} can be interconverted