NECTA A-Level
CHEMISTRY 2
May 2004

[04/2]
SECTION A

1. (a) Draw a sketch of a cell formed by combining $Zn^{2+}(aq)/Zn(s)$ and $Cu^{2+}(aq)/Cu(s)$ half-cells. Indicate on the sketch the following:
   (i) The positive electrode
   (ii) The direction of electron flow in the external circuit
   (iii) The electrode at which oxidation occurs
   (b) Calculate the e.m.f. of the cell operating under standard conditions given that:
   $Ag^{+}(aq) \mid Ag(s)$ $E^{o}/V = 0.80V$
   $Cu^{2+}(aq) \mid Cu(s)$ $E^{o}/V = 0.34V$
   $Zn^{2+}(aq) \mid Zn(s)$ $E^{o}/V = -0.76V$
   (c) Explain how the e.m.f. of the cell would be affected by:
   (i) Increase in $[Cu^{2+}]$
   (ii) Increase in $[Zn^{2+}]$
   (d) If the $Zn^{2+}(aq)/Zn(s)$ electrode system was replaced by $Ag^{+}(aq)/Ag(s)$ electrode system, what would the e.m.f. of the cell be?

2. (a) Explain the meaning of the following terms:
   (i) Zero order reaction
   (ii) Rate law
   (iii) Energy profile
   (b) For a reaction A + 2B → Products the initial rate for different initial concentrations were found and results were as follow:

Experiment	Initial Concentration		Initial rate
	[A] mol dm^{-3}	[B] mol dm^{-3}	Mol dm^{-3} s^{-1}
1.	$4.0x10^{-2}$	$4.0x10^{-2}$	$6.5x10^{-5}$
2.	$4.0x10^{-2}$	$8.0x10^{-2}$	$12.8x10^{-5}$
3.	$8.0x10^{-2}$	$4.0x10^{-2}$	$25.6x10^{-5}$
4.	$8.0x10^{-2}$	$8.0x10^{-2}$	$51.2x10^{-5}$

   (i) Calculate the order of reaction with respect to A and B
   (ii) What is the overall order of reaction?
   (iii) What units could be used for the rate constant?
   (iv) Calculate the rate constant (use the results of experiment 1).

3. (a) How does calcium hydroxide react with
   (i) Carbondioxide
   (ii) Ammonium salt
   (iii) Temporary hard water?
   In each case give the related equation.
   (b) Explain what happens and by using equations show all the chemical reactions that take place when:
   (i) Excess chlorine gas is passed through hot concentrated solution of sodium hydroxide.
   (ii) Concentrated aqueous ammonia falls drop by drop into chlorine gas
   (iii) Excess concentrated hydrochloric acid is added to an aqueous solution of lead (II) chloride.
   (iv) Solid ammonia chloride is heated.
   (c) Complete and balance the following equations;
   (i) $NaH + H_2O \rightarrow$
   (ii) $CaC + H_2O \rightarrow$
   (iii) $H_2S + H_2SO_4 \rightarrow$

4. (a) (i) Define the term Lewis acid
   (ii) Define a conjugate base
   (iii) State Kohlrauseh's Law of independent ionic mobilities

(iv) Give the meaning of the term "dilution", v, in the formula ^v = κv

(b) During potassium permanganate titrations, no indicator is used whereas, during iodometry titrations, starch indicator is added towards the end point. Explain.

(c) (i) Arrhenius equation can be written as $k = Ae^{-Ea/RT}$. What do the symbols k, A and R represent in the equation?

(ii) You are provided with data in the table below which obeys Arrhenius equation.

lnk	-4.60	-6.00	-7.20	-8.50	-9.80	-11.10
T (K) x10^2	3.448	3.333	3.226	3.125	3.030	2.941
1/T (K^{-1})						

Complete the table and then plot a graph of lnk against 1/T

(iii) Calculate the slope of the graph and use it to find the value of activation energy, Ea of the reaction.

(d) Calculate the molar conductivity of a 0.10M KCl solution which has an electrolytic conductivity of 1.29sm^{-1}

SECTION B

5. (a) Explain the following:

(i) While the pentavalent compounds of phosphorous are well known, the pentavalent compounds of nitrogen do not exist

(ii) $AlCl_3 \cdot 6H_2O$ is acidic in aqueous solution while CH_3COONa is basic in aqueous solution

(iii) Nitric acid attacks metals but aluminum containers are used to transport concentrated nitric acid

(iv) Calcium carbonate is insoluble in water but dissolves in presence of dissolved carbon dioxide.

(b) Acidified potassium permanganate solution oxidizes hot oxalic acid to carbon dioxide gas. Write:

(i) half ionic reduction equation

(ii) half ionic oxidation equation

(iii) net ionic balanced equation

(c) Calculate the mass of iodine liberated when 107g of potassium (I) iodate (v) (KIO_3) are added to 1dm^3 of 2.0 molar HCl solution containing excess of potassium iodide.

6. (a) (i) Write down the stable electronic configuration of Cr, Cu^+ and N

(ii) Define the term disproportionation

(b) Which of the following reactions display disproportionation phenomenon? Give reasons to support your answer.

(i) $Cl_2(g) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(l)$

(ii) $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

(iii) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

(iv) $2NO_2(g) + H_2O(l) \rightarrow HNO_2(aq) + HNO_3(aq)$

(c) Explain the following:

(i) The first ionization energy of oxygen is lower than that of nitrogen although oxygen is towards the right across period two in the periodic table

(ii) The chemistry of magnesium resembles that of lithium although magnesium is in group two while lithium is in group one in the periodic table

(iii) Silicon has a much higher melting point than it is expected

(iv) Graphite is used as a lubricant as well as cell electrodes but not diamond

7. (a) (i) With the help of one example define nuclear fission and gie two applications of the energy obtained from nuclear fission.

(ii) Chlorine consists of two isotopes $^{35}_{17}Cl$ whose relative atomic mass is 34.9694g mol^{-1} and $^{35}_{17}Cl$. If the relative abundance of $^{35}_{17}Cl$ is 75.77% and the relative atomic mass of chlorine is 35.4532g mol^{-1}. Calculate the relative atomic mass of $^{37}_{17}Cl$ isotope.

(b) Explain briefly the meaning of the following quantum numbers:

(i) n

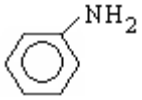
(ii) l
(iii) m
(iv) m_s

(c) Given the quantum number n = 2
(i) What are the possible orbitals present in this quantum energy level?
(ii) List down the possible values of m and m_s for this quantum number

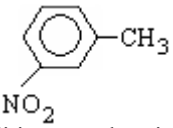
SECTION C

8. (a) (i) Differentiate amines from amides
(ii) Show that the reaction of amines with mineral acids is similar to the reactions of ammonia with mineral acid by using hydrochloric acid.

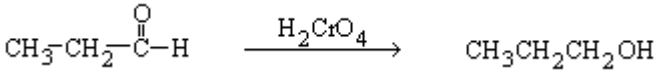
(b) Starting with benzene show how the following compounds can be prepared by means of chemical equations
(i) Phenylamine,

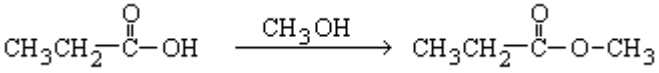


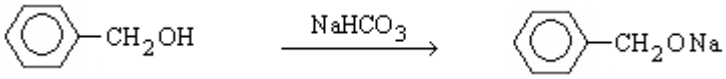
(ii) 3-Nitromethylbenzene,

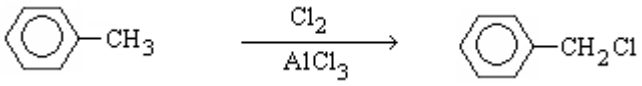


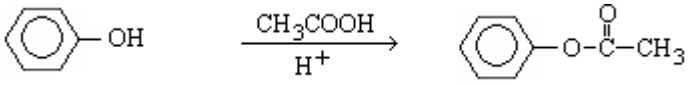
(c) In an examination paper, a student offered conditions or chemicals necessary for the conversions of organic compounds to take place as shown below. Study them carefully and for those conversions which were provided with wrong conditions or chemicals, rewrite them and show the correct conditions or chemicals which must be present for the conversions to be carried out:

(i) 

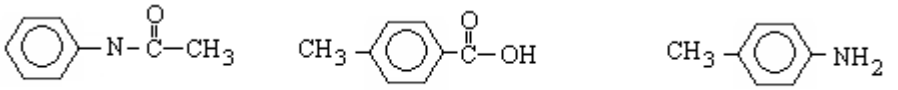
(ii) 

(iii) 

(iv) 

(v) 

(d) (i) The following three compounds are sparingly soluble in water but very soluble in ether.



N-phenyletharamide | 4-methylbenzene carboxylic acid | 4-methylphenylamine

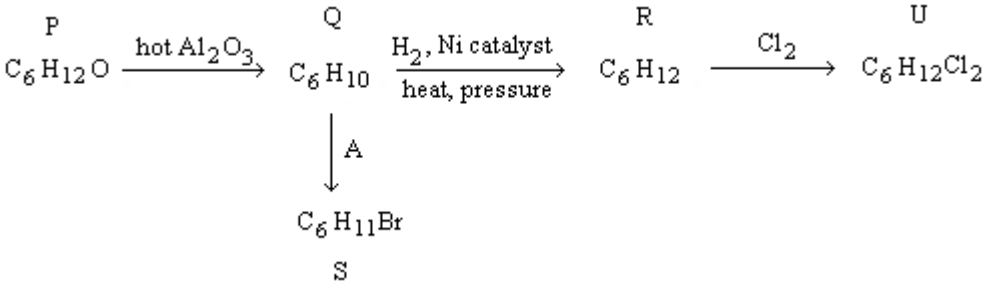
A mixture of all three compounds given above was dissolved in ether. The solution was put into a separating funnel and shaken with excess dilute hydrochloric acid. The aqueous layer was collected in a flask labeled "A". Next the ether layer was shaken with excess aqueous sodium hydrogen carbonate. The new aqueous layer was collected in a flask labeled "B". The remained ether layer was transferred into a flask labeled C. With the help of equations where necessary, which of the three compounds is contained in flask A, B and C?

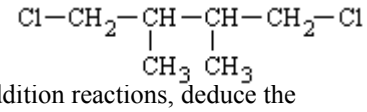
(ii) An organic compound has a relative molecular mass of 88. It was found to have two isomers, an aliphatic carboxylic acid and an aliphatic ester. Write the structural formulae of the two isomers and give their IUPAC names.

9. (a) Benzene is said to have delocalized electrons, what does this means?

(b) Compare and contrast the reactions of benzene, cyclohexene and cyclohexane by using bromine gas as a reagent.

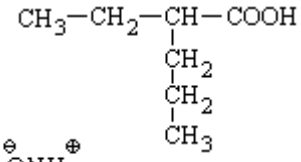
(c) Compound P of molecular formula $C_6H_{12}O$ reacts with sodium metal to form compound T of molecular formula $C_6H_{11}ONa$ with evolution of hydrogen gas. Compound P also reacts as show below:

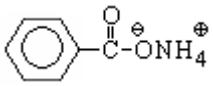


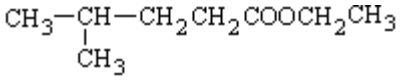
(i) If the structural formular of compound U is  and compound R cannot undergo further addition reactions, deduce the structural formulae of compound P, Q, R and T.

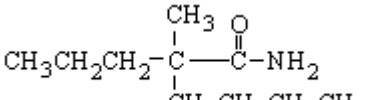
(ii) Which reagent is represented by A above that reacts with Q to from S. Give the structural formula of S.

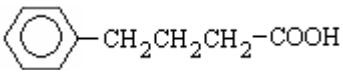
(d) Give the IUPAC names of the following organic compounds:

(i) 

(ii) 

(iii) 

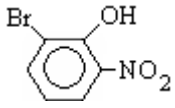
(iv) 

(v) 

10. (a) With the help of chemical equations show how you would bring about the following conversions:

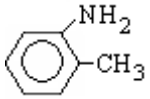
(i) Benzene to benzene carboxylic acid

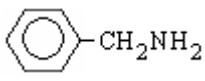
(ii) propanoic acid to ethanoic acid

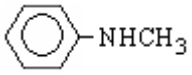
(b) The structure of one of the isomers of a compound whose molecular formula is $C_6H_4O_3BrN$ was given as: 

Write the structure of the other six isomers and give their IUPAC names

(c) Arrange the following compounds in order of increasing basic strength. Give reasons for you choice of arrangement.

(i) 

(ii) 

(iii) 

(iv)