A LEVEL CHEMISTRY PAPER 2 2013 MEETLEARN.COM

Advanced Level CHEMISTRY

JUNE 2013

SECTION A: PHYSICAL AND GENERAL CHEMISTRY
(Answer only TWO questions in this section)

1.   (a) What do you understand by (i)   Avogadro's number

(ii)   Amount of substance.   (2marks)

(b) A solution was made by dissolving 9.0g of hydrated aluminium sulphate (Al2(S04)3.6H20

in 250cm^3 of solution . (R.A.M: Al=27,0=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 (moldnr^3) of the hydrated aluminium sulphate .   (3 marks)

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

(i)   In a transformation 92^{238}U decays to 88^{226}Ra.

How many beta and alpha particles are emitted?   (3 marks)

(c)   Iron burns in chlorine to form a chloride. An experiment showed that 5.6g of iron combined with
10.65g of chlorine to form a chloride. (R.A.M: 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   (3marks)

(d)   (i)Define bond energy term

(ii)Write an equation to represent the lattice energy of calcium chloride. (2marks)

(e)   Given the following data
AH°at (C($_s$))=+717kjmol-1

AH°at(H2(g))=+218kJmol-1 of gaseous hydrogen atoms
AH°i(CH$_4$(g)) =-75KJmol-1

Determine the C-H bond energy in methane.   (3marks)

d) Theoretical and experimental values of lattice energies of a compound may differ.

(i)   Explain why the values may differ.

i)Give an example of a halide in each case were the values of lattice energies
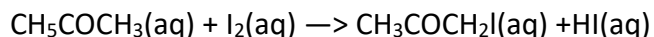
a) are different b) are similar (4 marks)

(g) Why is the Born Haber cycle used to determine the lattice of ionic compounds?

2 (a) What do you understand by

(i) initial rate of reaction (ii) order of reaction

(b) why is the order of a reaction important in study of reaction rate?

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

$CH_5COCH_3(aq) + I_2(aq) \longrightarrow CH_3COCH_2I(aq) + HI(aq)$

Experiment	Concentration			
	$[CH3COCH_3(aq)]/$ (mol dm^{-3})	$[I_2(aq)]/$(mol dm-^{3}c)	[HW/ (motdm-3)	Rate / mol dm-^{3}s-1
1	0.03	0.05	0.05	5.7x10-5
2	0.03	010	0.05	5.7 x10-5
3	0.03	0.05	0.10	1.2x10-4
4	0.04	0.05	0.20	3.1 x 10-4
5	0.36	0.05	0.05	7.1 x 10-4

(i)Deduce the order of the reaction with respect to: $(CHCOCH_{(aq)})$, $(I_{2(aq)})$, (H^+_{aq})

(i)   What is the over all order of the reaction?

(ii)   Write the rate expression for the reaction.

(iii)   Calculate the value of the rate expression indicating its units.

(v) State a method you would use to measure the rate of the reaction above without quenching the reaction.   (7 marks)

(b)   What is an ideal solution?   (1 mark)

(c)   Methanol and ethanol form an ideal solution. The vapour pressure of pure ethanol and pure methanol at 20°C is 44mmHg and 94mmHg respectively. A mixture of 30g of methanol (CH3OH) and 45g of ethanol (CH3CH2OH) is prepared. {RAM: 012,0=16;H=1).Calcuiate (i)   the mole fraction of the methanol in the solution.

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

(iii)   mole fraction of methanol in the vapour above the solution.   (3 marks)

(d)   (i)Suggest a method of separating the components of a solution containing ethanol and methanol.

(ii)   Sketch a label diagram of boiling point against composition for the mixture of trichloromethane (b.pt334K) and propanone (b.pt 329K).

(iii)   Can a mixture of trichloromethane and rxpanone be separated into the pure components by fractional distillation ? Explain. (5 marks) 3(a) State the equilibrium law.

(b) The equilibrium constant for the reaction

$$N_2(g)+3H_2(g) \rightleftharpoons 2NH_3(g)$$
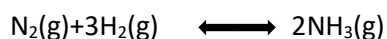
Is 1.0×10^{-1} at 500K, $8.0 \times 1 O^{15}$ at 700K and 5.0×10^{-8} at 1100K.

(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.

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)

(b)   Define standard electrode potential of an electrode system.   (1 mark)

(c)   Given the following redox potentials

$I_{2(aq)}+2e \rightleftharpoons 2I\text{-}(aq)$ $E°=+0.54V$ '

$S_2O_6{}^{2-}(aq)+2e \rightleftharpoons 2S_2O_3{}^{2}(aq)$ $E°=+0.10V$
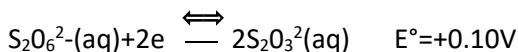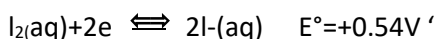
(i)   Select the species which is the strongest Adducing agent B:oxidising agent

(ii)   Write the cell diagram when the half cells are coupled and calculate the emf of the cell. (4mark) (d)

          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 Carbon and aluminium are solids, and 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) (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)

SECTION B : INORGANIC CHEMISTRY

(Answer only TWO questions in this section)

4 (a) The elements, F, Cl, Br and I belong to GROUP ViI (GROUP17) of the Periodic Table.
State and explain the trend of (i) physical state of the element down the group.

(ii)   oxidizing power of the element up the group.

(iii)   acid strength of the hydrogen halides (HX) down the group.   (6 marks)

(b)   (i) What is disproportionation?

(ii)Give balanced equations for the reaction of chlorine with

A: cold dilute potassium hydroxide B: hot concentrated potassium hydroxide.(3mks)

(c)   (i)Give balanced equations for the reaction of concentrated sulphuric acid with :

A: solid sodium chloride B: solid sodium iodide

(ii) Explain the difference, if any, in the reaction of solid sodium chloride and solid sodium iodide with

. concentrated sulphuric acid.   (3 marks)

(d)   Write the formula and name of the compounds in which sulphur has the following oxidation states.

Oxidation state	Formula of compound	Name of compound
+6		
+4		
+2		
-2		

(e)   Give the redox reaction in which the oxidation state of sulphur. (4 marks)

(i) increases from reactants to products (ii) decreases from reactants to products (2marks)

(f)   What is the consequence on the environment of the release of sulphur dioxide, into the atmosphere? (1 mark)

(g)   Give one important use of nitrogen compounds in agriculture.   (1 mark)

4   (a) (i) Distinguish between a d-block element and a transition element.

(ii) Give a suitable example in each case of A: d-block element B: transition element (3mark)
(b) Copper (29 CU) exhibits variable oxidation states
(i) Write down the electronic configuration of

Cu^+	
CU_{2+}	

(ii)Which of these oxidation states of copper is more stable in aqueous solution? Explain.(3)

(a)   What is meant by the terms bidentate and polydentate as applied in ligands? Give one example of each.(2 marks)

(b) The hydrated ion $(Ni(H_2O)_6)^{2+}$

(i)What is the oxidation state of nickel in the complex ion?

(ii) Name the complex ion and draw the shape of the ion $(Ni(H_2O)e)^{2+}$

(iii) Give the formula of the complex ion formed when a solution of EDTA is added to a solution of this complex ion.

(iv) What is the coordination number of the nickel-EDTA complex ion?

Give one use of EDTA.

5 This question is on the elements of the d-block, nitrogen and sulphur.

Cobalt, iron, manganese and copper are both d-block elements and transition elements.

(a) Why a e they considered as

(i) D-block elements? (ii) transition elements (2 marks)

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

3d					4s

(ii)Explain in terms of their electronic configure ion why Fe2+ ions are readily oxidized to Fe^{3+} ions while Mn^{2+} ions are not readily oxidized to Mn^{3+} ions. (4 marks)

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

(i) what is the coordination number of cobalt in the complex $(Co(H_2O)_4Cl_2)^+Cl^-$
(ii)Give an example and the name of a complex ion of one of the elements listed above which isA: tetrahedral in shape B : square planar in shape (3 marks)

(c) Sulphuric acid and nitric acid are important in the chemical industry. Using equations only^ show how

(i) Ammonia is converted to nitrogen dioxide

(ii) Sulphur is converted to sulphur(VI) oxide. (4 marks)

(c)   In the conversion of sulphur (IV) to sulphur (VI) oxide, the gases must be purified. How is the purification carried out?   (2 marks)

(d)   The industrial manufacture of both sulphuric acid and nitric acid is one cause for atmospheric pollution such as acid rain.

(i)   What substances released in these industrial processes are responsible for atmospheric pollution?

(ii)   How do these substances cause atmospheric pollution?

(iii)   Give two effects of acid rain on the environment.   (4 marks)

(e)   Give one industrial use of nitric acid.   (1 mark)
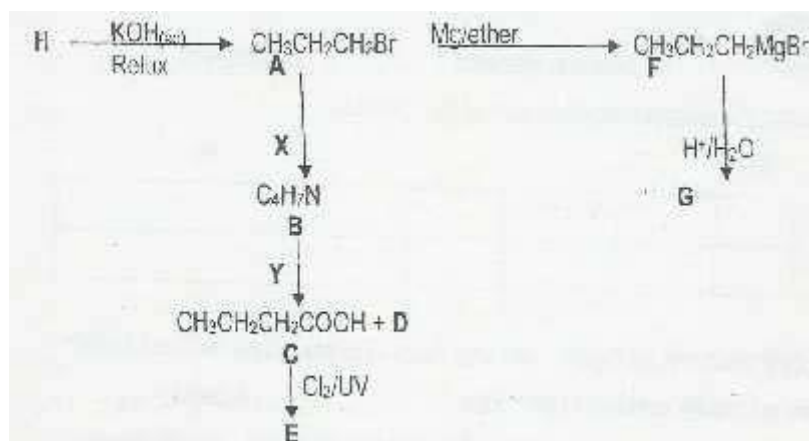
(a)   (i)Give the reagents and reaction conditions for processes x and y
(ii) Write the formulae and names of the products B; D, E, G and H.

Product	Formula or name
B	
D	
E	
G	
H	

(iv)   What type of reaction is involved in the formation of H?

(v)   Write out the mechanism for the formation Of H

(b)   But-1-ene,($CH_3CH_2CH=CH_2$), reacts with hydrogen bromide to give two possible products.

(i)   Give the formulae of the products.

(ii)   Which is the major product and why.

(iii)   State the rule which allows you to make your decision.   (5 marks)

(c)   The analysis of a halogeno-compound gave 45.09% carbon, 8.9% hydrogen and 42.2% chlorine.

(i)   Calculate the empirical formula of the compound (RAM: C=12,H=!0, C!=35.5)

(ii)   What is the molecule formula of the compound, given that its relative molecular mass is 78.5?

(iii)   How would you identify the presence of chlorine in the compound?   (5 marks)

6   Carbonyls : a class organic compounds consisting of aldehydes and ketones.

(a)   (i) What is the common feature in this class of organic compound ?

(ii)   What general method could be used to prepare both aldehydes and ketones.?

(iii)   How would you distinguish between aldehydes and ketones?

(vi)   Why do the carbonyl compounds have higher boiling points than the corresponding alkanes?

(6marks)

(b)   Carbonyl compounds undergo nucleophilic addition reactions such as the reaction between ethanol

(CH3CHO) and hydrogen cyanide (HCN).

(i)   What is meant by nucleophilic addition?

(ii)   Identify the nucleophile in the reaction mentioned above.

(ii) Write out the mechanism for the reaction.

(vii)   Give the reagents and reaction conditions for the conversion of the product

(hydroxypropanonitrile) to a hydroxycarboxylic acid.   (6 marks)

(c)   The oxidation of two isomers with molecular formula C_3H_6O gave compounds P and Q. Both P and Q give orange precipitates with 2,4-dinitrophenylhydrazine while only P gives a precipitate of copper(l) oxide with Fehling's solution.

(i)   Suggest the structural formulae of compounds P and Q.

(ii)   Give the name of the compound formed bythe reaction of compound Q with

2,4-dinitrophenylhrdrazine.

(iii)   Write out the isomers of the compound of molecular formula C_3H_8O.

Draw the structures of the hemi-acetal (alkoxyalcoho!) and the acetal (dialkoxyalkane) formed'by

the reaction of compound P with methanol (CH_3OH).   (8 marks)

9. This question is on organic compounds possessing the hydroxyl (-OH) functional group. (a)

Four compounds of molecular formula $C_4H_{10}O$ have the hydroxyl (-OH) group. Write down the

structural formulae of the four isomers and give their corresponding names. (6 marks) (b)

Describe a simple chemical test to confirm the presence of the -OH group in the compounds in (a)

above. (2 marks)

(c)   Given the compounds R, S and T below,

CH_3CH_2OH , C_6H_5OH $C_6H_5CH_2OH$
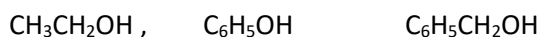
R   S   T

Compare the acidities of R and S.

Explain your reasoning.

(ii)   Describe a simple test to distinguish between S and T.

(iii)   Write an equation in each case for the esterification reaction of R and S with ethanoic acid,

giving the reaction conditions.   (6 marks)

(d)   One way of obtaining compound S starts with heating a mixture of benzene and

concentrated sulphuric acid to obtain benzensulphonic acid. Further reaction of this product with

sodium hydroxide finally yield sodium phenoxide.

(i)   Write down the mechanism for the sulphonation of benzene.

(ii)   How can free phenol be obtained from sodium phenoxide?

(iii)   Give the structure of the product formed when S reacts with aqueous bromine. (5 marks)

(e)   Compound T can be produced from benzaldehyde (phenyimethanat).

Write an equation for this reaction.   (1 mark)