NECTA A-Level
CHEMISTRY 1
May 2004

[04/1]
SECTION A

1. (a) (i) Outline the fundamental postulates of Plank's quantum theory
(ii) What does the term wave-particle duality nature of an electron mean?
(iii) State the uncertainty principle
(b) Calculate the energy of a photon of radiations whose wave length is 5.89×10^{-5}cm emitted from sodium atoms when heated

2. (a) State:
(i) Boyle's gas law
(ii) Charles's gas law
(b) (i) Under what conditions do real gases fail to obey Charles's and Boyle's gas laws?
(ii) With the help of Amagat's curves, show how carbon dioxide gas deviates from ideal gas behaviour.

3. (a) (i) State Raoult's law
(ii) Under what conditions does a solution formed upon mixing two liquids A and B behaves as an ideal solution?
(b) liquids A and B form an ideal solution when mixed together. If the boiling point of pure A is higher than the boiling point of pure B at 1atm. atmospheric pressure, sketch:
(i) A vapour pressure-composition curve for the solution of liquids A and B mixture
(ii) A temperature-composition curve for the solution of liquids A and B mixture
(iii) Explain what will happen when an equimolar solution mixture of A and B is distilled at an atmospheric pressure of 1atmosphere.

4. (a) State:
(i) A homogeneous catalyst
(ii) A heterogeneous equilibrium
(iii) Autocatalyst
(b) Deduce the relationship between K_p and K_c for the following gaseous equilibria:
(i) $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$
(ii) $NO(g) + 1/2O_2(g) \rightleftharpoons NO_2(g)$
(c) Consider the following equilibrium

$$\underset{\text{orange}}{Cr_2O_7^{2-}(aq)} + H_2O(l) \rightleftharpoons \underset{\text{yellow}}{2CrO_4^{2-}(aq)} + 2H^+(aq)$$

What would you expect to see if:
(i) dilute sodium hydroxide is added to the equilibrium mixture
(ii) dilute hydrochloric acid is added to the equilibrium mixture?

5. (a) (i) What does the term colligative properties mean?
(ii) Outline the limitations of colligative properties
(b) Study the table below and answer the questions that follow

Solution	Concentration mol/lit.	Freezing point (°C)
Cane sugar ($C_{12}H_{22}O_{11}$)	0.030	-0.054
Glycerol ($C_3H_8O_2$)	0.132	-0.200
Potassium bromide (KBr)	0.084	-0.300

Giving reasons comment on the variation of the freezing points with respect to the concentrations of the solutions in the table above.
(c) The vapour pressure of 1% urea solution at 38°C is 49.85mmHg. If the vapour pressure of pure water is 50mmHg and 250mmHg at 38°C and 72°C respectively, calculate the vapour pressure of 1% urea solution at 72°C.

6. (a) (i) Write down a balanced equation for the dissociation of phosphorous pentachloride gas and show the ratio of volumes of reactants to the volumes of products.

(ii) Write down the expression which relates the degree of dissociation of phosphorous pentachloride to its relative densities before and after dissociation.

(b) (i) Define normal density of a substance

(ii) Define relative density of a gas

(iii) The mass of 243cm^3 of a gas at 273K and at an atmospheric pressure of 1 atmosphere is 0.162g. Calculate the normal density and relative density of the gas.

SECTION B

7. Explain the following

(a) Although water and hydrogen sulphide are the hydrides of elements of the same group, boiling point of water is higher than that of hydrogen sulphide.

(b) Iodine and chlorine both are found in group seven of the periodic table but hydrogen iodide is a stronger reducing agent than hydrogen chloride

(c) The acidity of the solutions of the hydrides of elements from sodium to chlorine across the third period increases from left to right

(d) Hydrogen iodide does not form hydrogen bonding while hydrogen fluoride does although both are the hydrides of group seven.

(e) The passage of carbon dioxide through calcium hydroxide solution changes the latter into white precipitate which dissolves into a clear solution in excess of carbon dioxide.

8. Below is a portion of electrochemical series. Study it carefully and answer the questions that follow:

$Fe \rightarrow Fe^{2+} + 2e^-$	-0.44
$Sn \rightarrow Sn^{2+} + 2e^-$	-0.14
$Pb \rightarrow Pb^{2+} + 2e^-$	-0.13
$1/2H_2 \rightarrow H^+ + e^-$	0.00
$Cu \rightarrow Cu^{2+} + 2e^-$	+0.34
$2Cr^{3+} + 7H_2O \rightarrow 6e^- + Cr_2O_7^{2-} + 14H^+$	+1.33
$Cl^- \rightarrow 1/2Cl_2 + e^-$	+1.36
$Mn^{2+} + 4H_2O \rightarrow 5e^- + MnO_4^- + 8H^+$	+1.69

(a) Hydrogen gas can be prepared from the reaction of dilute hydrochloric acid and iron but not from the reaction of dilute hydrochloric acid and copper. Explain.

(b) Although lead could be a perfect coating material of iron metal against corrosion, food cans made of iron are coated with tin metal and not lead. Explain.

(c) Doring potassium (i) permanganate (vii) titrations, dilute hydrochloric acid can not be used as an acidic medium while during the titration of potassium (i) dichromate (vi), dilute hydrochloric acid is used. Explain.

(d) you are provided with the following pairs of reactants:

$Fe(s) + CuSO_4(aq) \rightarrow ?$ and

$Cu(s) + SnCl_2(aq) \rightarrow ?$

With the help of a balanced equation identify and explain which pair will react.

(e) Give the symbol of a cell of the highest e.m.f. which can be constructed from the above portion of electrochemical series. What is the value of its e.m.f?

9. (a) Write down the stable electronic configuration of the following:

(i) Fe^{2+}

(ii) Na^+

(iii) Mn^{2+}

(iv) Mg^{2+}

(v) Mn^{3+}

(vi) Fe^{3+}

(b) Explain the following in terms of electronic configuration:

(i) In manganese, the oxidation state of +2 is more stable than the oxidation

state of +3.

(ii) The size of Na^+ ion is larger than that of Mg^{2+} ion although both have the same number of electrons

(c) Give the coordination number, IUPAC names and the names of geometrical shapes of the following complex compounds

(i) $[FeSO_4(NO)_2COBrOH]$

(ii) $[NiCNH_2OC_2O_4NH_2SO_3]^{4-}$

10. (a) Define the following terms:

(i) equivalent weight

(ii) Molality

(iii) Normality

(iv) Mole fraction

(b) A solution of sulphuric acid contains 571.60g of the acid per dm^3 of the solution at 20°C has a density of 1.3294g/cm^3. Calculate:

(i) Normality of the acid solution

(ii) Molality of the acid solution

(iii) Percentage by mass of sulphuric acid in the solution

(iv) Mole fraction of sulphuric acid and water in the solution

SECTION C

11. A hydrocarbon compound M of molecular formula C_4H_6 reacts with one mole of hydrogen gas in presence of nickel catalyst to form compound P. Compound P can react with one mole of hydrogen at a temperature of 80 – 120°C in presence of nickel catalyst to from compound Q. Compound M reacts readily with bromine gas and it can decolourize bromine water. Compound P reacts readily with bromine gas to form compound R but P can not decolourize bromine water.

(a) Write the structural formulae of compounds M, P, Q and R

(b) Write the equations of reaction between compound:

(i) M and hydrogen gas in presence of nickel catalyst to form P

(ii) P and hydrogen gas in presence of nickel catalyst to form P

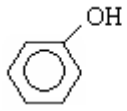
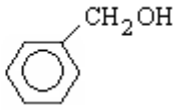
(iii) P and bromine gas to form compound R

12. (a) With the help of chemical equations give one chemical test used to distinguish the following pairs of compounds:

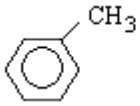
(i) $CH_3CH(Cl)CH_3$ from $CH_3CH_2CH_2Cl$

(ii) $CH_3CH_2CH_2OH$ from CH_3CH_2OH

(iii) $CH_3C{\equiv}CCH_3$ from $CH_3CH_2C{\equiv}CH$

(iv)  from 

(b) Complete the following conversions:

(i)  + Cl_2 $\xrightarrow{uv}$?

(ii) $CH_2{=}CH_2 + O_2 \rightarrow$?

(c) With the help of chemical equations show how you can prepare:

(i)  from CH_3Cl and C_6H_6

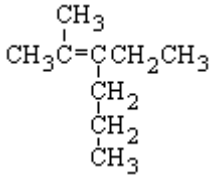
(ii) $CH_3CH_2CH_2CH_3$ from CH_3CH_3

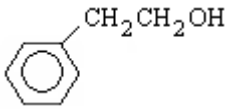
(iii)  from CH≡CH

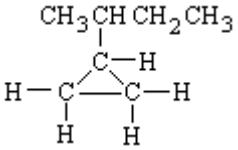
(iv) $CH_3CH_2CH_2CH_2CH_3$ from 

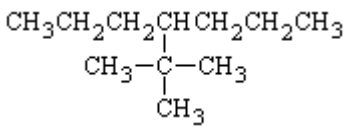
13. (a) By using IUPAC rules of naming organic compounds draw the correct structures from the following incorrect names and name them according to IUPAC rules:
    (i) 1,1,1,1-tetraethylmethane
    (ii) 1-chloropentan-4-ol
    (iii) 3-propyl-2-ethylpentane

(b) Give the IUPAC names of the following compounds:

(i)


(ii)


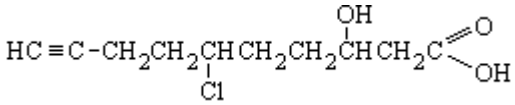
(iii)


(iv)


14. (a) Complete the following conversions by giving the structural formulae and the IUPAC names of compounds R, S and T

$CH_3CH_2CH_2CH_2Cl + NaOH(aq) \xrightarrow{25^oC} R + Na(s) \rightarrow S + CH_3I \xrightarrow{25^oC} T$

(b) You are provided with an organic compound L whose molecular structural formula is given below:

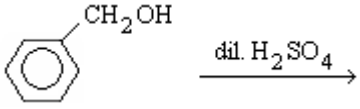


Give IUPAC names of the functional groups present in the compound L

(c) Write down the chemical equation for the reaction which will take place when the following reagents are added to compound L in 14.(b) above

(i) $Cl_2 \xrightarrow{FeCl_3}$

(ii) $NaOCH_3 \xrightarrow{25^oC}$

(iii) 

(iv)