NECTA A-Level
CHEMISTRY 1
May 2002

[02/1]
SECTION A

1. (a) Define the following terms:
        (i)   Radioactivity
        (ii)   Radioactive isotope
    (b) A radioactive isotope of the element Thorium $^{232}_{90}$Th decays according to the following
        scheme:

$$^{232}_{90}Th \xrightarrow[\text{emission}]{\alpha - \text{Particle}} X \xrightarrow[\text{emission}]{\beta - \text{Particles}} Y \xrightarrow[\text{emission}]{\beta - \text{Particles}} Z$$

        Deduce the mass number and atomic number of X, Y and Z
    (c) The mass spectrum of an element enables the relative abundance of each isotope of the
        element to be determined. Data relating to the mass spectrum of an element X whose aomic
        number is 35 appear as follows:

Mass number of isotopes	Relative abundance
79	50.5%
81	49.5%

        (i)   Define the term isotope
        (ii)   Write down the conventional symbols for the two isotopes of X
        (iii)   Calculate the relative atomic mass of X to three significant figures

2. (a) What do you understand by
        (i)   real gas
        (ii)   critical pressure?
    (b) state
        (i)   Graham's law of diffusion
        (ii)   The equilibrium Law
    (c) 200cm^3 of oxygen gas takes 250 seconds to diffuse through a porous diaphragm. Under
        identical conditions, 200cm^3 of an unknown gas T takes 177 seconds to diffuse. Calculate the
        relative molecular mass of the unknown gas.

3. (a) When a solution of Ba(OH)$_2$ is mixed with a solution of sulphuric acid (H$_2$SO$_4$), a white
        precipitate forms and its electrical conductivity decreases markedly.
        (i)   Write the balanced equation for the reaction that occurred.
        (ii)   Account for the decrease in electrical conductivity.
    (b) Calculate the p(OH) and hence the pH of a 0.1M solution of an aqueous ammonia given that
        $K_b = 1.8 \times 10^{-5}$ mol dm^{-3} at 298K.

4. (a) Define the following terms:
        (i)   Equilibrium constant
        (ii)   Reversible reaction
    (b) Ammonia gas dissolves in water to form a weak base, ammonium hydroxide:
        $$NH_3(g) + H_2O(aq) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$
        Is the position of this equilibrium largely on the right or on the left? Give reason(s) for your
        answer.
    (c) Nitrogen and hydrogen are mixed in a molar ratio 1:3. At equilibrium of 600°C and 10
        atmosphere, the percentage of ammonia in the mixture of gases is 15%. Calculate the value of
        K_p at 600°C

5. (a) Explain the terms
    (i)   saturated vapour pressure
    (ii)   boiling temperature
    (b) State two characteristics of compounds which are suitable for steam distillation.
    (c) An aromatic compound Z was steam distilled at 98.6°C under one atmospheric pressure. The distillate was found to contain 25.5 grams of water and 7.4 grams of aromatic compound Z. Given that the saturated vapour pressure of water at 98.6°C is 720mmHg, calculate the relative molecular mass of the aromatic compound.

6. (a) A solution of bismuth trichloride ($BiCl_3$) in concentrate hydrochloric acid contains four substances; bismuth trichloride ($BiCl_3$), bismuth chloride oxide ($BiOCl_2$), hydrochloric acid (HCl) and water (H_2O). All four substances are in equilibrium.
    $BiCl_3(aq) + H_2O(l) \rightleftharpoons BiOCl_2(s) + 2HCl$
    Bismuth chloride oxide is a white solid which is insoluble in water.
    (i)   Explain why adding water makes the solution change from clear to cloudy.
    (ii)   Suggest how you could make the cloudy solution clear again.
    (b) The half-life of radium is 1590 years. How long will it take for a sample of radium to decay 10% of its original radioactivity.

SECTION B

7. (a) What is the chief ore of zinc?
    (b) Outline the methods of extraction of the metal from zinc ore
    (c) Why is the addition of excess coke essential in the reduction of zinc oxide (ZnO)?

8. (a) There are three distinct compounds with the same formula ($Cr(H_2O)_6Cl_3$). One of these is violet in coulour; the second is light green in colour and the theird compound is dark green in colour. Their formula might be written as
    $[Cr(H_2O)_6]Cl_3$ (violet)
    $[CrCl(H_2O)_5]Cl_2*H_2O$ light green
    $[CrCl_2(H_2O)_4]Cl*2H_2O$ dark green
    (i)   What is the coordination number of chromium in the compounds?
    (ii)   What is the oxidation state of chromium in the compounds?
    (b) Suggest the name for each compound in (a) above.
    (c) how would you distinguish the compounds in (a) chemically? (Give one chemical test)

9. (a) Write down a balanced chemical equation for the following:
    (i)   Addition of excess ammonia
    (ii)   Iron (III) oxide is heated with aluminum powder
    (b) Write a balanced chemical equation and state what you would observe if H_2O_2 is added to
    (i)   acidified potassium iodide solution
    (ii)   a suspension of chromium (III) hydroxide ($Cr(OH)_3$) in sodium hydroxide solution and heated.
    (iii)   lead sulphide solution

10. (a) What is the meaning of the term "nascent hydrogen"?
    (b) Mention the properties of the hydrides of typical elements which are selected one from each of the s-, p- and d- block elements of the periodic table. (State only four properties from each of the s-, p- and d- block).
    (c) Explain why the chemistry of hydrogen is unique among the elements in some respect.

SECTION C

11.   (a) Write down the structural formulae for the following compounds:
            (i)   3 - methylpentane
            (ii)   3, 3 - dimethyl-4-ethylhexane
            (iii)   3 - methyl - 1 - pentyne
            (iv)   1, 4 - hexadiene

    (b) Give the formulae of the alkenes that on ozonolysis give:
            (i) $O=CHCH_2CH_2CH_2CH=O$ only.
            (ii) $CH_3CH_2CH=O$ only
            (iii) $(CH_3)_2C=O$ and $CH_3CH=O$
            (iv) $CH_2=O$ and $(CH_3)_2CHCH=O$

    (c) Write an equation for the reaction of isobutylene (2-methylpropene) with each of the following:
            (i)   hydrogen chloride
            (ii) H_2O, H^+

12.   (a) Write the structural formula and name of the product when each of the following reacts with 1 mole of bromine.
            (i)   1 - butene
            (ii)   1 3 - cyclohexadiene
            (iii)   1 4 – cyclohexadiene

    (b) What unsaturated hydrocarbon would react with what reagent to form each of the following compounds?
            (i)
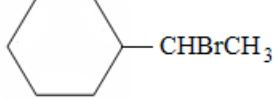
            (ii) $(CH_3)_3COH$

    (c) Write down the equations for each of the following reactions:
            (i)   1 – pentanol + sodium metal
            (ii)   Cyclopentanol + phosphorous trichloride
            (iii)   1 – octanol + hydrogen bromide + zinc bromide
            (iv)   benzyl alcohol + acetic acid
            (v)   1 – phenylethanol + thionyl chloride

13.   (a) Name the following compounds:
            (i) $(CH_3)_3CCH_2Br$
            (ii) $CH_3CH_2CH_2MgCl$
            (iii) $CH_3CH_2CF_2CH_3$

    (b) Give the structure of the products expected from dehydrohalogenation of:
            (i)   1 - bromohexane
            (ii)   2 - bromohexane
            (iii)   1 - bromo - 2 - methylpentane

    (c) name a single chemical test or reagent which chould distinguish between each of the following pairs. Indicate which member of the pair gives the positive test or greater reaction:
            (i) $CH_3CH_2CH_2CH_2CH_3$ and $CH_3CH_2CH_2CH=CH_2$
            (ii) $CH_3CH_2CH_2C\equiv CH$ and $CH_3CH_2CH_2CH=CH_2$
            (iii) $CH_3C\equiv CCH_3$ and $CH_3CH_2C\equiv CH$
            (iv) $CH_2=CHCH=CH_2$ and $CH_3CH_2C\equiv CH$

14.   (a) Write down the equations showing how each of the following conversions could be effected. (More than one reaction will be required in each case).

             (i)   1 - bromobutane to 2 - bromobutane
             (ii)   2 - bromopropane to 1 - bromopropane
             (iii)   chlorocyclohexane to 2 - chlorocyclohexanol

    (b) Name a simple chemical test or reagent which will readily distinguish between each of the following pairs of compounds. Indicate which member of the pair gives the positive test or greater reaction:

             (i) $CH_3CH_2CH_2CH_2CH_2CH_3$ and CH_3CH_2Br

             (ii)

             (iii)
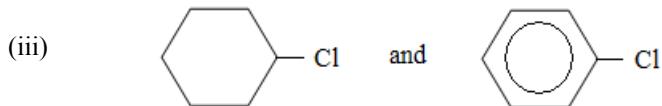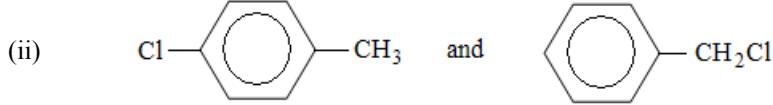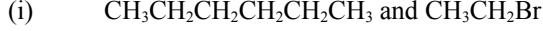
    (c) Write down the equations for the conversion of toluene ($C_6H_5CH_3$) into 1 - bromo - 4 - bromomethylbenzene (p-bromobenzyl bromide).