NATIONAL BUSINESS AND TECHNICAL EXAMINATIONS BOARD

(GENERAL EDUCATION EXAMINATION)

MAY/JUNE 2007

SECTION B

CHEMISTRY (ESSAY)

TIME: 1 HOUR 40 MINUTES

1. (a) Give THREE differences between a physical and chemical change.

(b) What do you understand by the term eletrovalency?

(C) X is an element with relative molecular mass 24 and atomic number 12. It form a chloride whose relative molecular mass is 95.

i. Give the equation of the reaction.

ii. When the element X reacts with water it forms a chloride which dissociate to give the ion, explain the differences between X atom and X ion.

iii. State the type of valency in the chloride.

iv. Write a balanced equation for the reaction of X with water

Solution

1) 3 differences between a physical and chemical change

Physical change	Chemical change
No new substances are formed	entirely new substances are formed
It is easily reversible	not easily reversible
No change in mass of substance. Involved	involved changes in mass of substances
Accompanied by small heat change	accompanied by great heat change.
Component can be separated by physical reaction	component cannot be separated by physical (but chemical) reaction

b. Eletrovalency is the process of forming an electrovalent bond/ions by transfer of electrons from

Substance (usually a metal) to another substance (usually a non- metal).

C(i) $X_{(s)} + Cl_2(g)$------→ $cl_{2(s)}$

(ii) $Xcl_2(s)$ -------→ X^{2+} + 2cl

X^{2+} + has 10 elections while

X has 12 electrons.

i. Electrovalency

ii. $X(s) + H_20$ (i) -----→ $Xo_5 + H_{2\,(g)}$

(d) Calculate the percentage of water of crystallization in the chemical compound magnesium tetraoxosulphate (V1) hexa hydrate. [H =1, 0 = 16, S = 32, Mg = 24]

(e) Give five examples of hydroscopic substances. Give their formulae.

(f) RMM of $MgSo_4 . 6H_20$

24 + 32 + (16X4) + 6(2+16) = 228

Rmm of $6H_20$ = 6(2+16) = 108

∴ PERCENTANGE of water of crystallization

$= \frac{108}{228} \times \frac{100}{1} =$ 47.37%

(e) $NaNO_3$ H_2SO_4 (Concentrated) Cu0, Cao(s)

(2a) State the law of constant composition.

(b) What is the (1) number of moles and (ii) mass of copper deposited when 96, 50.C coulombs of electricity is passed through copper II Salt.

(C). With the aid of a well labeled diagram, show how ethane can be prepared in the laboratory

(d). Give four chemical reactions of ethane (use equations only)

(e). Give four uses of ethane.

Solution

The law of constant composition states that all pure samples of a particular chemical compound contain the same elements combined in the same proportion by mass.

Cu^{2+} (aq) + 2e -----→ CU(s)

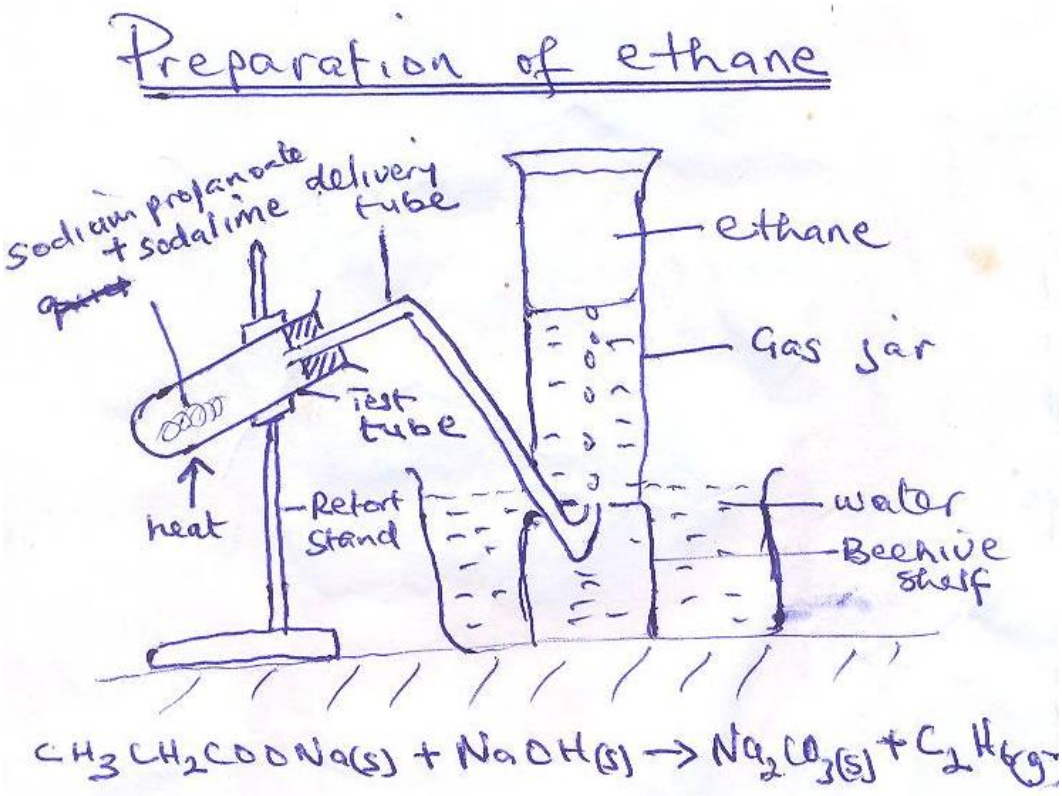
∴ 2 faraday (2x96, 500^{c}) deposits 1 mole (63.5g) of copper.

∴ 96.500C of electricity will deposit

63.50/193,000 x 96.50C = 0.32g of copper

0.32/63.5 = 0.0054 mole of copper.

Preparation of ethane



2(d) Chemical Properties of Ethane.

$2C_2H_6 + 7\ O_2 \rightarrow + 6H_2O + 4C0_2$

$C_2H_6 + 6Cl_2$ light $C_2cl_6 + 6HCl$

2(e) Uses

a. As fuel

b. In manufacture of other compound e.g. hexachloroethane (accept any derivative of C_2H_6).

3a. What is an electrolyte?

b. Describe the production of chlorine from brine

c. Write a balanced chemical equation for the reaction of chlorine with

i. An aqueous solution of sulphur oxide.

ii. A metal

iii. Potassium iodide

iv. Ethene

v. Ethyne

solution

(3a) An electrolyte is a molten compound or a compound in solution which conducts electricity by the movement of its ions (to the electrodes).

3b.The electrolytic cell is known as the kellner-solvary cell. The anode consists of carbon (graphite) rods dipping into brine contained in a tank. A layer of mercury flowing in at the base of the tank serves as the cathode. Fresh brine is introduced at one end of the tank and come out at the opposite end. At the anode chloride gas is liberated and then collected $2Cl^- \rightarrow cl_2 + 2e$.

At the cathode the sodium forms an amalgam.

Nat + Hg ---------> Ha/Hg. The amalgam is treated with water in another tank.

$2\ Na/Hg\ (L) + 2\ H_20\ (L) \text{ ----> } 2NaOH\ (aq) + H_2\ (g) + 2\ Hg$

(3Ci). $C\ l_2\ (g) + S0_2\ (g) + 2H_2o_{(2)}(g) \text{----> } H_2S0_4\ (aq) + 2\ HC(aq)$

ii. $2x + Cl_2 \rightarrow 2\ x\ Cl_2$

OR $X + Cl_2 \rightarrow X\ Cl_2$

OR $2X + 3cl_2 \rightarrow 2xcl_3$

(Metal must be specified to score)

1) $2\ kl\ (aq) + cl_2(g) \rightarrow 2kcl(ag) + I_2(s)$

2) $Cl_2 + C_2H_4 \rightarrow C_2H_2cl_4$

3) $2Cl_2 + C_2H_2 \rightarrow C_2H_2Cl_4$

(3d). What volume of dry hydrogen chloride gas at s.t.p will dissolve in $500cm^2$ of water to produce 0.1m solution of the acid.

(e) Consider the following nuclei

i. $^{12}C_6$ $^{13}C_6$, $^{14}C_6$

ii. $^{16}O_8$ $^{17}O_8$

i. $^{207}{}_{82}Pb$ $^{208}{}_{82}pb$

II. Give the number of protons and neutrons in their nuclei.

Solution

(3d). 0.1MH Cl = 0.1 mole Hcl in $1000cm^3$ of solution. This is equivalent to 0.05 mole in $500cm^3$ of solution /mole of Hcl gas occupies of 22, $400cm^2$ at stp.

$\therefore$ 0.05 mole Hcl gas will occupy (22400x0.05) cm^3 at stp = $1120CM^3$ OR 1.12dm at stp.

(3e) nuclei	number of protons	*1. number of neutrons*
$^{12}C_6$	6	*6*
$^{13}C_6$	6	*7*
$^{14}C_6$	6	*8*
$^{16}O_8$	8	*8*
$^{17}O_8$	8	*9*
$^{207}Pb_{82}$	82	*125*
$^{208}Pb_{82}$	82	*126*

4(a) With the aid of chemical equation only, distinguish between reversible and irreversible reaction.

$N_2(g) + 3H_2(g) \dashrightarrow 2NH_3((g)$ (reversible)

$Ag\ N0_3(ag) + NaCl\ (ag) \dashrightarrow AgCl(s) + NaNO_3$ (irreversible)

Accept other equation with appropriate reversibility or irreversibility sign.

4b.i) Give two condition that is required for iron to rust.

ii. State how the formation of rust can be prevented

Solution

4b.i) presence of air and water

ii. * Oiling

4) Galvanizing

5) Greasing

6) Painting

7) Electro planting

8) Cathodic protection

4c. Use equation to show what happens when the following compounds are exposed to the atmosphere.

1) Anhydrous calcium chloride

2) Calcium oxide

3) Solid sodium hydroxide.

4d. Calculate the mass of a metal which combine with 1.5mole of oxygen when 24.0g of a metallic oxide was reduced by dry hydrogen to the metallic element and water weighing 2.0g(0=16)

4d. $M0 + H_2 \rightarrow M + H_2O$

24g 2.0g

(Accept any other balance equation)

Mass of oxygen in 2.0g of H_2O

$\frac{16}{18} \times \frac{2.0}{1} = 1.8g$

* Mass of M in 24g of MO = 24 -1.8 =22.2g

∴ 1.5 mole of oxygen = 1.5 x 16 =24g

∴ 1.8g oxygen combines with 22.2g of m

∴ 24g of oxygen combines with

$\frac{22.2}{1.8} \times \frac{24}{1} = 296g$ of M.

4(e) Give two uses of sodium

(e) Uses of sodium

* Manufacture of compound e.g. sodium peroxide, sodium cyanide e.t.c
* In sodium vapors lamps (for lighting highway and airport)
* Liquid sodium is used as a coolant in nuclear reactors.
* Sodium and ethanol or sodium amalgam and water are very good reducing agents.

5a. List four factors that can alter the rate of chemical reaction.

FACTORS THAT CAN AFFECT REACTION RATE.

1) Nature of the reactants
2) Concentration/pressure (for gases) of the reactant
3) Surface area of reactants.
4) Temperature of reaction mixture
5) Presence of light
6) Presence of a catalyst.

5b. With the aid of equation show

1) How sodium reacts with water
2) What happens when water is added drop by drop to quick line
3) The amphoteric property of aluminum.

5bi. $2Na_{(s)} + 2H_2O\ (i) \rightarrow 2NaOH\ (aq) + H_2\ (g)$

ii. $CaO(s) + H_2O\ (i) \rightarrow Ca(OH)_2\ (s)$

iii. $2Al(s) + 6H\ Cl(ag) \rightarrow 2AlCl_3(aq) + 3H_2\ (g)$

OR

$2Al_{s)} + 6H_2SO_4\ (ag) \rightarrow Al_2\ (So_4)_3\ (ag) + 6H_2O\ (1) + 3SO_2(g)$

$2Al(s) + 2NaOH\ (aq) + 6H_2O\ (1) \rightarrow 2NaAl\ (OH)_4\ (aq) + 3H_2(q).$

(5ci) Explain how aluminum can be extracted

ii. Give THREE physical and chemical properties of Al

iii. Give three uses of Al

Solution

5ci. First heat the bauxite with NaOH (under pressure) to form sodium aluminates.

$Al_2o_3(s) + 2\ NaOH\ (aq) + 3H_2O\ (I)$ ----→ $2\ Na\ Al\ (OH)_4\ (aq)$

1) Filter the solution
2) Seed the filtrate with aluminum hydroxide crystal (in Order to precipitate AL $(OH)_3$).
   $Na\ Al\ (OH)_4(aq)$ -----→ $Al\ (OH)_3\ (s) + NaOH\ (aq)$
3) Filter off, (wash , dry) and heat strongly the $AL(OH)_3$ to Yield pure aluminum oxide (alumina)
   $2Al\ (OH)_3\ (s)$ heat→ $Al_2\ O_3\ (s) + 3H_2O_{(C)}\ (i)$

   The alumina is electrolyzed (at 950^{0c} with graphite electrodes)

4. At cathode , aluminum is deposited
   $Al^{3+} + 3e$ --→ Al

5. At anode oxygen gas is given off

20^{2-} ----→ $O_2 + 4e$

PHYSICAL PROPERTIES OF ALUMINUIM

- It is a silvery –white solid
- It has a relatively low density(2.7)
- It is very malleable and ductile
- It has a moderate tensile strength
- Its melting point is 660^{0c}
- It is a very good conductor of heat and electricity

(5ii) <u>CHEMICAL PROPERTIES OF ALUMINIUM</u>

- At 800^{0C} it reacts with air $4\ Al(s) + 3O_2(g)$ --→ $2Al_2O_3(s)$
- It combines directly with most non-metals $2Al\ (s) + 3Cl_2(g)$--→$2Alcl_3(s)$
- It reacts with acids $2Al + 6HCL$---→ $2AlCl_3 + 3H_2$
- It reacts with alkalis $2AL + 2NaOH + 6H_2O$--→$2NaAl(OH)_4 + 3H_2$
- It reduces Iron (III) oxide to iron $2Al(s) + fe_2O_3\ (s)$-→$AL_2O_3(s) + 2Fe(s)$
- It forms a white gelatinous precipitate with drops of ammonia.

$Al^{3+} + (ag) + OH\ (ag)$ --→ $Al\ (OH)_3(s)$.

This precipitate is insoluble in excess ammonia

5ciii). <u>USES OF ALUMINIUM</u>

- For making cooking utensil
- For making overhead electric cables
- Aluminum powder is used in paint/mirror , cars (coating of glass)
- For making alloys (e.g. bronze is CU&Al)
- In the thermit process (for welding iron together)
- Aluminum foil is used for packaging materials
- Aluminum ion is used as a coagulating agent/preparation of alums.

(5d) Naturally occurring lithium contains 90% 7_3 LI and 10% $6_{}_3$LI
calculate the relative atomic mass of lithium.

(d) Relative atomic mass = [90/100 x 7/1] + [10/100x 6/1] = 6.3 + 0.6 = 6.9

(5e) Copy and complete the table below

Element	Atomic Number	Number of Neutrons	Electronic Configuration
$^{1}_{1}H$	1	0	15^1
$^{16}_{8}o$	8	8	$15^2\ 25^2\ 2p^4$
$^{24}_{11}Na$	11	13	$15^2\ 25^2\ 2p^6\ 35^1$
$^{35.5}_{17}Cl$	17	18, 20	$15^2\ 25^2\ 2p^6\ 35^2\ 3p^5$
$^{31}_{19}K$	19	20	$15^2\ 25^2\ 2p^6\ 35^2\ 3p^5$
$^{55}_{25}mn$	25	30	$15^2\ 25^2\ 2p^6\ 35^2\ 3p^6 45^2 3d^5$
$^{12}_{6}C$	6	6	$15^2\ 25^2\ 2p^2$
$^{39.9}_{18}Ar$	18	21, 23	$15^2\ 25^2\ 2p^6\ 35^2\ 3p^6$