**Our country, our future**

**525/1**

# S6 CHEMISTRY

**Exam 11**

***PAPER 1***

## DURATION: 2 HOUR 45 MINUTES

**For Marking guide contact and consultations: Dr. Bbosa Science 0776 802709,**

Instructions

- This paper consists of two sections A and B
- Section A is compulsory
- Attempt only six questions in section B
- Answers must be written in the spaces provided only.
- Where applicable
  Gas constant, R, = 8.31 JK-1mol-1
  Molar volume at s.t.p is 22.4liters
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| For Examiner's Use Only | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| | | | | | | | | | | | | | | | | |

SECTION A

1(a) Define the term "standard heat of reaction."

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(b) Given the following data:

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|---|---|
| Enthalpy of formation of magnesium chloride | = - 641.62kJmol$^{-1}$ |
| Lattice energy of Magnesium chloride | = +2495.6 kJmol$^{-1}$ |
| Hydration energy of chloride ions | = -378.0 kJmol$^{-1}$ |
| Enthalpy of solution of hydrogen chloride gas | = -74.8 kJmol$^{-1}$ |
| Heat of formation of hydrogen chloride gas | = -92.32 kJmol$^{-1}$ |
| Hydration energy of magnesium ions | = -1926 kJmol$^{-1}$ |

Calculate the enthalpy of the reaction;

$Mg(s) + 2HC1\ (a\ q) \longrightarrow MgCl^{2}\ (aq) + H_2\ (g)$ (4 marks)

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2. A gaseous oxide of sulphur $SO_n$ diffused through a porous partition in 2.68 minutes while an equal vaolume methane at the same temperature diffused in 1.1985 minutes.

(a) Determine the value of n in the oxide $SO_n$, (2 ½ marks)

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(b) The oxide in (a) above reacts with benzene via an electrophilic substitution mechanism.

(i) Stale whether the oxide in (a) above acts as an electrophile or nucleophile. Give a reason for your answer. (1½ marks)

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(ii) Write equation for the reaction with benzene and outline the mechanism. (2 ½marks)

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3. Give the reagent(s) that can be used to distinguish between each of the following pairs of compounds and state what would be observed in each case if the reagent is reacted with each compounds. (2marks each)

$CH_3CHCH_3$ and $(CH_3)_2NH_2$
$NH_2$

(2 marks)

Reagent

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Observations.

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(b) NiO and CuO (2 marks)

Reagent

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Observations.

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(c) $Na_2C_2O_4$ (aq) and $Na_2SO_3$ (aq)

Reagent

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Oobservations

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3. Boron and nitrogen form chlorides in oxidation state +3

(a) Draw the structure and name of the shape adopted by each of the chloride (2marks)

(b) Explain why the molecules formed by booron in (a) above is non-polar. (2marks)

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(c) Write an equation for the reaction of each compound in 9a) above with water. (2marks)

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4. The standard redox potentials of $Fe^{3+}(aq)/Fe^{2+}$ and $Sn^{2+}(aq)/Sn^{4+}(aq)$ are -+0.76 V and -0.15V respectively.

(a) Write an equation for the half-cell reaction at the:

(i) the cathode (2marks)

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(ii) anode (2marks)

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……(b) State two conditions under which the electrode potentials above are measured (2marks)

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(c) Deduce if the overall reaction is feasible or not. Give a reason for your answer. (2 marks)

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5. (a)Define the term freezing point depression constant of a solvent. (1mark)

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(b) In an experiment, a 5 per cent solution of glucose , $C_6H_{12}O_6$ in water found give the same freezing point depression as a 3.3% aqueous solution of $C_nH_{2n}O_n$.

(i) Determine the molecular formula of $C_nH_{2n}O_n$• (3 marks)

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(ii) The compound in b(i) above forms a crystalline white precipitate with saturated sodium hydrogen sulphite solution but no observable change with ammoniacal silver nitrate solution. It also reacts with ethanoic acid in the presence of concentrated sulphuric acid to give a product with a sweet fruity smell.

Write the structural formulae and I U PAC name of one of the isomers of $C_nH_{2n}O_n$.

(l mark)

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6. The first ionization energies of group II metals and the melting point of their

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ionization energies of group Il metals and the melting points of their chl€l

| Metal | Mg | Ca | Sr | |
|---|---|---|---|---|
| [ First ionisation energy ((KJmol -l ) | 738 | 590 | 549 | 505 |
| Melting point of chloride CC) | 708 | 772 | 873 | 967 |

Explain.

(a) why the ionisation energy decreases from Mg to Ba. (2 marks)

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(b) why melting points of the chlorides of the metals increase With increase in acornžc numbera (2 marks;

1.7g of ammoniagas were into of water at In a closed sy stern .The mixture was maintained at equilibrium was establishcd and the

equali brium mixture found to contain I .67 i7í34g 01 unionised arnrnonta,

(i) Write an equation for the ionisation of ammonia in water. (l mark)

(ii) Calculate the degree of Ionisation of ammonia in water at 25 $^{0}$ C. (l mark)

(b) Deduce the basic dissociation constant of ammonia at 25 $^{0}$C from your answer a(il) above (1½ mark)

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(c) The basic dissociation constant of methylarnme is 4.38 x 10 $^{4}$ mol dill $^{3}$ at 2

(i) Compare the basic strength of ammonia and methylamine. ( '/9. mark)

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(ii) Give a reason for your answer in c(i) above. _rrlarks)

A solid mixturcof manganese (IV) oxide, potassium chlorate (V) and potasshydroxide was fused an Il-on crucible. Hot water was added (o the produci to forma green solution.

(i) Name the green solution. ( $^{I}$p, mark)

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(ii) Write an equation leading to the formation of the green solution ( j mark)

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(b) Carbondloxide gas was bubbled through the green solution in a(i) abovc.

(i) State what was observed. (1 mark)

(ii) Explain your observation in b(i) above. (2 rnarksj

## SECTaON g

Attempt any six questions from this section.

20cm of an organic compound Q belonging to C Il series were mixed with 200cm ox vgcm. The _rruxt-urc was sparked and the residual gaseous product absorbed in Lo oncentŸated potassium hydroxide solution. The final volume of gas at room 'temperatu re was found to be 30.0cm3 .

(a) Determinc the molecular formula of Q. (3 marks)

(b) Q react with bromine water and also decolourises acidified potassium ganate(Vll) (Mole ratio Q:$Br_2 = 1$

(l) Identifv Q. ( 1/2 mar-IQ)

(ii) Write an equation for the reaction between Q and Brorrllne water. mark)

(c) Q reacts with 1101 water in the presence of Conc. to form P which is oxidised to R by acidified potassium dichromate (VI).

(i) Identify P and R. (l mark)

(ii) Suggcsl a ii-ablc mcchanlsyxı for ⁱhe reactionlociwccn 'l? and hydroxylamine in Ûhc presence of arı acid. (3 111 arks)

(İ i İ) Namc thc final product for thc rcaction in c(ii) abovc. mark j

(a) Thc soluıbility product Ksp of calcİurn fluoridc can be determirıcd by conduc1İvİiY rncasuırcrncni at [25 $^{0}$C. Thc cicctrolytic corıdıiclivitjcs of watcr amcı a salı: rated

soluıiion of ca]cıuıvn fluoriclc arc2 75 x 10 $^{4}$ ç) cm 554 x 1 0 $^{-3}\Omega^{-1}$cmrcspccüıvcly. Giyen thaf -[hc molar conducfivitics of calcıum ions and fluoride ions atinfinite di]ution arc 1 19,0 and 5 5.41) $^{\hat{A}}$ cm $^{2}$ mo! respectivcly .

[Definc tYıc terrrı solutbilitv prod

(ii) Calculate the solubility -produci of calcium fluoride at 2 5 $^{0}$ C. State any assumption s) made. (5 marks)

( b) Compare the solubilitv of calcium fluoride in pure water and its golubility in

O. 1M potassium fluoride solution at 25 $^{o}$c ( : 2 mark)

(11 Explain your answer In b(i) above. (2 marks)

(c ) State one other factor that can affect the solu bility of calcium fluoride. ( rnarl<)

Group (Vll) elements rcact with hydrogen gas to form hydrides of thc formula $HX$ ($X$ = F, Cli and I).

(a) Describe thc reaction of the hydrides with:

(i) Sodium carbonate solution. (1 $^{1}$/9 marks)

(ii) Sulphuric acid marks)

Phe boiling points and bond dissociation encrgics of the hydrides (HX) are in the table below.

| Hydride (HX) | HF | HCl | HBr | HI |
|---|---|---|---|---|
| Bond energy ($(KJmol^{-1})$ | 562 | 431 | 366 | 298 |
| Boiling point (°C) | +19.9 | -85.0 | -67.0 | -35.0 |

the table below.

State and explain the variation In:

Boiling points of the hydri(hns.

Bondenergy oi Pi X bond flom PIF 1.0 (2 marks)

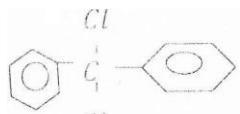
\vVrite equations to show how the following compounds can bc synthesized.

aIodoetharyc to Iodomethane. (3½ marks)

13.

14.

(b) Phenol 4 -bromobcnzencsulphonic acid. (3 marks)



enzoic acid to (2½ marks)

Explain each of the following observations.

a) Methanol are misciblel in all proportions however hexan-l-ol is immiscible with water (2 i 2 marks)

(b) The boiling points of water and brornobenzene are 100 °c and 1 56 $^{0}$C rcspecUEQiv however a mixture of water and bromobcnzene boils below 100 °c at atmospheric

pressure. (3 1/7, marks)

monia solution added to aqueous nickel (I l) sulphate solution, a precipitate soÀüble in excess ammonia to íorrn a blue solution. (3 marks)

15.

[ Ivdrooen -peroxidc can act as an oxidisinø or reducing agent.

(a) State the condition(s) under which hydrogen peroxide acts as.

(i) an oxidising agent. (½ mark}

(ii) a reducing agent. (½ mar ve

(b) Write half reactions to show how hydrogen peroxidc acts as a;

(i) reducing agent. (i tnavk)

(ii) Oxidising agent. (l mal k)

In an experiment if) deterrnme the volu me strength of Hydrogen peroxide (volume of oxygcrgas at s l. liberated by the decomposition of of sob Itian), of I lydrogcn peroxi (x volumes) were diluted to make 250 cyn of aqueous solution labellcd FAI . 20 cm of FAwere pipette followed by an equal volume of 1M Ii2S(W Thc mixture was titrated with exact/ v .30$cm^3$ of 0.02M potassium manganate (V Il) solution.

O) Write the redox reaction that occurs during the titration (l mark)

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(ii) Give a reason why the titration of hydrogen peroxide is done with potassium man [a]anate (VIl) but not a solution of Iron (Il) ions. (l marks)

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(iii) Calculate the volume strength of the hydrogen peroxide used in the above experiment.

2 [1202 (aq) $\longrightarrow 2H_20(l)$ molar gas volume at s. t. p 22400$cm^3$)

(3 5/2 marks

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16.

Chloroethcne and hcxane- l , 6-dioic acid and hexane-1 6-diaminc are monorncrs of two synt betic polymers namely; polvvjnyl chloride and nylon respectivelv.

(a) Define the tcrvn "Polymer ( 1 marks)

(b) Write the structural formula of;

(i) chloroethcne ( I/O mark)

(ii) hexane- I ,6-dioic acid and hexane- l ,6-diarnine. / > rnark)

(c) Write the structural formula of each of the polymers in (b) above and state the tv pc of polyrncrisation involved. (3 marks}

(d) State one use of each of the polymers in (c) above. (2 marks)

(c) Name one natural polymer formed by the same reaction as •

(i) Polyvinyl chloridc. (½ mark)

(ii) nylon, 6, 6. ma rk)

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Ethyl bromide reacts with sodium hvdroxidc according to the equation:

$CH_3CH_2Br(l) + NaOH(aq) \longrightarrow CH_3CH_3CH_2OH(aq)$ + Na/3r(aq)

• he -rate equation IS (Yiven by s

Rai e KIC/13C//È/3rl X iNaC)//l Y wherc x and y are the respective orders of reactio).02M cíhvtbrornide and sodium hydroxide •were mixed and refluxed in a flask.20cm samples were withdrawn at regular time Intervals and poured in excess cold water then titrated against 0.05M hydrochloric acid as shown below.

| Time (minutes) | o | 25 | 1 5 | 075 | 100 | 200 | 150 | 250 |
|---|---|---|---|---|---|---|---|---|
| Titrc (cm 3 ) | 32.0 | 18.0 | 10.0 | 8.4 | 8.8 | | 6.2 | 4.0 |

a Define I Inc term order of reaction. (1 marks)

(b) PloC a graph of titre (volume of 0.05M HCI) against Urne. (3 marks)

(i) Use your graph to determine the value of y in the rate equation (2 r

Rate = Cl[2Brl $^{x}[NaOH]$

(i!) Deduce the value of x in ratc equation if t_hc overall order of the reaction IS J (l mark)

(d) Brieflv explain how the rate of reaction would be affected by temperaturc if the concentrations of both reactants were maintained constant (l marks)