1992

CHEMISTRY

UNIT 3
TRIAL EXAM

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CANDIDATE'S NAME________________________________

CHEMISTRY ASSOCIATES

CHEMISTRY CAT 1 TRIAL
CHEMISTRY IN A PRACTICAL CONTEXT
(not to be used before Friday May 1, 1992)
Time allowed for test = 90 minutes.

MULTIPLE CHOICE ANSWER SHEET SECTION A

Instructions:(1) Mark letters with a single pencil line
EXAMPLE A B ~~C~~ D
(2) Completely erase any mistakes.
(3) One and only one letter should be marked for each item

(1) A B C D
(2) A B C D
(3) A B C D
(4) A B C D
(5) A B C D
(6) A B C D
(7) A B C D
(8) A B C D
(9) A B C D
(10) A B C
(11) A B C D
(12) A B C D
(13) A B C D
(14) A B C D E
(15) A B C D
(16) A B C D
(17) A B C D

<u>DETACH THIS ANSWER SHEET AT THE START OF THE EXAMINATION</u>

CHEMISTRY ASSOCIATES   CANDIDATE'S NAME ___________________________

CHEMISTRY CAT 1 TRIAL
CHEMISTRY IN A PRACTICAL CONTEXT

Structure of examination paper: Number of booklets = 1
Number of Sections = 2

SECTION	NUMBER OF QUESTIONS	NUMBER OF QUESTIONS TO BE ANSWERED	PERCENTAGE OF EXAMINATION
A	1 (17 items)	1 (17 items)	33
B	9 (numbered 2 to 10)	6 (numbered 2 to 10)	67

There is a Multiple Choice Answer Sheet attached to the front of this booklet.

DIRECTIONS TO CANDIDATES

(1) Answer ALL questions in Section A and as directed in Section B.

(2) Section A questions must be answered on the Multiple Choice Answer Sheet provided.

(3) Section B questions must be answered in the spaces provided.

(4) Approved calculators may be used.

(5) To answer certain questions, you may need to refer to the data sheet on the back of this page.

(6) At the end of the examination, place the Multiple Choice Answer Sheet inside the back cover of this booklet and hand them in.

(7) Please ensure that you write your name on this booklet AND on the Multiple Choice Answer Sheet.

SPECIFIC INSTRUCTIONS FOR SECTION A

(1) Section A, Question 1, consists of 17 multiple choice items and is worth 17 marks and therefore about 33% of the total marks available for this examination.You should therefore spend about 30 minutes on Section A.

(2) Choose the response you consider is correct or best, and mark your choice on the Multiple Choice Answer Sheet according to the instructions on that sheet.

(3) A correctly answered item scores 1, an incorrect item scores 0. No credit will be given for an item if two or more letters are marked for that item. Marks will NOT be deducted for incorrect answers and you are urged to attempt every item.

(4) Jottings should be done in the WORKING SPACES in this booklet.

1992 CHEMISTRY CAT 1 TRIAL

DATA

TABLE 1: RELATIVE ATOMIC MASS (^{12}C = 12.00)

Element	**Symbol**	**Atomic No.**	**Relative Atomic Mass**
Aluminium	Al	13	27.0
Barium	Ba	56	137.3
Bromine	Br	35	79.9
Calcium	Ca	20	40.1
Carbon	C	6	12.0
Chlorine	Cl	17	35.5
Copper	Cu	29	63.5
Iron	Fe	26	55.9
Hydrogen	H	1	1.0
Magnesium	Mg	12	24.3
Nitrogen	N	7	14.0
Sodium	Na	11	23.0
Oxygen	O	8	16.0
Phosphorus	P	15	31.0
Sulfur	S	16	32.1
Strontium	Sr	38	87.6
Zinc	Zn	30	65.4

TABLE 3: PHYSICAL CONSTANTS

Avogadro Constant (N_A) 6.023 x 10^{23} mol^{-1}
Gas Constant (R) 8.31 J K^{-1} mol^{-1}
Molar Volume of gas at STP 22 400 cm^3 mol^{-1} = 22.4 dm^3 mol^{-1}
Pressure 1 atmosphere = 101 325 Pa

Item 1
In a volumetric analysis, the correct technique is essential for accurate results. The correct preparation of a burette for volumetric analysis is:
A. Rinse with the solution to be used.
B. Rinse with distilled water.
C. Rinse with distilled water and dry thoroughly.
D. Dry thoroughly.

Item 2
When 5 cm^3 of 0.01M hydrochloric acid is mixed with 15 cm^3 of 0.03M hydrochloric acid, the hydrogen ion concentration of the resulting solution is
A. 0.045 M
B. 0.035 M
C. 0.025 M
D. 0.015 M

Item 3
Potassium dichromate, $K_2Cr_2O_7$, can be used to oxidise ethanol to acetic acid according to the partial equations:

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l) \text{ and}$$

$$C_2H_5OH(aq) + H_2O(l) \rightarrow CH_3COOH(aq) + 4H^+(aq) + 4e^-$$

The volume of 0.1M potassium dichromate required to oxidise 9.2 g of ethanol to acetic acid is
A. 0.33 dm^3.
B. 1.33 dm^3.
C. 2.33 dm^3.
D. 4.33 dm^3.

Item 4
Nitric acid can be manufactured from the element nitrogen using the steps:

$$N_2 \xrightarrow{\mathbf{1}} NH_3 \xrightarrow{\mathbf{2}} NO \xrightarrow{\mathbf{3}} NO_2 \xrightarrow{\mathbf{4}} HNO_3$$

The step in which there is a change of -1 in the oxidation number of nitrogen is
A. **1**
B. **2**
C. **3**
D. **4**

Item 5
On spacecraft the cabin atmosphere can be cleansed of carbon dioxide by passing the air through canisters of potassium hydroxide, KOH.
The equation that best describes this reaction is
A. $KOH = K^+ + OH^-$
B. $CO_2 + H_2O = HCO_3^- + OH^-$
C. $CO_2 + 2OH^- = CO_3^{2-} + H_2O$
D. $H^+ + OH^- = H_2O$

Item 6

The amount of the element barium in a solution may be determined experimentally by precipitating the barium as $BaSO_4$ using dilute sulfuric acid. If 24.90 cm^3 of 0.020 M sulfuric acid is needed to precipitate all of the barium as $BaSO_4$, then the mass of barium in the solution is

A. 0.034 g.
B. 0.068 g.
C. 0.116 g.
D. 68.4 g.

Item 7

5 g of sodium hydroxide is dissolved in 5 dm^3 of water. The molarity of the hydroxide ion in solution is approximately

(Molar mass of NaOH = 40 g mol^{-1})

A. 0.025 M
B. 0.25 M
C. 1.00 M
D. 10.00 M

Item 8

Ammonia can react with oxygen under controlled conditions to form nitrogen monoxide and water. The mass of nitrogen monoxide that can be produced from 34 g of ammonia in this reaction is

A. 17 g.
B. 30 g.
C. 34 g.
D. 60 g.

Item 9

When 100 cm^3 of 1 M HCl solution reacts exactly with 100 cm^3 of 1 M NaOH solution, the pH of the resulting solution is

A. 0
B. 1
C. -log 0.5
D. 7

Item 10

The equilibrium between NO(g), O_2(g) and NO_2(g) is described by the equation:

$$2NO(g) + O_2(g) \Leftrightarrow 2NO_2(g) \qquad \Delta H = -114 \text{ kJ}$$

At a temperature of 500 K , the equilibrium constant is 6.6×10^5.

When the temperature of this equilibrium mixture is decreased at constant volume, the number of mole of NO_2 in the equilibrium mixture

A. increases.
B. remains the same.
C. decreases.

Item 11

Sulfur trioxide is produced from sulfur dioxide and oxygen according to the equation

$$2SO_2(g) + O_2(g) \overset{\text{catalyst}}{\Leftrightarrow} 2SO_3(g) \quad \Delta H = -198 \text{ kJ mol}^{-1}$$

The equilibrium yield of sulfur trioxide will be **high** under conditions of

A. high temperature, high pressure and low concentation of sulfur dioxide.
B. low temperature, high pressure and excess air.
C. high temperature, low pressure and excess air.
D. low temperature, low pressure and excess sulfur dioxide.

Item 12

Sulfur trioxide, SO_3, is absorbed in water to form sulfuric acid, H_2SO_4. Assuming complete ionisation of the sulfuric acid, what is the pH of the resulting solution when 0.5 mol of SO_3 is completely absorbed in 100 cm^3 of water?

A. -log 0.25
B. -log 0.5
C. -log 5
D. -log 10

Item 13

The cracking of petroleum fractions is necessary in addition to fractional distillation because distillation does not produce

A. any of the lighter fractions.
B. any of the heavier fractions.
C. a sufficient amount of the lighter fractions.
D. a sufficient amount of the heavier fractions.

Item 14

How many mole of oxygen are required for the complete combustion of 1.5 mole of ethene (ethylene)?

A. 0.5
B. 1.0
C. 1.5
D. 2.0
E. 3.0

Item 15
Water has a higher surface energy than ethanol because there are

A. weaker bonds inside the water molecule than inside the ethanol molecule.
B. stronger bonds inside the water molecule than inside the ethanol molecule.
C. weaker bonds between the water molecules than between the ethanol molecules.
D. stronger bonds between the water molecules than between the ethanol molecules.

Item 16
Which one of the following is **NOT** a property of a catalyst?

A catalyst

A. increases the rate of a reaction.
B. changes the position of equilibrium in a reaction.
C. increases the rate of the forward and reverse reactions equally.
D. lowers the activation energy of a reaction.

Item 17
One advantage of a biological catalyst (enzyme) over an inorganic catalyst is that the enzyme

A. produces a more complete reaction.
B. works under less severe conditions.
C. operates equally well on a large number of chemical reactions.
D. does not produce any unwanted by-products.

SPECIFIC INSTRUCTIONS FOR SECTION B

(1) Section B consists of 9 short response questions, Questions 2 to 10, and is worth 36 marks and therefore about 67% of the total marks available for the CAT. You should therefore spend about 60 minutes on Section B. A suggested time allocation is given for each question and these time allocations are proportional to the marks available.

(2)You must answer questions 2, 3, 4, 5 and ONE of 6 or 7 and ONE of 8 or 9 or 10.

(3) Answers must be written in the spaces following each question in this booklet.

(4) You should show all working in numerical questions. No credit can be given for incorrect answers unless they are accompanied by details of the working.

(5) Full credit will **not** be given for unsimplified answers. When stating an answer, appropriate precision (number of significant figures) must be used and the units included.

(6) When chemical symbols are used in equations they must be accompanied by correct symbols of state, for example $H_2(g)$ for hydrogen gas.

(7) Chemical equations must be balanced

QUESTION 2 (15 minutes, 9 marks)
Metallic iron can be produced in a spectacular exothermic reaction by mixing aluminium powder with finely divided iron(III) oxide and igniting the mixture using a magnesium fuse. The reaction is called the **thermite** reaction. The heat of reaction is sufficient to produce iron in molten form. The other product in the reaction is aluminium oxide.

(a) Write a balanced equation for the thermite reaction.

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(b) In such a reaction, 10 g of iron(III) oxide was mixed with 5 g of aluminium powder and the mixture ignited.
Calculate the mass of iron that could be produced from this reaction.

QUESTION 2 (continued)

(c) The products in the above reaction were crushed and the metallic iron was separated magnetically from the aluminium oxide and then dissolved in dilute sulfuric acid. The solution was then made up to 250 cm^3 in a standard flask. 20cm^3 aliquots of this solution were titrated with 0.100M potassium permanganate, $KMnO_4$, until all of the iron was oxidised to iron(III). An average titre of 19.65 cm^3 of $KMnO_4$ was required.

Write the overall balanced equation for the reaction between iron(II) and potassium permanganate in acid solution.

(d) Calculate the actual mass of iron produced in this reaction and, hence, determine the percentage yield of iron from the thermite reaction.

QUESTION 3 (10 minutes, 6 marks)

Formic acid ionises in aqueous solution to produce hydrogen ions and formate ions according to the equation: $HCOOH(aq) \Leftrightarrow H^{+}(aq) + HCOO^{-}(aq)$.
The equilibrium constant, K_c, for this reaction at 25°C is $10^{-3.74}$ M.

(a) If the equilibrium constant of formic acid, HCOOH, is 10^{-2} M, calculate the hydrogen ion concentration at equilibrium

(b) What is the pH of this solution?

QUESTION 4 (5 minutes, 3 marks)
Explain briefly what is meant by a catalyst. In your answer, you should explain the similarities and differences between inorganic and biological catalysts.

QUESTION 5 (10 minutes, 6 marks)

Outline the processes of thermal and catalytic 'cracking' of crude oil. In your answer explain why 'cracking' is carried out and describe the types of products derived from the processes.

ANSWER ONE QUESTION ONLY FROM QUESTIONS 6 AND 7

QUESTION 6 (10 minutes, 6 marks)
Describe the method that is generally employed to produce metallic iron. You should include in your answer
(1) the reactants used.
(2) the chemical equations for the main reactions taking place.
(3) the methods used to deal with impurities.

ANSWER ONE QUESTION ONLY FROM QUESTIONS 6 AND 7

QUESTION 7 (10 minutes, 6 marks)
You are given a sample of reasonably pure copper(II) sulfide, CuS. How could you prepare a sample of copper metal, beginning with the CuS.
Your description may consist of chemical equations and brief explanatory notes as appropriate. You may assume you have access to a reasonable stock of chemicals and equipment.

ANSWER ONE QUESTION ONLY FROM QUESTIONS 8 , 9 AND 10

QUESTION 8 (10 minutes, 6 marks)
Sulfuric acid is such an important industrial chemical that it is often claimed that the quantity of sulfuric acid produced in a country is a measure of the economic activity of that country. Briefly describe

(1) the method of production of sulfuric acid.
(2) the properties of sulfuric acid.
(3) the uses of sulfuric acid.

ANSWER ONE QUESTION ONLY FROM QUESTIONS 8 , 9 AND 10

QUESTION 9 (10 minutes, 6 marks)
Ammonia plays a vital role in a wide range of chemical industries. Briefly describe

(1) the method of production of ammonia.
(2) the properties of ammonia.
(3) the uses of ammonia.

ANSWER ONE QUESTION ONLY FROM QUESTIONS 8 , 9 AND 10

QUESTION 10 (10 minutes, 6 marks)
Nitric acid is one of the key chemicals in a modern chemical society. Briefly describe

(1) the method of production of nitric acid.
(2) the properties of nitric acid.
(3) the uses of nitric acid.

END OF 1992 VCE CHEMISTRY TRIAL CAT 1

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CHEMISTRY CAT 1 TRIAL
CHEMISTRY IN A PRACTICAL CONTEXT
SUGGESTED SOLUTIONS

QUESTION 1

ITEM 1 ANS A
The burette must be rinsed with the solution to be used so that when it is filled to the mark, the liquid within will be the correct concentration. By rinsing, any reaction with contaminants inside the tube will occur before the burette is filled.

ITEM 2 ANS C
n(HCl) = (0.05 x 0.01) + (0.15 x 0.03) = 0.0005 + 0.0045 = 0.005
$c(H^+)$ = c(HCl) = 0.005/0.20 = 0.025 M

ITEM 3 ANS B
V(dichromate) = $\frac{2}{3} \times \frac{9.2}{46} \times \frac{1}{0.1} = 1.33 \text{ dm}^3$.

ITEM 4 ANS D
The changes in oxidation number are respectively from 0 to -3 to 2 to 4 to 5. Hence, the +1 change in oxidation number occurs from NO_2 to HNO_3

ITEM 5 ANS C
Carbon dioxide is an acidic oxide which reacts directly with hydroxide ions to produce carbonate ions and water.

ITEM 6 ANS B
n(Ba) = $n(H_2SO_4)$ = 0.02 x 0.02490
m(Ba) = 137.3 x 0.02 x 0.02490 = 0.068 g

ITEM 7 ANS A
c(NaOH) = $\frac{5}{40} \times \frac{1}{5}$ = 0.025M

ITEM 8 ANS D
The balanced equation is: $4NH_3 + 5O_2 = 4NO + 6H_2O$
Hence, n(NO) produced = n(NH3) used up = $\frac{34}{17}$ = 2.0
m(NO) = 2.0 x 30 = 60 g

ITEM 9 ANS D
When equimolar amounts of HCl and NaOH are mixed, a neutral solution is produced with a pH of 7.

SUGGESTED SOLUTIONS

ITEM 10 ANS A
When the temperature of an equilibrium mixture is decreased, the equilibrium constant increases for an exothermic reaction. Hence, the number of mole of NO_2 will increase.

ITEM 11 ANS B
For an exothermic reaction producing a smaller number of mole of gas, the yield will be increased with a lower temperature, a higher pressure and an excess of reactant.

ITEM 12 ANS D
The equations are $SO_3 + H_2O = H_2SO_4$ and $H_2SO_4 = 2H^+ + SO_4^{2-}$.

Therefore $n(H^+) = 2 \times n(SO_3)$. $= 2 \times 0.5 = 1.0$ mol.

Hence, pH = - log 10.

ITEM 13 ANS C
Industry needs much greater amounts of the lighter fractions from petroleum than are produced naturally from fractional distillation. Hence, more must be be produced by cracking.

ITEM 14 ANS E
The balanced equation is $C_2H_4 + 3O_2 = 2CO_2 + 2H_2O$

Hence, the number of mole of oxygen required = 3 x 1.5 = 4.5 mol.

ITEM 15 ANS D
The bonds between water molecules are stronger than those between ethanol molecules because of stronger hydrogen bonding. This produces a higher surface energy.

ITEM 16 ANS B
A catalyst does **not** change the postion of equilibrium. It does change the rate at which equilibrium is reached.

ITEM 17 ANS B
A biological catalyst must operate at body temperature. It is able to work under mild conditions of temperature and pressure unlike inorganic catalysts.

SUGGESTED SOLUTIONS

Question 2

(a) $Fe_2O_3(s) + 2Al(s) \rightarrow Al_2O_3(s) + 2Fe(l)$

(b) $n(Fe_2O_3) = \frac{10}{160} = 0.0625$ and $n(Al) = \frac{5}{27} = 0.1851$

n(Al) required to react = 2 x $n(Fe_2O_3)$ = 2 x 0.0625 = 0.125

Therefore, the aluminium is in excess. Hence, n(Fe) = 2 x $n(Fe_2O_3)$ = 2 x 0.0625 = 0.125

Hence, m(Fe) = 0.125 x 55.9 = 7.0 g **ANS**

(c) $5Fe^{2+}(aq) \rightarrow 5Fe^{3+}(aq) + 5e^-$ and $MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(l)$

Overall equation: $MnO_4^-(aq) + 5Fe^{2+}(aq) + 8H^+(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$

(d) n(Fe) in 25 cm3 aliquot = n(Fe2+) = 5 x n(MnO4-) = 5 x 0.100 x $\frac{19.65}{1000}$

Therefore, n(Fe) total = 5 x 0.100 x $\frac{19.65}{1000}$ x $\frac{250}{20}$ = 0.1228

m(Fe) = 0.1228 x 55.9 = 6.865 g

% yield of iron = $\frac{6.87}{7.00}$ x 100 = 98.1% **ANS**

Question 3

(a) $K_c = \frac{[H^+][HCOO^-]}{[HCOOH]} = 10^{-3.74}$ and

assuming that $[H^+] = [HCOO^-]$,

then $[H^+]^2 = 10^{-3.74} \times 10^{-2} = 10^{-5.74}$.

Hence, $[H^+] = 10^{-2.87}$M **ANS**

(b) $pH = -\log_{10} [H^+] = -\log_{10} (10^{-2.87}) = 2.87$ **ANS**

Question 4

Catalysts are chemical substances which are usually present in small amounts compared with the actual amounts of reactants in a chemical reaction. They increase the rate of a chemical reaction by increasing the rate at which equilibrium is achieved. The final position of equilibrium is not changed by the catalyst. At the end of the reaction, the catalyst remains unchanged (although it may need replacement due to contamination if it is reused many times). A catalyst works by lowering the activation energy of a chemical reaction by providing an alternative pathway for the reaction to proceed. Biological catalysts (also called enzymes) are proteins which are able to work under mild conditions of temperature and pressure to achieve very fast reaction rates while being particularly selective about the reactions which they catalyse.

Question 5
Cracking is the breaking up of larger alkane molecules by high temperature or catalysts into smaller alkane molecules together with unsaturated molecules such as ethene and propene and frequently hydrogen gas. Crude oil was not produced with the consumer in mind! Our society requires much more of the lighter fractions from crude oil than is naturally available.Cracking is carried out to provide a larger amount of the lighter fractions obtained from crude oil and also to produce the unsaturated molecules required by the petrochemical industry. The use of catalysts in cracking allows the process to be carried out at lower temperatures and with more control over the types of products obtained. A typical catalytic cracking reaction is the production of ethene:
$C_3H_8(g) = C_2H_4(g) + CH_4(g)$

Question 6
The production of metallic iron is carried out in a blast furnace. The reactants are iron ore (haematite), coke, limestone and air. The chemical equations which summarise this process are:
(1) $C(s) + O_2(g) \rightarrow CO_2(g)$; (2) $CO_2(g) + C(s) \rightarrow 2CO(g)$;
(3) $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(l) + 3CO_2(g)$; (4) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$;
(5) $CaO(s) + SiO_2(s) \rightarrow CaSiO_3(l)$. The blast furnace process is continuous with the reactants fed in at the top of the furnace and molten iron taken out at the bottom. The impurities such as SiO_2 and Al_2O_3 form a slag which floats on top of the molten iron in the form of calcium silicates and aluminates. There is a gradual increase in the temperature of the blast furnace from top to bottom. The iron produced is called "pig iron" and contains many impurities which give it a brittle nature.

Question 7
The copper sulfide could be heated at high temperature in an atmosphere of oxygen to produce blister copper according to the equation: $CuS(s) + O_2(g) = Cu(s) + SO_2(g)$.
This copper could then be made the anode of an electrolytic cell which also had a pure copper cathode. The anode reaction would be: $Cu(s) = Cu^{2+}(aq) + 2e^-$ and the cathode reaction would be: $Cu^{2+}(aq) + 2e^- = Cu(s)$. Alternatively, the CuS could be dissolved in sulfuric acid and electrolysed directly to produce copper on the cathode.

Question 8

(1) the method of production is called the Contact Process and the equations are:

(a) $S(s) + O_2(g) \rightarrow SO_2(g)$; (b) $2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$;

(c) $SO_3(g) + H_2SO_4(l) \rightarrow H_2S_2O_7(l)$; (d) $H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_4(l)$

(2) SO_2 is obtainable from many sources including the burning of sulfur and as a byproduct from the roasting of metal sulfide ores.

(3) SO_2 is dried and purified before further oxidation to prevent the poisoning of the catalyst.

(4) SO_2 is heated with air in the presence of V_2O_5 at about 450^oC to give SO_3.

(5) the equilibrium yield of SO_3 is favoured by high pressure, low temperature and a slight excess of air since the reaction is exothermic and involves the production of a smaller number of mole of gas.

(6) a compromise temperature must be used to ensure that the rate of SO_3 production does not become too slow.

(7) in practice, there is little to be gained from the use of high pressure since, at atmospheric pressure, the yield of SO_3 at 450^oC is 98%.

(8) a series of catalyst chambers is used in practice.

(9) the heat of reaction in the formation of SO_3 is used to heat the incoming gases.

(10) SO_3 is absorbed into 98% H_2SO_4 to produce oleum, $H_2S_2O_7$, which is then diluted with water to give H_2SO_4.

(11) direct reaction of SO_3 with water is not used since a fine mist of sulfuric acid results.

(12) sulfuric acid is a strong diprotic acid which ionises according to the equations:

(a) $H_2SO_4(aq) + H_2O(l) \Leftrightarrow H_3O^+(aq) + HSO_4^-(aq)$

(b) $HSO_4^-(aq) + H_2O(l) \Leftrightarrow H_3O^+(aq) + SO_4^{2-}(aq)$

(13) sulfuric acid is a dehydrating agent which can be used to dry gases that do not react with it and to remove water from organic compounds such as sugar.

(14) sulfuric acid has a high boiling temperature and therefore can be used to prepare volatile acids such as HCl and HNO_3.

(15) sulfuric acid is a strong oxidant and undergoes reaction in which the oxidation number of sulfur changes from +6 to either +4 (SO_2) or 0 (sulfur element) or -2 (sulfide ion).

(16) sulfuric acid has a wide variety of uses including

(a) preparation of fertilizers such as ammonium sulfate and "superphosphate".

(b) preparation of drugs and insecticides.

(c) cleaning of metal surfaces.

(17) each of the above uses can be related to a particular property of sulfuric acid e.g. its acidic properties are used in the preparation of fertilizers.

Question 9

Ammonia is produced from nitrogen gas and hydrogen gas in an equilibrium process known as the Haber Process. The equation for the reaction is:

$N_2(g) + 3H_2(g) = 2NH_3(g)$

In the Haber Process, the yield is maximised by keeping the temperature as low as possible and by using high pressures.

In the Haber Process, the rate of production of ammonia is maximised by using an efficient catalyst and a high temperature.This temperature is a compromise between yield and rate.

Question 10

Ammonia reacts with oxygen, in the presence of platinum, according to the equation:

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

The reaction of ammonia with oxygen tends to produce nitrogen gas rather than nitrogen monoxide gas under normal circumstances. However, by using a catalyst of a platinum-rhodium alloy, the production of NO is favoured. This is the main reason for the catalyst in this reaction.

In the Ostwald Process for the production of nitric acid, nitrogen dioxide must be produced from nitrogen monoxide before the final reaction with water can occur according to the equations:

$2NO(g) + O_2(g) = 2NO_2(g)$ (This reaction involves equilibrium)

nitrogen monoxide gas reacts with oxygen gas to produce nitrogen dioxide gas.

$2NO_2(g) + H_2O(l) = H^+(aq) + NO_3^-(aq) + HNO_2(aq)$

nitrogen dioxide gas reacts with water liquid to produce hydrogen ions aqueous, nitrate ions aqueous and nitrous acid aqueous.

$3NO_2(g) + H_2O(l) = 2HNO_3(aq) + NO(g)$

nitrogen dioxide gas reacts with water liquid to produce nitric acid aqueous and nitrogen monoxide gas.

Nitric acid is a strong monoprotic acid and is used in the production of metal nitrates and the important chemical ammonium nitrate.

END OF 1992 VCE CHEMISTRY TRIAL CAT 1 SOLUTIONS

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