**CHRIST CHURCH GRAMMAR SCHOOL**

**MULTIPLE CHOICE ANSWER SHEET**

**Year 12 Chemistry Trial Exam 2008**

NAME : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ TEACHER: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Answer all multiple choice questions on this sheet by crossing out one of the letters

e.g. [A] [B] [C] [D]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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] | [D] |
| 11 | [A] | ***[B]*** | [C] | [D] |
| 12 | [A] | [B] | [C] | ***[D]*** |
| 13 | [A] | [B] | ***[C]*** | [D] |
| 14 | ***[A]*** | [B] | [C] | [D] |
| 15 | [A] | [B] | ***[C]*** | [D] |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 16 | [A] | [B] | ***[C]*** | [D] |
| 17 | ***[A]*** | [B] | [C] | [D] |
| 18 | [A] | ***[B]*** | [C] | [D] |
| 19 | [A] | [B] | ***[C]*** | [D] |
| 20 | [A] | [B] | ***[C]*** | [D] |
| 21 | ***[A]*** | [B] | [C] | [D] |
| 22 | [A] | ***[B]*** | [C] | [D] |
| 23 | [A] | [B] | [C] | ***[D]*** |
| 24 | [A] | [B] | ***[C]*** | [D] |
| 25 | ***[A]*** | [B] | [C] | [D] |
| 26 | ***[A]*** | [B] | [C] | [D] |
| 27 | ***[A]*** | [B] | [C] | [D] |
| 28 | ***[A]*** | [B] | [C] | [D] |
| 29 | [A] | [B] | ***[C]*** | [D] |
| 30 | [A] | [B] | [C] | ***[D]*** |

**PART 2 (70 marks = 35% of paper)**

Answer ALL questions in Part 2 in the spaces provided below.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Write equations for any reactions that occur in the following procedures. If no reaction occurs write ‘no reaction’.

In each case describe in full what you would observe, including any colours, odours, precipitates (give the colour) and gases evolved (give the colour or describe as colourless). If no change is observed you should state this.

(a) Chlorine gas is bubbled through a solution of iron (II) nitrate.

Equation **Cl2(g) + 2 Fe2+(aq) → 2 Fe3+(aq) + 2 Cl–(aq) ✓✓**

Observation **pale green solution turns brown ✓**

(b) Dilute sulfuric acid is mixed with a solution of lead (II) nitrate.

Equation **SO42–(aq) + Pb2+(aq) → PbSO4(s) ✓✓**

Observation **white ppt formed ✓**

c) Potassium metal is placed is water.

Equation **2** **K(s) + 2 H2O(l) → H2(g) + 2 K+(aq) + 2 OH–(aq) ✓✓**

Observation **silver solid dissolves rapidly, c/o gas evolves ✓**

d) An excess of 6 mol L–1 ammonia solution is added silver oxide.

Equation **4 NH3(aq) + Ag2O(s) + H2O(l) → 2 [Ag(NH3)2]+(aq) + 2 OH–(aq) ✓✓**

Observation **brown (white) solid dissolves ✓**

[4 x 3 = 12 marks]

2. Atom A can be bonded covalently to a number of atoms of X and may also have

some valence electrons left over as lone pairs.

For each situation specified in the table below, use electron pair repulsion theory to predict the shape of the molecule.

In each case give an example of a molecule that possesses your predicted shape. (A and X may be different for each case)

The first row is an example

|  |  |  |
| --- | --- | --- |
| Description | Shape of Molecule  (name or sketch) | Example |
| AX | Linear | HF |
| AX3 with one lone pair on atom A | **Pyramidal** | **NH3** |
| AX3 with no lone pairs on atom A | **Trigonal Planar** | **BF3, SO3** |
| AX2 with one lone pair on atom A | **V-shape** | **SO2** |
| AX2 with no lone pairs on atom A | **Linear** | **CO2** |

**1 mark each**  [8 marks]

3. Give the name or formula of a substance that matches the following descriptions:

1. the substance used to galvanise iron objects **Zinc**
2. a metal which does not react with dilute HCl(aq) **Cu, Ag, Au, Pt**
3. the Group 4 hydride which has the lowest melting point **CH4**

[3 marks]

4. An electric current is passed through a 1 mol L–1 sulfuric acid solution using carbon electrodes. Write a half-equation for the reaction occurring at each electrode:

Negative electrode **2 H+(aq) + 2 e– → H2(g)**

Positive Electrode **2 H2O(l) → O2(g) + 4 H+(aq) + 4 e–**

[2 marks]

5. A group of students decided to conduct a mini-research project on **methods of preventing corrosion** of iron structures in a salt water environment. A number of iron plates, numbered 1 to 5, were placed in sea water as shown below.

|  |  |  |  |
| --- | --- | --- | --- |
| **1.**  untreated iron | **2.**  iron partly covered with tin | | **3.**  iron partly covered with zinc |
| **- +**  **4.**  iron attached to  negative terminal of battery  Iron  nail  5V | | **+ -**  **5.**  iron attached to  positive terminal of battery  Iron  nail  5V | |

(a) Which two plates showed the least degree of corrosion? Give reasons.

**Plates 3 and 4 show the least corrosion.**

**Plate 3 is protected by zinc which acts as a sacrificial anode. The zinc has a greater tendency to lose electrons (stronger reducing agent, more active metal) than iron, therefore it will become the anode of an electrochemical cell and corrodes instead of the iron which becomes the cathode, site of reduction and does not corrode until all zinc has corroded ✓✓**

**Plate 4 cannot corrode (lose electrons) because it is continually being supplied with electrons from the battery, so it becomes the cathode of an electrolytic cell. The iron nail (scrap iron) becomes the anode and it loses electrons and corrodes (sacrificial anode). ✓✓**

(b) Which two plates showed the **greatest** degree of corrosion? Give reasons.

**Plates 2 and 5 show the most corrosion.**

**In Plate 2 the iron acts as a sacrificial anode as it has a greater tendency to lose electrons (stronger reducing agent, more active metal) than tin, therefore the iron is oxidized in preference to the tin. ✓✓**

**Plate 5 has accelerated corrosion due to electrons being removed from the iron plate by the positive terminal of the battery. Thus the reaction Fe(s) → Fe2+(aq) + 2e– is most likely to occur and corrosion results. ✓✓**

[4,4 marks]

6. Hydrazoic acid (hydrogen azide), HN3, is a weak electrolyte.

(a) Write an equation for the ionisation of hydrazoic acid in water.

**HN3(aq) + H2O(l) ⇄ H3O+(aq) N3–(aq)**  **✓** [1 mark]

(b) How would the pH of 0.1 mol L–1 hydrazoic acid compare to the pH of

0.1 mol L–1 HCl and why?

Comparison (higher, lower, same) **Higher** **✓**

Explanation

**Since HCl is a strong acid and hydrolyses 100%, [H+] = 0.1 and pH = –log[H+], then pH of HCl = 1** **✓**

**Since HN3 is a weak electrolyte then [H+] << 0.1, hence pH > 1 ✓** [3 marks]

(c) What will happen to the pH of a hydrazoic acid solution if a small quantity of solid sodium azide (NaN3) is added to the acid? Give an explanation for your answer.

Effect on pH **increase ✓**

Explanation

**The solid will dissolve producing N3–(aq) which will cause the above equilibrium to shift left, ✓ therefore decreasing the** **[H+] ✓ and hence increasing the pH** [3 marks]

(d) Name a suitable indicator for the titration of 0.1 mol L–1 hydroazoic acid against

0.1 mol L–1 sodium hydroxide solution. Give an explanation for your choice.

Indicator used **phenolphthalein ✓**

Explanation

**The reaction between hydrazoic acid and sodium hydroxide is:**

**HN3(aq) + OH–(aq) ⇄ H2O (aq) + N3–(aq)**  **✓**

**The**  **N3–(aq) will hydrolyse accepting a proton from water forming hydroxide ions, the equivalence point will be basic and phenolphthalein changes colour in the basic range. ✓** [3 marks]

[total 10 marks]

7. An electrochemical cell was set up as shown below:

Direction of electron flow

V

Vanadium Salt bridge Nickel

Solution of 1 mol L–1 VCl2 Solution of 1 mol L–1 NiCl2

Direction of flow of positive ions

The cell was allowed to operate for about 15 minutes and, during this time, it was noticed that a dark coloured solid was deposited on the nickel electrode, and the green colour of the nickel chloride solution faded.

(a) Give the half-equation for the reaction occurring in the nickel half-cell.

**Ni2+(aq) + 2 e–(aq) 🡪 Ni(s) ✓**

(b) Which electrode in the anode? ­­­­­­­ **Vanadium** **✓**

(c) Which is the stronger oxidant, V2+ or Ni2+ ? **Ni2+ ✓**

(d) In the box provided on the diagram, mark the direction of electron flow in the external circuit.

(e) In the box provided on the diagram, mark the direction of the positive ion flow in the cell.

(f) At the beginning of the experiment the E.M.F generated by the cell was 0.92 volts. Use this information to determine the standard reduction potential (E0) for the reaction: V2+(aq) + 2e– 🡪 V(s)

**0.92 = Eored – Eoox**

**= –0.26 – Eoox**

**Eoox = –0.26 – 0.92**

**= –1.18 V**  **✓**

[1 each = 6 marks]

8. Phosgene is prepared from the reaction of carbon monoxide and chlorine in the

presence of an activated carbon catalyst.

CO(g) + Cl2(g) ⇄ COCl2(g)

The following graph shows what happens when all three gases are mixed in the presence of the catalyst:

Concentration (mol L–1)

CO

Cl2

COCl2

0 2 4 6 8 10 12 14 16 Time (minutes)

(a) How would you describe the system 3 minutes after mixing?

**At equilibrium** **✓** [1 mark]

(b) At 4 minutes after mixing the temperature is decreased to a constant value. From the system’s response as shown above deduce whether the reaction, as written, is endothermic or exothermic. Briefly explain your reasoning.

**From the graph more reactants are formed therefore the equilibrium has shifted left.** **✓**

**A temperature decrease favours the exothermic reaction hence the reverse reaction is exothermic ✓ and so the forward is ENDOTHERMIC✓**

[3 marks]

(c) At 10 minutes after mixing, extra phosgene (COCl2) was rapidly introduced in the system at constant temperature and volume. Show on the graph the effect of this change, on the concentration of the three gases. Assume that he system reaches equilibrium at about 14 minutes.

[3 marks]

9. (a) Give the I.U.P.A.C name of the following organic molecules:

CH3–CH2–CH–CH=C–CH3 CH3–CH­–CHO

| | |

CH3  CH2CH3 F

**3,5–dimethyl­–3–heptene ✓ 2–fluoropropanal ✓**

[2 marks]

(b) Draw the structure of the polymer formed from 1-butene. At least three

monomer units are required. [2 marks]

**H H CH2CH3 H H CH2CH3**

**| | | | | |**

**C C C C C C**

**| | | | | |**

**CH2CH3 H H H H H ✓✓**

**Repeating unit is H H**

**| |**

**C C**

**| |**

**H CH2CH3 n**

(b) Name the organic reactant and the reagent required to make propanone.

Reactant **2-propanol** **✓**

Reagent **acidified KMnO4 or acidified K2Cr2O7** **✓**

(c) Draw the structure of and name the organic product of reacting methanoic acid and 2-butanol in the presence of an acid catalyst.

[2 marks]

Name **2–butylmethanoate ✓**

Structure **O CH3**

**|| |**

**H – C – O – CH – CH2 – CH3 ✓**

[total 8 marks]

10. Consider the following substances and their melting points:

carbon tetraiodide 171oC ; hydrogen iodide –51oC ; iodine 114oC.

Explain the difference in their melting points.

**All three are covalent molecular solids. For melting to occur the intermolecular bonds must be disrupted and so melting point depends on the strength of the IMF. ✓**

**CI4 > I2**

**Both CI4 and I2 are non-polar molecules with only weak dispersion forces between molecules.** **✓ The strength of dispersion forces increase as the number of electrons in the molecule increases (hence molar mass) and so CI4 (Mr = 519.61) has a higher melting point than I2 (Mr = 253.8) ✓**

**I2 > HI**

**HI is a polar molecule with both dipole-dipole and dispersion forces acting between molecules. ✓ For molecules of similar molar mass dipole-dipole interactions are stronger than dispersion forces ✓ but since the Mr of I2 is approximately 2 x Mr HI, I2 has much stronger dispersion forces and in this case outweigh the dipole-dipole + dispersion force in HI. ✓**

[6 marks]

**End of Part 2**

**PART 3 (50 marks = 25% of paper)**

1. m(FeS2) = 1250 x 92.4/100 = 1155 kg = 1 155 000 g

n(FeS2) = m/M = 1 155 000 / 119.97 = 9627 mol

n(Na2S2O7) = n (FeS2) = 9627 mol

m(Na2S2O7) = n.M = 9627 x 222.1 = 2138 kg

% efficiency = 1620 / 2138 x 100 = 75.8%

or

m(FeS2) = 1250 x 92.4/100 = 1155 kg

n(Na2S2O7) = m/M = 1620 / 222.1 = 7294 mol

n(FeS2) = n(Na2S2O7) = 7294 mol

m(FeS2) = n.M = 7294 x 119.97 = 875 kg

% efficiency = 875 / 1155 x 100 = 75.8%

2. (a) n(C) = n(CO­2) = V/22.41 = 4.21 / 22.41 = 0.188 mol

m(C) = n.M = 0.188 x 12.01 = 2.26 g

n(H) = 2 x n(H2O) = 2 x m/M = 2 x 3.39 / 18.016 = 0.376 mol

m(H) = n.M = 0.376 x 1.008 = 0.379 g

m(O) = 4.14 - m(C) - m(H) = 1.50 g

n(O) = m/M = 1.50 / 16 = 0.0938 mol

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| C | : | H | : | O |
| 0.188 | : | 0.376 | : | 0.0938 |
| 0.0938 | | | | |
| 2 | : | 4 | : | 1 |  |

EF = C2H4O

(b) n = PV/RT = (102 x 1.12) / (8.315 x 443.1) = 0.0310 mol

M = m/n = 2.73 / 0.0310 = 88.06 g mol–1

M/EFM = 88 / 44 = 2

MF = 2 x EF = C4H8O2

(c) MF ⇒ carboxylic acid or ester

No reaction with Na2CO3 ∴ ester

One of:

O

‖

methyl propanoate CH3CH2C–O–CH3

O

‖

ethyl ethanoate CH3C–O–CH2CH3

O

‖

propyl methanoate H2C–O–CH2CH2CH3

O

‖

propyl methanoate H2C–O–CH(CH3)2

3. (a) Cu → Cu2+ + 2 e–

m(Cu) = m/M = 2.53 /63.55 = 0.0398 mol

n(e–) = 2 x n(Cu) = 0.0796 mol

Q = n(e–) x 96490 = 7683 C

I = Q/t = 7683 / 2400 = 3.20 A

(b) n(In) = m/M = 3.05 / 114.8 = 0.0266 mol

n(e–) / n(In) = 0.0796 / 0.0266 = 3

∴ In3+ / +3

(c) Cell 1 2 H2O + 2 e– → H2 + 2 OH–

n(H2) = 1/2 n(e–) = 0.0398 mol

Cell 2 2 Cl– → Cl2 + 2 e–

n(Cl2) = 1/2 n(e–) = 0.0398 mol

n(gas) = n(H2) + n(Cl2) = 0.0796 mol

V(gas) = nRT/P = (0.0796 x 8.315 x 297.1)/100.9

= 1.95 L

4. V(S2O32–)average = (15.30 + 15.25)/2 = 15.27 mL

n(S2O32­–) = c.V = 0.00120 x 0.01527 = 1.833 x 10–5 mol

n(I3–)20mL = 1/2 n(S2O32–) = 9.165 x 10–6 mol

n(I3–)total = 9.165 x 10–6 x 150/20 = 6.874 x 10-5 mol

n(Mn3+) = 2 x n(I3–) = 1.375 x 10–4 mol

n(Mn(OH)3) = n(Mn3+) = 1.375 x 10–4 mol

n(O2) = 1/4 n(Mn(OH)3) = 3.437 x 10–5 mol

m(O2) = n.M = 3.437 x 10–5 x 32 = 1.10 x 10–3 g

1.10 mg / 0.1 kg = 11.0 ppm

5. 6 Fe2+ + Cr2O72– + 14 H+ → 6 Fe3+ + 2 Cr3+ + 7 H2O

n(Cr2O72­–) = c.V = 0.0168 x 0.01831 = 3.08 x 10–4 mol

n(Fe2+) = 6 x n(Cr2O72–) = 1.85 x 10-3 mol

m(Fe) = n.M = 1.85 x 10-3 x 55.85 = 0.103 g

%(Fe) = 0.103 / 2.401 x 100 = 4.29%

n(MnO4–) = c.V = 0.1097 x 0.02596 = 2.85 x 10–3 mol

n(C2O42–)50mL = 5/2 x n(MnO4–) = 7.12 x 10–3 mol

n(C2O42–)total = 7.12 x 10–3 x 250/50 = 0.0356 mol

n(Ca) = n(C2O42–) = 0.0356 mol

m(Ca) = n.M = 0.0356 x 40.08 = 1.43 g

%(Ca) = 1.43 / 7.00 x 100 = 20.4%

**End of Part 3**

**PART 4 (20 marks = 10% of paper)**

Answer the following extended answer question. Where applicable use equations, diagrams and illustrative examples of the chemistry you are describing.

Marks are awarded for the relevant chemical content of your answer, but you will lose marks if what you write is unclear or lacks coherence.

Give an account of the chemistry of water.

You may discuss all aspects of the chemistry of water that you have studied, making particular reference to the points and data below.

* Structure, bonding and intermolecular forces in water

|  |  |  |
| --- | --- | --- |
| substance | molar mass (g mol–1) | melting point (K) |
|  |  |  |
| methane, CH4 | 16 | 91 |
| ammonia, NH3 | 17 | 195 |
| water, H2O | 18 | 273 |
| hydrogen fluoride, HF | 20 | 190 |

* Chemical equilibrium and the effect of changes of conditions upon it

|  |  |
| --- | --- |
| temperature (0C) | Kw |
|  |  |
| 0 | 2.0 x 10–15 |
| 25 | 1.2 x 10–14 |
| 50 | 5.5 x 10–14 |

* Acid/base chemistry, pH and the role of water in it

**End of Examination**