## Chemistry

### 2011 Trial Higher School Certificate Examination

**Section 1**

**Total marks (75)**

•This section has two parts, A and B.

# General Instructions

# Reading time – 5 minutes Part A

# Working time – 3 hours Total marks (20)

# Board approved calculators may be used

# Write using black or blue pen •Attempt Questions 1 - 20

# Draw diagrams using pencil •Allow 35 minutes for this part.

# A Data Sheet and a Periodic Table are

provided at the back of this paper

* Write your name as instructed **Part B**

Total marks (55)

•Attempt Questions 21 - 31

•Allow about 1 hour and 40 minutes

for this part.

# Section II

Total marks (25)

•Attempt ONE question from

Questions 32 - 36

•Allow about 45 minutes for this

section.

**Section 1**

**75 marks**

**Part A – 20 marks**

**Attempt Questions 1 – 20**

**Allow about 35 minutes for this part**

1. Synthetic polymers are created by joining monomers together, one at a time, by means of which two types of reactions?
   1. Addition reactions and oxidation reactions
   2. Addition reactions and condensation reactions
   3. Hydration reactions and oxidation reactions
   4. Hydration reactions and displacement reactions
2. With which of the following types of technologies was it first possible to synthesize transuranium elements?
   1. Paramagnetic diffusers
   2. Particle accelerators
   3. Phase-change fission nodes
   4. Optical isomers
3. Indicators are substances that have distinctly different colours in acidic and basic solutions. One commonly used indicator is phenolphthalein. Which of the following statements is correct?
   1. Phenolphthalein is colourless in acidic and neutral solutions but reddish-pink in basic solutions.
   2. Phenolphthalein is reddish-pink in acidic and neutral solutions but colourless in basic solutions.
   3. Phenolphthalein is colourless in acidic and neutral solutions but yellow in basic solutions.
   4. Phenolphthalein is yellow in acidic and neutral solutions but colourless in basic solutions.
4. How many possible isomers can be made for the molecule CHBr?
   1. 1
   2. 2
   3. 3
   4. 4
5. An oxide that exhibits both acidic and basic properties is known by which of the following terms?
   1. Allotropic
   2. Amphoteric
   3. Corrosive
   4. Cohesive
6. The diagram below shows a section of a polymer:

-( CF- CF)-

What is the correct name for the above monomer?

1. Butadiene
2. Fluoro-styrene
3. Vinyl fluoride
4. Tetrafluoro-ethylene
5. What volume of a 0.50 M KOH solution is needed to neutralize 10.0 ml of a 0.30 M HCl solution?
   1. 4.0 mL
   2. 5.0 mL
   3. 6.0 mL
   4. 7.0 mL
6. Name the oxoacid HPO
   1. Phosphoric acid
   2. Phosphorous acid
   3. Hypophosphoric acid
   4. Perphosphoric acid
7. The production of which chemical compound is commonly associated with the German chemist Fritz Haber?
   1. Ammonia
   2. Alcohol
   3. Aldehyde
   4. Ketone
8. A sample of water that was suspected to be contaminated with metal ions was analyzed and the results of tests on the water sample are given in the following table:

|  |  |
| --- | --- |
| Test | Result |
| Addition of dilute HCl | No change |
| Addition of dilute NaCO | No change |
| Flame test | Yellow colour |

What is the most likely metal ion contaminant in the water sample?

1. Ba
2. Na
3. K
4. Ni
5. Which of the following options is the correct name for the following compound?

CH-C ≡ C-CH-CH

* 1. 2 – methylpentane
  2. 2 – trimethylhexane
  3. 2 – ethylhexane
  4. 2 – pentyne

1. Which of the following is the correct oxidation number of the central metal atom in the following compound?

[ Ru (NH) (HO)] Cl

* 1. 0

(B) 1

(C) 2

(D) 3

1. A galvanic cell consists of a magnesium electrode in a 1.0 M Mg(NO) solution and a silver electrode in a 1.0 M AgNO solution.

Given that Ag(1.0M) + e → Ag E = 0.80 V

Mg(1.0M) + 2e → Mg E= -2.37 V

What is the standard emf of this electrochemical cell at 25° C?

1. 3.17 V
2. 4.15 V
3. 5.23 V
4. 6.18 V

1. Acetylene is an unstable compound. It has a tendency to form benzene according to the following reaction:

3 CH → CH

What is the standard enthalpy change in kilojoules for this reaction at 25° C?

1. -630.8 kJ
2. -740.2 kJ
3. -782.0 kJ
4. -795.5 kJ
5. Two alcohols react according to the following reaction in the presence of a catalyst HSO:

CHOH + HOCH → **X** + HO

What is the name of the compound **X?**

1. Methyl ether
2. Dimethyl ether
3. Ethyl ether
4. Diethyl ether
5. What classification best describes the carbon to carbon bond in the compound HCCH?
   1. Ionic
   2. Polar covalent
   3. Covalent
   4. Resonant
6. A gas expands in volume from 2.0 L to 6.0 L at constant temperature.

What is the work done by the gas if it expands against a constant pressure of 121.59 kPa?

* 1. -4.9 x 10 J
  2. -5.3 x 10 J
  3. -6.6 x10 J
  4. -7.6 x 10 J

1. Consider the following equilibrium equation at 700° C

2 H + S ↔ 2 HS

Analysis shows that there are 2.50 moles of H, 1.35 x 10 mole of S and 8.70 moles of HS present in a 12.0 L flask at equilibrium.

What is the equilibrium constant K for the reaction?

(A) 2.24 x 10

(B) 4.40 x 10

1. 1.08 x 10
2. 2.22 x 10
3. A bubble comes to the surface from the bottom of a dam. Using the initial and final conditions in the table below determine the final volume of the bubble if its initial volume was 2.1 mL.

|  |  |  |
| --- | --- | --- |
|  | Bottom of dam | Surface of dam |
| Temperature (°C) | 8 | 25 |
| Pressure (kPa) | 648.48 | 101.325 |

1. 6 mL
2. 12 mL
3. 14 mL
4. 16 mL
5. A chemist has synthesized a greenish-yellow gaseous compound of chlorine and oxygen and has determined that the compound has a density of 7.71 g/L at 36°C and 291.816 kPa.

What is the molar mass of the compound?

* 1. 67.9 g/mol
  2. 72.2 g/mol
  3. 73.8 g/mol
  4. 86.4 g/mol

**Part B – 55 marks.**

**Attempt Questions 21 – 31**

**Allow about 1 hour and 40 minutes for this part**

**Question 21** (3 marks)

Briefly describe how a student would prepare a phosphate buffer with a pH of 7.40.

**3**

**Question 22** (6 marks)

(a) The combustion of 3.795 mg of a liquid compound **X** which contains only C, H and

O, with excess oxygen gave a 9.708 mg of COand 3.969 mg of HO.

In a molar mass determination, 0.205g of compound **X** vaporized at 101.325 kPa and

200° C and occupied a volume of 89.8 mL.

(i) Derive an empirical formula for **X 1**

1. Derive a molecular formula for **X 1**
2. Draw THREE possible structures for **X** **3**

(b) A mixture of methane and bromine vapour is exposed to light and this reaction occurs

slowly.

CH + Br → CHBr+ HBr

Suggest a mechanism for this reaction. **1**

**Question 23** (3 marks)

Diethyl ether is a volatile, highly flammable organic fluid that is used mainly as a solvent.

(a) Draw the structure and formula for diethyl ether. **1**

(b) The vapour pressure of diethyl ether is 401 mmHg at 18° C.

Calculate its vapour pressure at 32° C. **2**

**Question 24** (4 marks)

(a) Outline the meaning of the terms “saturated” and “unsaturated” when they are applied to hydrocarbons. **2**

(b) Give an example of BOTH a saturated and an unsaturated hydrocarbon. **2**

**Question 25** (4 marks)

Nuclear power is routinely put forward in Australia as a potential energy source.

Discuss the use of nuclear power in terms of:

(a) global warming **1**

(b) nuclear reactor safety **1**

(c) armament risk **1**

(d) waste disposal **1**

**Question 26** (4 marks)

Titanium is a strong, lightweight metal that is used in aircraft and, amongst other things, bicycle frames.

Titanium is prepared by the reaction of titanium chloride with molten magnesium between temperatures of between 950°C and 1150°C.

Ti Cl + 2 Mg → Ti + 2 Mg Cl

During a certain industrial operation, 3.54 x 10 g of Ti Cl is reacted with

1.13 x 10g of Mg.

Calculate the theoretical yield of Ti in grams. **4**

**Question 27** (2 marks)

Write a balanced ionic equation to represent the oxidation of iodide ion (I) by permanganate ion (MnO) in basic solution to yield molecular iodine (I) and manganese (IV) oxide (MnO). **2**

**Question 28** (8 marks)

In an experiment, a student heats 2.40 g of the oxide of metal X in carbon monoxide (CO). The reaction yields the pure metal X and carbon dioxide (CO).

The molar mass of X is 55.9 g/mol.

(a) The mass of the metal present is 1.68g. Determine the simplest formula for the oxide. **4**

(b) Write a balanced equation for this reaction. **2**

(c) Describe TWO possible steps that the student could take to minimize

hazards and wastage of resources in the above experiment. **2**

**Question 29** (6 marks)

(a) At atmospheric pressure, a sample of Hgas has a volume of 2.73 L at 27° C. What volume, in litres will the Hgas occupy if the temperature is increased to 127° C and the pressure is held constant? **2**

(b) What is the temperature, in degrees Celsius, of 5.23 moles of

helium (He) gas which is confined to a volume of 5.23 L at a pressure of 529.93 kPa? **2**

(c) Describe using a simple labelled sketch, and ONE example, the

molecular conditions necessary for the existence of a dipole-dipole interaction. **2**

**Question 30** (8 marks)

(a) Draw the structure of the organic product formed in the following reactions:

(i) Toluene + Cl → (in the presence of light) **1**

(ii) Toluene + Cl → (in the presence of FeCl) **1**

(b) The compound 1,1-dimethylcyclohexane is a well-known substance.

However, the compound 1,1-dimethylcyclohexene does not exist.

Outline why this is so. **1**

(c) Hydrocarbons with the formula CH can be either alkenes or cycloalkanes.

Draw FIVE possible structural isomers that fit this formula and name them. **5**

**Question 31** (7 marks)

(a) A student collected a 100 ml sample of water from a local river for analysis.

The data collected after the analysis is shown in the following table:

|  |  |
| --- | --- |
| Mass of filter paper | 0.20 g |
| Mass of filter paper and solid | 0.50 g |
| Mass of evaporating basin | 50.50 g |
| Mass of evaporating basin and solid | 55.0 g |

(i) During the analysis the water was filtered and the filtrate evaporated.

Calculate the percentage of the total dissolved solids in the river sample.

**3**

(ii) There was a suspicion that the river water had a high concentration of

silver ions.

Describe a chemical test that the student could use on a water sample to confirm the presence of silver ions. **2**

(b) Name an ion, other than silver, that commonly pollutes local waterways. Identify a possible source of this ion and the effect of its presence on water quality. **2**

**Section 2 25 marks**

**Question 32 Industrial Chemistry**

**Question 33 Shipwrecks, Corrosion and Conservation**

**Question 34 The Biochemistry of Movement**

**Question 35 The Chemistry of Art**

**Question 36 Forensic Chemistry**

**Question 32 Industrial Chemistry** (25 marks)

(a) Distinguish between the THREE electrolysis methods used to extract sodium hydroxide. In your answer describe each process and outline the technical difficulties associated with each process. **6**

(b) Consider the electrolysis of molten barium chloride BaCl

(i) Write the relevant half equations. **2**

(ii) How many grams of barium metal can be produced by supplying 0.50 A for 30 minutes? **2**

(c) Consider the following equilibrium process between dinitrogen tetrafluoride

(NF) and nitrogen difluoride (NF)

NF ↔ 2 NF ΔH° = 38.5 kJ

(i) Determine the equilibrium constant expression for this reaction.

**1**

(ii) Predict the change in equilibrium if the reacting mixture is heated at constant volume. **1**

(iii) Predict the change in equilibrium if NF is removed from the

reacting mixture at constant temperature and volume. **1**

(d) Distinguish between anionic, cationic and non-ionic synthetic detergents in terms

of their chemical composition and uses. **5**

(e) Describe the processes used to extract sulfur from mineral deposits.

In your description, identify the properties of sulfur which allow its extraction and assess potential environmental issues that may be associated with its extraction.

**7**

**Question 33 – Shipwrecks, Corrosion and Conservation** (25 marks)

(a) “Galvanised iron” is steel sheet that has been coated with zinc whilst “tin cans”

are made of steel sheet coated with tin.

Discuss the function of these coatings and the electro-chemistry of the corrosion reactions that occur if an electrolyte contacts the scratched surface of a galvanized iron sheet or tin can. **4**

(b) Describe how the tendency of iron to rust depends on the pH of solution.

**2**

(c) A sample of iron ore weighing 0.2792 g was dissolved in an excess of a dilute

acid solution.

All the iron was first converted to Fe(II) ions.

The solution then required 23.30 mL of 0.0194 M KMnO for oxidation

to Fe(III) ions.

Calculate the percentage by mass of iron in the ore. **4**

(d) Electrolysis is a process in which electrical energy is used to bring about a non-

spontaneous chemical reaction.

(i) Use a simple labelled sketch to describe the electrolysis of an aqueous solution of potassium fluoride. Write the relevant half equations and state the overall reaction for the cell. **4**

(ii) How would the cathode be identified? **1**

(e) Describe the action of sulfate reducing bacteria around deep wrecks. **3**

(f) During your study you performed an investigation to compare conservation

and restoration techniques applied in TWO Australian maritime archaeological

projects.

Describe your investigation. **7**

**Question 34 – The Biochemistry of Movement** (25 marks)

(a) In terms of hydrolysis, what is the relationship between ATP and ADP?

**3**

(b) Describe the FOUR general stages of the process by which biochemical energy is obtained from food. **4**

(c) During triacylglycerol (TAG) mobilization, one molecule of glycerol is produced for each TAG completely hydrolyzed.

Assess the importance of TAGs as an energy dense store for humans. **5**

(d) Outline the nature of a peptide bond and using ONE specific example,

describe the chemistry involved in the formation of a peptide bond. **4**

(e) Muscle cells cause movement by contraction along the length.

Discuss the cause of the contraction movement in the formation of temporary bonds between the actin and myosin fibres and explain why ATP is consumed in this process. **4**

(f) Using a simple flowchart describe the tricarboxylic acid (TCA) cycle as another multi-enzyme system involved in respiration. **5**

**Question 35 – The Chemistry of Art** (25 marks)

(a) Explain the relationship between the number of electrons in the outer

shell of an element and its electro-negativity. **3**

(b) A ligand is a molecule or an ion that is bonded to a metal ion in a complex ion.

(i) Give ONE example of a chelated ligand. **1**

(ii) Discuss the importance of models in developing an understanding of the

nature ligands. **4**

(c) Chemists use a wide variety of technologies to study the spectra of elements.

(i) Outline the use of ultra violet (UV) light in the analysis and identification of pigments and their chemical composition. **2**

(ii) Explain the relationship between absorption and reflective spectra and the effect of light on pigments. **3**

(d) Explain, using the complex ions of a transition metal as an example, why species containing transition metals in a high oxidation state, will be strong oxidizing agents. **5**

(e) From the earliest times, people have used colour to decorate themselves and their surroundings.

Discuss the above statement with particular reference to pigments available and used in traditional art by Aboriginal people. **7**

**Question 36 – Forensic Chemistry** (25 marks)

(a) Outline THREE precautions that would be necessary to ensure accuracy and prevent contamination of samples for forensic analysis. **3**

(b) Using a simple table compare the processes of chromatography and

electrophoresis and identify the properties of mixtures that allow their separation.

**5**

(c) Draw the structural formula for the following tripeptide Ala – Gly – Val

**3**

(d) Using a simple labelled diagram draw the structure of a mass spectrometer and describe its use in forensic chemistry. **5**

(e) Describe the process used to analyse DNA and account for its use in

identifying relationships between people. **4**

(f) During your study you performed a first-hand investigation to determine

a distinguishing test for proteins.

Describe your investigation. **5**

End of paper