**2011**

HSCTRIAL

EXAMINATION PAPER

Chemistry

|  |  |
| --- | --- |
| General Instructions  * Reading Time – 5 minutes * Working Time – 3 hours * Write using black or blue pen * Draw diagrams using pencil * Board-approved calculators may be used * A data sheet and Periodic Table are provided at the back of this paper * Write your Student Number at the bottom of this page | Total Marks - 100Section I Pages 2–18 **75 marks**  This section has two parts, Part A and Part B  Part A – 20 marks   * Attempt Questions 1–20 * Allow about 35 minutes for this part   Part B – 55 marks   * Attempt Questions 21–31 * Allow about 1 hour and 40 minutes for this part   **Section II** Pages 19–24  **25 marks**   * Attempt ONE question from Questions 32–36 * Allow about 45 minutes for this section |



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This paper is used with the understanding that it has a Security Period.

Student Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Section I

**75 marks**

**Part A – 20 marks**

**Attempt Questions 1–20**

**Allow about 35 minutes for this part**

Use the multiple-choice answer sheet for Questions 1-20

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| **1** | Undecane C11H24 is cracked to produce an alkane and ethene.  Which equation correctly shows this reaction? | |
|  | (A) | C11H24(*l*) → C9H20(*l*) + C2H4(*g*) |
|  | (B) | C11H24(*l*) → C9H18(*l*) + C2H6(*g*) |
|  | (C) | C11H24(*l*) → C8H18(*l*) + C2H4(*g*) |
|  | (D) | C11H24(*l*) → C8H16(*l*) + C3H8(*l*) |
|  |  |  |
| **2** | A liquid rapidly decolourises bromine water after shaking.  Which liquid is most likely to react in this way? | |
|  | (A) | heptane |
|  | (B) | 2-heptene |
|  | (C) | 1-heptanol |
|  | (D) | heptanoic acid |
|  |  |  |
| **3** | Polylactic acid is made when bacteria produce lactic acid from starch. The lactic acid is then polymerised. Currently this biopolymer has one advantage over conventional polymers such as polyethylene.  Which alternative is an advantage of polylactic acid? | |
|  | (A) | It is biodegradable. |
|  | (B) | It is made using bacteria. |
|  | (C) | It is cheaper to manufacture. |
|  | (D) | It is produced from a non-renewable raw material. |
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| **4** | Ethanol is used instead of water as a solvent in a range of consumer products such as medicines and cosmetics, even though both ethanol and water have hydrogen bonds.  Which is the best explanation for the use of ethanol as a solvent in some products? | |
|  | (A) | Ethanol has a higher molecular mass than water. |
|  | (B) | Ethanol has a lower boiling point temperature. |
|  | (C) | Water has a higher density than ethanol. |
|  | (D) | Ethanol is miscible with many organic liquids. |
|  |  |  |
| **5** | A student set up a spirit burner containing 1-propanol (molar mass 60 g mol-1) to heat  100 g of water, at 25.0oC, in a calorimeter. The initial mass of the spirit burner was  303.7 g.  After the water temperature reached 55.0oC, the spirit burner was extinguished and its mass was found to be 299.1 g.  What is the molar heat of combustion of ethanol? | |
|  | (A) | 125.4 kJ mol-1 |
|  | (B) | 0.961 kJ mol-1 |
|  | (C) | 576.8 kJ mol-1 |
|  | (D) | 163.7 kJ mol-1 |
|  |  |  |
| **6** | Consider the following reaction    2Fe2+ (*aq)* + Br2(*l*) 2Fe3+ (*aq)* + 2Br - (*aq)*  Which statement is correct? | |
|  | (A) | The reducant in this reaction is Fe2+ |
|  | (B) | The reducant in this reaction is Br2 |
|  | (C) | The oxidation number of Br2 is 2 |
|  | (D) | The species Fe2+(*aq*) has been reduced |
|  |  |  |
| **7** | Why does a radioisotope, such as Radon-222, decay to release alpha particles? | |
|  | (A) | Too many neutrons for the number of protons |
|  | (B) | Too many protons for the number of neutrons |
|  | (C) | Too many protons and neutrons in the nucleus |
|  | (D) | Too much energy in the nucleus |
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| **8** | The table shows the colours of three indicators as the hydrogen ion concentration changes.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | [H+] mol L-1 | 10-2 | 10-4 | 10-6 | 10-8 | 10-10 | | Methyl orange | red | orange | yellow | yellow | yellow | | Bromothymol blue | yellow | yellow | green | blue | blue | | Phenolphthalein | colourless | colourless | colourless | colourless | pink |   A solution is colourless when tested with phenolphthalein, blue with bromothymol blue and yellow when tested with methyl orange.  Which statement about the solution is correct? | |
|  | (A) | The solution is strongly acidic with a pH of 6. |
|  | (B) | The solution is weakly acidic with a pH of 6. |
|  | (C) | The solution is weakly alkaline with a pH of 8. |
|  | (D) | The solution is strongly alkaline with a pH of 8. |
|  |  |  |
| **9** | Which equation correctly shows an industrial source of sulfur dioxide? | |
|  | (A) | CaO(*s*) + SO2(*g*) → CaSO3(*s*) |
|  | (B) | 2CuS(*s*) + 3O2(*g*) ↔ 2CuO(*s*) + 2SO2(*g*) |
|  | (C) | H2O(*l*)  + SO2(*g*) ↔ H2SO3(*aq*) |
|  | (D) | ZnS(*s*)  + O2(*g*) → ZnO(*s*) + SO2(*g*) |
|  |  |  |
| **10** | Nitric oxide (NO) reacts with oxygen to form nitrogen dioxide according to the following equation:    2NO(*g*) + O2(*g*) ↔ 2NO2(*g*)    What volume of oxygen gas at 250C and 100 kPa is required to produce 23 grams of NO2? | |
|  | (A) | 5.7 litres |
|  | (B) | 6.2 litres |
|  | (C) | 90.8 litres |
|  | (D) | 99.2 litres |
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| **11** | A, B, C and D are acids. They are prepared to have a concentration of 0.01 mol L-1. The pH is then measured.  Which acid has the highest degree of ionisation?   |  |  |  | | --- | --- | --- | | *Acid* | *Number of H+ per molecule* | *pH* | | (A) | 1 | 2 | | (B) | 1 | 2.2 | | (C) | 2 | 2.6 | | (D) | 3 | 4.6 | | |
|  |  |  |
| **12** | What is the conjugate acid of HSO4- ? | |
|  | (A) | H2SO4 |
|  | (B) | SO4-2 |
|  | (C) | H2S |
|  | (D) | H2O |
|  |  |  |
| **13** | What is the correct method of preparing a 250 mL volumetric flask prior to making up a primary standard? | |
|  | (A) | wash, rinse with distilled water three times, then use |
|  | (B) | wash, rinse with distilled water three times then completely dry inside |
|  | (C) | wash, rinse with the solution that is going in the flask three times, then use |
|  | (D) | pour the primary standard straight into the flask as the concentration will not be  changed |
|  |  |  |
| **14** | Which action would lower the yield of methyl ethanoate?  methanol + ethanoic acid ↔ methyl ethanoate + water | |
|  | (A) | adding more methanol |
|  | (B) | adding more water |
|  | (C) | removing the methyl ethanoate as it formed |
|  | (D) | adding a few drops of concentrated sulphuric acid |
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| **15** | A compound has the following structural formula.  What is its correct name?  Cl  Cl  C  C  F  H  Cl  C  H  H  H | |
|  | (A) | 1,1,2-trichloro-3-fluorobutane |
|  | (B) | 3,3,2-trichloro-1-fluoropropane |
|  | (C) | 1,1,2-trichloro-3-fluoropropane |
|  | (D) | 3,3,2-trichloro-1-fluorobutane |
|  |  |  |
| **16** | The boiling point of a number of compounds is shown in the table below.   |  |  | | --- | --- | | *Name of Compound* | *Boiling Temperature* (0C) | | Pentane | 36 | | 1-Pentanol | 138 | | Pentanoic acid | 155 |   Why does pentanoic acid have the highest boiling temperature? | |
|  | (A) | It ionises in water, pentane and 1-pentanol do not |
|  | (B) | It has the strongest dispersion forces between the molecules |
|  | (C) | It has the strongest hydrogen bonding between the molecules |
|  | (D) | It has the longest chain length of all the molecules |
|  |  |  |
| **17** | Incomplete combustion of hydrocarbons is a major cause of air pollution.  Which of the following represents the incomplete combustion of hexane? | |
|  | (A) | C6H12 + 12O2 → 6CO + 6H2O |
|  | (B) | 2C5H12 + 11O2 → 10CO + 12H2O |
|  | (C) | 2C6H14 + 13O2 → 12CO + 14H2O |
|  | (D) | 2C6H14 + 19O2 → 12CO2 + 14H2O |
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| **18** | Eutrophication of aquatic systems is a natural process taking place over long periods of time. However, the activities of humans accelerate the process.  Which human activity could promote eutrophication? | |
|  | (A) | smelting sulfide minerals |
|  | (B) | burning fossil fuels |
|  | (C) | farming with inorganic fertilisers |
|  | (D) | building a desalination water treatment plant |
|  |  |  |
| **19** | Which anion can be identified using Barium nitrate solution? | |
|  | (A) | Cl- |
|  | (B) | Ag+ |
|  | (C) | Cu+2 |
|  | (D) | SO4-2 |
|  |  |  |
| **20** | Which is the most effective method to measure the total dissolved solids in a sample of creek water? | |
|  | (A) | carry out a titration with EDTA solution |
|  | (B) | use a pH meter |
|  | (C) | use a conductivity meter |
|  | (D) | test using atomic absorption spectroscopy |

**2011 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION**

Chemistry

**Section I — (continued)**

**Part B – 55 marks**

**Attempt Questions 21–31**

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

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

**Question 21** (5 marks)

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| Ethylene is readily transformed into many useful products through various addition reactions. | |  |
| (a) | Explain the term *addition reaction* and identify the property of ethylene which allows so many useful products to be prepared. | **3** |
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| (b) | Write chemical equations for TWO addition reactions involving ethylene. | **2** |
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**Question 22** (6 marks)

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| (a) | Draw a segment of the polymer cellulose showing the bond between TWO of the monomer units. | **2** |
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| (b) | Identify the reaction type and the other product formed with cellulose. | **1** |
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| (c) | Justify why chemists are investigating sources of cellulose as future raw materials to replace petrochemicals. | **3** |
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**Question 23** (7 marks)

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| Two students were measuring the potential difference (voltage) generated in a galvanic cell. They used a strip of magnesium metal as one electrode in a beaker with magnesium nitrate. A strip of copper in a beaker of copper sulfate made up the other half cell. | |  |
| (a) | Draw a fully labelled diagram of their galvanic cell showing everything required to generate a voltage. Label the anode and cathode. | **3** |
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| (b) | Write the equation for the galvanic cell reaction. | **1** |
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| (c) | Calculate the cell voltage under standard conditions. | **1** |
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| (d) | The students obtained a valve of 1.85V which is less than the theoretical value for this galvanic cell.  Other than making a mistake, give TWO possible reasons for the difference. | **2** |
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**Question 24** (4 marks)

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| Compare TWO methods of producing radioisotopes. Give an example of an isotope produced by each method. | **4** |
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**Question 25** (5 marks)

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| (a) | Classify the following oxides as acidic, amphoteric and basic. Present your answer as a data table.  K2O, Al2O3, P4O10, SnO2, CO2,, MgO | **3** |
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|  |  |  |
| (b) | Select ONE of the oxides and write an equation to show the formation of an acid. | **1** |
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| (c) | Define the term *amphoteric*. | **1** |
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**Question 26** (6 marks)

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| In a titration, a group of students found that, on average, 28.3 mL of acetic acid was required to neutralise 25 mL of a 0.20 mol L-1 sodium hydroxide solution.  The equation for the reaction is below.  CH3COOH(*aq*) + NaOH → NaCH3COO(*aq*) + H2O(*l*) | |  |
| (a) | Calculate the concentration of acetic acid, in mol L-1. | **2** |
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| (b) | Suggest a suitable indicator solution for this titration and give a reason for your choice. | **2** |
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| (c) | Give ONE advantage and ONE disadvantage of working in a group. | **2** |
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**Question 27** (4 marks)

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| Outline how the concept of acids has changed over time. In your answer name THREE scientists who have contributed to our understanding of these compounds. | **4** |
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**Question 28** (5 marks)

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| Discuss the need for monitoring of the reaction vessel during the production of ammonia. | **5** |
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**Question 29** (4 marks)

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| A group of students were conducting tests to distinguish between three white compounds possibly containing barium, calcium or lead cations. One student suggested they conduct a flame test on each compound.  Assess the risks involved and write a recommendation to the students on how to go about safely identifying the cations present. | **4** |
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**Question 30** (4 marks)

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| Oxygen (O2) and Ozone (O3) are allotropes with different properties. | |  |
|  | |  |  |  |  | | --- | --- | --- | --- | | *Allotrope* | *Density of liquid*  (g mL-1) | *Melting point*  (0C) | *Boiling point*  (0C) | | O2 | 1.15 | -219 | -183 | | O3 | 1.61 | -193 | -111 | |  |
| (a) | Draw an electron dot diagram of an ozone molecule. | **1** |
|  |  |  |
|  |  |  |
| (b) | Explain why ozone has a greater density and higher melting and boiling point temperatures than oxygen in terms of molecular structure and bonding. | **3** |
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**Question 31** (5 marks)

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| Assess the effectiveness of a physical and a chemical process used to purify and sanitise a town’s water supply. | **5** |
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**End of Section I**

**2011 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION**

Chemistry

**Section II**

**25 marks**

**Attempt ONE question from Questions 32–36**

**Allow about 45 minutes for this section**

Answer the parts of the question in a writing booklet. Clearly label each part of the question.

Show all relevant working in questions involving calculations.

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| --- | --- | --- |
|  |  | Pages |
| Question 32 | Industrial Chemistry | 20 |
| Question 33 | Shipwrecks, Corrosion and Conservation | 21 |
| Question 34 | The Biochemistry of Movement | 22 |
| Question 35 | The Chemistry of Art | 23 |
| Question 36 | Forensic Chemistry | 24 |

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

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| (a) | With the aid of balanced chemical equations, describe the industrial reactions of sulphuric acid acting as: | |  |
|  | (i) | an oxidising agent | **2** |
|  | (ii) | a dehydrating agent | **2** |
| (b) | Colourless nitrogen trichloride reacts with oxygen to produce brown nitrogen dioxide and light green chlorine gas as shown by the following equation.  2NCl3(*g*) + 2O2(*g*) ↔ 2NO2(*g*) + 3Cl2(*g*)  A 1 litre reaction vessel initially contained 1.5 mol nitrogen trichloride, 1.0 mol nitrogen dioxide and 1.5 mol oxygen gas. When the reaction reached equilibrium there was 0.3 mole of chlorine gas. | |  |
|  | (i) | Write the equilibrium expression for this reaction. | **1** |
|  | (ii) | Determine the concentration of NCl3, O2 and 2NO2 at equilibrium. Then calculate the equilibrium constant, K for the reaction. Show relevant working. | **2** |
|  | (iii) | Predict the effect on the reaction direction by reducing the volume of the reaction vessel. Explain your answer. | **2** |
|  | (iv) | How would reducing the volume impact on the appearance of the reaction mixture? | **1** |
| (c) | During your course you performed a first-hand investigation to produce and test a sample of soap. | |  |
|  | (i) | Outline the procedure you used for making soap, naming the reactants and products involved in the reaction. | **3** |
|  | (ii) | Describe ONE precaution you took to minimise the hazards, or to dispose of wastes safely. | **1** |
|  | (iii) | Describe how you tested the product. | **1** |
|  | (iv) | Explain the cleaning action of soaps by describing their basic structure. | **3** |
| (d) | Justify the selection of the membrane process for the extraction of sodium hydroxide rather than the use of alternative processes. | | **7** |

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

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| --- | --- | --- | --- |
| (a) | Seawater is an electrolyte containing a mixture of dissolved mineral salts. The concentration of dissolved minerals is on average 35 g L-1, although it varies considerably throughout the oceans. | |  |
|  | (i) | Describe TWO sources of dissolved minerals in seawater. | **4** |
|  | (ii) | In general, how would the concentration of dissolved minerals in tropical waters compare with the average concentration? | **1** |
| (b) | An electrolytic cell consisting of a solution of 0.5 M potassium iodide and two graphite electrodes is set up in a beaker. | |  |
|  |  | |  |
|  | (i) | Write the half equations for the reactions taking place at the anode and cathode. | **2** |
|  | (ii) | Describe the changes you would expect to observe at the anode and cathode. | **2** |
|  | (iii) | Explain the effect of replacing one graphite electrode with a copper electrode. | **2** |
| (c) | Explain the process of rusting using relevant equations. | | **4** |
| (d) | During your course you planned and performed a first-hand investigation to compare the effectiveness of different methods of protecting iron from corrosion. | |  |
|  | (i) | Outline the procedure you used in your investigation and describe the results obtained. | **3** |
|  | (ii) | Assess the validity of your investigation. | **3** |
| (e) | Explain, using TWO examples, why salvaged artefacts are conserved using different techniques. | | **4** |
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**Question 34 — The Biochemistry of Movement** (25 marks)

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| (a) | The chemical formulae of five organic compounds are shown below.  C5H10O5  C2H5OH CHOOH C12H22O11 C4H9O3N | |  |
|  | (i) | Which of the organic compounds would be classified as carbohydrates? Give a reason for your selection. | **2** |
|  | (ii) | Relate the structure of glycogen to its function. | **3** |
| (b) | Many common fats and oils (tricylglycerols) are formed when a molecule of glycerol reacts with three molecules of fatty acids. | |  |
|  | (i) | Give the systematic name of glycerol and draw its structural formula. | **2** |
|  | (ii) | Account for the difference in solubility of glycerol and tricylglycerols. | **3** |
| (c) | You carried out a first-hand investigation into the effects of temperature change on a reaction catalysed by a named enzyme. | |  |
|  | (i) | Name the reaction and the enzyme used in your investigation. | **1** |
|  | (ii) | Outline the procedure you used to safely carry out your investigation. | **3** |
|  | (iii) | Sketch an appropriate graph to show the effect of increasing temperature on the reaction you investigated. | **2** |
|  | (iv) | Evaluate the validity and reliability of your first-hand investigation. | **3** |
| (d) | Compare and contrast type 1 and type 2 skeletal muscle fibres in terms of structure and function. | | **6** |

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

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| (a) | Identify TWO pigments used in traditional Aboriginal art and describe the chemical composition of each. | | **3** |
| (b) | Current analytical technologies can be used to identify elements present in art works. | |  |
|  |  | |  |
|  | (i) | Identify a current analytical technology and explain the scientific principle behind its operation. | **3** |
|  | (ii) | Outline how the information gained can be used to validate or restore art work. | **2** |
| (c) | Explain the relationship between the elements with outer-most electrons assigned to s, p, d and f blocks and the organisation of the Periodic Table. | | **5** |
| (d) | During your course you performed a first-hand investigation to demonstrate the oxidising strength of potassium permanganate, KMnO4. | |  |
|  | (i) | Identify a risk in conducting this investigation and state a safety precaution taken. | **2** |
|  | (ii) | Outline your procedure and describe the results of your investigation. | **4** |
|  | (iii) | The following half equation represents one reduction of the permanganate ion:  MnO4- + 8H+ +5e- → Mn2+ + 4H2O  What change in oxidation state is taking place to manganese? | **1** |
|  | (iv) | Explain why manganese can have a range of oxidation states. | **3** |
| (e) | Define the term *chelated ligand* and give an example. | | **2** |
|  |  |  |  |

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

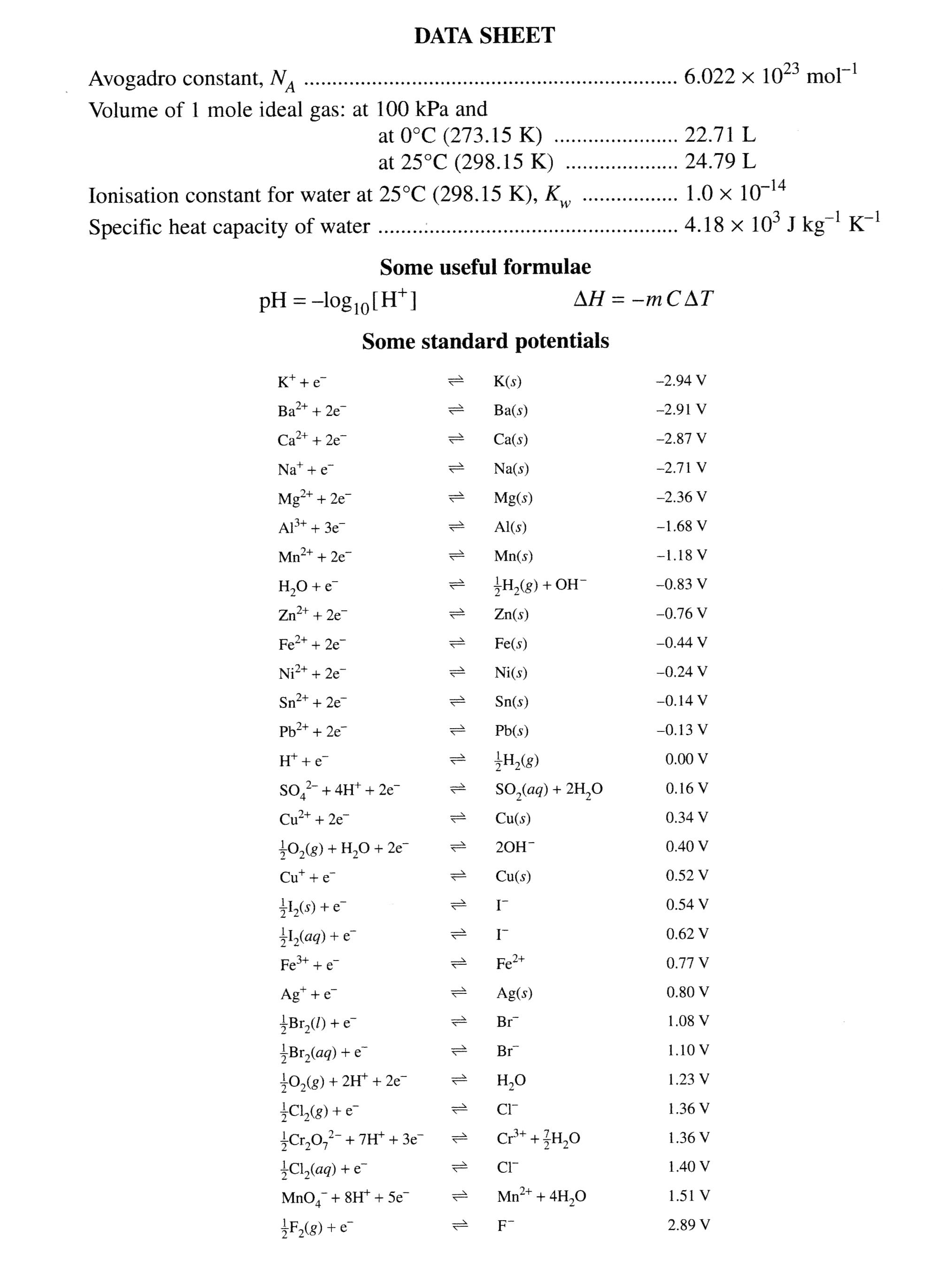
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| --- | --- | --- | --- |
| (a) | A student was asked to distinguish between three colourless liquids: water, ethanol and acetic acid.  He said he would test each with universal indicator and record the colour and pH. Then he would add a piece of sodium metal to each one and observe the reactions.  Critically evaluate his strategy and suggest improvements. | | **4** |
| (b) | Cellulose, starch and glycogen are all polymers made of the monomer glucose.  Contrast these polymers in terms of structure, function and properties. | | **5** |
| (c) |  | |  |
|  | (i) | Write the general formula for an amino acid. | **1** |
|  | (ii) | Draw TWO amino acids linked together through the formation of a peptide bond. | **2** |
|  | (iii) | Which compounds can break peptide bonds in living things? | **1** |
|  |  | |  |
| (d) | You performed a first-hand investigation into the range of solvents that can be used for chromatography. | |  |
|  | (i) | Outline the procedure you used in your investigation and describe the results obtained. | **4** |
|  | (ii) | Compare and contrast gas-liquid chromatography with high performance liquid chromatography in small sample analysis. | **4** |
| (e) | Assess the use of destructive analysis techniques, such as mass spectroscopy and atomic emission spectroscopy, in forensic investigations. | | **4** |

**End of paper**

**2011 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION**

Chemistry

**DATA SHEET**

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|  |
| --- |
| **PERIODIC TABLE OF THE ELEMENTS** |
| **KEY**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | 1 [**H**](http://en.wikipedia.org/wiki/Hydrogen) 1.008 Hydrogen | Atomic number  Chemical symbol  Relative atomic mass  Name of element | |  | | | | | | | | | | | | | | 2 [**He**](http://en.wikipedia.org/wiki/Helium) 4.003 Helium | | 3 [**Li**](http://en.wikipedia.org/wiki/Lithium) 6.941 Lithium | 4 [**Be**](http://en.wikipedia.org/wiki/Beryllium) 9.012 Beryllium |  | | | | | | | | | | 5 [**B**](http://en.wikipedia.org/wiki/Boron) 10.81 Boron | 6 [**C**](http://en.wikipedia.org/wiki/Carbon) 12.01 Carbon | 7 [**N**](http://en.wikipedia.org/wiki/Nitrogen) 14.01 Nitrogen | 8 [**O**](http://en.wikipedia.org/wiki/Oxygen) 16.00 Oxygen | 9 [**F**](http://en.wikipedia.org/wiki/Fluorine) 19.00 Fluorine | 10 [**Ne**](http://en.wikipedia.org/wiki/Neon) 20.18  Neon | | 11 [**Na**](http://en.wikipedia.org/wiki/Sodium) 22.99 Sodium | 12  [**Mg**](http://en.wikipedia.org/wiki/Magnesium) 24.31 Magnesium |  | | | | | | | | | | 13 [**Al**](http://en.wikipedia.org/wiki/Aluminium) 26.98 Aluminium | 14 [**Si**](http://en.wikipedia.org/wiki/Silicon) 28.09 Silicon | 15 [**P**](http://en.wikipedia.org/wiki/Phosphorus) 30.97 Phosphorus | 16 [**S**](http://en.wikipedia.org/wiki/Sulfur) 32.07  Sulfur | 17 [**Cl**](http://en.wikipedia.org/wiki/Chlorine) 35.45 Chlorine | 18 [**Ar**](http://en.wikipedia.org/wiki/Argon) 39.95  Argon | | 19 [**K**](http://en.wikipedia.org/wiki/Potassium) 39.10 Potassium | 20 [**Ca**](http://en.wikipedia.org/wiki/Calcium) 40.08 Calcium | 21 [**Sc**](http://en.wikipedia.org/wiki/Scandium) 44.96 Scandium | 22 [**Ti**](http://en.wikipedia.org/wiki/Titanium) 47.87 Titanium | 23 [**V**](http://en.wikipedia.org/wiki/Vanadium) 50.94 Vanadium | 24 [**Cr**](http://en.wikipedia.org/wiki/Chromium) 52.00 Chromium | 25 [**Mn**](http://en.wikipedia.org/wiki/Manganese) 54.94 Manganese | 26 [**Fe**](http://en.wikipedia.org/wiki/Iron) 55.85 Iron | 27 [**Co**](http://en.wikipedia.org/wiki/Cobalt) 58.93 Cobalt | 28 [**Ni**](http://en.wikipedia.org/wiki/Nickel) 58.69 Nickel | 29 [**Cu**](http://en.wikipedia.org/wiki/Copper) 63.55 Copper | 30 [**Zn**](http://en.wikipedia.org/wiki/Zinc) 65.38 Zinc | 31 [**Ga**](http://en.wikipedia.org/wiki/Gallium) 69.72 Gallium | 32 [**Ge**](http://en.wikipedia.org/wiki/Germanium) 72.64 Germanium | 33 [**As**](http://en.wikipedia.org/wiki/Arsenic) 74.92 Arsenic | 34 [**Se**](http://en.wikipedia.org/wiki/Selenium) 78.96 Selenium | 35 [**Br**](http://en.wikipedia.org/wiki/Bromine) 79.90 Bromine | 36 [**Kr**](http://en.wikipedia.org/wiki/Krypton) 83.80 Krypton | | 37 [**Rb**](http://en.wikipedia.org/wiki/Rubidium) 85.47 Rubidium | 38 [**Sr**](http://en.wikipedia.org/wiki/Strontium) 87.61 Strontium | 39 [**Y**](http://en.wikipedia.org/wiki/Yttrium) 88.91 Yttrium | 40 [**Zr**](http://en.wikipedia.org/wiki/Zirconium) 91.22 Zirconium | 41 [**Nb**](http://en.wikipedia.org/wiki/Niobium) 92.91  Niobium | 42 [**Mo**](http://en.wikipedia.org/wiki/Molybdenum)  95.96 Molybdenum | 43 [**Tc**](http://en.wikipedia.org/wiki/Technetium)  Technetium | 44 [**Ru**](http://en.wikipedia.org/wiki/Ruthenium) 101.1 Ruthenium | 45 [**Rh**](http://en.wikipedia.org/wiki/Rhodium) 102.9 Rhodium | 46 [**Pd**](http://en.wikipedia.org/wiki/Palladium) 106.4 Palladium | 47 [**Ag**](http://en.wikipedia.org/wiki/Silver) 107.9 Silver | 48 [**Cd**](http://en.wikipedia.org/wiki/Cadmium) 112.4 Cadmium | 49 [**In**](http://en.wikipedia.org/wiki/Indium) 114.8 Indium | 50 [**Sn**](http://en.wikipedia.org/wiki/Tin) 118.7  Tin | 51 [**Sb**](http://en.wikipedia.org/wiki/Antimony) 121.8 Antimony | 52 [**Te**](http://en.wikipedia.org/wiki/Tellurium) 127.6 Tellurium | 53 [**I**](http://en.wikipedia.org/wiki/Iodine) 126.9 Iodine | 54 [**Xe**](http://en.wikipedia.org/wiki/Xenon) 131.3  Xenon | | 55 [**Cs**](http://en.wikipedia.org/wiki/Caesium) 132.9 Caesium | 56 [**Ba**](http://en.wikipedia.org/wiki/Barium) 137.3 Barium | Lanthanoids 57-71 [**\***](http://en.wikipedia.org/wiki/Lanthanides) - | 72 [**Hf**](http://en.wikipedia.org/wiki/Hafnium) 178.5 Hafnium | 73 [**Ta**](http://en.wikipedia.org/wiki/Tantalum) 180.9 Tantalum | 74 [**W**](http://en.wikipedia.org/wiki/Tungsten) 183.9 Tungsten | 75 [**Re**](http://en.wikipedia.org/wiki/Rhenium) 186.2 Rhenium | 76 [**Os**](http://en.wikipedia.org/wiki/Osmium) 190.2 Osmium | 77 [**Ir**](http://en.wikipedia.org/wiki/Iridium) 192.2 Iridium | 78 [**Pt**](http://en.wikipedia.org/wiki/Platinum) 195.1 Platinum | 79 [**Au**](http://en.wikipedia.org/wiki/Gold) 197.0 Gold | 80 [**Hg**](http://en.wikipedia.org/wiki/Mercury_(element)) 200.6 Mercury | 81 [**Tl**](http://en.wikipedia.org/wiki/Thallium) 204.4 Thallium | 82 [**Pb**](http://en.wikipedia.org/wiki/Lead) 207.2  Lead | 83 [**Bi**](http://en.wikipedia.org/wiki/Bismuth) 209.0  Bismuth | 84 [**Po**](http://en.wikipedia.org/wiki/Polonium)  Polonium | 85 [**At**](http://en.wikipedia.org/wiki/Astatine)  Astatine | 86 [**Rn**](http://en.wikipedia.org/wiki/Radon)  Radon | | 87 [**Fr**](http://en.wikipedia.org/wiki/Francium)  Francium | 88 [**Ra**](http://en.wikipedia.org/wiki/Radium)  Radium | Actinoids 89-103 [**\*\***](http://en.wikipedia.org/wiki/Actinides) - | 104 [**Rf**](http://en.wikipedia.org/wiki/Rutherfordium)  Rutherfordium | 105 [**Db**](http://en.wikipedia.org/wiki/Dubnium)  Dubnium | 106 [**Sg**](http://en.wikipedia.org/wiki/Seaborgium)  Seaborgium | 107 [**Bh**](http://en.wikipedia.org/wiki/Bohrium)  Bohrium | 108 [**Hs**](http://en.wikipedia.org/wiki/Hassium)  Hassium | 109 [**Mt**](http://en.wikipedia.org/wiki/Meitnerium)  Meitnerium | 110 [**Ds**](http://en.wikipedia.org/wiki/Darmstadtium)  Darmstadtium | 111 [**Rg**](http://en.wikipedia.org/wiki/Roentgenium)  Roentgenium | 112 [**Cn**](http://en.wikipedia.org/wiki/Copernicium)  Copernicium |  |  |  |  |  |  | |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | \***[Lanthanoids](http://en.wikipedia.org/wiki/Lanthanide" \o "Lanthanide)** | 57 [**La**](http://en.wikipedia.org/wiki/Lanthanum) 138.9 Lanthanum | 58 [**Ce**](http://en.wikipedia.org/wiki/Cerium) 140.1 Cerium | 59 [**Pr**](http://en.wikipedia.org/wiki/Praseodymium) 140.9 Praseodymium | 60 [**Nd**](http://en.wikipedia.org/wiki/Neodymium) 144.2 Neodymium | 61 [**Pm**](http://en.wikipedia.org/wiki/Promethium)  Promethium | 62 [**Sm**](http://en.wikipedia.org/wiki/Samarium) 150.4 Samarium | 63 [**Eu**](http://en.wikipedia.org/wiki/Europium) 152.0 Europium | 64 [**Gd**](http://en.wikipedia.org/wiki/Gadolinium) 157.3 Gadolinium | 65 [**Tb**](http://en.wikipedia.org/wiki/Terbium) 158.9 Terbium | 66 [**Dy**](http://en.wikipedia.org/wiki/Dysprosium) 162.5  Dysprosium | 67 [**Ho**](http://en.wikipedia.org/wiki/Holmium) 164.9 Holmium | 68 [**Er**](http://en.wikipedia.org/wiki/Erbium) 167.3 Erbium | 69 [**Tm**](http://en.wikipedia.org/wiki/Thulium) 168.9 Thulium | 70 [**Yb**](http://en.wikipedia.org/wiki/Ytterbium) 173.1 Ytterbium | 71 [**Lu**](http://en.wikipedia.org/wiki/Lutetium) 175.0 Lutetium | |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | \*\***[Actinoids](http://en.wikipedia.org/wiki/Actinide" \o "Actinide)** | 89 [**Ac**](http://en.wikipedia.org/wiki/Actinium)  Actinium | 90 [**Th**](http://en.wikipedia.org/wiki/Thorium) 232.0 Thorium | 91 [**Pa**](http://en.wikipedia.org/wiki/Protactinium) 231.0  Protactinium | 92 [**U**](http://en.wikipedia.org/wiki/Uranium) 238.0  Uranium | 93 [**Np**](http://en.wikipedia.org/wiki/Neptunium)  Neptunium | 94 [**Pu**](http://en.wikipedia.org/wiki/Plutonium)  Plutonium | 95 [**Am**](http://en.wikipedia.org/wiki/Americium)  Americium | 96 [**Cm**](http://en.wikipedia.org/wiki/Curium)  Curium | 97 [**Bk**](http://en.wikipedia.org/wiki/Berkelium)  Berkelium | 98 [**Cf**](http://en.wikipedia.org/wiki/Californium)  Californium | 99 [**Es**](http://en.wikipedia.org/wiki/Einsteinium)  Einsteinium | 100 [**Fm**](http://en.wikipedia.org/wiki/Fermium)  Fermium | 101 [**Md**](http://en.wikipedia.org/wiki/Mendelevium)  Mendelevium | 102 [**No**](http://en.wikipedia.org/wiki/Nobelium)  Nobelium | 103 [**Lr**](http://en.wikipedia.org/wiki/Lawrencium)  Lawrencium | |
| Elements with atomic numbers 113 and above have been reported but not fully authenticated.  Standard atomic weights are abridged to four significant figures.  Elements with no reported values in the table have no stable nuclides. |

Student Number/Name………………………………

**2011 CHEMISTRY TRIAL HSC EXAMINATION**

**Section I – Part A Answer Sheet**

**20 marks**

**Attempt Questions 1 –20**

**Allow about 35 minutes for this section**

Select the alternative A, B, C, or D that best answers the question. Fill in the response circle completely.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **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 |



2011 Chemistry HSC Trial Marking Guidelines

**Section I — Part A**

**MULTIPLE CHOICE ANSWERS**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **1** | A | **6** | A | **11** | A | **16** | C |
| **2** | B | **7** | C | **12** | A | **17** | C |
| **3** | A | **8** | C | **13** | A | **18** | C |
| **4** | D | **9** | B | **14** | B | **19** | D |
| **5** | D | **10** | B | **15** | C | **20** | C |

**Section I — Part B**

**Question 21 (7 marks)**

**a**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides detailed explanation of addition reaction and description of double bond reactivity. | 3 |
| * Provides brief explanation of addition reaction and identification of double bond in ethylene | 2 |
| * Provides either brief explanation of addition reaction or identification of double bond in ethylene | 1 |

*Suggested answer*

In an addition reaction two atoms or groups of atoms are added to each carbon atom linked by a double bond. The double bond is broken and replaced by a single bond. The double bond in ethylene is highly reactive. Two pairs of electrons produce a centre of negative charge that is reactive to a wide range of electron acceptors.

**b**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Gives any two correct addition reactions involving ethylene | 2 |
| * Gives one correct addition reaction involving ethylene | 1 |

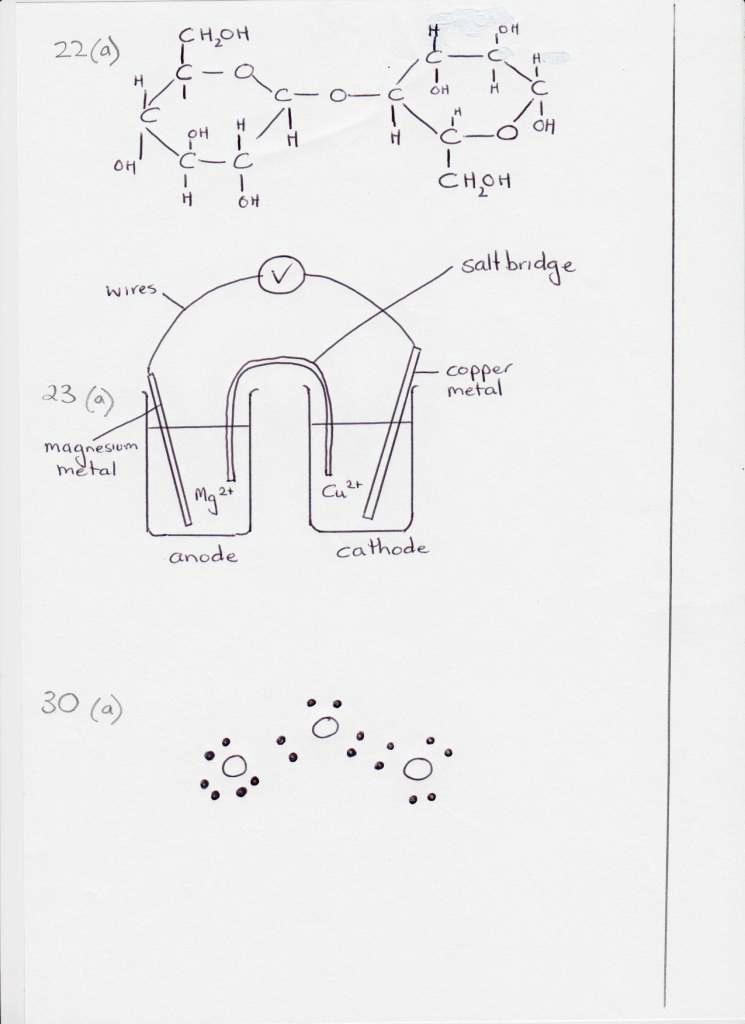
|  |  |
| --- | --- |
|  | *Suggested answer*  C2H4 + Br2 → C2H4Br2 |
| or | C2H4 + H2O→ C2H5OH |
| or | n(C2H4 ) → --(CH2---CH2)--n |

**Question 22**

**(a)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Diagram shows two glucose monomers linked by a glycoside bond (-C-O-C-). The glucose monomers are represented correctly as rings of 5 carbons. The glycoside bond links carbon 1 to carbon 4. Total number of atoms correct after H2O is eliminated. | 2 |
| * Diagram shows two glucose monomers linked by a glycoside bond (-C-O-C-). Some error in representing monomers. | 1 |

*Suggested answer*

**

**b**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Names reaction type as **condensation** AND **water** named as other product formed with cellulose | 1 |

**c**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Acknowledges cellulose is as a renewable resource which can be used to produce petrochemicals such as ethylene. The process is outlined. Non-renewable petroleum is identified as the present source of most petrochemicals. The depletion of petroleum reserves is stated as the reason why chemists are investigating alternative sources of cellulose. | 3 |
| * As above but lacking the process by which cellulose can be used to produce petrochemicals. | 2 |
| * Identifies renewable nature of cellulose or non-renewable nature of petroleum   OR   * States depletion of petroleum reserves | 1 |

*Suggested answer*

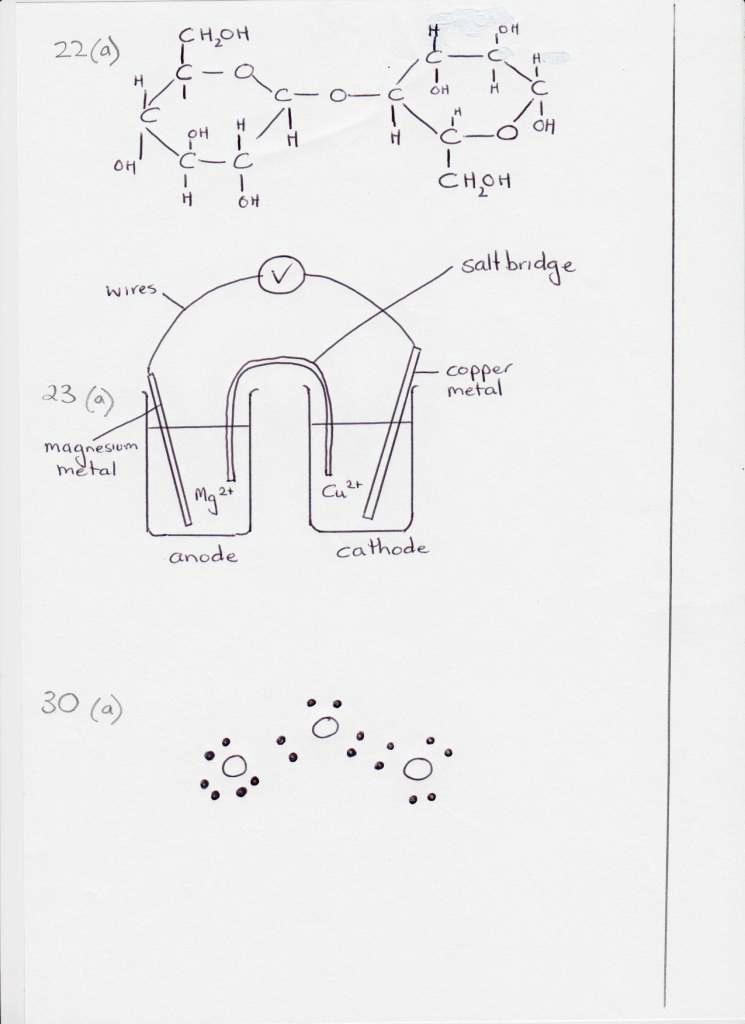
Cellulose is found in biomass which is derived from plant material. Cellulose is a renewable raw material which can be digested by microorganisms into glucose. The glucose can then be fermented into ethanol which is dehydrated into ethylene. Ethylene is an important petrochemical used to manufacture many other compounds. Currently most ethylene is derived from petroleum but this is a non-renewable resource and reserves are being depleted. Therefore chemists are investigating sources of cellulose so that the compounds which are now produced from ethylene can be manufactured into the future.

**Question 23**

**a**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Shows on a labelled diagram two half cells connected by a **salt bridge** and the electrodes connected by **leads (**wires) to form the external circuit. The **anode and cathode** are correctly labelled. | 3 |
| * Two out of three of the above are correctly labelled on the diagram | 2 |
| * One of the above are correctly labelled on the diagram | 1 |

*Suggested answer*

****

**b**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Mg(s) + Cu+2(aq) → Mg+2(aq) + Cu(s) | 1 |

**c**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| Mg(s) → Mg+2(aq) + 2e-  2.37 V  2e- + Cu+2(aq) → Cu(s)  0.34 V  2.37 + 0.34 = 2.71V | 1 |

**d**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Identifies non-standard conditions as the reason why students result is different from the theoretical value. Two differences such as concentration of electrolyte solutions, temperature, purity of electrodes stated as possible variations from non-standard conditions. | 2 |
| * Supplies one variation from non-standard conditions | 1 |

*Suggested answer*

The theoretical value is obtained by measuring the half cell potentials under standard conditions of 25 0C and 101.3 kPa and solutions with concentrations of 1 mol L-1. The students may have made their measurements under other conditions or used electrodes of low purity.

**Question 24**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Describes a similarity and a difference between reactor and particle accelerator produced radioisotopes OR two similarities or two differences given * Gives an example of at least one radioisotope produced by each method given | 4 |
| * Describes one similarity or difference between methods of production * Gives an example of at least one radioisotope produced by each method   OR   * as above but only one example of a reactor or accelerator radioisotope given | 3 |
| * Gives one similarity or difference between methods of production and only one example of a reactor or accelerator radioisotope | 2 |
| * Gives either a similarity or difference   OR   * Names one example of a radioisotope | 1 |

*Suggested answer*

Radioisotopes can be produced in a nuclear fission reactor or in a particle accelerator. In both cases the target nuclei is bombarded with particles to create a new nuclide. In a reactor the target nuclei are bombarded with neutrons whereas in a particle accelerator the target nuclei are bombarded with charged particles such as protons or the nuclei of small atoms that have been accelerated to high speeds. Radioisotopes produced in reactors are described as neutron rich such as cobalt-60, iodine-131 or sodium-24. Radioisotopes produced by particle accelerators are described as proton rich such as gallium-67, nitrogen-13 or oxgen-13.

**Question 25**

**a**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Constructs data table with three columns, headings, grid and all oxides correctly classified. | 3 |
| * Constructs data table with one error in table or oxide classification | 2 |
| * Constructs data table with two errors either in data table or in oxide classification. | 1 |

*Suggested answer*

|  |  |  |
| --- | --- | --- |
| Acidic oxides | Amphoteric oxides | Basic oxides |
| CO2 | Al2O3 | MgO |
| P4O10 | SnO2 | K2O |

**b**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| CO2(g) + H2O(l) → H2CO3(aq) OR  P4O10(s) + 6H2O(l) → 4H3PO4(aq) | 1 |

**c**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Defines amphoteric as a metal oxide which can react with both acids and bases | 1 |

**Question 26**

**a**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Supplies working out shown with correct answer to required number of significant figures and unit | 2 |
| * As above with one omission | 1 |

*Suggested answer*

C x 0.0283 = 0.20 x 0.025

C = 0.18 mol L-1

**b**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Correctly chooses indicator and valid reason supplied | 2 |
| * Correctly chooses indicator or valid reason supplied | 1 |

*Suggested answer*

As a strong base is reacting with a weak acid an indicator such as phenolphthalein is required which will have an end point in the alkaline pH range.

**c**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Supplies a valid advantage and disadvantage to group work | 2 |
| * Supplies either a valid advantage or disadvantage to group work | 1 |

*Suggested answer*

When working in a group, tasks can be discussed and work load shared between several group members so that the tasks can be completed faster. When working in a group individuals must be willing to discuss different viewpoints and compromise when decisions need to be made, this can be time consuming and the best approach may not emerge.

**Question 27**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides at least three different correct methods of defining acids, showing how the definition has evolved over time. * Names three scientists who were responsible for changing ideas are named. | 4 |
| * Provides two correct definitions and three named scientists   OR   * Provides three definitions and two named scientists | 3 |
| * Provides two correct definitions and two named scientists are | 2 |
| * Provides one correct definition and one name scientist | 1 |

*Suggested answer*

An early definition of acids was made by Antoine Lavoisier who said that acids were compounds which contained the element oxygen. When acids were discovered that did not contain oxygen the definition was adjusted to acids were compounds that contained the element hydrogen. Svante Arrhenius improved this idea by theorising that acids were compounds that produced hydrogen ions in water. The concept of acid was further developed by two chemists Johannes Brⱷnsted and Thomas Lowry who said that acids are chemical species that transfer a proton to another species.

**Question 28**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Discusses in detail at least three different reasons why the reaction vessel needs to be monitored * Includes a correctly balanced equation with description of shifting equilibrium to the right to produce more ammonia. | 5 |
| * As above with or without the equation and/or three or two different reasons why discussed. | 4-3 |
| * Provides equation and/or discusses one or two different reasons why the reaction vessel needs to be monitored | 2 |
| * Provides a single reason why the reaction vessel needs to be monitored | 1 |

*Suggested answer*

It is essential that the reaction vessel be monitored during the production of ammonia. Decisions concerning safety, yield and production costs are made based on the information which is gathered during monitoring of the reaction vessel.

(continued)

Safety is a major concern when manufacturing ammonia as one of the reactants, hydrogen, is explosive if it comes in contact with air. So the reaction vessel needs to be monitored to ensure that only hydrogen and nitrogen gas are entering the reaction vessel.

N2(g)  + 3H2(g) ↔ 2NH3(g) is a reversible reaction where the equilibrium lies far to the left. So that the yield can be increased the reaction is monitored and manipulated with elevated temperatures and pressures to an optimal level. Also the equilibrium is shifted to the right by continually adding more reactants and removing the product ammonia.

An expensive iron catalyst is used to speed up the reaction to make the production of ammonia more cost effective. Contaminants in the reaction vessel could damage the catalyst and greatly increase the production costs. The reaction vessel must therefore be constantly monitored to efficiently produce ammonia.

**Question 29**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Identifies and assesses risks using chemicals and Bunsen flame * States precautions required to prevent injury * Recommends an alternative safer strategy | 4 |
| * Identifies and assesses risks using chemicals and Bunsen flame * States precautions required to prevent injury | 3 |
| * States a risk and a precaution | 2 |
| * States either a risk or a precaution | 1 |

*Suggested answer*

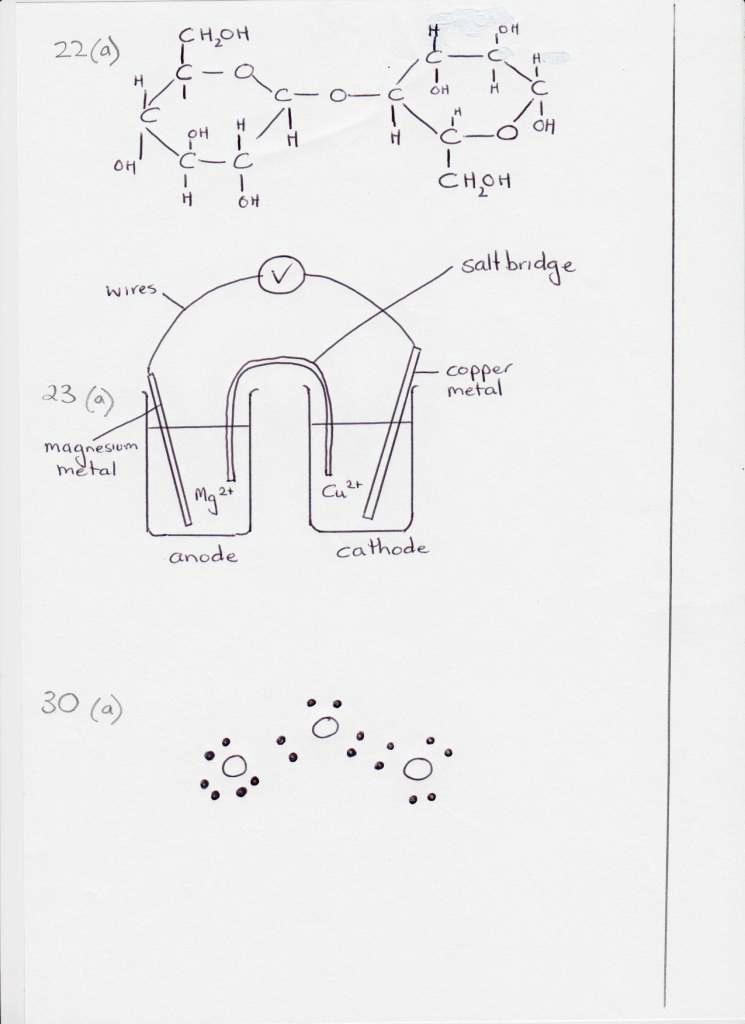
The possible risks involved in this activity included handling toxic compounds such as lead and barium salts. It will be necessary to minimise exposure to these compounds. Also risks exist in conducting flame tests due to the presence of the flame and hot equipment. It will be necessary to take great care when using the Bunsen burner to prevent hair and clothing from catching alight and from burns due to touching hot items of equipment.

The precautions needed to prevent injury include testing very small quantities of chemicals, wearing safety glasses and wiping up any spills immediately. Also long hair should be tied back. To prevent inhalation of toxic fumes from possible lead compounds a precipitation test could be conducted first by adding sodium chloride solution to solutions of each compound as only the lead compound would produce a white precipitate thus eliminating the need to test a lead compound using a flame test. Alternatively the flame tests could be conducted in a fume cupboard.

**Question 30**

**a**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Draws ozone molecule showing correct arrangement of electrons | 1 |

******

*Suggested answer*

**b**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Explains fully, in terms of molecular structure and bonding, differences in density and MP/BP between ozone and oxygen. | 3 |
| * As above but with less detail, omitting name of intermolecular force or name of bonds present in molecules when explaining differences in density and MP/BP | 2 |
| * Attempts to explain differences in density or MP/BP in terms of molecular structure or bonding | 1 |

*Suggested answer*

Ozone (O3) molecules have a higher mass than oxygen (O2) molecules but the volume occupied by these gases are the same at the same temperature and pressure. This produces a higher density for ozone. Ozone molecules have one double bond and one coordinate covalent bond which produces greater intermolecular forces (dispersion forces) between ozone molecules than between oxygen molecules which only have one double bond. The stronger dispersion forces require more energy to overcome when melting solid ozone or boiling liquid ozone compared with oxygen. This is why ozone has higher melting point and boiling point temperatures.

**Question 31**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Describes in detail a physical process and a chemical process as used to purify and sanitise a town’s water supply * Assesses the effectiveness of each process against criteria such as safety for human consumption and cost | 5 |
| * Describes a physical process and/or a chemical process as used to purify and sanitise a town’s water supply * Assesses the effectiveness of each process against criteria such as safety for human consumption and cost | 4-3 |
| * Describes briefly a physical process and a chemical process as used to purify and sanitise a town’s water supply. | 2 |
| * Describes either a physical process or a chemical process used to purify and sanitise a town’s water supply   OR   * Identifies two processes | 1 |

*Suggested answer*

Filtration is a physical process where water is passed through screens, gravel beds and sand beds to filter out solid wastes present in water. Only large particles are removed using this process. Dissolved substances and microorganisms can pass through these filters; however this is a relatively economical method of treating large volumes of water.

Chlorination is a chemical process where chlorine gas reacts with water to form the hypochlorite ion which destroys biological contaminants such as bacteria. This is a relatively economical method of ensuring that water will not spread disease causing microorganisms. Neither of these water treatment processes is able to remove dissolved contaminants such as metal ions or organic molecules

**Section II — Electives**

**Question 32 (25 marks) – INDUSTRIAL CHEMISTRY**

**a (i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides both description and equation | 2 |
| * Provides either description or equation | 1 |

*Suggested answer*

Pb(s) + PbO(s) + 4H+ (aq) + 2SO4 2- (aq) → 2PbSO4 (S) + 2H2O(l)

In car batteries the sulphuric acid is used as an oxidising agent to change Pb to Pb2+

**(ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides both description and equation | 2 |
| * Provides either description or equation | 1 |

*Suggested answer*

conc. H 2SO 4

CH5OH(l) → C2H4(g) + H2

In the production of ethylene from ethanol concentrated sulphuric acid acts as a dehydrating agent.

**b(i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides below | 1 |

*Suggested answer*

k = [NO2]2  [Cl2]3

[NCl3]2 [O2]2

**(ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides correct equilibrium concentrations and valve of k | 2 |
| * Makes an error in calculating equilibrium concentrations or value of k | 1 |

*Suggested answer*

|  |  |  |
| --- | --- | --- |
| species | initial conc.  mol L-1 | equilibrium conc.  mol L-1 |
| NCl3 | 1.5 | 1.5 -(2/3 x 0.3)= 1.3 |
| O2 | 1.5 | 1.5 -(2/3 x 0.3)= 1.3 |
| NO2 | 1.0 | 1.0 +(2/3 x 0.3)= 1.2 |
| Cl2 | 0 | 0.3 |

k = (1.2)2 x (0.3)3

(1.3)2 x (1.3)2

= 0.014

**(iii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Correctly predicts reaction direction with sound explanation | 2 |
| * Correctly predicts reaction direction | 1 |

*Suggested answer*

If the volume of the reaction vessel was halved the reaction will shift to the left favouring the reactants with 4 moles of gaseous molecules compared to 5 moles of gaseous molecules on the product side. By halving the volume the pressure is doubled. Le Chatelier’s principle predicts the reaction will shift to the direction which opposes the change. A shift to the left will help reduce the pressure as the reaction establishes a new equilibrium.

**(iv)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Correctly states change in appearance of colour of gas mixture in reaction vessel | 1 |

*Suggested answer*

Colourless reactants increase, brown/green products reduce therefore the mixture is lighter in colour.

**c (i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Correctly and completely outlines steps needed to make soap in school laboratory, naming reactants required and products | 3 |
| * Completes most steps needed to make soap in school laboratory, naming reactants required and products | 2 |
| * Completes some steps needed to make soap in school laboratory | 1 |

*Suggested answer*

4 g of Olive oil (or another source of triglycerides) was added to 10 mL of water and 1g of sodium hydroxide solution in a beaker. The mixture was heated for 30 minutes. Then 50 mLs of saturated sodium chloride was stirred into the mixture. A precipitate formed which was separated by filtration. The products were a sodium carboxylate compound and glycerol.

**(ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides one safety precaution described or method of disposing of waste | 1 |

*Suggested answer*

Wear safety glasses and gloves as sodium hydroxide is corrosive. Wash any spills on skin or clothes with large volume or water.

Wash wastes down drain with large amounts of water to dilute strong alkali.

**(iii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Describes a method of testing soap | 1 |

*Suggested answer*

Place a 0.5 gram sample of soap in a large test tube with 10 mLs of water. Stopper test tube and shake. Measure height of lather. Repeat with a commercial soap and compare.

**(iv)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Explains fully cleaning action of soap in terms of ability to emulsify and disperse dirt held by oil or grease on a surface due to polar and non-polar interactions between the soap molecule and the water and stain * Describes the structure of soap (surfactant) in terms of hydrophilic and hydrophobic ends of molecule | 3 |
| * Explains basically cleaning action of soap in terms of ability to emulsify and disperse dirt held by oil or grease on a surface due to polar and non-polar interactions between the soap molecule and the water and stain. * Describes the structure of soap (surfactant) in terms of hydrophilic and hydrophobic ends of molecule | 2 |
| * Provides a simple explanation of cleaning action of soap or describes soap molecule structure | 1 |

*Suggested answer*

Soap acts as a surfactant or wetting agent which can dissolve in water to form a surfactant ion with a long non-polar end and a polar changed end. The changed end dissolves in water (as it is hydrophilic). The non-polar end (hydrophobic) can mix with the stain (dirt, grease or oil). This allows the stain to break up and be surrounded by soap molecules. The stain will be removed from the surface as it emulsifies and is dispersed in the washing water.

**d**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides a comprehensive description of three methods of producing sodium hydroxide including an equation, technical and environmental difficulties * Justifies the selection of the membrane process in terms of safety and/or environmental impact. | 7-6 |
| * Provides a description of three methods of producing sodium hydroxide including an equation or technical or environmental difficulties * Justifies the selection of the membrane process in terms of safety and/or environmental impact. | 5-4 |
| * Provides a description of one or two methods of producing sodium hydroxide including technical and/or environmental difficulties | 3-2 |
| * Identifies other methods of producing sodium hydroxide | 1 |

*Suggested answer*

Sodium hydroxide is produced by the electrolysis of concentrated sodium chloride solution as summarised by the equation:

2NaCl(aq) + 2H2O(l) → 2NaOH(aq) + Cl2(g)  + H2(g)

Three methods are used to keep the products from reacting; the mercury process, the diaphragm process and the membrane process. In the mercury process sodium is formed in the liquid mercury cathode and is continually removed to another vessel where it reacts with water forming sodium hydroxide and hydrogen gas. The mercury is recycled but some is always lost to the environment where it enters the food chain causing illness and death. In the diaphragm process an asbestos diaphragm lines the steel mesh cathode preventing the products from mixing. Exposure to asbestos fibres poses a considerable risk to the workers causing mesothelioma. Another problem is that the sodium hydroxide is contaminated with sodium chloride and must be separated. In the membrane process an ion exchange membrane made of a synthetic polymer separates the anode and cathode compartments. The membrane allows sodium ions to pass but not chloride or hydroxide ions thus preventing contamination or formation of other products. The membrane process is safer for workers and has a lower impact on the environment and should be used in place of the other processes.

**Question 33 (25 marks) – SHIPWRECKS, CORROSION AND CONSERVATION**

**a (i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Identifies TWO sources of dissolved minerals and a feature of each is described | 4 |
| * Identifies TWO sources of dissolved minerals but only one is described with a feature | 3 |
| * Identifies TWO sources OR identifies ONE and described | 2 |
| * Identifies ONE source | 1 |

*Suggested answer*

Rainwater dissolves minerals from rocks and soil by a process called weathering. The dissolved minerals flow into creeks and rivers and end up in the ocean. This is the main source of dissolved mineral salts in sea water. Hydrothermal vents along mid-ocean ridges causes seawater to be superheated when it comes into contact with magma. This superheated water then dissolves minerals from the surrounding rocks. The dissolved minerals disperse into the surrounding water.

**(ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Correctly connects tropical water with higher temperatures and increased solubility and therefore higher concentration of mineral salts | 1 |

*Suggested answer*

The concentration of dissolved minerals would be higher than average in tropical waters.

**b (i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Correctly writes half equations for reactions taking place at anode and cathode | 2 |
| * Writes an error with half equations or identification of anode/cathode | 1 |

*Suggested answer*

Anode 2I-(aq) → I2(aq) + 2e-

Cathode 2H2O + 2e- → H2(g) + 2OH-

**b (ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Correctly describes an observable change at the anode and cathode | 2 |
| * Describes one observation | 1 |

*Suggested answer*

Cathode: Bubbles of colourless gas form

Anode: Purple colour forms around electrode and disperses into electrolyte

**b (iii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Explains the change of product at the anode | 2 |
| * Generally identifies a change in product | 1 |

*Suggested answer*

Replacing one of the inert graphite electrodes with a copper electrode would result in a different product. Copper would be oxidised at the anode instead of iodide ions. Copper ions would go into solution. The oxidation of copper has a more positive E0 than the oxidation of iodide ions.

**c**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Gives detailed explanation of the formation of rust with 3 to 4 correct equations | 4 |
| * Gives explanation with some correct equations | 3 -2 |
| * Gives explanation without correct equations | 1 |

*Suggested answer*

For iron to rust both oxygen and water must be present. Iron is firstly oxidised to iron (II) ions. The electrons produced move through the iron to the surface where dissolved oxygen is reduced to hydroxide ions.

Anode Fe(s) → Fe2+(aq) + 2e-

Cathode O2(g) + 2H20(l) +4e- → 4OH-(aq)

The iron (II) ions and hydroxide ions then form iron hydroxide.

Fe2+(aq) + 2OH-(aq) → Fe(OH)2(aq)

The iron hydroxide is then oxidised to hydrated iron oxide (rust)

4Fe(OH)2(s) + O2(g) → 2(Fe2 O3 H2O)(s) + 2H20(l)

**d (i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides detailed procedure consisting of a series of steps to place samples of iron with various treatments under controlled conditions to compare the time taken to start rusting against a control (iron without treatment). Controlled variables such as surface area of iron, temperature, concentration of electrolyte, exposure to oxygen are included. * Provides statement of results obtained.- | 3 |
| * As above but with some design feature missing | 2 |
| * Outlines simple procedure consisting of steps to place samples of iron with various treatments under conditions to compare the time taken to start rusting * Gives some brief statement of results obtained | 1 |

*Suggested answer*

Procedure

1. Four equal sized iron nails are cleaned with steel wool to remove all rust.

2. Three iron nails are treated with a coating; grease, paint and tin.

3. Each nail is placed in a clean test tube.

4. Nails are covered with 15 mLs of 1M NaCl solution.

5. Nails are observed for the appearance of rust each week over four weeks.

Results

Compared to the control test tube the nail covered with grease showed some rust at the third week. No result was observed in the test tube with the painted nail or the tin coated nail.

**d (ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Makes judgement on the validity of the investigation in terms of design features such as ability to control variables and make accurate measurements. At least two design features used to make judgement of investigation validity. | 3 |
| * As above with one design feature used to make judgement of investigation validity | 2 |
| * Makes simple statement on the validity of investigation | 1 |

*Suggested answer*

The validity of this investigation was low as it was not possible to control all variables. The thickness of the various coatings on the nails was not controlled and the possibility of small cracks or gaps in the coatings could not be prevented. The accuracy of the measurements of time to start rusting also contributed to the low validity of this investigation. The ability to judge when rusting had started dependent on individuals’ eyesight and frequency of checking test tubes.

**e**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides detailed explanation of reasons why artefacts made of two different materials must be treated using different conservation techniques | 4 |
| * Provides explanation of why artefacts made of one to two different materials must be treated using different conservation techniques | 3-2 |
| * Provides some information on a conservation technique provided | 1 |

*Suggested answer*

Salvaged wooden artefacts are firstly cleaned of mud and silt then they are placed in water. (If a wooden object is allowed to dry out it will harden become brittle and crack). Wooden artefacts often have a deposit of calcium carbonate which must be removed by soaking it in an acid bath. The artefact is then dried out at low temperatures and pressures. It may then be coated with wax or polymer.

Salvaged iron artefacts will corrode rapidly if removed from seawater unless treated. They are firstly soaked in an alkaline solution to remove chlorides and other salts. The iron object is then dried using solvents that promote rapid evaporation and warmed to drive out all moisture.

**Question 34 (25 marks) – THE BIOCHEMISTRY OF MOVEMENT**

**a(i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Correctly selects two carbohydrates and gives correct reason for selection | 2 |
| * Correctly selects two carbohydrates or selects one correctly and gives reason for selection | 1 |

*Suggested answer*

C5H10O5 and C12H22O11 are both carbohydrates as their formula has only carbon, hydrogen and oxygen with the ratio of hydrogen to oxygen equal to 2:1 or complies with general formula Cx(H2O)y

**(ii)**

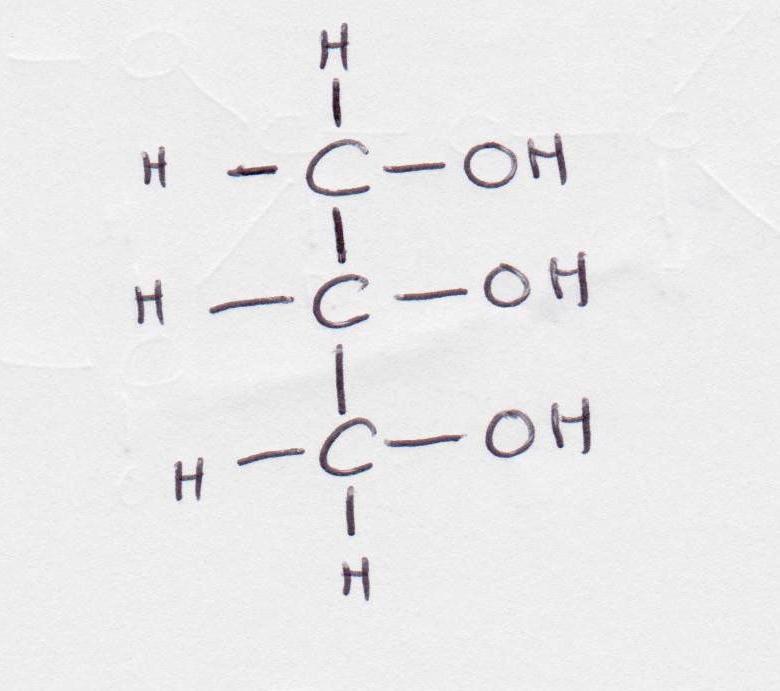
|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Gives a detailed description of the branched polymer glycogen found in granules in the liver and muscles and relates this branching to its ability to quickly release stored glucose | 3 |
| * Describes the structure of glucose and states its function as an energy storage molecule found in the liver and muscles | 2 |
| * Describes the structure of glucose or states its function as an energy storage molecule found in the liver and muscles | 1 |

*Suggested answer*

Glycogen is a highly branched polymer of glucose. Bonds form between the first carbon on one monomer and the fourth carbon on another to create a backbone. In addition side branches form when the first carbon on one glucose molecule bonds with the sixth carbon on another. Glycogen is stored as granules in the liver and muscles. Its highly branched form allows glycogen to be hydrolysed quickly to release glucose.

**b(i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Gives the correct systematic name and draws a structural formula | 2 |
| * Gives the correct systematic name or draws a structural formula | 1 |

*Suggested answer*

1,2,3-propanetriol

**(ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Explains the reason for the water solubility of glycerol in terms of polar hydrogen bonding between hydroxyl functional groups on glycerol and water molecules. * States the reason for non-water solubility of TAGs in terms of non-polar ester molecules | 3 |
| * Explains simply tthe water solubility of polar glycerol molecules in terms of like dissolves like * States non-water solubility of TAGs in terms of non-polar molecules not dissolving with polar water | 2 |
| * imply tthe water solubility of polar glycerol molecules in terms of like dissolves like   OR   * States non-water solubility of TAGs in terms of non-polar molecules not dissolving with polar water | 1 |

*Suggested answer*

Glycerol is a polar molecule soluble in water or other polar liquids as hydrogen bonding forms between the -OH on glycerol and water molecules. TAGs are non-polar molecules and are not soluble in water but will dissolve in non-polar solvents due to the fact that the -OH groups are lost when the ester bonds form between glycerol and fatty acids.

**c(i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Matches reaction and enzyme | 1 |

*Suggested answer*

Possible reactions performed in schools include decomposition of hydrogen peroxide catalysed by catalase (from liver or potato), milk protein coagulation catalysed by rennin (from junket tablets).

**(ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Gives procedure with steps which indicate at least 5 of the following; * how enzyme was prepared, * quantities of enzyme and substrate used, * how reaction rate was measured at different temperatures. * safety precautions taken * how variables were controlled for a valid investigation * repetition of procedure | 3 |
| * Gives procedure including at least 4 of the above | 2 |
| * Gives procedure including at least 3 of the above | 1 |

*Suggested answer*

1. 10 mL of chilled milk is placed in 5 test tubes

2. Each test tube is placed in a water bath held at different temperatures- 00C, 150C, 300C, 400C and 500C, taking care with hotplates.

3. A rennin tablet is crushed and mixed with 10 mLs of water.

4. Two mLs of rennin solution is added to another test tube and placed in the water baths

5. The rennin is then poured into the milk and a stop watch is used to time how long it takes the milk to coagulate.

6. Repeat steps 1 to 5 the average results

**(iii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Draws graph with appropriate labels on axes * Shows on graph increased reaction rate until a maximum is reached after which reaction rate declines rapidly | 2 |
| * Draws graph with appropriate labels on axes   OR   * Shows on graph increased reaction rate until a maximum is reached after which reaction rate declines rapidly. | 1 |

**(iv)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Judges validity in terms of design features such as controlled variables and method of measuring the dependent variable * Judges reliability in terms of how close repeated results are to the original | 3 |
| * Describes validity and reliability design features | 2 |
| * Describes validity or reliability design features | 1 |

*Suggested answer*

The validity of the experiment is low as was is very difficult to judge when the milk coagulated to stop timing. The validity and reliability was improved by using the same volume of milk and rennin in each test tube. Also placing both the milk and rennin in the water baths allowed both solutions to reach the same temperature before mixing which improved validity. The reliability was fair as we obtained similar results when the experiment was repeated.

**d**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Compares more than two similarities in structure and/or function between type1 and type 2 skeletal muscle fibres * Contrasts more than two differences in structure and/or function between type1 and type 2 skeletal muscle fibres are contrasted. | 6-5 |
| * Describes at least two similarities in structure and/or function between type1 and type 2 skeletal muscle fibres * Describes more than two differences in structure and function between type1 and type 2 skeletal muscle fibres | 4-3 |
| * Describes at least one similarity in structure and/or function between type1 and type 2 skeletal muscle fibres * Describes at least one difference in structure and/or function between type1 and type 2 skeletal muscle fibres | 2 |
| * Describes one similarity in structure and/or function between type1 and type 2 skeletal muscle fibres is described   OR   * Describes one difference in structure and/or function between type1 and type 2 skeletal muscle fibres | 1 |

*Suggested answer*

Type 1 and type 2 muscle fibres are present in all skeletal muscle tissue used for movement and are composed of actin and myosin fibres. When muscle fibres contract the actin fibres slide across the myosin fibres by way of cross-bridges. Both type 1 and type 2 muscle fibres contract when an impulse triggers the release of acetyl choline, then calcium ions are released. This causes ATP to release the energy needed to contract the muscle.

Type 1 skeletal muscle fibres have more mitochondria and capillaries than type 2. This causes type 1 to appear red in colour whereas type 2, appear white in colour. Type 1 muscle fibres have fewer stores of glycogen and carry out aerobic respiration where as type 2 muscle fibres have many glycogen stores and carry out mainly anaerobic respiration. Type 1 muscle fibres are used for light endurance exercise whereas type 2 muscle fibres are used for heavy exercise and sprinting.

**Question 35 (25 marks) – THE CHEMISTRY OF ART**

**(a)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Identifies TWO pigments and the chemical composition of both is provided | 3 |
| * Identifies TWO pigments and the chemical composition of one provided | 2 |
| * Identifies TWO pigments | 1 |

*Suggested answer*

Traditional Aboriginal art used pigments such as Red ochre composed of ground haematite (Fe2O3) and yellow ochre composed of ground limonite (FeO(OH)).

**(b) (i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Names current analytical technology * Provides a detailed explanation of the scientific principle behind its operation | 3 |
| * Names current analytical technology * Provides a basic explanation of the scientific principle behind its operation | 2 |
| * Names current analytical technology | 1 |

*Suggested answer*

Laser microspectral analysis. A laser is focused on the surface of the art work to vaporise a tiny sample that will absorb energy. The plasma that forms is a micro-source of light which can be analysed by an atomic emission spectroscopy. The emission spectra will consist of lines corresponding to the specific elements present in the pigments used on the art work. The spectral lines represent the energy emitted when excited electrons return to lower energy levels.

**b(ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Outlines how information on the specific elements and their concentrations in pigments present in an art work can be used to restore or validate the authenticity of an art work | 2 |
| * Outlines in general how information gained can be used to restore or validate an art work | 1 |

*Suggested answer*

The elemental composition of a pigment can allow a restorer to exactly match the pigment used or provide a synthetic substitute for the colour required on a valuable art work. Or the elemental composition of a pigment can be used to distinguish genuine art works from forgeries based on knowledge of historical pigment composition and use.

**c**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Demonstrates thorough knowledge and understanding of the relationship between outermost electrons filling sub-shells and the organisation of the Periodic Table. * Links the gradual filling of s, p, d and f sub-shells to all named blocks or groups. | 5 |
| * Demonstrates sound knowledge and understanding of the relationship between outermost electrons filling sub-shells and the organisation of the Periodic Table. * Links the gradual filling of two or more sub-shells to named blocks or groups. | 4-3 |
| * Demonstrates a basic knowledge and understanding of the relationship between outermost electrons filling sub-shells and the organisation of the Periodic Table. * Connects a named block or group to gradual filling of a sub-shell. | 2 |
| * Communicates simple ideas about the structure of the Periodic Table | 1 |

*Suggested answer*

The structure of the Periodic table reflects the organisation of electrons in energy levels and sub-shells. The filling of its outermost sub-shell will place an element in a block within the Periodic Table. The s-blocks consists of Group 1 with a half filled s sub-shell and Group 2 with a complete s sub-shell. Groups 3 to 8 see the gradual filling of the p sub-shell and are called the p block which can hold up to 6 electrons. The transition metals block refers to the gradual filling of the d sub-shell which can hold up to 10 electrons. The f block consisting of the lanthanide and actinide metals refers to the gradual filling of the f sub-shell which can hold up to 14 electrons.

**d(i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Identifies a risk AND states a safety precaution taken | 2 |
| * Identifies a risk OR states a safety precaution taken | 1 |

*Suggested answer*

Potassium permanganate is a powerful oxidising agent which could damage eyes, skin or clothing if splashed. Care should be taken to wear safety glasses, gloves or lab. coat

**d (ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides steps of a valid procedure to demonstrate the oxidising strength of KMnO4 * Identifies equipment and reagents used. Description of results. | 4 |
| * Provides steps of a valid procedure to demonstrate the oxidising strength of KMnO4   AND/OR   * Identifies equipment and reagents used.   AND/OR   * Describes results | 3-2 |
| * Provides steps of a valid procedure to demonstrate the oxidising strength of KMnO4.   OR   * Identifies equipment and reagents used   OR   * Describes results | 1 |

*Suggested answer*

Procedure will vary from qualitative to quantitative approaches.

A qualitative approach may compare equal concentrations and volumes of acidified KMnO4 with other oxidising agents such as MnO2 and MnCl2 in redox reactions with various reagents such as FeSO4 , (COOH)2 , NaNO2 . The presence of a colour change would signify a reaction. The number of reactions that occurred could be used to make a conclusion.

**d(iii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Correct change in oxidation sate of Mn provided | 1 |

*Suggested answer*

The oxidation state of Mn changes from +7 to +2

**(vi)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Relates the multiple oxidation states of manganese to the involvement of both s and d sub-shell electrons in bonding. * Identifies all the possible oxidation states and links these to manganese’ electron configuration. | 3 |
| * Relates the multiple oxidation states of manganese to the involvement of both s and d sub-shell electrons in bonding. * Identifies some oxidation states. | 2 |
| * Relates the multiple oxidation states of manganese to the involvement of both s and d sub-shell electrons in bonding. | 1 |

*Suggested answer*

Manganese is a transition metal with 2 electrons in the 4s sub-shell and 5 electrons in the 3d sub-shell. As the 4s and 3d sub-shell electrons are very close in energy some or all can be involved in bonding. When the two 4s electrons are given up the oxidation sate of manganese is +2. When two 4s and two 3d electrons are given up the oxidation state of manganese is +4. If all 4s and 3d electrons are involved in bonding the oxidation state is +7.

**e**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Defines term AND provides an example | 2 |
| * Defines term OR provides an example | 1 |

*Suggested answer*

A chelated ligand has more than one donor atom and can often form rings which surround the metal ion. An example of a chelated ligand is the oxalate ion -OOC-COO-

(or the triphosphate ion [P3O10}5-).

**Question 36 (25 marks) – FORENSIC CHEMISTRY**

**a**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Identifies colour/pH of each substance, identifies observation of each reaction with sodium metal * Deduces inability to distinguish the three substances and evaluates strategy as inadequate * Suggests an alternative strategy to correctly distinguish water, ethanol and acetic acid | 4 |
| * Identifies colour/pH of each substance, identifies observation of each reaction with sodium metal * OR -Deduces inability to distinguish the three substances and evaluates strategy as inadequate * OR -Suggests an alternative strategy to correctly distinguish water, ethanol and acetic acid | 3 |
| * Evaluates strategy as inadequate with some evidence and suggests an alternative to correctly distinguish water, ethanol and acetic acid | 2 |
| * Evaluates strategy as inadequate without evidence and suggests an alternative to distinguish a substance | 1 |

*Suggested answer*

When tested with universal indicator only acetic acid could be identified as it would be the only chemical to produce a red colour/low pH. Both water and ethanol could give similar results. When reacted with sodium metal all three substances would produced bubbles of colourless gas, which on testing could be shown to be hydrogen gas. Therefore, this reaction would not be able to distinguish between water and ethanol. After identifying acetic acid using universal indicator the remaining clear liquids could be tested with dilute potassium permanganate as only ethanol would produce a colour change. This would then allow water and ethanol to be distinguished.

**b**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Demonstrates thorough knowledge and understanding of the structure, function and properties of cellulose, starch and glycogen | 5 |
| * Demonstrates a sound knowledge and understanding of the structure, function and/or properties of cellulose, starch and glycogen | 4-3 |
| * Demonstrates a basic knowledge and understanding of the structure, or function or properties of cellulose, starch and glycogen | 2 |
| * Communicates simple ideas about the polymers cellulose or starch or glycogen | 1 |

*Suggested answer*

Polymers could be contrasted in table format.

|  |  |  |  |
| --- | --- | --- | --- |
| Polymer | Structure | Function | Properties |
| Cellulose |  |  |  |
| Starch |  |  |  |
| Glycogen |  |  |  |

**c (i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides correct general formula for an amino acid | 1 |

*Suggested answer*

H2N-CHR-COOH

**c (ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Diagram shows two amino acids linked through a peptide bond | 2 |
| * Diagram shows peptide bond but some error made in amino acid structure | 1 |

*Suggested answer*

H2N-CHR-**CO- HN**-CHR-COOH

**c (iii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Identifies correct biological reagent to break peptide bonds | 1 |

*Suggested answer*

Enzymes break peptide bonds in living things

**d (i)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Provides steps of a valid procedure to investigate the range of solvents that can be used to separate a mixture using chromatography * Identifies equipment and reagents used. Description of results | 4 |
| * Provides steps of a valid procedure to investigate the range of solvents that can be used to separate a mixture using chromatography   AND/OR   * Identifies equipment and reagents used   AND/OR   * Describes results | 3-2 |
| * Provides steps of a valid procedure to investigate the range of solvents that can be used to separate a mixture using chromatography OR Identifies equipment and reagents used OR Describes results | 1 |

*Suggested answer*

Procedure

1. Four strips of chromatography paper 15 cm x 3 cm are prepared.

2. A tiny drop of a food dye mixture is placed 2 cm from the bottom of each strip.

3. Four large test tubes are prepared with 5 mLs of a solvent to be tested- water, ethanol, acetone and acetic acid.

4. The chromatography strips are placed into a test tube so that the dye is 1 cm above the solvent and left for one hour then removed and examined.

Results

The food dye mixture separated into individual colours best using ethanol followed by-+ water.

**d (ii)**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Describes two similarities and two differences between G-L Chromatography and High Performance Liquid Chromatography | 4 |
| * Describes one/two similarities and one/two differences between G-L Chromatography and High Performance Liquid Chromatography | 3 |
| * States a similarity and a difference between G-L Chromatography and High Performance Liquid Chromatography | 2 |
| * States a similarity or a difference between G-L Chromatography and High Performance Liquid Chromatography | 1 |

*Suggested answer*

Both G-L Chromatography and HPLC are methods of separating mixtures based on the components being distributed between a stationary phase and a mobile phase. Both G-L Chromatography and HPLC can be connected to a detector which can allow both qualitative and quantitative analysis.

In G-L Chromatography the mobile phase is an inert gas usually helium and in HPLC the mobile phase is a liquid which is chosen based on the nature of the mixture to be separated. The mixture being separated using G-L Chromatography must be heated to high temperatures and vaporised so it is not suitable for many biological molecules. Unlike GLC HPLC operates at low temperatures allowing separation of a wide range of organic and inorganic mixtures.

**e**

|  |  |
| --- | --- |
| **Criteria** | **Marks** |
| * Relates the need for small sample analysis techniques to the requirement not to destroy all the evidence during forensic analysis * Describes how mass spectroscopy and atomic emission spectroscopy are used for small sample analysis * Makes a judgement on the use of mass spectroscopy and atomic emission spectroscopy in forensic investigation | 4 |
| * Identifies the destructive nature of mass spectroscopy and atomic emission spectroscopy * Outlines how mass spectroscopy and atomic emission spectroscopy are used * Makes a judgement on the use of mass spectroscopy and atomic emission spectroscopy in forensic investigation | 3 |
| * Identifies the destructive nature of mass spectroscopy and atomic emission spectroscopy   AND/OR   * Outlines how mass spectroscopy and atomic emission spectroscopy are used OR Makes a judgement on the use of mass spectroscopy and atomic emission spectroscopy in forensic investigation | 2 |
| * Identifies the destructive nature of mass spectroscopy and atomic emission spectroscopy OR Outlines how mass spectroscopy and atomic emission spectroscopy are used OR Makes a judgement on the use of mass spectroscopy and atomic emission spectroscopy in forensic investigation | 1 |

*Suggested answer*

Sometimes the evidence collected at a crime scene is a very small sample and many of the techniques used to chemically analyse the evidence will destroy it. During a trial the defence or prosecution may seek to re-test evidence for a second opinion. Therefore techniques such as mass spectroscopy and atomic emission spectroscopy are very useful because both require only tiny amounts of material for accurate analysis.

In mass spectroscopy high voltage is used to produce ions. Ions are then separated in a magnetic field according to their masses. When combined with other instruments mass spectroscopy can detect concentrations of one part-per-billion. It is used to detect metals in evidence from a gunshot or organic molecules such as suspect drugs. Atomic emission spectroscopy is designed to detect the light emitted when excited electrons fall back to lower energy levels producing a characteristic line emission spectrum. It can be used in investigations of soil evidence.

**2011 TRIAL HIGHER SCHOOL CERTIFICATE**

**CHEMISTRY EXAMINATION**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Question** | **Marks** | **Content** | **Syllabus outcomes** | |
| **Section 1**  **Part A** | | | | |
| 1 | 1 | 9.2.1.2.2 | H9, 8 | |
| 2 | 1 | 9.2.1.3.2 | H9,6 | |
| 3 | 1 | 9.2.2.3.1 | H4 | |
| 4 | 1 | 9.2.3.2.3 | H6 | |
| 5 | 1 | 9.2.3.2.7 | H10 | |
| 6 | 1 | 9.2.4.2.3 | H6 | |
| 7 | 1 | 9.2.5.2.1 | H6 | |
| 8 | 1 | 9.3.1.3.3 | H6, 14 | |
| 9 | 1 | 9.3.2.2.6 | H8 | |
| 10 | 1 | 9.3.2.2.6 | H10 | |
| 11 | 1 | 9.3.3.2.8 | H10, 6 | |
| 12 | 1 | 9.3.4.2.5 | H6 | |
| 13 | 1 | 9.3.4.2.8 | H11, 12 | |
| 14 | 1 | 9.3.5.2.4 | H8 | |
| 15 | 1 | 9.4.4.2.9 | H6 | |
| 16 | 1 | 9.3.2.2.6 | H9, 6 | |
| 17 | 1 | 9.4.1.2.3 | H9,8 | |
| 18 | 1 | 9.4.5.3.2 | H4 | |
| 19 | 1 | 9.4.3.3.1 | H6 | |
| 20 | 1 | 9.4.5.2.1 | H4 | |
| **Section 1**  **Part B** | | | | |
| 21 (a) | 3 | 9.2.1.2.3 | H8, 9 | |
| 21 (b) | 2 | 9.2.1.2.1 | H6, 9 | |
| 22 (a) | 2 | 9.2.2.2.4 | H6, 9 | |
| 22 (b) | 1 | 9.2.2.2.3 | H9 | |
| 22 (c) | 3 | 9.2.2.2.1 | H5 | |
| 23 (a) | 3 | 9.2.4.2.5, 9.2.4.2.6 | H6, 7 | |
| 23 (b) | 1 | 9.2.4.3.4 | H7 | |
| 23 (c) | 1 | 9.2.4.3.4 | H7, 10 | |
| 23 (d) | 2 | 9.2.4.3.2 | H12 | |
| 24 | 4 | 9.2.5.2.3 | H6, 3 | |
| 25 (a) | 3 | 9.3.2.2.1 | H6, 13 | |
| 25 (b) | 1 | 9.2.1.2.1 | H6 | |
| 25 (c) | 1 | 9.3.2.2.1 | H6 | |
| 26 (a) | 2 | 9.3.4.3.3 | H10 | |
| 26 (b) | 2 | 9.3.4.2.8 | H14 | |
| 26 (c) | 2 | 15.1 | H15 | |
| 27 | 4 | 9.3.4.2.1, 9.3.4.2.2 | H1,2 | |
| 28 | 5 | 9.4.3.2.10 | H8 | |
| 29 | 4 | 9.4.3.3.1, 12.1(d) | H12 | |
| 30 (a) | 1 | 9.4.4.2.5 | H6 | |
| 30 (b) | 3 | 9.4.4.2.6 | H6 | |
| 31 | 5 | 9.4.5.2.3, 9.4.5.3.3 | H4 | |
| **Section II**  **Question 32 – Industrial Chemistry** | | | | |
| 32 (a) (i) | 2 | 9.5.3.2.6 | | H6 |
| 32 (a) (ii) | 2 | 9.5.3.2.6 | | H6 |
| 32 (b) (i) | 1 | 9.5.2.2.2 | | H8 |
| 32 (b) (ii) | 2 | 9.5.2.3.4 | | H10 |
| 32 (b) (iii) | 2 | 9.5.2.2.1 | | H14, 8 |
| 32 (b) (iv) | 1 | 9.5.2.2.1 | | H14 |
| 32 (c) (i) | 3 | 9.5.5.3.1, 9.5.5.2.3, 12.1 | | H12 |
| 32 (c) (ii) | 1 | 9.5.2.3.4, 12.1 | | H12 |
| 32 (c) (iii) | 1 | 9.5.2.3.4 | | H12 |
| 32 (c) (iv) | 3 | 9.5.2.3.4 | | H6 |
| 32 (d) | 7 | 9.5.2.3.4 | | H4, 8 |
|  |  |  | |  |
| **Question 33- Shipwrecks, Corrosion and Conservation** | | | | |
| 33 (a) (i) | 4 | 9.6.1.2.1 | | H8, 6 |
| 33 (a) (ii) | 1 | 9.6.5.2.1 | | H14 |
| 33 (b) (i) | 2 | 9.6.3.2.1 | | H7 |
| 33 (b) (ii) | 2 | 14.1(d) | | H14 |
| 33 (b) (iii) | 2 | 9.6.3.2.2 | | H6 |
| 33 (c) | 4 | 9.6.2.2.4 | | H7 |
| 33 (d) (i) | 3 | 9.6.4.3.2, 11.2, 11.3 | | H11 |
| 33 (d) (ii) | 3 | 11.2 | | H11 |
| 33(e) | 4 | 9.6.7.2.5 | | H3, 4 |
|  |  |  | |  |
| **Question 34 – The Biochemistry of Movement** | | | | |
| 34 (a) (i) | 2 | 9.7.2.2.1 | | H9, 6 |
| 34(a) (ii) | 3 | 9.7.2.2.2 | | H6 |
| 34 (b) (i) | 2 | 9.7.3.2.4 | | H9 |
| 34 (b) (ii) | 3 | 9.7.3.3.2 | | H6 |
| 34 (c) (i) | 1 | 9.7.4.3.2 | | H8, 9 |
| 34 (c) (ii) | 3 | 11.3 | | H11 |
| 34 (c)(iii) | 2 | 13.1 | | H13 |
| 34 (c)(iv) | 3 | 11.2 | | H11 |
| 34(d) | 6 | 9.7.5.3.1, 9.7.8.3.1, 9.7.10.3.1 | | H5 |
|  |  |  | |  |
| **Question 35 – The Chemistry of Art** | | | | |
| 35 (a) | 3 | 9.8.1.3.1 | | H6, 4 |
| 35 (b) (i) | 3 | 9.8.2.3.3, 14.1(h) | | H3, 14 |
| 35 (b) (ii) | 2 | 9.8.2.3.3 | | H4 |
| 35 (c) | 5 | 9.8.3.2.6 | | H6 |
| 35 (d) (i) | 2 | 12.1 | | H12 |
| 35 (d) (ii) | 4 | 11.1, 11.2, 11.3 | | H11 |
| 35 (d)(iii) | 1 | 9.8.4.3.3 | | H6 |
| 35 (d)(iv) | 3 | 9.8.4.2.5 | | H6 |
| 35 (e) | 2 | 9.8.5.2.5 | | H6 |
|  |  |  | |  |
| **Question 36 – Forensic Chemistry** | | | | |
| 36 (a) | 4 | 9.9.1.3.4, 14 | | H14 |
| 36(b) | 5 | 9.9.2.2.4, 9.9.2.3.2 | | H9 |
| 36 (c) (i) | 1 | 9.9.3.2.3 | | H9 |
| 36 (c) (ii) | 2 | 9.9.3.2.4 | | H9 |
| 36 (c) (iii) | 1 | 9.9.3.2.4 | | H9 |
| 346(d) (i) | 4 | 9.9.3.3.4, 11.3 | | H11.2 |
| 36 (d) (ii) | 4 | 9.9.5.2.2 | | H3 |
| 36 (e) | 4 | 9.9.5.2.1, 9.9.5.2.3, 9.9.5.3.1 | | H3, 4 |
|  |  |  | |  |