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**CHEMISTRY**

**UNIT 1**

**2024**

**MARKING GUIDE**

***TIME ALLOWED FOR THIS PAPER***

Reading time before commencing work: Ten minutes

Working time for the paper: Three hours

***MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER***

**To be provided by the supervisor:**

This Question/Answer Booklet

Multiple-choice Answer Sheet

Chemistry Data Book

**To be provided by the candidate:**

Standard items: pens, pencils, eraser or correction fluid, ruler, highlighter.

Special items: calculators satisfying the conditions set by the SCSA for this subject.

***IMPORTANT NOTE TO CANDIDATES***

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

**Structure of this paper**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Section | Number of questions available | Number of questions to be answered | Suggested working time  (minutes) | Marks available | Percentage of exam |
| Section One  Multiple-choice | 25 | 25 | 50 | 25 | 25 |
| Section Two  Short answer | 9 | 9 | 60 | 76 | 35 |
| Section Three  Extended answer | 5 | 5 | 70 | 87 | 40 |
|  |  |  |  | **Total** | 100 |

**Section One: Multiple-choice 25% (25 marks)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | a □ b □ c □ d ■ |  | 6 | a □ b □ c □ d ■ |  | 11 | a □ b □ c ■ d □ |
| 2 | a □ b ■ c □ d □ |  | 7 | a □ b □ c □ d ■ |  | 12 | a □ b □ c ■ d □ |
| 3 | a □ b □ c ■ d □ |  | 8 | a □ b ■ c □ d □ |  | 13 | a □ b ■ c □ d □ |
| 4 | a □ b □ c ■ d □ |  | 9 | a □ b □ c ■ d □ |  | 14 | a □ b ■ c □ d □ |
| 5 | a □ b □ c □ d ■ |  | 10 | a ■ b □ c □ d □ |  | 15 | a ■ b □ c □ d □ |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 16 | a ■ b □ c □ d □ |  | 21 | a □ b ■ c □ d □ |  |  |  |
| 17 | a □ b □ c □ d ■ |  | 22 | a □ b □ c □ d ■ |  |  |  |
| 18 | a ■ b □ c □ d □ |  | 23 | a □ b □ c □ d ■ |  |  |  |
| 19 | a □ b ■ c □ d □ |  | 24 | a □ b □ c □ d ■ |  |  |  |
| 20 | a □ b ■ c □ d □ |  | 25 | a ■ b □ c □ d □ |  |  |  |

**Section Two: Short answer 35% (76 marks)**

**Question 26 (10 marks)**

(a) Complete the table above. (8 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Species | Symbol | Protons | Neutrons | Electron config. | Mass number | | W |  | 11 | 11 | 2, 8, 1 | **22** | | X | 3- | 15 | **16** | **2, 8, 8** | 31 | | Y | **2+** | **12** | 12 | 2, 8 | 24 | | Z |  | **17** | 19 | **2, 8, 7** | 36 |   Award 1 mark per correct cell. | 8 |
| **Total** | **8** |

(b) Which of these species is a cation? Describe how a cation is formed. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Y / 24Mg2+ | 1 |
| Formed when a species loses electrons / has a greater number of protons than electrons. | 1 |
| **Total** | **2** |

**Question 27 (6 marks)**

Complete the table below, by writing either the name or the formula of the compound.

|  |  |
| --- | --- |
| **Description** | **Marks** |
| |  |  | | --- | --- | | **Name** | **Formula** | | sodium dichromate | **Na2Cr2O7** | | **hydrogen peroxide** | H2O2 | | **iron(III) chloride** | FeCl3 | | zinc hydroxide | **Zn(OH)2** | | boron trihydride | **BH3** | | **ammonium phosphide** | (NH4)3P |   Award 1 mark per correct cell. | 6 |
| **Total** | **6** |

**Question 28 (13 marks)**

(a) State the location of antimony on the periodic table. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Period number 5 | 1 |
| Group number 15 | 1 |
| **Total** | **2** |

(b) Determine the identity of the other isotope of antimony. Support your answer with relevant calculations. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| (0.6 x 121) + (0.4 x ) = 121.8 | 1 |
| 72.6 + 0.4 = 121.8  0.4 = 49.2 | 1 |
| = 123  Other isotope is Sb-123 | 1 |
| **Total** | **3** |
| Note: award full marks for other valid calculation methods; if logic is sound, no penalty if every step not shown | |

(c) Use your answer to part (b) to complete the mass spectrometer readout above. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  |  |
| Correctly drawn column for Sb-123. | 1 |
| **Total** | **1** |
| Note: award follow through marks if incorrect calculation in part (b). | |

(d) Briefly outline how this calibration curve would have been obtained. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Use samples with known Sb concentration. | 1 |
| Analyse samples by AAS to determine absorbances. | 1 |
| Plot data points with line of best fit. | 1 |
| **Total** | **3** |

(e) Calculate the number of atoms of antimony that a person would ingest, if 1 g of this drinking water was consumed. (Note: 1 ng = 1.0 x 10-9 g) (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| In 1 g of water;  m(Sb) = 4 ng | 1 |
| = 4 x 10-9 g | 1 |
| n(Sb) = 4 x 10-9 / 121.8  = 3.284 x 10-11 mol | 1 |
| N(Sb) = 3.284 x 10-11 x 6.022 x 1023  = 1.98 x 1013 atoms | 1 |
| **Total** | **4** |

**Question 29 (5 marks)**

Consider the six (6) gas samples, labelled A – F, shown in the diagrams below. Different types of atoms are represented by different patterns and shading. Using these diagrams, answer the questions below.

|  |  |
| --- | --- |
| **Description** | **Marks** |
| |  |  | | --- | --- | | Which samples are pure substances? | **A, B, D** | | Which sample could be chlorine gas? | **D** | | Which sample is a mixture of elements? | **F** | | Which samples contain a compound? | **A, C, E** | | Suggest the identity of gas sample B. | **any Noble gas** |   Award 1 mark per correct cell. | 5 |
| **Total** | **5** |

**Question 30 (8 marks)**

(a) Explain, in terms of structure and bonding, these **bolded** properties of platinum. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| *Description of metallic bonding:*  Metallic bonding consists of positive metal ions in a sea of delocalised electrons. | 1 |
| *High melting point:*   * There is a strong electrostatic attraction (between the delocalised electrons and metal ions), * Therefore a large amount of heat is required to disrupt the bonding. | 2 |
| *Ductile:*   * The bonding (between the delocalised electrons and metal ions) is non-directional, * Therefore when a force is applied the metal can change shape without disrupting bonds. | 2 |
| *Electrical conductivity:*  Mobile charge is present in the form of delocalised electrons, (allowing platinum to conduct electricity). | 1 |
| **Total** | **6** |

(b) Identify the type of bonding that accounts for the higher melting point of graphite. Give a brief description of this type of bonding. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Covalent network | 1 |
| Strong covalent bonding extends throughout large interconnected network. | 1 |
| **Total** | **2** |

**Question 31 (11 marks)**

(a) Identify which substance is likely to match this description, and justify your answer in terms of the bonding present. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| H2SiF6 | 1 |
| The covalent molecular bonding present results in a lower melting point / a liquid at room temperature. | 1 |
| **Total** | **2** |

(b) Suggest a likely appearance for the other two substances, at room temperature. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| (White) crystalline solid. | 1 |
| **Total** | **1** |

(c) Calculate the percentage composition of sodium fluorosilicate. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| M(Na2SiF6) = 188.07 g mol-1 | 1 |
| % Na = (2 x 22.99) / 188.07 x 100  = 24.45% | 1 |
| % Si = 28.09 / 188.07 x 100  = 14.94% | 1 |
| % F = (6 x 19) / 188.07 x 100  = 60.62% | 1 |
| **Total** | **4** |

(d) Calculate the mass of fluorosilicic acid that should be dissolved in 1 L of drinking water, in order to obtain this fluoride concentration. You may assume all the fluorine in fluorosilicic acid is released into the water as fluoride ions. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| N(F- in 1L) = 3.17 x 1016 x 103  = 3.17 x 1019 ions | 1 |
| n(F-) = 3.17 x 1019 / 6.022 x 1023  = 5.264 x 10-5 mol | 1 |
| n(H2SiF6) = (1/6) x n(F-)  = (1/6) x 5.264 x 10-5  = 8.773 x 10-6 mol | 1 |
| m(H2SiF6) = 8.773 x 10-6 x 144.106  = 1.264 x 10-3 g **OR** 1.264 mg | 1 |
| **Total** | **4** |

**Question 32 (9 marks)**

(a) Complete the following table by either writing the IUPAC name or drawing a structural diagram of the organic compound. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| (cis-)5,6-dibromohex-2-ene | 2 |
| 3-methyloctane | 2 |
|  | 2 |
| **Total** | **6** |
| Note: award 1 mark for minor error | |

(b) Identify this compound, and describe the observations that would allow it to be distinguished from the others. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 3-methyloctane | 1 |
| It would appear/remain orange. | 1 |
| The other two substances would decolorise. | 1 |
| **Total** | **3** |
| Note: award mark for answers indicating “the second structure” rather than  3-methyloctane, or award follow through mark if 3-methyloctane incorrectly named in part (a). | |

**Question 33 (6 marks)**

(a) Identify one (1) component of; (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| (i) CaCO3 / HCl | 1 |
| (ii) beaker / benchtop / air / laboratory | 1 |
| **Total** | **2** |

(b) Classify this reaction as endothermic or exothermic. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Endothermic | 1 |
| **Total** | **1** |

(c) Identify whether the beaker would have felt cooler or warmer when the reaction was taking place, compared to before the acid was added. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Cooler | 1 |
| **Total** | **1** |

(d) Describe how the chemical reaction is able to conserve the total amount of energy, despite the associated enthalpy change. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Identifying that an energy transfer/transformation occurs | 1 |
| Describing how the total energy is conserved | 1 |
| *Examples of a 1 mark response:*  Energy is transferred from the surroundings to the system.  **or**  The system absorbs heat from the surroundings.  **or**  Heat energy is lost from the surroundings / to the system.  *Examples of a 2 mark response;*  The energy lost by the surroundings is equal to the energy gained by the system, (therefore the total amount of energy is conserved).  **or**  Heat energy from the surroundings is transformed into enthalpy within the system, (so the total amount of energy is conserved).  **or**  The energy of the products is equal to the energy of the reactants plus the energy consumed from the surroundings, (therefore the total energy is conserved). |  |
| **Total** | **2** |

**Question 34 (8 marks)**

(a) Calculate the mass of calcium sulfate that would have been produced. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| m(H3PO4) = 1.83 x 103  = 1830 g | 1 |
| n(H3PO4) = 1830 / 97.994  = 18.6746 mol | 1 |
| n(CaSO4) = (5/3) x n(H3PO4)  = (5/3) x 18.6746  = 31.1244 mol | 1 |
| m(CaSO4) = 31.1244 x 136.14  = 4237 g **OR** 4.24 kg | 1 |
| **Total** | **4** |

(b) Calculate the percentage purity of the fluorapatite used. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| n(Ca5(PO4)3F) = (1/3) x n(H3PO4)  = (1/3) x 18.6746  = 6.2249 mol | 1 |
| m(Ca5(PO4)3F) = 6.2249 x 504.31  = 3139.3 g | 1 |
| = 3.1393 kg | 1 |
| % purity = 3.1393 / 3.24 x 100  = 96.9% | 1 |
| **Total** | **4** |

**Section Three: Extended answer 40% (87 marks)**

**Question 35 (17 marks)**

(a) On the graph above, label each line to indicate which represents the period 2 elements and which represents the period 3 elements. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Dotted line (- - -) labelled as Period 2  Solid line (–––) labelled as Period 3 | 1 |
| **Total** | **1** |

(b) Justify the choice you made in part (a). Your answer should include a definition of first ionisation energy. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| First ionisation energy is the energy required to remove one mole of electrons from one mole of atoms in the gaseous state. | 1 |
| Period 2 elements have their valence electrons in the second shell / in a shell closer to the nucleus than period 3 elements.  **or**  Period 3 elements have their valence electrons in the third shell / in a shell further from the nucleus than period 2 elements, | 1 |
| Therefore the valence electrons (in the period 2 elements) experience a greater attractive force from the positive nucleus.  **or**  Therefore the valence electrons (in the period 3 elements) experience a lesser attractive force from the positive nucleus. | 1 |
| Thus (the valence electrons in the period 2 elements) require more energy to remove.  **or**  Thus (the valence electrons in the period 3 elements) require less energy to remove. | 1 |
| **Total** | **4** |

(c) Explain why the general trend in first ionisation energy shows an increase across a period. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| There is an increased number of positive protons in the nucleus as you move across a period. | 1 |
| Thus the electrons are held more strongly / experience greater attraction to the nucleus. | 1 |
| Therefore the electrons are harder to remove / more energy is required to remove the electrons. | 1 |
| **Total** | **3** |

(d) Explain why the group 18 elements in period 2 and 3 are not assigned an electronegativity value. Your answer should include a definition of electronegativity. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Electronegativity is the force of attraction exerted on a bonding pair of electrons. | 1 |
| Group 18 elements have a stable electron arrangement, with 8 electrons in the valence shell (or 2 in the case of He). | 1 |
| Thus they do not tend to attract electrons. | 1 |
| **Total** | **3** |

(e) Identify which has the; (2 marks)

1. smallest atomic radius.
2. largest atomic radius.

|  |  |
| --- | --- |
| **Description** | **Marks** |
| (i) Neon / Ne | 1 |
| (ii) Sodium / Na | 1 |
| **Total** | **2** |

(f) Identify two elements that could have produced compound XY2 if the bonding within the compound was; (2 marks)

1. ionic.
2. covalent.

|  |  |
| --- | --- |
| **Description** | **Marks** |
| (i) magnesium and chlorine / MgCl2 | 1 |
| (ii) sulfur and chlorine / SCl2 | 1 |
| **Total** | **2** |

(g) Describe the difference between ionic and covalent bonding, in terms of electron behaviour. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| In ionic bonding electrons are transferred. | 1 |
| In covalent bonding electrons are shared. | 1 |
| **Total** | **2** |

**Question 36 (19 marks)**

(a) Describe how UV radiation can result in diatomic carbon becoming ‘excited’. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Electrons can absorb energy/photons from the UV radiation, | 1 |
| causing electrons to move to higher energy levels / to electrons shells further from the nucleus (resulting in the atom becoming excited). | 1 |
| **Total** | **2** |

(b) Describe how the excited diatomic carbon is then able to produce this distinctive green light. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The atoms return to the ground state / The electrons fall back to lower energy levels, | 1 |
| releasing energy/photons (equivalent to the difference in energy between the electrons shells) as they do so. | 1 |
| The wavelength/frequency of the light/photons emitted corresponds to a green colour. | 1 |
| **Total** | **3** |

(c) Suggest a reason, in terms of electron arrangement, that diatomic carbon is unstable at ambient conditions. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Does not follow the octet rule. | 1 |
| **Total** | **1** |

(d) Describe how diamond and graphite are structurally different from one another. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| In diamond, every carbon atom is bonded to 4 other carbon atoms. | 1 |
| This results in a 3D network (containing no delocalised electrons). | 1 |
| In graphite, every carbon atom is bonded to 3 other carbon atoms. | 1 |
| This results in layers of carbon/graphene interspersed with layers of delocalised electrons. | 1 |
| **Total** | **4** |

(e) Define a nanomaterial. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Material containing particles in the size range 1-100 nm. | 1 |
| **Total** | **1** |

(f) Identify one (1) example of a fullerene, as well as a use for this fullerene. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Identifies an example | 1 |
| Identifies a use for this example | 1 |
| *Many appropriate answers are possible, including:*   |  |  | | --- | --- | | Example | Use | | * Carbon nanotubes * Buckyballs | * Battery components; transistors; high strength fabrics; sports equipment; bicycle components; biosensors; formation of various composites with increased strength * Biomedical applications; can be used in MRIs/X-rays; drug delivery; tumour/cancer treatment; gene therapy | |  |
| **Total** | **2** |

(g) Define an isotope. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Atoms with the same number of protons, but a different number of neutrons.  **or**  Atoms with the same atomic number, but a different mass number.  **or**  Atoms of the same element that have different numbers of neutrons. | 1 |
| **Total** | **1** |

(h) State whether this molecule, when excited, would be likely to emit the same green light observed from comet C/2022 E3. Justify your answer. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Yes, same colour likely. | 1 |
| Isotopes have the same number of electrons / same electron configuration.  **or**  Isotopes have the same chemical properties. | 1 |
| **Total** | **2** |

(i) Calculate the number of carbon-13 atoms likely to be present in this sample. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| n(C) = 0.0344 / 12.01  = 0.002864 mol | 1 |
| N(C) = 0.002864 x 6.022 x 1023  = 1.725 x 1021 atoms | 1 |
| N(C-13) = (1.07/100) x 1.725 x 1021  = 1.846 x 1019 atoms | 1 |
| **Total** | **3** |
| Alternate working and answer:  m(C-13) = (1.07/100) x 0.0344  = 3.6808 x 10-4 g  n(C-13) = m / M  = 3.6808 x 10-4 / 13  = 2.8314 x 10-5 mol  N(C-13) = (2.8314 x 10-5) x 6.022 x 1023  = 1.705 x 1019 atoms | |

**Question 37 (18 marks)**

(a) Suggest two (2) safety concerns the students may have identified, as well as a strategy they could put in place to minimise each of these risks. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Identifies two safety concerns | 2 |
| Identifies appropriate minimisation strategy for each concern | 2 |
| *Many appropriate answers are possible, including:*   |  |  | | --- | --- | | Safety concern | Minimisation strategy | | * Heat/flame from Bunsen burner * Benzene fumes are dangerous * Benzene is flammable * Hot water/equipment | * Wear gloves/use safety equipment * Ensure appropriate ventilation/use a fume hood * Fire safety equipment * Wear gloves, lab coat/work carefully | |  |
| **Total** | **2** |

(b) Write a balanced thermochemical equation for the combustion of benzene in excess oxygen. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 2 C6H6(g) + 15 O2(g) → 12 CO2(g) + 6 H2O(g) + 6530 kJ  **or**  2 C6H6(g) + 15 O2(g) → 12 CO2(g) + 6 H2O(g) DH = -3265 kJ mol-1 |  |
| Correct species | 1 |
| Correct balancing | 1 |
| Correct enthalpy change | 1 |
| **Total** | **3** |

(c) Justify how the data collected by the students supports this statement. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Exothermic reactions release heat | 1 |
| This is shown by the temperature increase of the water. | 1 |
| **Total** | **2** |

(d) Explain, in terms of bond breaking and formation, why an exothermic reaction has a negative sign associated with the enthalpy change value. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The energy released in the formation of bonds, | 1 |
| is greater than the energy consumed in bond breaking. | 1 |
| Therefore the products have a lower enthalpy than the reactants.  **or**  Therefore there is an overall release of heat. | 1 |
| **Total** | **3** |

(e) Calculate the experimentally determined molar heat of combustion of benzene. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| m(C6H6 combusted) = 149.33 – 148.21  = 1.12 g | 1 |
| n(C6H6) = 1.12 / 78.108  = 0.01434 mol | 1 |
| DHc = 43.24 / 0.01434  = 3015.5 kJ mol-1 | 1 |
| **Total** | **3** |

(f) State whether this suggests the presence of random or systematic error. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Systematic | 1 |
| **Total** | **1** |

(g) Identify two (2) potential sources of this type of error. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any two (2) acceptable answers, including;   * Heat of Bunsen burner flame lost to surroundings * Heat lost from water to surroundings / no insulation on beaker * Incorrect calibration of thermometer * Incorrect calibration of balance * Balance not zeroed/tared | 2 |
| **Total** | **2** |

**Question 38 (17 marks)**

(a) Classify crude oil as a fossil fuel or biofuel. Justify your answer. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| It is a fossil fuel. | 1 |
| It is a non-renewable fuel, made over millions of years.  **or**  It is made from the fossilised remains of plants and animals. | 1 |
| **Total** | **2** |

(b) Name and briefly outline the process by which crude oil is separated into its various components. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Fractional distillation. | 1 |
| The crude oil is heated causing the components to vaporise. | 1 |
| The components condense at different temperatures (based on their molecular weight) and are separated. | 1 |
| **Total** | **3** |

(c) Classify the 3 products as saturated or unsaturated. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Correctly identifies saturated | 1 |
| Correctly identifies unsaturated | 1 |
| |  |  | | --- | --- | | Saturated | Unsaturated | | C7H16­ | C2H4  C3H6 | |  |
| **Total** | **2** |

(d) Calculate the quantity of heat energy consumed. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| m(cetane) = 3.88/100 x 1.53  = 0.059364 t | 1 |
| = 59364 g | 1 |
| n(cetane) = 59364 / 226.432  = 262.171 mol | 1 |
| Energy = 262.171 x 283.11  = 74223 kJ **or** 7.42 x 104 kJ | 1 |
| **Total** | **4** |

(e) Calculate the mass of ethene formed. State your answer to the appropriate number of significant figures. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| n(ethene) = 3 x n(cetane)  = 3 x 262.171  = 786.51 mol | 1 |
| m(ethene) = 786.51 / 28.052  = 22063 g | 1 |
| = 2.21 x 104 g **or** 22.1 kg | 1 |
| **Total** | **3** |
| Note: award follow through marks | |

(f) Write an equation showing the production of ethanol from ethene. Use structural formulae for all organic compounds. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  |  |
| Correct reactants | 1 |
| Correct products | 1 |
| **Total** | **2** |
| Note: award maximum of 1 mark if structural formulae not shown. | |

(g) Name the type of reaction occurring in the conversion of ethene to ethanol. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Addition / hydration | 1 |
| **Total** | **1** |

**Question 39 (16 marks)**

(a) Identify the type of bonding exhibited by these substances. (2 marks)

|  |  |  |
| --- | --- | --- |
| **Description** | | **Marks** |
| Sodium chloride | ionic | 1 |
| Water | covalent (molecular) | 1 |
| **Total** | | **2** |

(b) Explain, in terms of structure and bonding, why there is such a difference in the melting point of sodium chloride and water. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| In NaCl there are strong electrostatic attractions between the cations and anions. | 1 |
| Therefore a large amount of heat is required to disrupt the bonding. | 1 |
| In H2O there are discrete molecules with weak intermolecular forces. | 1 |
| Therefore a small amount of heat is required to disrupt the bonding. | 1 |
| **Total** | **4** |

(c) Explain why sodium chloride solution does not have a distinct, measurable melting point. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| It is a mixture. | 1 |
| The properties are therefore dependent upon composition. | 1 |
| **Total** | **2** |

(d) Explain, in terms of structure and bonding, why solid sodium chloride and liquid water are each unable to conduct electricity, but when mixed together the resulting sodium chloride solution can conduct electricity. (5 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Neither NaCl(s) or H2O(l) contain mobile charge. | 1 |
| In NaCl(s) the ions are held in fixed positions | 1 |
| In H2O(l) all electrons are localised. | 1 |
| In NaCl(aq) the ions have dissociated.  **or**  NaCl(aq) → Na+(aq) + Cl-(aq) | 1 |
| This produces mobile charge/ions (which are able to conduct electricity). | 1 |
| **Total** | **5** |

(e) Identify the name of this separation technique. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Distillation | 1 |
| **Total** | **1** |

(f) Label on the diagram above, where the solid sodium chloride and liquid water would each be found, upon completion of the separation process. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  |  |
| Correctly identifies NaCl(s) location | 1 |
| Correctly identifies H­2O(l) location | 1 |
| **Total** | **2** |