Multiple-choice Answer Sheet

Student number

|  |
| --- |
| Name: |

**INSTRUCTIONS**

|  |
| --- |
| For each question shade the box to indicate your answer.  Use **only** a blue or black **pen** to shade the boxes.  For example, if b is your answer: a □ b ■ c □ d □  If you make a mistake, place a cross through that square and shade your new answer. **Do not** erase or use correction fluid/tape.  For example, if b is a mistake and d is your answer: a □ b ■ c □ d ■  If you then want to use your first answer b, cross out d and then circle b.  a □ b ■ c □ d ■  Marks will **not** be deducted for incorrect answers.  **No marks** will be given if more than one answer is completed for any question. |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 □ |  |  |  |
| 17 | a □ b □ c □ d □ |  |  |  |
| 18 | a □ b □ c □ d □ |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**Question 19 (10 marks)**

Complete the following table by writing either the name or formula for each substance. Then state the major type of bonding (i.e. ionic or covalent) present within each substance.

|  |  |  |
| --- | --- | --- |
| **Name** | **Formula** | **Type of bonding**  **(ionic / covalent)** |
| iron(III) oxide | **Fe2O3** | **ionic** |
| **dinitrogen tetrafluoride** | N­2F4 | **covalent** |
| hydrogen peroxide | **H2O2** | **covalent** |
| **strontium nitride** | Sr3N2 | **ionic** |
| silver chromate | **Ag2CrO4** | **ionic and covalent** |

**Question 20 (9 marks)**

Consider the key below, which refers to three (3) common allotropes of carbon; graphite, diamond and buckyballs.

No

A **buckyballs**

Is the substance a covalent network?

Yes

B **graphite**

Is the substance an electrical conductor?

Yes

No

C **diamond**

(a) Complete the key above, by writing the labels ‘graphite’, ‘diamond’ and ‘buckyballs’ in the appropriate boxes labelled A, B and C. (3 marks)

(b) Justify the choices you made in part (a), using your knowledge of the differences in structure and bonding of these 3 allotropes. (6 marks)

* **Buckyballs are large molecules (C60)**
* **Therefore they do not form a covalent network structure**
* **Each carbon atom in graphite forms 3 covalent bonds to other carbon atoms**
* **The fourth valence electron is delocalised, constituting mobile charge, therefore it is an electrical conductor**
* **Each carbon atom in diamond forms 4 covalent bonds to other carbon atoms**
* **There is no mobile charge, therefore diamond cannot conduct electricity**

**Question 21 (11 marks**

Consider the data provided regarding species V, W, X, Y and Z in the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Species** | **Symbol** | **Number of protons** | **Number of neutrons** | **Electron configuration** |
| **V** | Mg2+  24  12 | 12 | 12 | **2, 8** |
| **W** | **H**  **1**  **1** | **1** | 0 | 1 |
| **X** | **S2-**  **33**  **16** | 16 | 17 | 2, 8, 8 |
| **Y** | Ar  40  18 | 18 | **22** | **2, 8, 8** |
| **Z** | P  31  15 | **15** | 16 | **2, 8, 5** |

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

(b) Which two (2) species would be electrostatically attracted to one another? (1 mark)

* **species V and X**

(c) Which two (2) species have the same number of electrons? (1 mark)

* **species X and Y**

(d) Which two (2) species could form covalent bonds with each other? (1 mark)

* **species W and Z**

**Question 22 (6 marks)**

Consider the organic compounds (A to C) shown in the table below.

(a) Complete the table below by writing the IUPAC name of each compound. (3 marks)

|  |  |  |
| --- | --- | --- |
|  | Structure | IUPAC Name |
| **A** |  | 2-methylbut-1-ene |
| **B** |  | propylbenzene |
| **C** |  | 2,3-dibro-2-fluoromoheptane |

When **compound B** underwent combustion in the presence of limited oxygen, carbon monoxide gas was formed instead of carbon dioxide gas.

(b) Write a balanced chemical equation representing this combustion process. (3 marks)

|  |
| --- |
| 2C9H12 + 15O2 → 18CO +12H2O  Correct formula for propylbenzene  Shows correct products  Equation balanced |

**Question 23 (9 marks)**

Use the outline of the Periodic Table below to answer questions a–e.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| T |  | |  |  |  |  |  | |  |  |  |  |  |  |  |  | P |
|  |  |  |  |  |  |  |  |  |  |  | R |  |  |  | Q |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| X |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Y |  |
|  |  |  |  |  |  |  | A |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| S |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Z |  |

(a) Shade Period five and write “A” on it (1 mark)

(b) Give the letter of the element with the **highest** electronegativity.

Q (1 mark)

(c) Give the letter of the **most** metallic element on the table

S (1 mark)

d

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Decreases | **1** |
| Increasing core charge | **1** |
| Shells pulled closer to nucleus | **1** |
| **Total** | **3** |

e

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Increases | **1** |
| Increasing number of shells | **1** |
| Greater diameter | **1** |
| **Total** | **3** |

**Question 24 (8 marks)**

Draw an electron–dot (Lewis) structure for each of the following compounds. Show all the bonds as dots or bond lines. State the compound name in the last column. (8 marks)

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | | | **Marks** |
| **Compound** | **Electron–dot structure** | **Name** |  |
| CH3Cl | pay if valence electrons around Cl omitted  H  C  H  H  Cl | Chloromethane | **1**  **1** |
| SO2 | O  O  S | Sulfur dioxide | **1**  **1** |
| PBr3 | H  H  N  H  H  +  Br  Br  P  Br | Phosphorus tribromide  Must have tri | **1**  **1** |
| NH4+ |  | Ammonium ion | **1**  **1** |
| **Total** | | | **8** |

**Question 25 (19 marks)**

An impure sample of anhydrous sodium carbonate is dissolved in an excess of hydrochloric acid producing carbon dioxide gas. To determine the %purity of the Na2CO3  a 4.72 g sample of impure Na2CO3 was added to a beaker containing HCl that weighed 74.30 g. When the bubbling had finished the beaker was re weighed and found to weigh 77.22 g

Na2CO3 + 2HCl → 2NaCl + H2O + CO2

Mass of impure Na2CO3 4.72 g

mass of acid and beaker initially 74.30 g

mass of beaker and contents after reaction 77.22 g

1. What mass of CO2 was released? (2 marks)

(Mass of impure Na2CO3 + mass of acid and beaker - mass of beaker and contents after reaction)

= 4.72 + 74.30 – 77.22 1

= 1.80g 1

1. What mass of Na2CO3 was present? (4 marks)

nCO2 = m/M = ans a /44 = 0.0409 1

n(Na2CO3) = n CO2 = 0.0409 2

m = n xM = 0.0409 x 106 = 4.34g 1

If based on anything but m of CO2 then max of 1 for above line

1. What is the % purity of the sample? (If you could not determine and answer to part b above use a mass of 4.50 g as the mass of Na2CO3 (2 marks)

Ans b / 4.72 x 100 = 91.9%

1 1

Sodium carbonate is sometimes added to bathwater to “soften” the water and is still used in Bath Salts. “Softening” water means to remove the calcium ions in water as calcium carbonate so that less soap needs to be used:

Ca2+(aq) + CO32–(aq) → CaCO3(s)

An experiment was performed by two students to calculate the concentration of calcium ions in a sample of tap water, as follows:

(i) Excess sodium carbonate was added to 1 litre of tap water.

(ii) A sheet of filter paper was weighed on an accurate balance

(iii) The solution was filtered.

(iv) The filter paper with precipitate was dried in an oven for 30 minutes.

(v) The filter paper and precipitate were reweighed.

The balance readings were as follows:

Mass of dry filter paper = 0.87 g

Mass of filter paper and precipitate after drying = 0.92 g

1. From these readings calculate: (3 marks)

(i) the mass of calcium carbonate precipitate 0.050 g

(ii) the number of moles of calcium carbonate present \_\_\_\_\_\_0.0005\_\_\_\_\_ mol

(iii) the number of moles of Ca2+ in the water \_\_\_\_\_\_\_\_0.0005\_\_\_\_\_\_\_\_\_\_\_ mol

Pay 1 if ii and iii are wrong but agree with each other

1. Calculate the error in the mass of calcium carbonate precipitate determined in (d) part (i).and comment on how suitable this method is in determining the mass of precipitate. (3 marks)

Error in dry filter paper = ±0.01g pay 1 if some rational shown 1

Error in calcium carbonate = ±0.02g 1

Not a good method as error is really high considering masses being measured 1

**Question 25 continued**

In washing soda, the salt exists as **hydrated** sodium carbonate – with a certain number of water molecules called “water of crystallisation” bonded to the molecule e.g. Na2CO3•xH2O, where x is an unknown integer.

The same two students wanted to determine the value of x by weighing and heating the hydrated salt in a crucible to remove the water of crystallisation. This was done in an oven at 250 oC to produce anhydrous sodium carbonate (no water of crystallisation attached to the salt).

Here are their readings:

Mass of empty crucible = 98.70 g

Mass of crucible with washing soda before heating = 107.60 g

Mass of crucible with washing soda after heating = 102.00 g

1. (d) By calculating the number of moles of anhydrous sodium carbonate and the number of moles of water that was attached (x), calculate the simplest ratio of water of crystallization to sodium, carbonate in washing soda. (5 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Mass of anhydrous salt = 102.0 – 98.7 = 3.30 g | **1** |
| Mass of water = 107.6 – 102.0 = 5.60 g | **1** |
| Moles: | |
| n(Na2CO3) = | **1** |
| n(H2O) = | **1** |
| Ratio of 0.0311: 0.308 reduces to 1 : 10 | **1** |
| **Total** | **5** |
| Formula:  Na2CO3. 10H2O. | |

**Question 26 (17 marks**)

Chloropropene has the formula C3H5Cℓ

(a) Draw and name four isomers of chloropropene in the table below. (8 marks)

|  |  |  |
| --- | --- | --- |
| **Drawing** | **Name** | **Marks** |
| C  H  C  H  H  C  Cl  H  H | 3-chloropropene  or  3-chloroprop-1-ene  (Note: no cis/trans) | **2** |
| C  Cl  C  H  H  C  H  H  H | 2-chloropropene  or  2-chloroprop-1-ene  (Note no cis/trans) | **2** |
| C  H  C  Cl  H  C  H  H  H | *trans* -1- chloropropene | **2** |
| C  H  C  HH  Cl  C  H  H  H | *cis* -1- chloropropene | **2** |
| CH2  CHCl  CH2 | chlorocyclopropane | **2** |
| **Notes:**   * **1 mark correct unique drawing, must include all hydrogens** * **1 mark correct name to match the drawing** * **Marks awarded for unique drawing first not just names** | | |

(b) A chemist has two test–tubes – one contains chloropropene (Tube A) and the other chloropropane (Tube B).

(i) What chemical reagent could be used for a good test to distinguish between these two chemicals? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Bromine water | **1** |
| **Total** | **1** |
| **Note: Although it can react, pure bromine is too dangerous to your health and has restricted use. An aqueous solution of bromine was used in our experiments.** | |

(ii) Give one observation of this test for each of the liquids in the tubes A and B

. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| In tube A the orange colour (of bromine) would disappear (turn colourless) quickly | **1** |
| In Tube B no colour change would be observed (stay orange) or slowly decolourise | **1** |
| **Note: “clear” is not a colour** | |

(iii) Name the type of reactions occurring in each tube. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Tube A: addition | **1** |
| Tube B: substitution | **1** |

Apart from its use as a flavouring, ethanoic acid can be used to clean and etch rusty iron. Ethanoic acid reacts with rust (formula Fe(OH)3) to produce iron (III) ethanoate and water:

**3** CH3COOH + Fe(OH)3 → Fe(CH3COO)3 + **3** H2O

1. Balance the equation above by inserting integers. (1 mark)

An ethanoic acid solution is used to react with a 3.74 g sample of pure Fe(OH)3.

(d) Calculate the number of moles of ethanoic acid solution that would be required to completely dissolve the sample. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| n(Fe(OH)3) = = = 0.0350 mol (3.50 x 10-2 mol) | **1** |
| n(CH3COOH) required = 3 x n(Fe(OH)3) | **1** |
| = 3 x 0.0350 = 0.105 mol (1.05 x 10-1 mol) | **1** |
| **Total** | **3** |
| **Note: SCSA examiners reports indicate that molar stoichiometric ratios must be shown separately and have one mark for this question** | |

**Question 27 (13 Marks)**

1. Diamond (solid carbon) and dry ice (solid carbon dioxide) both have covalent bonds between their atoms. Explain why there is such a difference in their melting points. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Diamond has a network. | **1** |
| Strong covalent bonds require very high temp to break | **1** |
| There are weak forces holding CO2 together | **1** |
| Requires little heat to overcome these forces of attraction | **1** |
| **Total** | **4** |

1. Silicon dioxide has a melting point of 1600 oC but sulfur dioxide has a melting point of -72 oC (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Silicon dioxide has a giant 3–D covalent network structure arranged in a tetrahedron, which is very strong and required a lot of heat energy to break the bonds and melt it. | **1** |
| Sulfur dioxide, however, is covalent molecular and exists as discrete molecules with very little intermolecular force. | **1** |
| **Total** | **2** |

1. Solid potassium chloride will not conduct electricity but a solution of potassium chloride in water is a good conductor. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Potassium chloride has ionic bonds with all its valency electrons used for bonding. Ions are in fixed position. No charge carriers | **1** |
| When potassium chloride is dissolved in water, the lattice is broken by the water molecules to give individual potassium ions and chloride ions which can move freely. | **1** |
| This allows charge to be transported and so conduction can occur. | **1** |
| **Total** | **3** |

1. When a force is applied to copper it will bend but when a force is applied to a cube of sodium nitrate it will break. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Copper, being a metal, has delocalised electrons which attract towards the bulk of the metal (metallic bonding) in a non–directional fashion. | **1** |
| This means that when the metal is bent, the electrons can still cancel out the repulsion of positive ions coming closer together without breaking the bonds | **1** |
| Sodium nitrate has a giant network of ions which, when pulled out of place by a force can come to cause two positively charged ions to be adjacent. | **1** |
| This would cause repulsion and a breaking apart of the substance | **1** |
| **Total** | **4** |

**Question 28 (16 marks)**

(a) Write the equation showing the reaction between the magnesium in the alloy and the hydrochloric acid. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Mg(s) + 2 HCℓ(aq) → MgCℓ2(aq) + H2(g | **1** |
| **Total** | **1** |

(b) Calculate the number of moles of hydrogen gas produced. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| n(H2) = | **1** |
| Correct 4 sig figs | **1** |
| **Total** | **2** |

(c) From answer b), calculate the number of moles and mass of magnesium that reacted. (If you did not obtain an answer for part b), use a value of 0.360 for the number of moles of hydrogen produced) (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| n(Mg) = n(H2) = 0.3570 mol  m(Mg) = n x M  = 8.678g | **1** |
| **1** |
| **1** |
| **Total** | **3** |

(d) Calculate the percentage of magnesium in the alloy X–10. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| m(Mg) = = 8.678 g | **1** |
| % = m(Mg)/m(alloy) x 100 | **1** |
| **1** |
| **Total** | **3** |

(e) If 0.800 mol of HCℓ was used. Calculate the number of moles of acid that remained in the reaction vessel after the reaction. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| n(HCℓ) required to react with 0.3570 mol of Mg = 2 x 0.3570  = 0.7140 mol. | **1** |
| Therefore the excess HCℓ = 0.8000 – 0.7140 = 0.0860 mol | **1** |
| **Total** | **2** |