**Year 11 CHEMISTRY Sem 1 2021**

**ANSWER KEY**

**Section One: Multiple–choice 25% (25 Marks)**

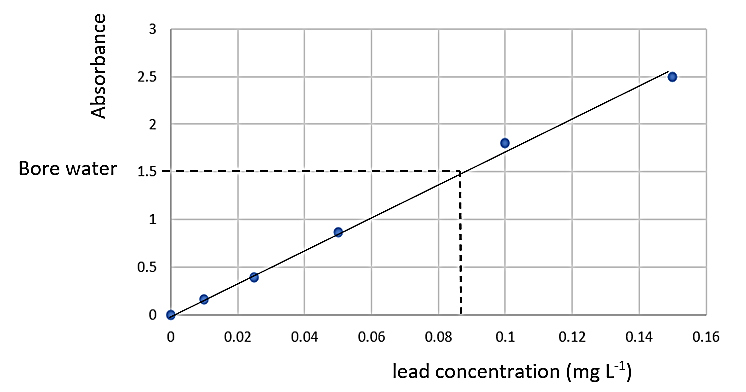
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **1** | **A** |  | **14** | **D** |  | **A = 6** |
| **2** | **C** |  | **15** | **D** |  | **B = 6** |
| **3** | **D** |  | **16** | **C** |  | **C = 7** |
| **4** | **A** |  | **17** | **C** |  | **D = 6** |
| **5** | **C** |  | **18** | **B** |  |  |
| **6** | **D** |  | **19** | **D** |  |  |
| **7** | **C** |  | **20** | **A** |  |  |
| **8** | **B** |  | **21** | **B** |  |  |
| **9** | **A** |  | **22** | **B** |  |  |
| **10** | **B** |  | **23** | **B** |  |  |
| **11** | **D** |  | **24** | **D** |  |  |
| **12** | **A** |  | **25** | **A** |  |  |
| **13** | **C** |  |  |  |  |  |

**Section Two: Short Answer 35% (70 Marks)**

**Question 26 (9 marks)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Lead concentration (mg L–1)** | **0.010** | **0.025** | **0.050** | **0.10** | **0.15** |  | **Bore water** |
| **Absorbance** | 0.16 | 0.41 | 0.87 | 1.8 | 2.5 |  | 1.5 |

(a) Draw a suitable graph of the results on the grid below and, using the graph, explain that the bore water is safe to use for watering plants but not safe for drinking. (6 marks)



|  |  |
| --- | --- |
| **Description** | **Marks** |
| Axes labelled and scales correct | **2** |
| Line of best fit (not join dots) for standard solutions | **1** |
| LOBF goes through origin | **1** |
| Bore water shown on graph or refers to graph in answer | **1** |
| Not safe for drinking | **1** |
| **Total** | **6** |

(b) Explain why each element has a unique absorption spectrum. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The energy of each electron level is different for each atom | **1** |
| Therefore, the energy absorbed in electron transitions are unique to that element | **1** |
| So, each element has a unique absorption spectrum | **1** |
| **Total** | **3** |

**Question 27 (8 marks)**

(a) Using information from the data booklet, determine the approximate percentage abundance of the two main isotopes of boron **10**B and **11**B in a sample of boron. Show your working. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Assume X% of isotope 11 and (100 – X)% of isotope 10 | **1** |
| 10.82 = (11 × X) + (10 × (100 – X))  100 | **1** |
| X = 82 = 82% of isotope 11 | **1** |
| Therefore 18% of isotope 10 (must state this %) | **1** |
| **Total** | **4** |

(b) List 4 key steps in the mass spectrometry process to determine the abundance of these isotopes in a sample of boron. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Mass spectrometry:  1. vaporises and ionises a sample of boron | **1** |
| 2. accelerates the particles through a magnetic field | **1** |
| 3. which separates the various isotope ions | **1** |
| 4. and measures their relative intensity and therefore abundance | **1** |
| **Total** | **4** |

**Question 28 (7 marks)**

(a) Draw a full structural formula and name the main organic product in the reaction between benzene and bromine liquid in the presence UV light. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  |  |
| Benzene structure | **1** |
| Bromine bonded | **1** |
| Name: bromobenzene | **1** |
| **Total** | **3** |

(b) Name the other product in this reaction. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Hydrogen bromide (do not accept HBr) | **1** |
| **Total** | **1** |

(c) Draw a full structural formula for and name the main organic product in the reaction between pent–2–ene and chlorine gas. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  |  |
| 5 carbon backbone | **1** |
| Chlorine on carbon #2 and #3 | **1** |
| Name: 2,3–dichloropentane | **1** |
| **Total** | **3** |

**Question 29 (3 marks)**

Balance the following equations. Each formula is correctly written.

(a) Ca(OH)2(aq) + HCℓ(aq) → CaCℓ2(aq) + H2O(ℓ) (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Equation correctly balanced  Ca(OH)2(aq) + 2 HCℓ(aq) → CaCℓ2(aq) + 2 H2O(ℓ) | **1** |
| **Total** | **1** |

(b) FeCℓ3(aq) + Mg(s) → MgCℓ2(aq) + Fe(s) (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Equation correctly balanced  2 FeCℓ3(aq) + 3 Mg(s) → 3 MgCℓ2(aq) + 2 Fe(s) | **1** |
| **Total** | **1** |

(c) (NH4)2CO3(s) + HNO3(aq) → NH4NO3(aq) CO2(g) + H2O(ℓ) (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Equation correctly balanced  (NH4)2CO3(s) + 2 HNO3(aq) → 2 NH4NO3(aq) + CO2(g) + H2O(ℓ) | **1** |
| **Total** | **1** |

**Question 30 (9 marks)**

Complete the table describing some properties of carbon graphite, carbon dioxide and silicon carbide (SiC) by circling the correct terms. (9 marks)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Description** | | | | **Marks** |
|  | **Graphite** | **Carbon dioxide** | **Silicon carbide** |  |
| **Strength of the solid structure** | low | low | high | **3** |
| **Melting point** | high | low | high | **3** |
| **Electrical conductivity** | high | low | low | **3** |
| **Total** | | | | **9** |

**Question 31 (8 marks)**

Draw full structural formulas for and name 4 possible isomers of C4H8. (8 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any 4 suitable correctly drawn structures and names |  |
| but–1–ene | **2** |
| *cis*–but–2–ene | **2** |
| *trans*–but–2–ene | **2** |
| methylpropene | **2** |
| cyclobutane | **2** |
| **Total** | **8** |

**Question 32 (7 marks)**

(a) Explain, with the aid of a labelled diagram, the structure of gold that allows it to conduct electricity. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Delocalised electrons conduct electricity/carry charge | **1** |
| Diagram shows:  regular arrangement of positive ions (Au3+) | **1** |
| interspaced with electrons | **1** |
| **Total** | **3** |

(b) What size range are nanoparticles? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 1–100 nanometres | **1** |
| **Total** | **1** |

(c) If gold is harmless to the body can it be assumed gold nanoparticles will also be harmless Justify your answer. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| no | **1** |
| Nanoparticles and bulk materials have very different properties | **1** |
| and due to their small size there may be a danger from breathing in nanoparticles  OR an effect on the body’s cells | **1** |
| **Total** | **3** |

**Question 33 (7 marks)**

(a) Draw and label a diagram of the structure of a nitrogen atom showing the particles in the nucleus and electron levels. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Electrons shown correctly in 2 levels  7 protons and a similar number of neutrons shown in the centre (nucleus)  Nucleus and electron levels labelled | **1**  **1**  **2** |
| **Total** | **4** |

(b) Briefly describe (or draw) how J.J. Thomson’s model of this atom might look. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| diagram should show electrons inside a circle (positively charged sphere)  OR describe as: small negatively charged electrons embedded in a large uniformly positive sphere | **1** |
| **Total** | **1** |

(c) Which subatomic particle did Sir James Chadwick discover in 1932 and why was this particle the last to be discovered? (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| neutron | **1** |
| Difficult to detect with equipment (available at the time) as it has no charge | **1** |
| **Total** | **2** |

**Question 34 (12 marks)**

(a) By referring to its bonding and structure explain why aluminium is a solid at room temperature. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Forms a 3D lattice of metallic bonds | **1** |
| with a strong electrostatic force of attraction (between positive ions and delocalised electrons) | **1** |
| Requires a large amount of energy to break these bonds (so it has a high melting point/is a solid) | **1** |
| **Total** | **3** |

(b) By referring to its bonding and structure explain why chlorine is a gas at room temperature. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Chlorine forms diatomic molecules | **1** |
| very weak forces of attraction between chlorine molecules | **1** |
| Very little energy required to break intermolecular forces  (so it has a low melting point/is a gas) | **1** |
| **Total** | **3** |

(c) State the trend in electronegativity for Period 3 elements. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Left to right increase | **1** |
| **Total** | **1** |

(d) Refer to the electron configurations of the elements chlorine and aluminium to explain why aluminium chloride has the formula AℓCℓ3. (5 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Aℓ electron configuration 2.8.3 | **1** |
| Cℓ electron configuration 2.8.7 | **1** |
| Aluminium has 3 valence electrons to ‘give away’ to have a full shell | **1** |
| Chlorine accepts 1 electron to have a full shell | **1** |
| 3 chlorines are needed to accept the 3 electrons from aluminium hence AℓCℓ3 | **1** |
| **Total** | **5** |

**End of Section Two**

**Section Three: Extended answer 40% (80 Marks)**

**Question 35 (21 marks)**

(a) List the names of three biofuels and three fossil fuels. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Biofuels** (accept other suitable alternatives) |  |
| Biogas | **1** |
| Biodiesel | **1** |
| bioethanol | **1** |
| **Fossil fuels** (accept other suitable alternatives) |  |
| Coal | **1** |
| Oil | **1** |
| Natural gas | **1** |
|  | **6** |

(b) Compare the general differences between biofuels and fossil fuels by completing the table below (Circle correct choice) (6 marks)

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | | | **Marks** |
|  | **Biofuel** | **Fossil fuel** |  |
| Carbon emissions | high | high | **2** |
| Sulfur emissions | low | high | **2** |
| Sustainability | high | low | **2** |
| **Total** | | | **6** |

C19H36O2(ℓ) + 27 O2(g) → 19 CO2(g) + 18 H2O(ℓ)

(c) Calculate the number of moles of CO2 emissions produced from 1.00 kg of biodiesel. (4 marks)

|  |  |  |
| --- | --- | --- |
| **Description** |  | **Marks** |
| M(biodiesel) = 12.01 × 19 + 1.008 × 36 + 16.0 × 2 = 296.478 |  | **1** |
| n(biodiesel) = 1000/296.478 = 3.3729 mol |  | **1** |
| Stoichiometry n(CO2) = 19 × n(biodiesel) |  | **1** |
| n(CO2) = 19 × 3.3729 = 64.0857 = 64.1 mol |  | **1** |
| **Total** |  | **4** |

(d) Given that 1.00 kg of biodiesel has a volume of about 1.14 L; calculate the mass of oxygen gas required to completely burn 1.00 L of biofuel vapour. (5 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| m(1.00 L biodiesel) = 1000/1.14 = 877.193 g | **1** |
| n(biodiesel) = 877.193/296.478 = 2.9587 mol | **1** |
| Stoichiometry n(O2) = 27 × n(biodiesel) | **1** |
| n(O2) = 27 × 2.9587 = 79.885 mol | **1** |
| m(O2) = 79.885 × 16.00 × 2 = 2556 g (2.56 × 103 g) | **1** |
| **Total** | **5** |

**Question 36 (17 marks)**

(a) State one safety issue that could arise and how the risk could be minimised. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Risk : flammable liquid, liquid harmful on skin, harmful vapours to breathe in | **1** |
| Minimisation Strategy: any suitable e.g. carry out in fume hood, wear safety glasses and mask | **1** |
| **Total** | **2** |

(b) Use the following information about some liquid fuels to write a hypothesis for the experiment. (3 marks)

|  |  |
| --- | --- |
| **Liquid fuel** | **Energy released (kJ g–1)** |
| Petrol | 48 |
| Diesel | 45 |
| Bioethanol | 30 |
| Biodiesel | 42 |

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The temperature of the water will increase the most for petrol and least for bioethanol (or similar) |  |
| The hypothesis should link the independent variable (type of fuel) | **1** |
| and dependent variable (temperature rise of water) | **1** |
| And be testable | **1** |
| **Total** | **3** |

(c) Complete the table below describing this experiment (4 marks)

|  |  |  |
| --- | --- | --- |
| **Description** | | **Marks** |
| Two controlled variables | Equipment used | **1** |
| air temperature | **1** |
| One possible random error | Air currents/inconsistent measure of volume of water | **1** |
| One possible systematic error | Equipment not calibrated: Thermometer/electronic mass balance/measuring cylinder | **1** |
| **Total** | | **4** |

(d) Describe the effect random errors have on a set of results and state one way to reduce random errors. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Increases the standard deviation/causes inconsistency in the results | **1** |
| Always present due to limitations in the equipment | **1** |
| Take many readings and use the mean | **1** |
| **Total** | **3** |

(e) Describe the effect systematic errors have on a set of results and state one way to reduce systematic errors. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Shift the mean/results consistently higher or lower than the actual value | **1** |
| Caused by incorrect technique or calibration | **1** |
| Buy more expensive equipment/read scales at eye level/improve the method | **1** |
| **Total** | **3** |

(f) After obtaining many results how would the students know the results were reliable? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| If they were grouped closely around the mean | **1** |
| **Total** | **1** |

(g) How could the students improve the validity of their experiment? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Ensure all variables are controlled | **1** |
| **Total** | **1** |

**Question 37 (15 marks)**

(a) Briefly describe how they could use evaporation and crystallisation to obtain a sample of solid potassium sulfate. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Evaporation** |  |
| Mixture heated to allow water to evaporate | **1** |
| Leaving a more concentrated solution | **1** |
| **Crystallisation** |  |
| Concentrated solution left to allow crystals to form | **1** |
| **Total** | **3** |

(b) Explain why the energy required to decompose water is much greater than the energy required to evaporate water. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| In equation 1 weak intermolecular bonds between water molecules are broken | **1** |
| (This is a physical change) requiring little energy to separate molecules | **1** |
| In equation 2 strong covalent bonds within water molecules are broken | **1** |
| (This is a chemical change) which requires larger amounts of energy | **1** |
| **Total** | **4** |

(c) Complete the table describing the substances found at A, B and C. (6 marks)

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | | | **Marks** |
| **Substance** | **Name of substance** | **Pure substance or mixture?** |  |
| A | water vapour | pure | **2** |
| B | Solution/salt water | mixture | **2** |
| C | water | pure | **2** |
| **Total** | | | **6** |

(d) Describe two differences in physical properties that allow separation of salt and water by distillation. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Salt is soluble in water | **1** |
| Water boils at a much lower temperature than salt | **1** |
| **Total** | **2** |

**Question 38 (13 marks)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Nutrient concentration (mg kg–1)** | | | | | | | |
| **Product** | **Ca** | **Cu** | **Fe** | **Mg** | **K** | **P** | **Na** |
| Table salt | 393 | 0.1 | 0 | 84 | 152 | 0 | 427,636 |
| Himalayan salt | 1799 | 0.1 | 44 | 1345 | 2086 | 29 | 394,315 |

The recommended intake of salt per day for an adult is less than 6.00 g (1 teaspoon).

The recommended minimum daily intake of calcium for an adult is 1.00 x 103 g.

(a) Calculate the percentage of this daily intake of calcium provided by 1 teaspoon of Himalayan salt? State your answer to 3 significant figures. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 6 ÷ 1000 × 1799 = 10.794 mg | **1** |
| % = 10.794 ÷ 1000 × 100 = 1.0794% | **1** |
| Answer to 3 sig fig: 1.08% | **1** |
| **Total** | **3** |

(b) If 50.0 g of table salt is dissolved in water and made up to 500.0 mL, calculate the concentration of sodium in g L–1 and mol L–1. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **g L–1** |  |
| 427 636 mg Na in 1 Kg table salt = 21.3818 g in 50.0 g salt | **1** |
| 21.3818g in 500.0 mL = 42.8 gL–1 | **1** |
| **mol L–1** |  |
| n(Na) = 21.3818 ÷ 22.99 = 0.930 mol | **1** |
| 0.930 in 500.0 mL = 1.86 mol L–1 | **1** |
| **Total** | **4** |

(c) Under the following headings compare the bonding in sodium and sodium chloride.

(6 marks)

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | | | **Marks** |
|  | **sodium** | **sodium chloride** |  |
| **Type of bonding** | Metallic(1) | ionic(1) | **2** |
| **Main particles involved in bonding** | Positive ions (1) (delocalised) electrons(1) | Positive ions (1)  negative ions(1)  just states ions = 1 mark | **2** |
| **Total** | | | **6** |

**Question 39 (14 marks)**

(a) Name the elements in Period 2 of the Periodic Table which can exhibit covalent bonding. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| (beryllium, boron) carbon, oxygen and fluorine  (nitrogen not awarded a mark as it is stated in question) | **2** |
| one incorrect or missing | **1** |
| **Total** | **2** |

(b) Describe a covalent bond. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| (at least) one pair of electrons shared between two atoms | **1** |
| Resulting in an electrostatic force of attraction | **1** |
| Between the nuclei of the atoms | **1** |
| And the shared pair of electrons | **1** |
| **Total** | **4** |

2 NH3(g) + H3PO4(aq) → (NH4)2HPO4(s)

(c) Calculate the number of atoms of hydrogen in 1 mole of diammonium hydrogen phosphate.

(2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 9 atoms in (NH4)2HPO4 | **1** |
| 9 × 6.022 × 1023 = 5.418 × 1024 | **1** |
| **Total** | **2** |

(d) Use the equation above to calculate the minimum mass of phosphoric acid required to react with 10.5 g of ammonia.

(6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| M(NH3) = 17.03 g | **1** |
| n(NH3) = 10.5 ÷ 17.03 = 0.61656 mol | **1** |
| As mol ratio is 2:1 | **1** |
| n(H3PO4) = 0.61656 ÷ 2 = 0.30828 mol | **1** |
| M(H3PO4) = 98.00 g | **1** |
| m(H3PO4) = 0.30828 × 98.00 = 30.2 g | **1** |
| **Total** | **6** |

**End of questions**