

**Year 11 ATAR Chemistry 2024**

**Test 1 – Atomic Structure and Bonding**

**Weighting: 3.75%**

**Time: 50 min**

**Marks: / 55 %**

**Name:** \_\_\_\_**Answers**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Section One: Multiple-choice (15 Marks)**

This section has **15** questions. Circle the correct answer. No marks will be given if more than one answer is completed for any question.

Suggested working time: 15 minutes.

**­­­­­­­­­­­­­­­­**

1. Which of the following groups contains pure substances only?

(a) steel, oxygen, sulfur, calcium

(b) wood, air, graphite, water

(c) sodium chloride, blood, zinc, ammonia

(d) iron, silicon dioxide, carbon dioxide, copper

2. Most of the volume taken up by an atom is:

(a) Empty space.

(b) Due to the nucleus.

(c) Positive charge with negatively charged electrons embedded in it.

(d) Due to the small positively charged particles that revolve around the nucleus.

3.How many electrons are in the valence shell of the following species?

**Mg A**ℓ**3+ O2- P**

1. 2 3 6 5
2. 2 8 8 5
3. 1 6 4 8
4. 2 0 8 8

Questions 4 and 5 refer to the following information. The table below lists information about six different atoms.

|  |  |  |  |
| --- | --- | --- | --- |
| **Atom** | **Number of Protons** | **Number of Neutrons** | **Number of Electrons** |
| I  II III IV V VI | 92  92  93  94  99  101 | 146  143  144  144  154  157 | 92  89  90  94  99  99 |

4. The two atoms with a +3 charge are:

* 1. II and III
  2. III and IV
  3. IV and V
  4. V and VI

5. The two atoms with the same mass number are:

1. I and II
2. III and IV
3. V and VI
4. I and IV

6.When the salts of different metals are sprayed into a flame, different colours result. The colour of the flame can be used to identify the metal salts. These colours are produced because:

1. Light is being absorbed by the metal particles in the flame
2. Light is emitted when atoms absorb energy from the flame to become ions
3. Light is being absorbed when bonds are broken by the heat energy

(d) Light is emitted when electrons fall from higher energy levels

7. The electronic structure of a number of atoms are listed below.

I 2, 8, 2

II 2, 8, 5

III 2, 8, 18, 2

IV 2, 8, 18, 9, 2

The two elements in the same period of the periodic table would be:

1. I and II
2. II and III
3. III and IV
4. I and III

8.Which element is found in group 15, period 5?

1. Tin
2. Antimony
3. Polonium
4. Bismuth

9.Which of the following statements is the best definition of ionisation energy?

(a) It is the energy needed to change a mole of a substance from a liquid to a gas.

(b) It is the energy required to dissociate one mole of ions in the solid phase.

(c) It is the energy required to remove a mole of electrons from a mole of atoms or ions of an element in the gaseous phase.

(d) It is the energy required to form one mole of an ionic substance from its constituent atoms.

10. Which one of the following does NOT occur as we move from left to right across the third row of elements in the periodic table?

1. Electronegativity of the elements across the row increases.
2. The size of the atomic radius increases.
3. Melting and boiling points increase up to the Group IV elements, then decrease.
4. The number of outer energy level electrons increases.

11.Which of the following would contain discrete molecules?

(a) Bromine

(b) Sodium chloride

(c) Graphite

(d) Copper

12. Crystobalite has very poor electrical conductivity in any state, and melts at 1713°C. The most

likely structure of solid crystobalite is:

1. metallic.
2. ionic.
3. covalent molecular.
4. covalent network.

13. For a substance to be malleable and ductile, it must consist of:

(a) Negatively charged anions surrounded by a sea of delocalised electrons.

(b) Molecules that are free to move.

(c) Positively charged cations surrounded by a sea of delocalised electrons.

(d) Molecules that are highly polar and form strong intermolecular forces.

14. The melting point of MgO is higher than that of NaF. Explanations for this observation

include which of the following?

I. Mg2+ is more positively charged than Na+

II. O2– is more negatively charged than F–

III. The O2– ion is smaller than the F– ion

(a) I and II only

(b) I and III only

(c) II and III only

(d) I, II, and III

15. Which one of these is the best description of the crystal structure of magnesium chloride (MgCℓ2)?

(a) A regular arrangement of positively charged magnesium atoms and negatively charged chlorine atoms in a crystalline lattice with electrostatic forces of attraction between oppositely charged atoms.

(b) Six magnesium ions surrounded by six chlorine ions in a crystalline lattice with electrostatic forces of attraction between oppositely charged ions.

(c) A regular arrangement of positively charged magnesium ions and negatively charged chloride ions in a crystalline lattice with electrostatic forces of attraction between oppositely charged ions.

(d) A three-dimensional structure of magnesium atoms and chlorine atoms with an electrostatic force of attraction between shared electrons and the nuclei of adjacent atoms.

**Section Two: Short answer (40 Marks)**

This section has **five (5)** questions. Answer all questions. Write your answers in the spaces provided.

Suggested working time: 35 minutes.

**Question 16 (9 marks)**

(a) Isotopes of carbon are used to determine the age of fossilised organic samples dug up by archaeologists. Explain what is meant by the term isotope. (2 marks)

**Two or more forms of same element with same # protons and electrons (1)**

**and different number of neutrons (1)**

(b)Complete the table below, showing the subatomic particle arrangement of the four different species. (7 marks)

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Number of protons** | **Number of neutrons** | **Electron configuration** |
| 18F | **9** | **9** | **2, 7** |
| **26Mg2+** | 12 | 14 | 2, 8 |
| 31P3- | **15** | 16 | **2, 8, 8** |
| **29Si** | 14 | 15 | 2, 8, 4 |

**Question 17 (5 marks)**

A sample of copper was analysed using a mass spectrometer to identify the isotopic composition

of the copper.

(a) Explain briefly how the mass spectrometer is able to separate the ions of the different

isomers of copper. (3 marks)

**The ions are deflected by a different amount (1)**

**When passed through a magnetic field (1)**

**Due to differences in the mass of the ions (1)**

In the process, copper ions with relative atomic masses of 63 and 65 were identified.

The following results were obtained.

(b) From the data given, calculate the relative atomic mass of this sample of copper. (2 marks)

A graph of different sizes and numbers

Description automatically generated with medium confidence

**Average = (71.0 × 63)/100 + (29.0 × 65)/100 (1)**

**= 63.58 *(no units required)* (1)**

**Question 18 (8 marks)**

Consider the elements labelled A-J on the periodic table below.

A grid with letters and a letter g

Description automatically generated

(a) State the group and period number for element F (2 marks)

Group 4 Period 4

(b) Which element above would have the; (3 marks)

(i) highest 1st ionisation energy? D

(ii) largest atomic radius? J

(iii) highest electronegativity? C

(c) Explain why the first ionisation energy of elements increases going from left to right across

row 3 of the periodic table, i.e. from Na to Ar. (2 marks)

**The first ionisation energy of elements increases across the table as more electrons are filling up the same shell so no movement further from the nucleus (1) - same shielding effect**

**Therefore the increasing nuclear charge means that there is an increasing attraction on the outer electrons making them harder to remove (1)**

(d) Define the term electronegativity. (1 mark)

**Electronegativity is a measure of the ability of an atom in a chemical compound to attract**

**electrons.**

**Question 19 (8 marks)**

(a) Classify the following 8 substances as metals, ionic compounds, covalent network substances and covalent molecular substances by completing the table below. (4 marks)

**Cu CuS CaH2 Hg**

**NH4C**ℓ **H2O2 SiO2 CF4**

|  |  |  |  |
| --- | --- | --- | --- |
| **Metals** | **Ionic compounds** | **Covalent network substances** | **Covalent molecular substances** |
| **Cu**  **Hg** | **CuS**  **NH4C**ℓ  **CaH2** | **SiO2** | **H2O2**  **CF4** |

(1 mark off for each 1-2 mistakes. No ½ marks)

(b) Match the following descriptions of bonding in different types of solids with the substances given. Simply place a letter as your answer. (4 marks)

(A) Lattice of positive and negative ions held together by electrostatic forces

(B) Closely packed lattice with delocalized electrons throughout

(C) Strong covalent bonds with weak intermolecular forces   
  
 (D) Network of covalent bonds

(i) Which is carbon dioxide, CO2(s)? C

(ii) Which is cesium chloride, CsCℓ (s)? A

(iii) Which is methane, CH4(s)? C

(iv) Which is gold, Au(s)? B

**Question 20 (10 marks)**

The properties of metallic, ionic, covalent molecular and covalent network substances can differ dramatically. With reference to chemical structure, account for the following.

(a) Diamond and graphite are allotropes of carbon. Explain why diamond does not conduct

electricity whereas graphite will conduct electricity. (4 marks)

**Each carbon atom in a diamond is bonded to its four neighbouring carbon atoms by strong covalent bonds. (1)**

**This means there are no mobile particles (electrons or ions) to carry an electric current and therefore diamond cannot conduct. (1)**

**In graphite each carbon atom is covalently bonded to 3 other carbon atoms in hexagonal layers. This leaves each atom with a spare electron, which together form a delocalised ‘sea’ of electrons loosely bonding the layers together. (1)**

**These delocalised electrons can move within the layer making graphite a good electrical conductor**. **(1)**

(b) Iron can be bent into shapes while iron (II) chloride cannot. (6 marks)

* **Iron has metallic bonding.**
* **It is made up of positive ions (cations) and sea of delocalised valance electrons.**
* **When a force is applied both the ions and delocalised electrons move as the bonding is non-directional so no repulsion is experienced.**
* **Iron (II) chloride has ionic bonding.**
* **It has a fixed 3D lattice made up of positive and negative ions.**
* **When a force is applied ions of similar charge line up and repel each other.**

**END OF TEST**