Gateways School

**Atomic structure & Bonding**

**Revision PPQ**

50 marks

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_**

**Q1.**

(a)    **Table 1** shows some data about fundamental particles in an atom.

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 1** | | | |
| **Particle** | proton | neutron | electron |
| **Mass / g** | 1.6725 × 10–24 | 1.6748 × 10–24 | 0.0009 × 10–24 |

(i)      An atom of hydrogen can be represented as 1H

Use data from **Table 1** to calculate the mass of this hydrogen atom.

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**(1)**

(ii)     Which **one** of the following is a fundamental particle that would **not** be deflected by an electric field?

**A**     electron

**B**     neutron

**C**     proton

Write the correct letter, **A**, **B** or **C**, in the box.



**(1)**

(b)     A naturally occurring sample of the element boron has a relative atomic mass of 10.8.  
In this sample, boron exists as two isotopes, 10B and 11B

(i)      Calculate the percentage abundance of 10B in this naturally occurring sample of boron.

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**(2)**

(ii)     State, in terms of fundamental particles, why the isotopes 10B and 11B have similar chemical reactions.

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**(1)**

(c)    Complete **Table 2** by suggesting a value for the third ionisation energy of boron.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Table 2** | | | | | |
|  | **First** | **Second** | **Third** | **Fourth** | **Fifth** |
| **Ionisation energy / kJ mol–1** | 799 | 2420 |  | 25 000 | 32 800 |

**(1)**

(d)     Write an equation to show the process that occurs when the **second** ionisation energy of boron is measured. Include state symbols in your equation.

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**(1)**

(e)     Explain why the second ionisation energy of boron is higher than the first ionisation energy of boron.

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**(1)**

**(Total 8 marks)**

**Q2.**

A sample of ethanedioic acid was treated with an excess of an unknown alcohol in the presence of a strong acid catalyst. The products of the reaction were separated and analysed in a time of flight (TOF) mass spectrometer. Two peaks were observed at *m / z* = 104 and 118.

(a)     Identify the species responsible for the two peaks.

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**(2)**

(b)     Outline how the TOF mass spectrometer is able to separate these two species to give two peaks.

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**(4)**

**(Total 6 marks)**

**Q3.**

Fluorine forms compounds with many other elements.

(a)     Fluorine reacts with bromine to form liquid bromine trifluoride (BrF3).  
State the type of bond between Br and F in BrF3 and state how this bond is formed.

Type of bond \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How bond is formed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(b)     Two molecules of BrF3 react to form ions as shown by the following equation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 2BrF3 |  | BrF2+ | + | BrF4– |

(i)      Draw the shape of BrF3 and predict its bond angle.  
Include any lone pairs of electrons that influence the shape.

Shape of BrF3

Bond angle \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(ii)     Draw the shape of BrF4– and predict its bond angle.  
Include any lone pairs of electrons that influence the shape.

Shape of BrF4–

Bond angle \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(c)     BrF4– ions are also formed when potassium fluoride dissolves in liquid BrF3 to form KBrF4Explain, in terms of bonding, why KBrF4 has a high melting point.

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**(3)**

(d)     Fluorine reacts with hydrogen to form hydrogen fluoride (HF).

(i)      State the strongest type of intermolecular force between hydrogen fluoride molecules.

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**(1)**

(ii)     Draw a diagram to show how two molecules of hydrogen fluoride are attracted to each other by the type of intermolecular force that you stated in part (d)(i). Include all partial charges and all lone pairs of electrons in your diagram.

**(3)**

(e)     The boiling points of fluorine and hydrogen fluoride are –188 °C and 19.5 °C respectively.  
Explain, in terms of bonding, why the boiling point of fluorine is very low.

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**(2)**

**(Total 15 marks)**

**Q4.**

Lithium hydride, LiH, is an ionic compound containing the hydride ion, H–The reaction between LiH and aluminium chloride, AlCl3, produces the ionic compound LiAlH4

(a)     Balance the equation below which represents the reaction between LiH and AlCl3

LiH +    AlCl3  →      LiAlH4   +     LiCl

**(1)**

(b)     Give the electronic configuration of the hydride ion, H–

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**(1)**

(c)     Predict the shape of the  ion. Explain why it has this shape.

*Shape* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Explanation* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(3)**

(d)     A bond in  can be represented by H → Al

Name this type of bond and explain how it is formed.

*Type of bond* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Explanation* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(3)**

**(Total 8 marks)**

**Q5.**

Iodine and graphite are both solids. When iodine is heated gently a purple vapour is seen. Graphite will not melt until the temperature reaches 4000 K. Graphite conducts electricity but iodine is a very poor conductor of electricity.

(a)     State the type of crystal structure for each of iodine and graphite.

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**(2)**

(b)Describe the structure of and bonding in graphite and explain why the melting point of graphite is very high.

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**(4)**

(c)     Explain why iodine vaporises when heated gently.

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**(2)**

(d)     State why iodine is a very poor conductor of electricity.

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**(1)**

**(Total 9 marks)**

**Q6.**

Which one of the following lists the first ionisation energies (in kJ mol−1) of the elements Mg, Al, Si, P and S in this order?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **A** | 577 | 786 | 1060 | 1000 | 1260 |
| **B** | 736 | 577 | 786 | 1060 | 1000 |
| **C** | 786 | 1060 | 1000 | 1260 | 1520 |
| **D** | 1060 | 1000 | 1260 | 1520 | 418 |

**(Total 1 mark)**

**Q7.**

Which one of the following explains why boron has a lower first ionisation energy than beryllium?

**A**       A boron atom is smaller than a beryllium atom.

**B**       In beryllium all the electrons are paired in full sub-shells.

**C**       A beryllium atom has fewer protons than a boron atom.

**D**       In boron the 2*p* electron occupies a higher energy level than a 2*s* electron.

**(Total 1 mark)**

**Q8.**

Which one of the following ionisations requires less energy than the first ionisation energy of oxygen?

**A**       S(g) → S+(g) + e−

**B**       O+(g) → O2+(g) + e−

**C**       N(g) → N+(g) + e−

**D**       F(g) → F+(g) + e−

**(Total 1 mark)**

**Q9.**

In which one of the following pairs is the first ionisation energy of element **Y** greater than that of element **X**?

|  |  |  |
| --- | --- | --- |
|  | electronic configuration of element **X** | electronic configuration of element **Y** |
| **A** | 1s1 | ls2 |
| **B** | 1s2 2s2 | ls22s2 2p1 |
| **C** | 1s2 2s22p3 | ls22s22p4 |
| **D** | 1s2 2s22p6 | ls22s22p6 3s1 |

**(Total 1 mark)**