CHEMISTRY ONLINE
— TUITION —

Phone: +442081445350

www.chemistryonlinetuition.com

Email:asherrana@chemistryonlinetuition.com

CHEMISTRY

INORGANIC CHEMISTRY

Level & Board	AQA (A-LEVEL)
TOPIC:	Group 2 Metals
PAPER TYPE:	SOLUTION - 2
TOTAL QUESTIONS	10
TOTAL MARKS	37

Group 2 Metals - 2

1. C

(1)

2.

(a)

The melting point of magnesium is higher than the melting point of sodium. Because Mg atoms are smaller than Na atoms and Mg has more delocalised electrons than Na in case of ions Mg^{2+} has a higher charge than Na^{+}. So, Mg^{2+} ions are smaller and have a greater charge density having stronger attraction to delocalised sea of electrons i.e. stronger metallic bonding.

(2)

(b)

Equation:

$2Mg + TiCl_4 \rightarrow 2MgCl_2 + Ti$

Mg changes oxidation state from **0 to +2** so electrons are lost i.e. oxidation.
Ti changes oxidation state from **+4 to 0** so gains electrons i.e. reduction.

(2)

(c)

If dilute aqueous sodium hydroxide is added to separate solutions of magnesium chloride and barium chloride observations are as:

Observation with $MgCl_2$: (slight) white ppt
Observation with $BaCl_2$: no (visible) change / no reaction

(2)

3. C

(1)

4.

(a)

Observation when magnesium reacts with steam: **Bright white light / white powder**

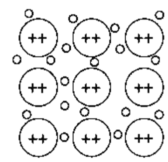
Equation for this reaction

$Mg(s) + H_2O(g) \rightarrow MgO(s) + H_2(g)$

(2)

(b)

The bonding in magnesium is attractions between Mg^{2+} ions in the lattice, between the nuclei of magnesium atoms and the delocalized electrons, and between the Mg^{2+} ions and the delocalized electrons. The outer shell electrons of magnesium atoms contribute to the sea of delocalized electrons, forming a characteristic feature of metallic bonding.



(2)

(c)

The high melting point of magnesium chloride ($MgCl_2$) is due to its giant ionic lattice structure, which consists of Mg^{2+} and Cl^- ions arranged in a three-dimensional array. This structure leads to strong electrostatic forces of attraction between the oppositely charged ions

Giant Ionic Lattice:

Magnesium chloride forms a giant ionic lattice, having a vast network of Mg^{2+} and Cl^- ions extending throughout the solid.The extensive lattice structure requires a great amount of energy to break the electrostatic attractions between ions.

Strong Electrostatic Forces of Attraction:

The Mg^{2+} ions and Cl^- ions have opposite charges, leading to strong electrostatic forces of attraction. These forces hold the ions in fixed positions within the lattice. This requires a great amount of energy to break the electrostatic attractions between ions.

(3)

(d)

Magnesium hydroxide works by reacting with stomach acid to form magnesium chloride and water. This reaction helps neutralize excess stomach acid, providing relief from acidity-related issues.

(1)

5. B

(1)

6.

(a)

Full electron configuration for the calcium ion, Ca^{2+}

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^0$

(1)

(b)

The outer electron in Ca^{+} is farther from the nucleus, is in a higher energy orbital (4s), and have more shielding, that is why the second ionisation energy of calcium is lower than the second ionisation energy of potassium.

(2)

(c)

Be /Beryllium

(1)

(d)

$Mg(OH)_2$ is least soluble in water.

(1)

(e)

Ionic Equation for Precipitation:

$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$

The balanced chemical equation for the reaction is:

$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$

Moles of $BaCl_2$:

$0.25\ mol/dm^3 \times 6\ cm^3 \times 10^{-3}\ dm^3$

$= 0.0015\ mol$

Moles of Na_2SO_4:

$0.15\ mol/dm^3 \times 8\ cm^3 \times 10^{-3}\ dm^3$

$= 0.0012\ mol$

Since the moles of $BaCl_2$ (0.0015 mol) are greater than the moles of Na_2SO_4 (0.0012 mol), $BaCl_2$ is in excess.

The balanced equation shows a 1:1 mole ratio between $BaCl_2$ and Na_2SO_4. Since we have 0.0015 mol of $BaCl_2$, we need the same amount of moles of Na_2SO_4.
Volume of Na_2SO_4=0.15mol/dm^{3}0.0015mol×10^{3}cm^3
=10cm^3

(3)

7. **A**

(1)

8.

Given:

- *Relative atomic mass of strontium = 87.7*
- *Ratio of abundances of ^{86}Sr : ^{87}Sr = 1 : 1*

The isotopes of strontium have identical chemical properties because of the same electronic configuration i.e. same number of electrons all have 37 electrons.

$$\frac{86x + 87x + 88(100 - 2x)}{100} = 87.7$$

$86x+87x+88(100-2x)=87.7\times100$
$86x+87x+8800-176x=8770$
$-3x+8800=8770$
$-3x=-30$
$x=10\%$

(4)

9. **B**

(1)

10.

(a)

$^{138}Ba^+$ is the ion with the longest time of flight.

(1)

(b) A $^{137}Ba^{+}$ ion travels through the flight tube of a TOF mass spectrometer with a kinetic energy of 3.65×10^{-16} J
This ion takes 2.71×10^{-5} s to reach the detector.
KE = ½ mv^2
where m = mass (kg) and v = speed ($m\ s^{-1}$)
The Avogadro constant, L = $6.022 \times 10^{23}\ mol^{-1}$
Calculate the length of the flight tube in metres.
Give your answer to the appropriate number of significant figures.

Mass = $\frac{137\times10^{-3}}{6.022\times10^{23}}$
= 2.275×10^{-25} (kg)
As KE = ½ mv^2
v^2 = 2KE/m
$v^2 = \frac{2\times3.65\times10^{-16}}{2.275 \times 10^{-25}}$
$v^2 = 3.2088 \times 10^{9}$
Taking square root
$v = 5.6646\times10^{4}$
v = d/t
d = vt
So
$d = 5.6646 \times 10^{4} \times 2.71 \times 10^{-5}$
= 1.53 m

(5)

DR. ASHAR RANA

M.B.B.S / MS. CHEMISTRY

CHEMISTRY ONLINE
TUITION

Phone: +442081445350
www.chemistryonlinetuition.com
Email: asherrana@chemistryonlinetuition.com

- Founder & CEO of Chemistry Online Tuition Ltd.
- Completed Medicine (M.B.B.S) in 2007
- Tutoring students in UK and worldwide since 2008
- CIE & EDEXCEL Examiner since 2015
- Chemistry, Physics, Math's and Biology Tutor

CONTACT INFORMATION FOR **CHEMISTRY ONLINE TUITION**

- UK Contact: 02081445350
- International Phone/WhatsApp: 00442081445350
- Website: www.chemistryonlinetuition.com
- Email: asherrana@chemistryonlinetuition.com

Address: 210-Old Brompton Road, London SW5 OBS, UK