CHEMISTRY ONLINE
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CHEMISTRY

INORGANIC CHEMISTRY

Level & Board	AQA (A-LEVEL)
TOPIC:	PERIODICITY
PAPER TYPE:	SOLUTION - 1
TOTAL QUESTIONS	10
TOTAL MARKS	30

Periodicity - 1

1.

(a)

The atomic radii decrease across Period 3 because the number of protons (nuclear charge) increases, leading to a higher effective nuclear charge. This increase in nuclear charge strengthens the attraction between the nucleus and electrons, pulling the outer electrons closer to the nucleus and resulting in a smaller atomic radius.

(2)

(b)

The larger size of S_8 molecules compared to P_4 molecules results in stronger van der Waals (dispersion/London) forces between the molecules in sulfur.
So, this increased molecular size leads to a greater number of electrons in the S_8 molecule, contributing to stronger van der Waals forces, and consequently, a higher melting point for sulfur compared to phosphorus.

(2)

(c)

Sodium oxide forms an alkaline solution when it reacts with water as: Sodium oxide contains O^{2-} ions. These O^{2-} ions react with water, leading to the formation of hydroxide (OH^-) ions according to the following equation:

$$O^{2-} + H_2O \rightarrow 2OH^-$$

In this reaction, each O^{2-} ion reacts with water to produce two hydroxide ions. The release of hydroxide ions into the solution giving alkaline properties, resulting in an alkaline solution when sodium oxide reacts with water.

(2)

(d)

Ionic equation for the reaction of phosphorus(V) oxide with an excess of sodium hydroxide solution As:

$$P_4O_{10} + 12OH^- \rightarrow 4PO_4^{3-} + 6H_2O$$

(1)

2. A

(1)

3.

(a)

In sodium oxide, the ionic O^{2-} ion reacts with water, leading to the formation of hydroxide ions (OH^-) or sodium hydroxide (NaOH), according to the reaction:

$O^{2-}+H_2O \rightarrow 2OH^-$

This reaction gives the transformation of oxide ions into hydroxide ions in the presence of water, contributing to the high alkalinity of the resulting solution with a pH of 14.

(3)

(b)

The general type of oxide that forms acidic solutions in water is non-metal oxide. Non-metal oxides tend to react with water to form acidic solutions.

One example of a non-metal oxide that forms an acidic solution in water is sulfur dioxide (SO_2).

The reaction of sulfur dioxide with water can be represented as:

$SO_2+H_2O \rightarrow H_2SO_3$

(2)

4. D

(1)

5.

The balanced chemical equations for the reactions of water with sodium and sodium oxide:

Reaction of Water with Sodium:

$2Na+2H_2O \rightarrow 2NaOH+H_2$

Reaction of Water with Sodium Oxide:

$Na_2O+2H_2O \rightarrow 2NaOH$

(2)

6. D

(1)

7.

(a)

The elements phosphorus, sulfur, chlorine and argon are classified as p block elements because as these have outer electrons are in p orbitals.

(1)

(b)

The trend in atomic radius from phosphorus to chlorine across Period 3 decreases.

This trend is due to the increase in effective nuclear charge as the number of protons in the nucleus rises. Despite the electrons being added to the same principal energy level (n=3), the constant shielding effect from inner electron shells cannot counterbalance the stronger attraction of outer electrons to the increasingly positive nucleus. So, the electrons are pulled closer to the nucleus, resulting in a reduction in atomic radius.

(3)

(c)

The larger size of S_8 molecules compared to P_4 molecules results in stronger van der Waals (dispersion/London) forces between the molecules in sulfur.

So, this increased molecular size leads to a greater number of electrons in the S_8 molecule, contributing to stronger van der Waals forces, and consequently, a higher melting point for sulfur compared to phosphorus

(3)

8. C

(1)

9.

Reaction of Phosphorus(V) Oxide (P_4O_{10}) with Water:

$P_4O_{10}+6H_2O \rightarrow 4H_3PO_4$

The product is phosphoric acid (H_3PO_4), and a 1M aqueous solution of phosphoric acid would have an approximate pH around 0 to 0.5.

Reaction of Sulfur Dioxide (SO_2) with Water:

$SO_2+H_2O \rightarrow H_2SO_3$

The product is sulfurous acid (H_2SO_3), and a 1M aqueous solution of sulfurous acid would have an approximate pH around 3.

(4)

10. C

(1)

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