**Question**
Phosphorus(V) oxide is classified as an acidic oxide. Write an equation for its reaction with sodium hydroxide.

**Answer**
\[ P_4O_{10} + 12NaOH \rightarrow 4Na_3PO_4 + 6H_2O \]

**Question**
Ions are formed when sulfur dioxide reacts with water. Write an equation for this reaction.

**Answer**
\[ SO_2 + H_2O \rightarrow H^+ + HSO_3^- \]
Allow \( 2H^+ + SO_3^{2-} \)

**Question**
Suggest why silicon dioxide is described as an acidic oxide even though it is insoluble in water.

**Answer**
\( \text{SiO}_2 \text{ reacts with bases / NaOH / CaO / CaCO}_3 \)

**Question**
Suggest why white phosphorus is stored under water.

**Answer**
To prevent it reacting with oxygen in the air.

**Question**
Suggest why phosphorus(V) oxide it is usually represented by \( P_4O_{10} \) rather than by \( P_2O_5 \)

**Answer**
Because it exists as \( P_4O_{10} \)

**Question**
Write an equation for the reaction between phosphoric acid and magnesium oxide.

**Answer**
\[ 3\text{MgO} + 2\text{H}_3\text{PO}_4 \rightarrow \text{Mg}_3(\text{PO}_4)_2 + 3\text{H}_2\text{O} \]
Question

Explain why the use of an excess of sodium hydroxide to neutralise acid solution might lead to environmental problems.

1 mark

Answer

The resulting solution would be highly alkaline and be toxic to wildlife.

1 mark

Question

Write an equation for the acid–base reaction that occurs when Na₂O reacts with P₄O₁₀ in the absence of water.

1 mark

Answer

6Na₂O + P₄O₁₀ → 4Na₃PO₄

It is insoluble in water.

1 mark

Question

Write an ionic equation for the reaction of Al₂O₃ with HCl.

1 mark

Answer

Al₂O₃ + 6H⁺ → 2Al³⁺ + 3H₂O.

1 mark

Question

Write an ionic equation for the reaction of Al₂O₃ with NaOH.

1 mark

Answer

Al₂O₃ + 2OH⁻ + 3H₂O → 2Al(OH)₄⁻
or Al₂O₃ + 6OH⁻ + 3H₂O → 2Al(OH)₆³⁻

1 mark

Question

Suggest one reason why a thin layer of aluminium oxide protects aluminium from corrosion in moist air.

1 mark

Answer

It is insoluble in water.

1 mark

Question

Explain why the melting point of phosphorus(V) oxide is low.

1 mark

Answer

Weak van der Waals’ forces and/or dipole-dipole forces between molecules.

1 mark
Phosphorus(V) oxide is classified as an acidic oxide. Write an equation for its reaction with sodium hydroxide.

Phosphorus(V) oxide is classified as an acidic oxide. Write an equation for its reaction with sodium hydroxide.

It is insoluble in water.

Write an equation to show how sodium oxide reacts with water.

Write an equation for the reaction of aluminium with oxygen.

Suggest one property of the aluminium oxide coating that causes aluminium to resist corrosion in water.

State the type of bonding in aluminium oxide.

Write an equation for the reaction of Sulphur with oxygen.

Explain why SiO₂ does not react with water.

The covalent bonds in SiO₂ are too strong to be broken by the water molecules.
Chemistry

**Periodicity**

**Question**
Write an equation for a reaction that shows MgO acting as a base.

**Answer**
Reagent must be water or an acid. Correctly balanced equation.

**Question**
Write an equation for the reaction of water with $P_4O_{10}$ and give the final pH of the solution formed.

**Answer**
$pH = -1$ to 2
$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$

**Question**
Explain in terms of structure and bonding why sodium oxide has a high melting point.

**Answer**
Forms a giant ionic lattice with many strong ionic bonds.

**Question**
Explain why sulfur trioxide has a higher melting point than sulfur dioxide.

**Answer**
Sulfur trioxide is a bigger molecule and has stronger van der Waals forces between the molecules.

**Question**
Explain why sulfur dioxide has a low melting point.

**Answer**
It forms molecules with weak van der Waals forces between the molecules.

**Question**
Outline an experiment that shows $Na_2O$, MgO and $Al_2O_3$ are ionic substances.

**Answer**
Apply heat to melt the substances and show they conduct an electric current.
**Periodicity**

**Question**
State the structure and bonding in phosphorus(v) oxide.

---

**Answer**
Molecular. Covalent bonding.

---

**Question**
State the general type of reaction illustrated by this example.

---

**Answer**
6Na₂O + P₄O₁₀ $\rightarrow$ 4Na₃PO₄
Acid-base

---

**Question**
Write an equation for the reaction between Na₂O and P₄O₁₀ and P₄O₁₀.

---

**Answer**

---

**Question**
Which period 3 oxides are insoluble in water?

---

**Answer**
Aluminium oxide and silicon dioxide.

---

**Periodicity**

**Question**
Which period 3 oxides form a solution with a pH below 3?

---

**Answer**
P₄O₁₀ or SO₃

---

**Periodicity**

**Question**
Deduce the oxidation states of the period 3 elements in Na₂O and Al₂O₃.

---

**Answer**
+1 and +3

---

**Periodicity**

**Question**
SiO₂ does not react with HCl; it does react with NaOH. State 1 property of SiO₂ that can be deduced from this and write an equation for its reaction with NaOH.

---

**Answer**
SiO₂ is acidic.

---

SiO₂ + 2NaOH $\rightarrow$ Na₂SiO₃ + H₂O

---

**Periodicity**

**Question**
Which period 3 oxides do not react with HCl;

---

**Answer**
SiO₂ does not react with HCl;

---

**Periodicity**

**Question**

---

**Answer**

---
By reference to structure and bonding, explain why SiO$_2$ is insoluble in water.

Macromolecular with strong covalent bonding. Water cannot break the covalent lattice/bonds.

Compare the difference in melting points between P$_4$O$_{10}$ and SiO$_2$.

High Mp for SiO$_2$ due to giant macromolecule where many strong covalent bonds need to be broken. P$_4$O$_{10}$ forms small molecules held together by weak van der Waals forces.

State the bonding present in basic oxides and explain what causes them to be basic.

Ionic bonding. They contain O$^{2-}$ ions which can react with H$^+$ ions to form water or OH$^-$ ions.

Predict whether the melting point of Li$_2$O is higher than, the same as, or lower than that of Na$_2$O and explain your prediction.

Higher as the Li$^+$ ion is smaller than the Na$^+$ ion so it attracts the O$^{2-}$ ion more strongly.

Give the formula of a period 3 oxide in which the element is not in its highest oxidation state. Give the oxidation state in the oxide.

SO$_2$; +4  Higher oxidation state +6 in SO$_3$.

The chloride and oxide of X have high Mpts. The oxide reacts readily with water. What is X? What is the bonding in X?

Metallic bonding. X is Na.
**Question**

Give equations for the reactions of Na₂O and P₄O₁₀ with water. Give the pH of the solutions formed.

**Answer**

Na₂O + H₂O → 2NaOH; pH = 14
P₄O₁₀ + 6H₂O → 4H₃PO₄; pH = -1 to 2

**Question**

Describe what you would observe when Mg burns in oxygen. Write an equation for the reaction and state the bonding in the oxide formed.

**Answer**

Bright white flame and white solid fumes. 2Mg + O₂ → 2MgO
Ionic bonding

**Question**

In terms of structure and bonding explain why the melting points of sodium oxide and silicon dioxide are high.

**Answer**

Strong ionic bonds in giant ionic sodium oxide lattice. Strong covalent bonds in macromolecular silicon dioxide.

**Question**

State and explain the trend in electronegativity across period 3.

**Answer**

Electronegativity increase. Proton number increases, shielding of outer electrons remains the same, attraction between nucleus and bonding pair of electrons increases.

**Question**

Explain, in terms of their type of structure and bonding, why P₄O₁₀ can be vaporised by gentle heat but SiO₂ cannot.

**Answer**

P₄O₁₀ is a molecular Weak intermolecular forces or van der Waals forces between molecules
SiO₂ is a macromolecule (Strong) covalent bonds must be broken.
**PERIODICITY**

**CHEMISTRY**

P is an oxides of Period 3 elements. It is a solid with a high melting point. It does not conduct electricity when solid but does conduct when molten or when dissolved in water. Oxide P reacts with water forming a solution with a high pH. Identify P. State the type of bonding present in P and explain its electrical conductivity. Write an equation for the reaction of P with water. (5)

**MARK SCHEME**

- Ionic (1)
- Ions not free to move in the solid state (1)
- Ions free to move when molten or in aqueous solution (1)
- Identity of P: Na₂O or sodium oxide (1) *
- Equation: Na₂O + H₂O → 2 NaOH (1)

**Comment**

- If a formula given this must be correct
- Reference to electrons instead of ions is incorrect and will be considered a chemical error.

**PERIODICITY**

**CHEMISTRY**

Q is an oxides of Period 3 elements. Oxide Q is a colourless gas at room temperature. It dissolves in water to give a solution with a low pH. Identify Q. State the type of bonding present in Q and explain why it is a gas at room temperature. Write an equation for the reaction of Q with water. (4)

**MARK SCHEME**

- Covalent (1)
- van der Waals forces, or dipole-dipole forces are weak(1)
- Identity of Q: SO₂ or sulphur dioxide (1)
- Equation: SO₂ + H₂O → H₂SO₃(1)

**Comment**

- N.B. Any answer including a reference to hydrogen bonding is incorrect
R is a hydroxide of a Period 3 element. It is insoluble in water but dissolves in both aqueous sodium hydroxide and aqueous sulphuric acid. Give the name used to describe this behaviour of the hydroxide. Write equations for the reactions occurring. Suggest why R is insoluble in water. (6)

The oxide of element Z is a crystalline solid with a very high melting point. This oxide is classified as an acidic oxide but it is not soluble in water. Deduce the type of crystal shown by the oxide of element Z. Identify element Z. Write an equation for a reaction which illustrates the acidic nature of the oxide of element Z. (4)

Amphoteric. 
Al(OH)_3 + NaOH → NaAl(OH)_4 
R identified as Al(OH)_3 or Al(OH)_3(H_2O)_3 
2Al(OH)_3 + 3H_2SO_4 → Al_2(SO_4)_3 + 6H_2O 
Large lattice energy

A great deal of energy is needed to break down the bonding in the hydroxide and hydration will not supply sufficient energy for this change to occur

Macromolecular. 
Silicon 
CaO + SiO_2 → CaSiO_3

Any equation stated must be balanced for 2 marks. 
1 mark is for a suitable base.