Q1.(a) Write an equation for the reaction that occurs when magnesium is heated in steam. Describe what you would observe when this reaction occurs.

Equation .....

Observations .....

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(3)

(b) Write an equation for the reaction that occurs when sodium is heated in oxygen. Describe what you would observe when this reaction occurs.

Equation .....

Observations .....

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(3)
(Total 6 marks)

Q2.(a) The table below contains data that show a trend in the melting points of some oxides of the Period 3 elements.

Oxide	Sodium oxide	Magnesium oxide	Aluminium oxide	Silicon(IV) oxide	Phosphorus(V) oxide	Sulfur(IV) oxide
Melting point / K		3125	2345	1883	573	

(i) Use data from the table above to predict an approximate melting point for sodium oxide.

Tick (✓) **one** box.

250 K ☐

500 K ☐

1500 K ☐

3500 K ☐

(1)

(ii) Explain, in terms of structure and bonding, why sodium oxide has a high melting point.

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(2)

(iii) Use data from the table above to predict a value for the melting point of sulfur(IV) oxide.

Suggest, in terms of structure and bonding, why the melting point of sulfur(IV) oxide is different from that of phosphorus(V) oxide.

Predicted melting point of sulfur(IV) oxide .....

Why the melting point is different from phosphorus(V) oxide .....

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(3)

(b) Write an equation for the reaction of sulfur(IV) oxide with water.

Suggest the pH value of the resulting solution.

Equation

.....

pH value .....

(2)

(c) Silicon(IV) oxide is insoluble in water.

Explain, using an equation, why silicon(IV) oxide is classified as an acidic oxide.

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(2)
(Total 10 marks)

Q3. Magnesium oxide, silicon dioxide and phosphorus(V) oxide are white solids but each oxide has a different type of structure and bonding.

(a) State the type of bonding in magnesium oxide.
Outline a simple experiment to demonstrate that magnesium oxide has this type of bonding.

Type of bonding .....

Experiment .....

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(3)

(b) By reference to the structure of, and the bonding in, silicon dioxide, suggest why it is insoluble in water.

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(3)

(c) State how the melting point of phosphorus(V) oxide compares with that of silicon dioxide. Explain your answer in terms of the structure of, and the bonding in, phosphorus(V) oxide.

Melting point in comparison to silicon dioxide .....

Explanation .....

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(3)

(d) Magnesium oxide is classified as a basic oxide.

Write an equation for a reaction that shows magnesium oxide acting as a base with another reagent.

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(2)

(e) Phosphorus(V) oxide is classified as an acidic oxide.

Write an equation for its reaction with sodium hydroxide.

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(1)

(Total 12 marks)

Q4.(a) Explain why the atomic radii of the elements decrease across Period 3 from sodium to chlorine.

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(2)

(b) Explain why the melting point of sulfur (S_8) is greater than that of phosphorus (P_4).

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(2)

(c) Explain why sodium oxide forms an alkaline solution when it reacts with water.

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(2)

(d) Write an ionic equation for the reaction of phosphorus(V) oxide with an excess of sodium hydroxide solution.

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(1)
(Total 7 marks)

Q5. This question is about some Period 3 elements and their oxides.

(a) Describe what you would observe when, in the absence of air, magnesium is heated strongly with water vapour at temperatures above 373 K.
Write an equation for the reaction that occurs.

Observations .....

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Equation .....

(3)

(b) Explain why magnesium has a higher melting point than sodium.

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(Extra space) .....

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(2)

(c) State the structure of, and bonding in, silicon dioxide.
Other than a high melting point, give **two** physical properties of silicon dioxide that are characteristic of its structure and bonding.

Structure .....

Bonding.....

Physical property 1.....

Physical property 2.....

(4)

(d) Give the formula of the species in a sample of solid phosphorus(V) oxide.
State the structure of, and describe fully the bonding in, this oxide.

Formula .....

Structure .....

Bonding.....

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(4)

(e) Sulfur(IV) oxide reacts with water to form a solution containing ions.

Write an equation for this reaction.

.....

(1)

(f) Write an equation for the reaction between the acidic oxide, phosphorus(V) oxide, and the basic oxide, magnesium oxide.

.....

(1)
(Total 15 marks)

Q1. Some melting points of Period 3 oxides are given in this table.

	Na_2O	SiO_2	SO_2	SO_3
Melting point / K	1548	1883	200	290

(a) Explain, in terms of structure and bonding, why sodium oxide has a high melting point.

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(2)

(b) Explain, in terms of structure and bonding, why sulfur trioxide has a higher melting point than sulfur dioxide.

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(2)

(c) Some Period 3 oxides have basic properties.

State the type of bonding in these basic oxides.
Explain why this type of bonding causes these oxides to have basic properties.

Type of bonding .....

Explanation .....

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(3)

(d) Sulfur dioxide reacts with water to form a weakly acidic solution.

(i) Ions are formed when sulfur dioxide reacts with water.
Write an equation for this reaction.

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(1)

(ii) With reference to your equation from part (d)(i), suggest why sulfur dioxide forms a weakly acidic solution.

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(1)

(e) Suggest why silicon dioxide is described as an acidic oxide even though it is insoluble in water.

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(1)
(Total 10 marks)

Q2. The data in the table below show the melting points of oxides of some Period 3 elements.

	Na_2O	P_4O_{10}	SO_2
T_m/K	1548	573	200

(a) In terms of structure and bonding, explain why

(i) sodium oxide has a high melting point

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(Extra space) .....

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(2)

(ii) sulfur dioxide has a low melting point.

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(Extra space) .....

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(2)

(b) Explain why the melting point of P_4O_{10} is higher than the melting point of SO_2

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(Extra space) .....

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(2)

(c) Write equations for the reactions of Na_2O and P_4O_{10} with water. In each case give the approximate pH of the resulting solution.

Equation for Na_2O.....

pH .....

Equation for P_4O_{10}.....

pH .....

.....

(4)

(d) Write an equation for the acid–base reaction that occurs when Na_2O reacts with P_4O_{10} in the absence of water.

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(1)

(Total 11 marks)

Q3. Sodium, aluminium and silicon are solid elements with a silver colour. These elements react with oxygen to form oxides with high melting points. Aluminium is a reactive metal, but it resists corrosion in water because it has a surface coating of aluminium oxide.

(a) In terms of its structure and bonding, explain why silicon dioxide has a high melting point.

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.....

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(3)

(b) State the type of bonding in aluminium oxide.

.....

(1)

(c) Write an equation for the reaction of aluminium with oxygen.

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(1)

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

.....

(1)

(e) Sodium metal is **not** resistant to corrosion in water, despite having a surface coating of sodium oxide. Write an equation to show how sodium oxide reacts with water.

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(1)

(f) Aluminium oxide is amphoteric. It reacts with acids and alkalis.

(i) Write an equation for the reaction between aluminium oxide and hydrochloric acid.

.....

(1)

(ii) Write an equation for the reaction between aluminium oxide and an excess of aqueous sodium hydroxide.

.....

(1)

(g) Silicon dioxide does **not** react with hydrochloric acid but it does react with sodium hydroxide. State **one** property of silicon dioxide that can be deduced from this information and write an equation for its reaction with sodium hydroxide.

Property ….....

Equation .....

(2)

(Total 11 marks)

Q4. White phosphorus (P_4) is a hazardous form of the element. It is stored under water.

(a) Suggest why white phosphorus is stored under water.

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(1)

(b) Phosphorus(V) oxide is known as phosphorus pentoxide.
Suggest why it is usually represented by P_4O_{10} rather than by P_2O_5

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(1)

(c) Explain why phosphorus(V) oxide has a higher melting point than sulfur(VI) oxide.

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(2)

(d) Write an equation for the reaction of P_4O_{10} with water to form phosphoric(V) acid.
Give the approximate pH of the final solution.

Equation .....

pH .....

(2)

(e) A waste-water tank was contaminated by P_4O_{10}. The resulting phosphoric(V) acid solution was neutralised using an excess of magnesium oxide. The mixture produced was then disposed of in a lake.

(i) Write an equation for the reaction between phosphoric(V) acid and magnesium oxide.

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(1)

(ii) Explain why an excess of magnesium oxide can be used for this neutralisation.

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(1)

(iii) Explain why the use of an excess of sodium hydroxide to neutralise the phosphoric(V) acid solution might lead to environmental problems in the lake.

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(1)
(Total 9 marks)

Q5. This question is about the chemistry of the Period 3 elements and the trends in their properties.

(a) (i) Describe what you would observe when magnesium burns in oxygen. Write an equation for the reaction that occurs. State the type of bonding in the oxide formed.

Observations .....

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.....

.....

Equation .....

Type of bonding .....

(4)

(ii) Describe what you would observe when sulfur burns in oxygen. Write an equation for the reaction that occurs. State the type of bonding in the oxide formed.

Observations .....

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.....

.....

Equation .....

Type of bonding .....

(4)

(b) State the type of bonding in sodium oxide. Explain why sodium oxide reacts to form an alkaline solution when added to water.

Type of bonding .....

Explanation.....

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(3)

(c) Outline an experiment that could be used to show that aluminium oxide contains ions.

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(Extra space) ….....

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(2)

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

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(1)

(e) Write an ionic equation in each case to show how aluminium oxide reacts with the following

(i) hydrochloric acid

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(1)

(ii) aqueous sodium hydroxide.

.....

(1)

(Total 16 marks)

Q1. There is a link between the properties of the oxides of the Period 3 elements and their structure and bonding. The table below shows the melting points of the oxides of some Period 3 elements.

	Na_2O	SiO_2	P_4O_{10}
T_m/K	1548	1883	573

(a) In terms of crystal structure and bonding, explain in each case why the melting points of sodium oxide and silicon dioxide are high.

Na_2O .....

.....

.....

SiO_2 ….....

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.....

(4)

(b) Predict whether the melting point of lithium oxide is higher than, the same as, or lower than the melting point of sodium oxide and explain your prediction.

Prediction .....

Explanation .....

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(3)

(c) Phosphorus(V) oxide has a lower melting point than sodium oxide.

(i) State the structure of and bonding in phosphorus(V) oxide.

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(2)

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

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(1)

(d) Separate samples of phosphorus(V) oxide and sodium oxide were reacted with water.
In each case, predict the pH of the solution formed and write an equation for the reaction.

pH with P_4O_{10} .....

Equation .....

pH with Na_2O.....

Equation .....

(4)

(e) Write an equation for the reaction between Na_2O and P_4O_{10}
State the general type of reaction illustrated by this example.

Equation .....

Reaction type .....

(2)
(Total 16 marks)

Q2. (a) State and explain the trend in electronegativities across Period 3 from sodium to sulfur.

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(4)

(b) Explain why the oxides of the Period 3 elements sodium and phosphorus have different melting points. In your answer you should discuss the structure of and bonding in these oxides, and the link between electronegativity and the type of bonding.

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(6)

(c) A chemical company has a waste tank of volume 25 000 dm^3. The tank is full of phosphoric acid (H_3PO_4) solution formed by adding some unwanted phosphorus(V) oxide to water in the tank.

A 25.0 cm^3 sample of this solution required 21.2 cm^3 of 0.500 mol dm^{-3} sodium hydroxide solution for complete reaction.

Calculate the mass, in kg, of phosphorus(V) oxide that must have been added to the water in the waste tank.

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(5)
(Total 15 marks)

Q3. Consider the following oxides.

Na_2O, MgO, Al_2O_3, SiO_2, P_4O_{10}, SO_3

(a) Identify one of the oxides from the above which

(i) can form a solution with a pH less than 3 .....

(ii) can form a solution with a pH greater than 12 .....

(2)

(b) Write an equation for the reaction between

(i) MgO and HNO_3

.....

(ii) SiO_2 and $NaOH$

.....

(iii) Na_2O and H_3PO_4

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(3)

(c) Explain, in terms of their type of structure and bonding, why P_4O_{10} can be vaporised by gentle heat but SiO_2 cannot.

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(4)
(Total 9 marks)

Q4. (a) The melting points of some of the oxides formed by Period 3 elements are given in a random order below.

Oxide	**A**	**B**	**C**	**D**	**E**
T_m/°C	2852	–73	1610	1275	300

(i) Using the letters **A** to **E**, give **two** oxides which have simple molecular structures.

Explain your answer.

Oxide 1 .....

Oxide 2 .....

Explanation .....

.....

(ii) Give a simple chemical test which could be used to show which of the oxides in the table is sodium oxide. State the observation you would make.

Chemical test .....

.....

Observation .....

(6)

(b) The base calcium oxide can be used to remove sulfur dioxide from flue-gases produced when fossil fuels are burnt in coal-fired power stations. Calcium oxide is produced when calcium carbonate, is decomposed by heat.

(i) Write an equation for the action of heat on calcium carbonate.

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(ii) Identify the product formed when sulfur dioxide reacts with calcium oxide.

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(iii) Despite the additional cost, operators of power stations are encouraged to remove the sulfur dioxide from flue-gases. Explain why this may not be environmentally beneficial.

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(4)
(Total 10 marks)