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 .....

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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

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(ii) SiO_2 and $NaOH$

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(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 .....

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(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 .....

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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)