9. The Periodic Table: Chemical Periodicity

9.2 Periodicity of chemical properties

Paper 2

Question Paper

Q1.

(e)(i)	<table><tr><td>Na</td><td>solid</td><td>10–14</td></tr><tr><td>S</td><td>gas</td><td>0–4</td></tr></table> 4 correct = 2 marks 2 or 3 correct = 1 mark 0 or 1 correct = 0 marks	**2**
(e)(ii)	acid–base **OR** neutralisation	**1**
(e)(iii)	$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$	**1**
(f)(i)	reacts with both acids and bases **OR** shows both acidic and basic behaviour	**1**
(f)(ii)	$Al(OH)_3 + NaOH \rightarrow NaAl(OH)_4$	**1**

Q2.

(a)(i)	hydrolysis	**1**
(a)(ii)	silicon(IV) chloride / silicon tetrachloride **ALLOW** phosphorus(III) chloride / phosphorus trichloride	**1**

Q3.

(e)(i)	$Si + 2Cl_2 \rightarrow SiCl_4$	**1**
(e)(ii)	effervescence / misty / steamy fumes	**1**
(e)(iii)	**M1** SiO_2 is giant covalent **AND** $SiCl_4$ is simple covalent / simple molecular / molecular **M2** so need less **energy** to overcome IMF's in $SiCl_4$, compared to the **bonds** in SiO_2 **ora**	**2**
(f)	$Sn(SO_4)_2$	**1**

Q4.

(a)(i)	M1 $4Na + O_2 \rightarrow 2Na_2O$	1
	M2 $S + O_2 \rightarrow SO_2$	1
(a)(ii)	Al^{3+} 	1
(a)(iii)	it increases	1
	as number of valence electrons (which can be used in bonding / lost / shared / donated) increases	1

(b)(i)	<table><tr><th>Period 3 oxide</th><th>product of rxn with water</th><th>pH of solution formed</th></tr><tr><td>• MgO</td><td>$Mg(OH)_2$</td><td>• $8 \leqslant pH \leqslant 12$</td></tr><tr><td>$P_4O_{10}$</td><td>• H_3PO_4</td><td>• $1 \leqslant pH \leqslant 4$</td></tr></table> •✓•✓	2

Q5.

(f)(i)	$TeF_x + xH_2O \rightarrow Te(OH)_x + xHF$ **OR** $TeF_6 + 6H_2O \rightarrow Te(OH)_6 + 6HF$	1

f(ii)	hydrolysis	1

Q6.

(a)	**M1** *appearance* (colourless / yellow) liquid **M2** *structure and bonding* simple / molecular **AND** covalent	2

(b)	<table><tr><th></th><th>$MgCl_2$</th><th>PCl_5</th></tr><tr><td>appearance</td><td>• (white) crystals / solid</td><td>• (white OR pale yellow) crystals / solid</td></tr><tr><td>one similarity in observation</td><td colspan="2">(colourless) solution made</td></tr><tr><td>one difference in observation</td><td>no (misty / steamy) fumes</td><td>misty / steamy fumes</td></tr><tr><td>pH</td><td>• 6.5–7</td><td>• 0–4</td></tr></table> [1] [1] [1] [1]	4

Q7.

(a)(i)	<table><tr><td>element</td><td>Na</td><td>Mg</td><td>Al</td><td>Si</td><td>P</td></tr><tr><td>maximum oxidation number of elements in chlorides</td><td>(+)1</td><td>(+)2</td><td>(+)3</td><td>(+)4</td><td>(+)5</td></tr></table> All correct for one mark	1
(a)(ii)	number of outer/valence electrons	1
(b)(i)	$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$	1
(b)(ii)	1–4	1
(c)(i)	$PCl_5 + 4H_2O \rightarrow 5HCl + H_3PO_4$	1
(c)(ii)	1–4	1

Q8.

(d)(ii)	$POCl_3 + 3H_2O \rightarrow H_3PO_4 + 3HCl$	1

Q9.

(a)(i)	$NaCl$ **AND** $MgCl_2$	1
(a)(ii)	$AlCl_3$ **AND** $SiCl_4$ **AND** PCl_5	1
(a)(iii)	$NaCl$	1
(a)(iv)	$SiCl_4$	1

Q10.

(d)(i)	**M1** (structure =) simple / molecular, because it has a low melting / boiling point	1
	M2 (bonding =) covalent, because it is hydrolysed	1

Q11.

(a)	<table><tr><td>NaCl</td><td>AlCl$_3$</td><td>SiCl$_4$</td><td>PCl$_5$</td></tr><tr><td>I</td><td>I OR C</td><td>C</td><td>C</td></tr></table>	1
	<table><tr><td>G</td><td>G</td><td>S</td><td>S</td></tr></table>	1
	<table><tr><td>+1</td><td>+3</td><td>+4</td><td>+5</td></tr></table>	1
	<table><tr><td>+3</td><td>+2</td></tr></table>	1
(b)	**M1** NaCl(s) → Na$^+$(aq) + Cl$^-$(aq)	1
	PCl$_5$(s) + 4H$_2$O(l) → H$_3$PO$_4$(aq) + 5HCl(aq) **M2** balanced equation	1
	M3 all state symbols for PCl$_5$ equation	1

Q12.

(a)(i)	P$_4$ + 5O$_2$ → P$_4$O$_{10}$	1
(a)(ii)	any **two** from: • reacts vigorously • solid disappears / colourless solution forms • hydrolysis • exothermic • acid(ic) (solution) • steamy / misty fumes	2

Q13.

(a)	more acidic / less basic (from Na to S across period)	1
(b)	**M1:** increases (from Na to S / across period)	2
	M2: increasing (number of) **valence** electrons **OR** (number of) electrons in **outer** (electron) shell increases	
(c)	<table><tr><td>reaction</td><td>**name** of product</td></tr><tr><td>sodium oxide with water</td><td>sodium hydroxide</td></tr><tr><td>phosphorus(V) oxide with water</td><td>phosphoric(V) acid</td></tr></table>	2

(g)(i)	Na$_2$O + SiO$_2$ → Na$_2$SiO$_3$	1
(g)(ii)	Na$_2$CO$_3$ → Na$_2$O + CO$_2$	1

Q14.

(a)(i)	$P_4 + 10Cl_2 \rightarrow 4PCl_5$	1
(a)(ii)	simple / molecular AND covalent	1
(b)(i)	steamy / misty fumes	1
(b)(ii)	$PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$	1
(b)(iii)	0 to 4	1

Q15.

(f)(i)	**M1** sodium silicate / Na_2SiO_3	1
	M2 water / H_2O	1
(f)(ii)	acid(ic)	1

Q16.

(a)(i)	$SiCl_4(l) + 2H_2O(l) \rightarrow SiO_2(s) + 4HCl\,(aq / g)$ (state symbols required)	1
(a)(ii)	hydrolysis	1

Q17.

(a)

Na_2O	**MgO**	**Al_2O_3**	**SiO_2**	**SO_3**
ionic	ionic	ionic	covalent	covalent
giant	giant	giant	giant / macro-molecular	simple / molecular

Award one mark for each correct row. **2**