12. Nitrogen and sulfur

12.1 Nitrogen and sulfur

Paper 2

Marking Scheme

Q1.

(a)(i)	(natural =)lightning	1
	(man-made =)internal combustion engines	1
(a)(ii)	$2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$ **OR** $4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3$	1
(a)(iii)	It / NO_2 reacts with (unburned) hydrocarbons / VOCs **ALLOW** reaction of unburned hydrocarbons / VOCs in presence of NO_2	1
(a)(iv)	$2HNO_3 + CaO \rightarrow Ca(NO_3)_2 + H_2O$	1
(a)(v)	brown fumes given off	1

Q2.

(b)(i)	**M1** • high temperature • high pressure • N_2 Any two correct for **M1** **M2** $N_2 + O_2 \rightarrow 2NO$ **OR** $N_2 + 2O_2 \rightarrow 2NO_2$ **OR** $N_2 + xO_2 \rightarrow 2NO_x$	2

(b)(ii)	**M1** NO_2 is the catalyst (for $SO_2 \rightarrow SO_3$) **OR** catalytic oxidation (of SO_2) by NO_2 **M2** $NO_2 + SO_2 \rightarrow NO + SO_3$ **AND** $2NO + O_2 \rightarrow 2NO_2$ **M3** SO_3 reacts with rain **OR** moisture/water (in atmosphere) to form sulfuric acid / H_2SO_4 **OR** $SO_3 + H_2O \rightarrow H_2SO_4$	3
(b)(iii)	photochemical smog / PAN	1

Q3.

(d)	*natural process:* lightning	1
	man-made process: internal combustion engines	1
(e)(i)	species with 1 or more unpaired electrons	1
(e)(ii)	$NO_2 + SO_2 \rightarrow SO_3 + NO$	1
	$NO + \frac{1}{2} O_2 \rightarrow NO_2$	1
(e)(iii)	(formation of) acid rain	1

Q4.

(a)(i)	$4P / P_4 + 5O_2 \rightarrow P_4O_{10}$	1
	$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$	1

Q5.

(b)(i)	**M1** react with (unburnt) hydrocarbons **M2** (form) PAN / peroxyac(et)yl nitrate	**2**
(b)(ii)	$2NO + 2CO \rightarrow 2CO_2 + N_2$ **OR** $NO_2 + 2CO \rightarrow \frac{1}{2}N_2 + 2CO_2$	**1**

(c)	any Group 1 hydroxide or $Ca(OH)_2$ / $Sr(OH)_2$ / $Ba(OH)_2$	**1**

Q6.

(d)	lightning	**1**

Q7.

(a)	$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$	**1**

(d)	**M1** *state the effect of NO gas on contact with moist air* NO reacts with water **OR** NO reacts with oxygen and water. **M2** *consequence of M1 in terms of atmospheric pollution* causing acid rain **OR** photochemical smog / ground level ozone OR destroy ozone layer	**2**

(f)	fertiliser	**1**