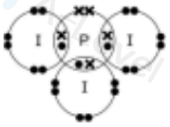
1(f)(i)	 **M1** correct bonding pairs **M2** correct number of remaining outer electrons on each atom	**2**
1(f)(ii)	hydrolysis	**1**
1(f)(iii)	proton donor / H^+ donor fully dissociates / fully ionises	**2**
1(f)(iv)	$H_2PO_3^-$	**1**

Question	Answer	Marks
2(a)	curved line from (0,0) to reach same horizontal line	**1**
2(b)	equilibrium position would / it moves to left / reactants	**1**
	forward reaction is exothermic (so disfavoured by increase in *T*)	**1**
2(c)	mole fraction NO $\frac{0.605}{1.60}$ (= 0.378125) NO_2 $\frac{0.605}{1.60}$ = (= 0.378125) N_2O_3 $\frac{0.390}{1.60}$ (= 0.24375)	**1**
	(partial pressure / kPa 38.19 38.19 24.62) $K_p = 24.62 \div 38.19^2 = 0.0169$	**1**
	kPa^{-1}	**1**
2(d)	*natural process:* lightning	**1**
	man-made process: internal combustion engines	**1**
2(e)(i)	species with 1 or more unpaired electrons	**1**
2(e)(ii)	$NO_2 + SO_2 \rightarrow SO_3 + NO$	**1**
	$NO + ½ O_2 \rightarrow NO_2$	**1**
2(e)(iii)	(formation of) acid rain	**1**
2(f)(i)	magnesium hydroxide / $Mg(OH)_2$	**1**
2(f)(ii)	$Mg(NO_3)_2 \rightarrow MgO + 2NO_2 + ½O_2$	**1**
2(f)(iii)	increases	**1**

Question	Answer	Marks
3(a)	**M1** rates of forward and reverse / backward reactions are equal **M2** no change in measurable properties **OR** concentration of reactants **AND** products remain constant	**2**
3(b)(i)	**M1** change to appearance of the mixture: (goes) darker red / more red **M2** change to relative concentration of $Fe^{3+}(aq)$: decreases **M3** change to the value of equilibrium constant, K_c: constant / none	**3**

Question	Answer	Marks
3(b)(ii)	Method 1 **M1** conc of initial conc of Fe^{3+} and SCN^- = 0.0020 (mol dm^{-3}) **M2** at equilibrium the conc of Fe^{3+} and SCN^- are (M1 – 0.000423) **M3** use 0.000423 ÷ (**M1** – 0.000423)^2 to calculate K_c = 170(.089) **M4** units = $mol^{-1}\,dm^3$ **OR** $dm^3\,mol^{-1}$ Method 2 **M1** no mol $FeSCN^{2+}$ = $4.23 \times 10^{-4} \times 25 / 1000 = 1.0575 \times 10^{-5}$ **M2** no mol Fe^{3+} and SCN^- are (5×10^{-5} – **M1**) = 3.9425×10^{-5} **M3** 0.000423 ÷ (**M2** × 1000 / 25)^2 = 170(.089) **M4** units = $mol^{-1}\,dm^3$ **OR** $dm^3\,mol^{-1}$	**4**

1(b)	NH_4^+	11 p^+ **AND** 10 e^-	**1**
	CO_3^{2-}	30 p^+ **AND** 32 e^-	**1**
	PO_4^{3-}	47 p^+ **AND** 50 e^-	**1**
1(c)(i)	proton / H^+ donor		**1**
1(c)(ii)	***ionic** equation*	$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$	**1**

Question	Answer	Marks
3(a)(i)	**M1** rate(s) of forward and reverse / backward reactions are equal / are the same **M2** no change in measurable properties **OR** concentration of reactants and products remain constant	2
3(a)(ii)	(colourless gas) becomes purple (gas)	1
3(a)(iii)	$K_p = \frac{(pH^2)(pI^2)}{(pHI)^2}$	1
3(a)(iv)	**M1** *use correct expression for finding amount of HI used up in reaction* 86.4 = 100 × (0.025 – x) / 0.025 – x + x / 2 + x / 2) where x = *HI mol used up* OR 86.4 = 100 × (0.025 – 2x) / (0.025 – 2x + x + x) where 2x = *HI mol used up* **M2** *correct calculation to find amount of HI(mol) at equilibrium based on* *HI(mol) at eq'm = 0.025 – HI(mol) used* = 0.025 – 0.0034 = 0.0216 **OR** 0.022 (mol) **alternative method** **M1** *use the pp H_2 and pp I_2 at equilibrium (= 13.6) to calculate no mol H_2 & I_2 at equilibrium* (either 0.0034 in total **OR** 0.0017 each) **M2** *use value for no mol H_2 + I_2 in expression to find no mol HI* 0.025 – (no mol H_2 + I_2) = 0.0216	2
3(b)	evaluation, to give a value, based on calculation using: • all three correct bond energies [HI = 299, H_2 = 436, I_2 = 151] • correct use of stoichiometry to calculate ΔH for 1 mol HI x = 1 and y = ½ • *calculate a value for ΔH correctly* i.e. x(299) – y(436 + 151) ΔH = (+)5.5 kJ mol^{-1}	2
3(c)	none / no change	1
3(d)(i)	acid-base	1

Question	Answer	Marks
3(d)(ii)	$8HI + H_2SO_4 \rightarrow 4I_2 + H_2S + 4H_2O$ **OR** $8H^+ + 8I^- + H_2SO_4 \rightarrow 4I_2 + H_2S + 4H_2O$	1
3(d)(iii)	*explanation in terms of comparison of reducing nature of HI to HCl* i.e. HI / I^- is stronger reducing agent compared to Cl^- / HCl **OR** *explanation in terms of additional behaviour of HI (compared to HCl)* i.e. HI / I^- reduces S (in sulfuric acid) / (concentrated) sulfuric acid	1