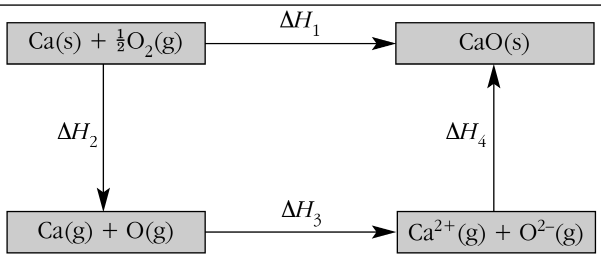
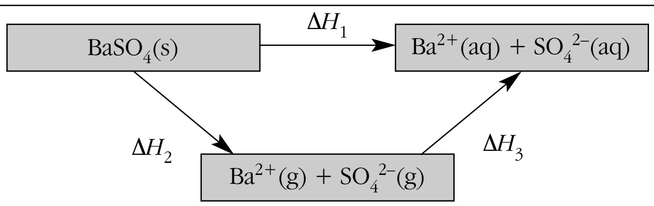
Answers to The Oceans End of Unit Test

Q	Answer with marks	Marking suggestions
1(a)	CO_2 is a gas (1); which has more entropy as there are more ways of arranging its molecules (1)	
1(b)	$\Delta S^{\ominus}_{sys} = 214 + 38 - 93$ (1); $= +159\ J\ K^{-1}\ mol^{-1}$ (1), including sign and units	
1(c) (i)	$-180 \times 1000/300$ (1); $= -600\ J\ K^{-1}\ mol^{-1}$ (1), including sign and units	
1(c) (ii)	-150 (1) ($J\ K^{-1}\ mol^{-1}$)	
1(d)	$\Delta S^{\ominus}_{tot} = \Delta S^{\ominus}_{sys} + \Delta S^{\ominus}_{surr}$ This is negative at 300 K and positive at 1200 K (1); Positive values means reactions are possible (1)	
1(e) (i)	 Top line correct, labelled ΔH or enthalpy change of formation (1); Rest of cycle correct, arrows labelled ΔH or some attempt to assign specific enthalpy changes (1)	Or alternative cycle drawn as an enthalpy level diagram
1(e) (ii)	Lattice enthalpy $= \Delta H_4 = \Delta H_1 - \Delta H_2 - \Delta H_3$ (1) $= -635 - (178 + 249) - (596 + 1152 - 147 + 753)$ $= -3416\ kJ\ mol^{-1}$ (1)	Units not essential for mark
1(f) (i)	At the bottom of the lake the pressure is higher (1); this means the equilibrium will move to the left, increasing the concentration of $CO_2(aq)$ (1)	
1(f) (ii)	Deep oceans can absorb a lot of CO_2 (1); this acts as a 'sink' for the extra CO_2 we are producing (1)	

Q	Answer with marks	Marking suggestions
2(a)	Ammonia has only (an average) of one hydrogen bond per molecule (1); water has two (1); greater intermolecular forces mean higher boiling point (1)	
2(b)	Ammonia would be less efficient (1); as it has a lower specific heating capacity than water (1); thus less energy would be transferred per mole/gram of ammonia (1)	

Q	Answer with marks	Marking suggestions
3(a) (i)	It is an equilibrium (1); so the benzoic acid is not fully reacted/ionised (1)	
3(a) (ii)	$K_a = \frac{[C_6H_5COO^-][H_3O^+]}{[C_6H_5COOH]}$ (1) for products on nominator; reactants on denominator; (1) completely correct	
3(b) (i)	$-\lg[H^+]/-\lg[H_3O^+]$ (1)	
3(b) (ii)	$[H_3O^+]^2 = (1 \times 10^{-4}) \times 0.010 = 1 \times 10^{-6}$ (1) $[H_3O^+] = 1 \times 10^{-3}\ mol\ dm^{-3}$ (1) pH = 3 (1)	
3(b) (iii)	pH = 2 (1)	
3(b) (iv)	HCl is fully ionised (1); (benzoic acid is partially ionised) hence the concentration of $[H_3O^+]$ is lower (1)	

3(c) (i)	$\frac{[C_6H_5COO^-]}{[C_6H_5COOH]} = K_a/[H_3O^+] = 1$ (1)	
3(c) (ii)	$\frac{[C_6H_5COO^-]}{[C_6H_5COOH]} = K_a/[H_3O^+] = 10^{-4}/10^{-6} = 100$ (1)	
3(d)	Benzoic acid (1); since there is very little of this present at pH 6 where preservation is poor (1)	
3(e)	pH 4 (1); concentrations of benzoic acid and benzoate more equal there (1); buffering depends on large reservoirs of these (1)	
3(f)	$[OH^-] = 0.100$, thus $[H_3O^+] = 1 \times 10^{-13}$ mol dm^{-3} (1); pH = 13 (1)	

Q	Answer with marks	Marking suggestions
4(a)	$[Ba^{2+}]^2 = 1.0 \times 10^{-10}$ (1); $[Ba^{2+}] = 1.0 \times 10^{-5}$ mol dm^{-3} (1); No, this is smaller than 1.0×10^{-3} (1)	
4(b)	$[Ba^{2+}] = 1.0 \times 10^{-10}/1.0 \times 10^{-2}$ (1); $= 1.0 \times 10^{-8}$ mol dm^{-3} (1);Yes, it's lower still! (1)	
4(c) (i)	Water molecules cluster round/hydrate positive ions and negative ions (1); the energy released when they do this/the enthalpy changes of hydration (1); roughly cancel the lattice enthalpy/the amount of energy needed to break up the lattice (1)	
4(c) (ii)	 (1) basic shape (1) detail correct (1) for calculation: Enthalpy of solution = $\Delta H_2 + \Delta H_3 = -(-2374) + (-1360) + (-1087)$ = -73 kJ mol^{-1}	Or alternative cycle drawn as an enthalpy level diagram, first two marks can be scored for a cycle showing enthalpy of solution as negative Units not necessary for calculation mark
4(c) (iii)	Mg^{2+} is smaller than Ba^{2+}, thus more water molecules gather round it/it is more highly hydrated (1); thus more bonds form/more energy is released (1)	
4(c) (iv)	$\Delta H^\ominus$ for $MgSO_4$ more exothermic (1); indicates that it may be more soluble (1); needs data of entropy changes of the reactions involved (1)	