1. Nov/2022/Paper_41/No.1

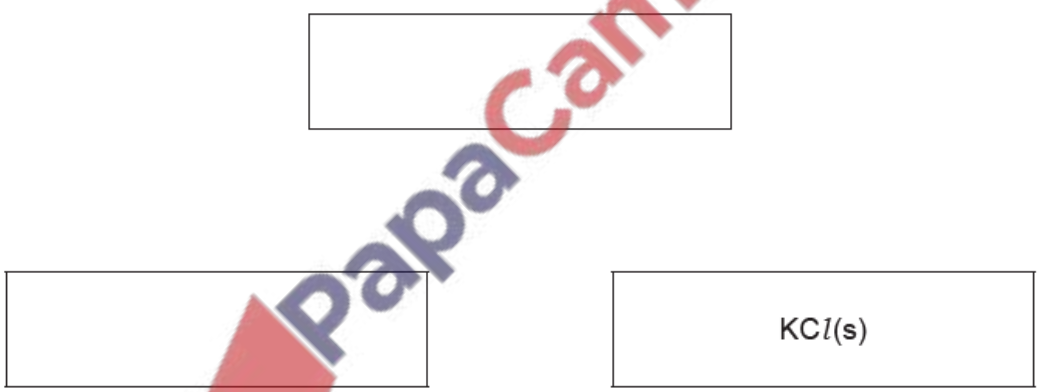
Potassium chloride, KC*l*, and magnesium chloride, MgCl_2, are both ionic solids.

Table 1.1

energy change	value / kJ mol^{-1}
standard enthalpy change of solution, $\Delta H^{\ominus}_{sol}$, of KC*l*	+15
lattice energy, $\Delta H^{\ominus}_{latt}$, of KC*l*(s)	–701
standard enthalpy change of hydration, $\Delta H^{\ominus}_{hyd}$, of K^+	–322
standard enthalpy change of hydration, $\Delta H^{\ominus}_{hyd}$, of Cl^-	–364
standard enthalpy change of solution, $\Delta H^{\ominus}_{sol}$, of MgCl_2	–155
lattice energy, $\Delta H^{\ominus}_{latt}$, of MgC$l_2$(s)	–2493

(a) Complete the energy cycle involving the enthalpy change of solution and the lattice energy of potassium chloride, KC*l*, and the relevant enthalpy changes of hydration. Label your diagram.

State symbols should be used.



[2]

(b) Use the data in Table 1.1 to calculate the enthalpy change of hydration of magnesium ions, Mg^{2+}. Show your working.

$\Delta H^{\ominus}_{hyd}$ of magnesium ions, Mg^{2+} = ... kJ mol^{-1} [2]

(c) Explain the reasons why the lattice energy of $MgCl_2$ is more exothermic than the lattice energy of KCl.

.....

.....

.....

..... [2]

(d) Define the following terms.

(i) enthalpy change of atomisation .....

..... [1]

(ii) first electron affinity .....

..... [1]

(e) **(i)** Explain what is meant by entropy, S.

.....

..... [1]

(ii) Potassium chloride is very soluble in water at 20 °C.

Explain the solubility of potassium chloride by reference to change in entropy, ΔS.

.....

..... [1]

(iii) Use the Gibbs equation and your answer to **(e)(ii)** to predict whether potassium chloride is more soluble in water at 20 °C or at 80 °C. Explain your answer.

.....

.....

..... [1]

[Total: 11]

2. Nov/2022/Paper_42/No.1

Calcium chloride, $CaCl_2$, is an ionic solid.

The values of some energy changes are shown in Table 1.1.

Table 1.1

energy change	value / kJ mol^{-1}
lattice energy, $\Delta H^{\ominus}_{latt}$, $CaCl_2(s)$	–2237
standard enthalpy change of atomisation of calcium	+193
first ionisation energy of calcium	+590
second ionisation energy of calcium	+1150
standard enthalpy change of atomisation of chlorine	+121
first electron affinity of chlorine	–364

(a) Define lattice energy.

.....

..... [1]

(b) Use the data in Table 1.1 to calculate the standard enthalpy change of formation, $\Delta H^{\ominus}_{f}$, of calcium chloride. It may be helpful to draw an energy cycle. Show all your working.

$\Delta H^{\ominus}_{f}(CaCl_2(s))$ = ... kJ mol^{-1} [2]

(c) Three possible values for the first electron affinity of bromine are shown in Table 1.2. One of them is correct.

Place a tick by the correct value. Explain your choice.

Table 1.2

possible values	place **one** tick (✓) in this column
–342 kJ mol^{-1}	
–364 kJ mol^{-1}	
–386 kJ mol^{-1}	

explanation .....

..... [1]

(d) The enthalpy change of hydration of the chloride ion can be calculated using the lattice energy of calcium chloride and the data shown in Table 1.3.

Table 1.3

energy change	value / kJ mol^{-1}
standard enthalpy change of solution of $CaCl_2$(s)	–83
standard enthalpy change of hydration of Ca^{2+}(g)	–1650

(i) Define the following terms.

enthalpy change of solution .....

.....

enthalpy change of hydration .....

.....

[2]

(ii) Calculate the standard enthalpy change of hydration of the chloride ion, Cl^-(g). It may be helpful to draw an energy cycle. Show all your working.

$\Delta H^{\ominus}_{hyd}(Cl^-(g))$ = ... kJ mol^{-1} [2]

(e) Calcium fluoride, $CaF_2(s)$, can be synthesised directly from its elements.

The value of $\Delta H_f^{\ominus}(CaF_2(s))$ is $-1214\,kJ\,mol^{-1}$.

(i) Predict the sign of the entropy change, $\Delta S^{\ominus}$, for this synthesis. Explain your answer.

The sign of the entropy change is ..... .

explanation .....

.....

[1]

(ii) Use the value of $\Delta H_f^{\ominus}(CaF_2(s))$ given in **(e)** and your answer to **(e)(i)** to predict how the feasibility for this synthesis will change with increasing temperature.

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.....

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..... [2]

[Total: 11]