Carbonates

Question Paper

Level	Pre U
Subject	Chemistry
Exam Board	Cambridge International Examinations
Topic	Carbonates- Main group chemistry
Booklet	Question Paper

Time Allowed: **23 minutes**

Score: **/19**

Percentage: **/100**

Grade Boundaries:

2 Quicklime is manufactured from limestone by the reaction shown.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

Thermodynamic data for these compounds, at 298 K, is given in the table.

compound	standard entropy / $J\,K^{-1}\,mol^{-1}$	standard enthalpy change of formation / $kJ\,mol^{-1}$
$CaCO_3(s)$	to be calculated in **(a)(iii)**	–1206.9
$CaO(s)$	39.7	to be calculated in **(b)(ii)**
$CO_2(g)$	213.6	–393.5

(a) (i) What type of reaction is involved in the conversion of limestone to quicklime?

.....[1]

(ii) Explain why the value for the standard entropy of CO_2 is greater than the value for CaO.

.....

.....

.....[1]

(iii) The standard entropy change of the system, $\Delta S^{\ominus}(298\,K)$, for the conversion of limestone to quicklime is $+160.4\,J\,K^{-1}\,mol^{-1}$.

Calculate the standard entropy of $CaCO_3(s)$.
Give your answer to one decimal place.

$S^{\ominus}(298\,K)$ = ... $J\,K^{-1}\,mol^{-1}$ [2]

(b) (i) State Hess's law.

.....

.....

.....[2]

(ii) The standard enthalpy change of reaction, $\Delta_r H^{\ominus}(298\,K)$, for the conversion of limestone to quicklime is $+178.3\,kJ\,mol^{-1}$.

Calculate the standard enthalpy change of formation, $\Delta_f H^{\ominus}(298\,K)$, for CaO(s). Give your answer to one decimal place and include a sign in your answer.

$\Delta_f H^{\ominus}$ CaO(s)(298 K) = ... $kJ\,mol^{-1}$ [2]

(iii) Calculate the entropy change of the surroundings, at 298 K, during the conversion of limestone to quicklime and hence calculate the total entropy change of the reaction.
Give your answers to one decimal place and include signs in your answers.

$\Delta S^{\ominus}_{surroundings}(298\,K)$ = ... $J\,K^{-1}\,mol^{-1}$

$\Delta S^{\ominus}_{total}(298\,K)$ = ... $J\,K^{-1}\,mol^{-1}$ [3]

(iv) Calculate the temperature at which $\Delta S^{\ominus}_{total}$ is zero and explain the significance of this temperature.
Assume that $\Delta H^{\ominus}$ and $\Delta S^{\ominus}$ are independent of temperature.

temperature = ... K

explanation .....

.....

.....[3]

(c) A sample of calcium carbonate, $CaCO_3$, was heated in a sealed container at 1200 °C until no further change occurred.

(i) Give the expression for the equilibrium constant, K_p, for the reaction.

K_p =

[1]

(ii) Using equations from the *Data Booklet*, and appropriate information from **(a)(iii)** and **(b)(ii)**, calculate the value of the equilibrium constant, K_p, for the reaction. Assume that $\Delta_r H^{\ominus}$ and $\Delta S^{\ominus}$ are independent of temperature and pressure.

K_p = ...[4]

[Total: 19]