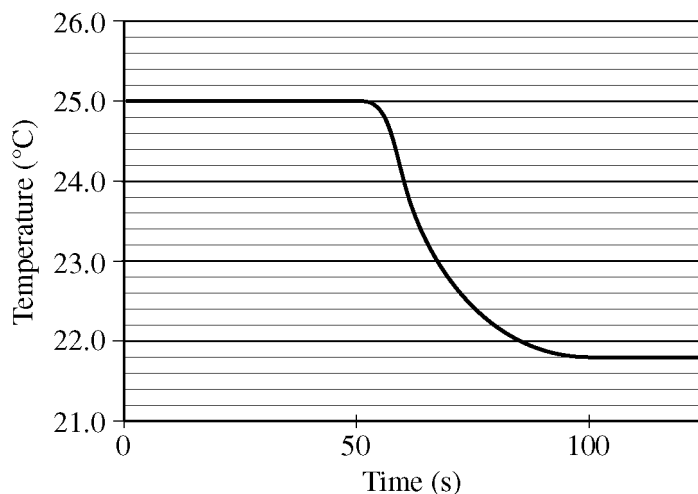


2010 AP[®] CHEMISTRY FREE-RESPONSE QUESTIONS

2. A student performs an experiment to determine the molar enthalpy of solution of urea, H_2NCONH_2 . The student places 91.95 g of water at 25°C into a coffee-cup calorimeter and immerses a thermometer in the water. After 50 s, the student adds 5.13 g of solid urea, also at 25°C , to the water and measures the temperature of the solution as the urea dissolves. A plot of the temperature data is shown in the graph below.



- Determine the change in temperature of the solution that results from the dissolution of the urea.
- According to the data, is the dissolution of urea in water an endothermic process or an exothermic process? Justify your answer.
- Assume that the specific heat capacity of the calorimeter is negligible and that the specific heat capacity of the solution of urea and water is $4.2 \text{ J g}^{-1} ^\circ\text{C}^{-1}$ throughout the experiment.
 - Calculate the heat of dissolution of the urea in joules.
 - Calculate the molar enthalpy of solution, $\Delta H_{\text{soln}}^\circ$, of urea in kJ mol^{-1} .
- Using the information in the table below, calculate the value of the molar entropy of solution, $\Delta S_{\text{soln}}^\circ$, of urea at 298 K. Include units with your answer.

	Accepted Value
$\Delta H_{\text{soln}}^\circ$ of urea	14.0 kJ mol^{-1}
$\Delta G_{\text{soln}}^\circ$ of urea	-6.9 kJ mol^{-1}

- The student repeats the experiment and this time obtains a result for $\Delta H_{\text{soln}}^\circ$ of urea that is 11 percent below the accepted value. Calculate the value of $\Delta H_{\text{soln}}^\circ$ that the student obtained in this second trial.
- The student performs a third trial of the experiment but this time adds urea that has been taken directly from a refrigerator at 5°C . What effect, if any, would using the cold urea instead of urea at 25°C have on the experimentally obtained value of $\Delta H_{\text{soln}}^\circ$? Justify your answer.