Quiz (Rate Equation and Energy Profile)

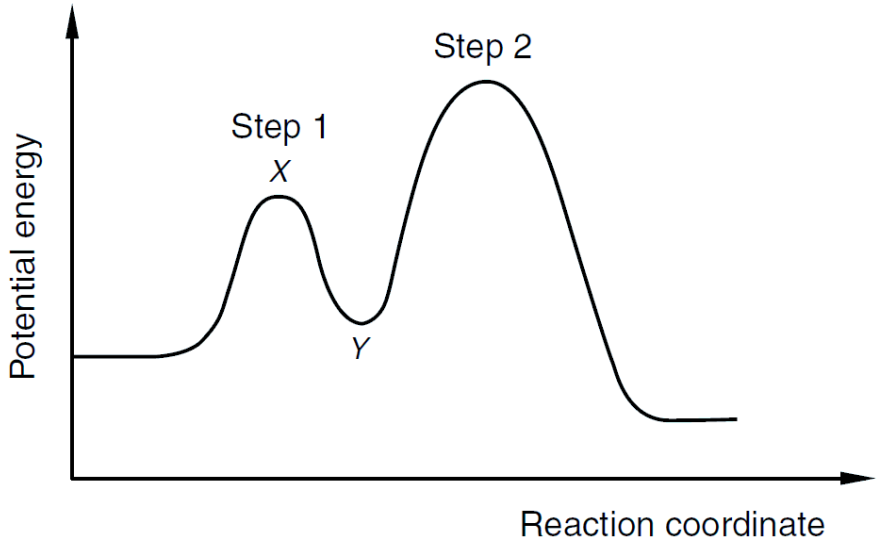
1. Consider the following reversible reaction:
   $2SO_2(g) + O_2(g) \leftrightarrows 2SO_3(g) \quad \Delta H^{\circ} = -196 \text{ kJ mol}^{-1}$

   (a) Draw a labelled energy profile (One-step reaction) for the reaction. Indicate in the diagram the activation energy, E_a, of the forward reaction (which is 58 kJ mol^{-1}) and the enthalpy change of the reaction.

   (b) Calculate the activation energy of the backward reaction.

   (c) Write the rate equation for the forward and backward reaction.

2. The energy profile of a two-step reaction is shown in the diagram below.



   (a) Name the species *X* and *Y* in the energy profile.

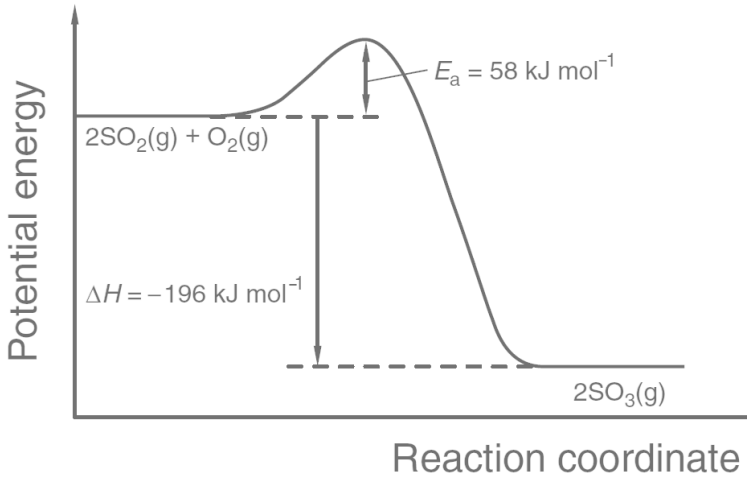
   (b) In the energy profile, indicate the activation energies of Steps 1 and 2, and label them as E_{a1} and E_{a2} respectively.

   (c) Explain whether Step 1 or Step 2 is the rate-determining step.

   (d) Explain whether the reaction is exothermic or endothermic.

Suggested Answer

1. (a)

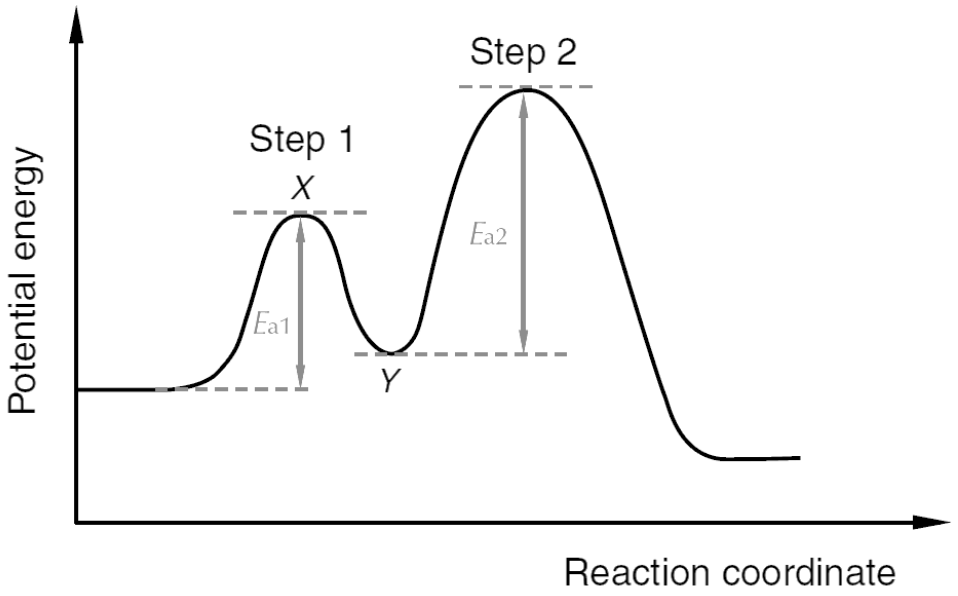


(b) Activation energy of the backward reaction
= 58 + 196
= 254 kJ mol^{-1}

(c) Forward: Rate = k $[SO_2(g)]^2$ $[O_2(g)]$
Backward: Rate = k' $[SO_3(g)]^2$

2. (a) Species X is the activated complex of step 1.
Species Y is the intermediate.

(b)



(c) Step 2 is the rate-determining step because it has higher activation energy.

(d) Exothermic. This is because the potential energy of the products is less than that of the reactants.