

14. (c)
15. (a)
16. (b)
17. (d)
18. (b)

CHAPTER 6 REVIEW

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Understanding Concepts

1. pressure or volume, conductivity, absorbency of light
2. concentration, temperature, catalysis, chemical nature of reactants
3. Additional surface area = $18 \times 1 \text{ cm}^2$

Total surface area = 24 cm^2

Proportional change in surface area = $\frac{24 \text{ cm}^2}{6 \text{ cm}^2} = 4$

The rate would be multiplied by a factor proportional to the surface area change:

$$r = 4 \times 20 \text{ mL/s}$$

$$r = 80 \text{ mL/s}$$

4. (a) rate increases
(b) rate decreases
(c) rate increases
(d) rate increases
5. (a) $r = \frac{\Delta V}{\Delta t}$

$$= \frac{44.2 \text{ mL}}{30.0 \text{ s}}$$

$$r = 1.47 \text{ mL/s}$$
 - (b) (i) With a 5°C increase in temperature, the rate could be doubled and the time halved.
 - (ii) Without the catalyst, the reaction might be imperceptibly slow.
6. (a) $r = k [\text{ClO}_{2(\text{aq})}]^2 [\text{OH}_{(\text{aq})}^-]$
(b) This is a third-order reaction.
(c) The rate would quadruple.
(d) The rate would double.
7. (a) When we compare Trials 1 and 2, we see that as $[\text{Cl}_2]$ is doubled, rate is multiplied by 2; therefore, rate depends on $[\text{Cl}_2]^1$.
 When we compare Trials 2 and 3, we see that as $[\text{NO}]$ is doubled, rate is multiplied by 4; therefore, rate depends on $[\text{NO}]^2$.
 Overall, $r = k [\text{Cl}_2]^1 [\text{NO}]^2$.
 (b) The rate-determining step is most likely to be
 $2 \text{ NO}_{(\text{g})} + \text{Cl}_{2(\text{g})} \rightarrow \text{product or intermediate}$
 (c) $k = \frac{r}{[\text{NO}]^2 [\text{Cl}_2]}$

$$= \frac{1.8 \times 10^{-2} \text{ mol/(L}\cdot\text{s)}}{(0.10 \text{ mol/L})^2 \times 0.10 \text{ mol/L}}$$

$$k = 18 \text{ L}^2/(\text{mol}^2\cdot\text{s})$$

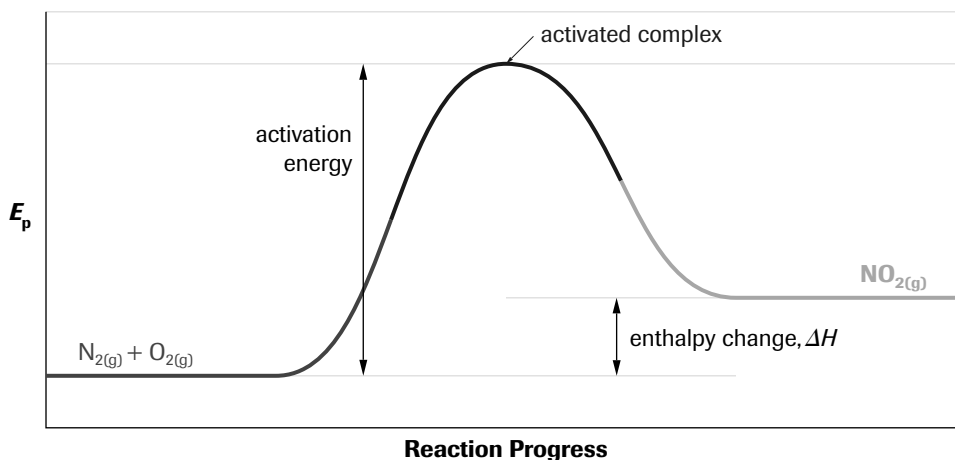
 (d) $r = k [\text{NO}]^2 [\text{Cl}_2]$

$$= 18 \text{ L}^2/(\text{mol}^2\cdot\text{s}) (0.30 \text{ mol/L})^2 \times 0.40 \text{ mol/L}$$

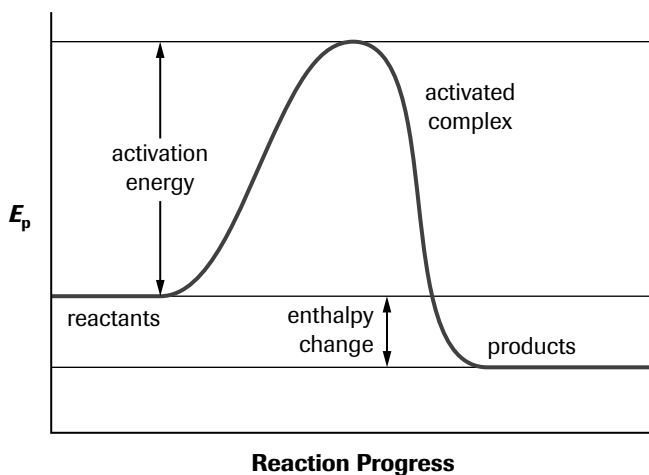
$$r = 0.65 \text{ mol/(L}\cdot\text{s)}$$

8. (a) Half-life is the amount of time for one-half the mass of a radioisotope to decay.
 (b) 14.0 a is four half-lives. The percentage remaining is $100\% \times (\frac{1}{2})^4 = 6.25\%$.
- 9.

Potential Energy Diagram of Formation of Nitrogen Dioxide



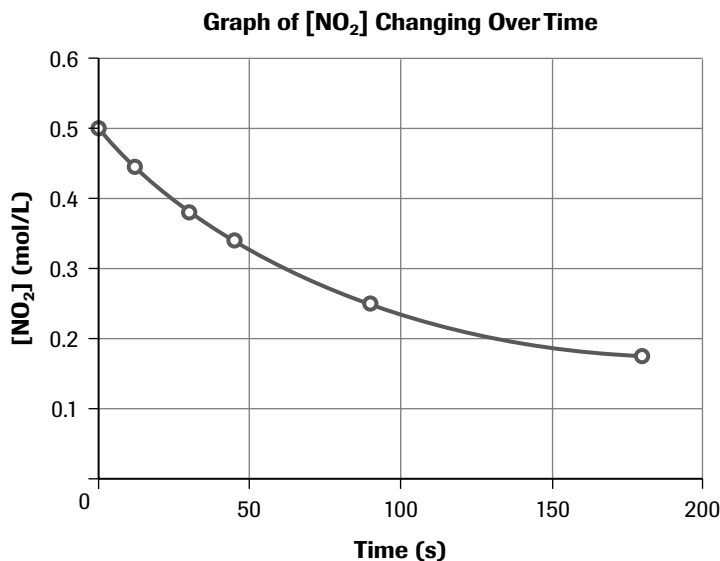
10. **Potential Energy Diagram of an Exothermic Reaction**



11. (a) There are generally one, two, or three particles involved in each elementary step.
 (b) Collisions of more particles at the same point in time and space are much less probable as the number of particles increases. Four-body collisions are effectively impossible as contributors to a reaction process.
12. (a) A catalyst might be consumed in one step of a mechanism as long as it is regenerated in a subsequent step.
 (b) Homogeneous catalysts, like acid in aqueous solution, are in the same phase as reactants. Heterogeneous catalysts, like platinum in gases, are in different phases from reactants.
13. (a) catalyst (necessary in first step but regenerated): $Cu_{(aq)}^{2+}$
 intermediates (produced but then consumed): $Cu_{(aq)}^+$, $I_{(aq)}^-$, $CuSO_{4(aq)}^+$
 (b) $S_2O_{8(aq)}^{2-} + 2 I_{(aq)}^- \rightarrow I_{2(aq)} + 2 SO_{4(aq)}^{2-}$
 (c) Since the $I_{(aq)}^-$ is not part of the rate-determining (slow) step, increasing its concentration will have no effect on the overall rate.
 (d) Since the $S_2O_{8(aq)}^{2-}$ is part of the rate-determining (slow) step, increasing its concentration will increase the overall rate.

Applying Inquiry Skills

14. (a)



(b) Average rate, $r_{ave(t = 10 - 60)} = \frac{\Delta c}{\Delta t}$
 $= (0.45 - 0.30) / (10 - 60)$

$$r_{ave(t = 10 - 60)} = 0.003 \text{ mol/(L}\cdot\text{s)}$$

(c) Instantaneous rate, $r_{ins(c = 0.46)} = \frac{\Delta c}{\Delta t}$

$$r_{ins(c = 0.46)} = 0.004 \text{ mol/(L}\cdot\text{s)}$$

Instantaneous rate, $r_{ins(c = 0.23)} = \frac{\Delta c}{\Delta t}$

$$r_{ins(c = 0.23)} = 0.001 \text{ mol/(L}\cdot\text{s)}$$

(d) As [NO₂] was halved, the rate was multiplied by 1/4, roughly.

(e) The reaction is second order or rate is proportional to [NO₂]².

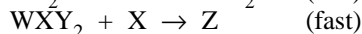
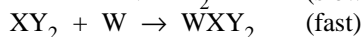
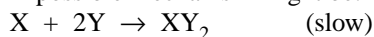
15. (a) When we compare Trials 1 and 2, we see that as [W] is doubled, rate is unchanged; therefore, rate depends on [W]⁰. When we compare Trials 1 and 3, we see that as [X] is doubled, rate is multiplied by 2; therefore, rate depends on [X]¹.

When we compare Trials 1 and 4, we see that as [Y] is doubled, rate is multiplied by 4; therefore, rate depends on [Y]².

Overall, $r = k [X]^1 [Y]^2$.

(b) The rate-determining step is $X + 2Y \rightarrow \text{products}$.

(c) A possible mechanism might be:



Making Connections

16. (a) When we compare Trials 1 and 2, we see that as [Hbn] is doubled, rate is multiplied by 2; therefore, rate depends on [Hbn]¹.

When we compare Trials 2 and 3, we see that as [CO] is tripled, rate is multiplied by 3; therefore, rate depends on [CO]¹.

(b) The overall order is two.

(c) Overall, $r = k [Hbn]^1 [CO]^1$.

(d) The carbon monoxide rate constant might be expected to be larger than the oxygen rate constant because it seems to bind so quickly to hemoglobin. On the other hand, as will be discovered in the next unit, the more significant factor is the equilibrium constant for the binding reaction, which is much larger for carbon monoxide than for oxygen.