



1. Consider the reaction



Suppose that, at a particular moment during the reaction,  $\text{H}_2(\text{g})$  is being formed at the rate of 0.312 M/s. At what rate is  $\text{P}_4(\text{g})$  being formed?

- A. 0.013 M/s    B. 0.026 M/s    C. 0.052 M/s    D. 0.156 M/s    E. 0.312 M/s

2. Consider the hypothetical reaction  $\text{A} + 2\text{B} \rightarrow \text{products}$ . Use the following data to determine the **rate constant,  $k$** , for the reaction.

Expt. #	$[\text{A}]_0$	$[\text{B}]_0$	Initial rate
1	0.20	0.20	1.46 M/min
2	0.20	0.40	1.46 M/min
3	0.40	0.20	2.92 M/min

- A.  $3.8 \text{ min}^{-1}$     B.  $7.3 \text{ min}^{-1}$     C.  $11 \text{ min}^{-1}$     D.  $22 \text{ min}^{-1}$     E.  $26 \text{ min}^{-1}$

3. If concentration is expressed in units of molecules per cubic centimeter ( $\text{molec}/\text{cm}^3$ ) and time in units of seconds (s), the **units of a zero-order rate constant** are

- A.  $\text{cm}^3 \text{ molec}^{-1} \text{ s}^{-1}$     B.  $\text{cm}^6 \text{ molec}^{-2} \text{ s}^{-1}$     C.  $\text{s}^{-1}$   
D.  $\text{s}^{-2}$     E.  $\text{molec cm}^{-3} \text{ s}^{-1}$

4. The chemical reaction  $\text{A} \rightarrow \text{products}$  is known to have a rate law of the general type

$$\text{rate} = k[\text{A}]^n.$$

A plot of  $\ln[\text{A}]$  versus time was found to give a straight line with a negative slope. What is  **$n$** , the order of reaction?

- A. zero    B. first    C. second    D. third    E. none of these

5. At  $25^\circ\text{C}$ , the second-order reaction



is 50% complete after 13 hours when the initial concentration of NOCl is 2.00 mol/L. How long will it take for the reaction to be 75% complete?

- A. 26 hr    B. 39 hr    C. 52 hr    D. 78 hr    E. 156 hr

6. What is the **half-life** of a compound if 10 percent of a given sample of the compound decomposes in 10 min? Assume first-order kinetics.

- A. 13 min      B. 17 min      C. 23 min      D. 35 min      E. 66 min

7. The reaction



is second-order in [NOCl] with a rate constant,  $k$ , of  $0.040 \text{ M}^{-1}\text{hr}^{-1}$  at  $25^\circ\text{C}$ . If the initial concentration of NOCl were  $4.00 \text{ M}$ , what would be the **concentration of NOCl** after 15 hrs?

- A. 3.0 M      B. 2.4 M      C. 1.8 M      D. 1.2 M      E. 0.80 M

8. Given that  $E_a$  for a certain biological reaction is  $41 \text{ kJ/mol}$ , and that the rate constant,  $k$ , is  $3.7 \times 10^{12} \text{ s}^{-1}$  at  $15^\circ\text{C}$ , **what is the rate constant at  $37^\circ\text{C}$ ?**

- A.  $0.087 \text{ s}^{-1}$       B.  $0.12 \text{ s}^{-1}$       C.  $0.17 \text{ s}^{-1}$   
D.  $0.24 \text{ s}^{-1}$       E.  $0.36 \text{ s}^{-1}$

9. For a certain reaction, raising the temperature from  $25^\circ\text{C}$  to  $45^\circ\text{C}$  increases the value of the rate constant,  $k$ , by a factor of 2.35. What is the **activation energy,  $E_a$** , for this reaction in units of  $\text{kJ/mol}$ ?

- A. 8.8      B. 24.2      C. 33.7      D. 44.9      E. 55.6

10. A particular catalyst increases the rate of a certain reaction by a factor  $1.00 \times 10^3$  at  $25^\circ\text{C}$ . By how much ( $\text{kJ/mol}$ ) must this catalyst have lowered the **activation energy** for this reaction? (Assume the frequency factor remains the same.)

- A. 17.1  $\text{kJ/mol}$       B. 21.1  $\text{kJ/mol}$       C. 25.1  $\text{kJ/mol}$       D. 29.1  $\text{kJ/mol}$       E. 33.1  $\text{kJ/mol}$

11. The overall reaction



is thought to occur by the following three-step mechanism:

- (1)  $\text{A} + \text{E} \rightleftharpoons \text{F} + \text{G}$   
(2)  $\text{B} + \text{F} \rightleftharpoons \text{H} + \text{C}$   
(3)  $\text{G} + \text{H} \rightleftharpoons \text{E} + \text{D}$

Identify the **catalyst(s)** in the proposed mechanism.

- A. E      B. F & G      C. F, G & H      D. E & H      E. E, F, G & H

12. Which statement correctly describes the effect of a catalyst on the activation energy of a reaction?