



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  $0.624\text{M/s}$ . At what rate is  $\text{P}_4(\text{g})$  being formed?

- A.  $0.013\text{ M/s}$     B.  $0.026\text{ M/s}$     C.  $0.052\text{ M/s}$     **D.  $0.104\text{ M/s}$**     E.  $0.624\text{ M/s}$

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	2.19 M/min
2	0.20	0.40	2.19 M/min
3	0.40	0.20	4.38 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.  $\text{molec cm}^3\text{ s}^{-1}$**     B.  $\text{cm}^6\text{ molec}^{-2}\text{ s}^{-1}$     C.  $\text{s}^{-1}$   
D.  $\text{s}^{-2}$     E.  $\text{cm}^3\text{ molec}^{-1}\text{ s}^{-1}$

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  $[\text{A}]$  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 26 hours when the initial concentration of  $\text{NOCl}$  is  $1.00\text{ mol/L}$ . 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 34 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 25 hrs?

- A.  $3.0 \text{ M}$       B.  $2.4 \text{ M}$       C.  $1.8 \text{ M}$       D.  $1.2 \text{ M}$       E.  **$0.80 \text{ M}$**

8. Given that  $E_a$  for a certain biological reaction is  $52 \text{ kJ/mol}$ , 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 1.25. 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  $5.00 \times 10^3$  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 **intermediate(s)** in the proposed mechanism.

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

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

- A. A catalyst raises the activation energy by changing the rate  
B. A catalyst lowers the activation energy by changing the rate.  
C. A catalyst does not change the activation energy.  
D. A catalyst raises the activation energy by changing the reaction mechanism.  
E. **A catalyst lowers the activation energy by changing the reaction mechanism.**

13. For the following reaction in aqueous solution,