Reaction Rates Test 2019 V1 35 **Name:** _____

1. Consider the following reaction: $N_{2\,(g)} + 3\,H_{2(g)} \rightarrow 2\,NH_{3(g)}$. Under a certain set of conditions, the rate of formation of ammonia, (NH_3), was found to be 24 litres per minute. At what rate was hydrogen, (H_2), being consumed ?

   A) 12 L/min B) 16 L/min C) 24 L/min D) 36 L/min

2. Which of the following describes the energy of colliding particles as molecules approach each other?

	KE	PE
A.	decreases	increases
B.	increases	decreases
C.	decreases	remains constant
D.	remains constant	increases

3. Pieces of magnesium are reacted in test tubes containing hydrochloric acid at different concentrations and at different temperatures. Select the combination of acid concentration and temperature that would probably produce the greatest rate.

   A) 1.0 mol/L at 12°C
   B) 3.0 mol/L at 12°C
   C) 1.0 mol/L at 36°C
   D) 3.0 mol/L at 36°C

4. Which of the following reactions will occur the most rapidly at room temperature?

   A) $CH_{4(g)} + 2\,O_{2(g)} \rightarrow CO_{2(g)} + 2\,H_2O_{(g)}$
   B) $2\,H_{2(g)} + O_{2(g)} \rightarrow 2\,H_2O_{(g)}$
   C) $Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)}$
   D) $Cu_{(s)} + 2\,Ag^{+}_{(aq)} \rightarrow 2\,Ag_{(s)} + Cu^{2+}_{(aq)}$

5. Consider the following reaction: $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$
   The rate law for this equation can be expressed as: $r = k[N_2][H_2]^3$. In order to increase the rate of production of ammonia, a chemist doubles the mass hydrogen, H_2, used. Determine the factor by which the reaction rate increases under the new conditions.

   A) 2 B) 4 C) 8 D) 16

6. At a given temperature, the rate law for an elementary reaction is: $\mathbf{r = k\,[C]^2\,[D]}$
   Which of the elementary reactions below is represented by the rate law above?

   A) $C_2D_{(s)} \rightarrow 2\,C_{(g)} + D_{(g)}$
   B) $2\,C_{(g)} + D_{(g)} \rightarrow C_2D_{(g)}$
   C) $C_{2(g)} + D_{(g)} \rightarrow C_2D_{(g)}$
   D) $C_2D_{(s)} \rightarrow C_{2(g)} + D_{(g)}$

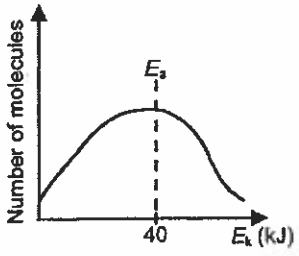
7. When zinc metal reacts with hydrochloric acid, hydrogen gas is produced according to the following equation: $Zn_{(s)} + 2\,HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$. Which of the following would *INCREASE* the rate of formation of hydrogen?

   1. Use powdered zinc instead of a solid piece of zinc. ✓
   2. Increase the temperature of the acid. ✓
   3. Increase the volume of acid used. ✗
   4. Increase the size of the reaction container. ✗

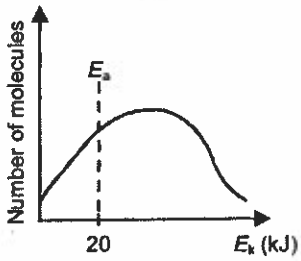
   A) 1 and 2 B) 1 and 4 C) 2 and 3 D) 3 and 4

8. Graph 1 represents the kinetic energy distribution curve of the reactant molecules and indicates the activation energy (E_a) of this reaction.

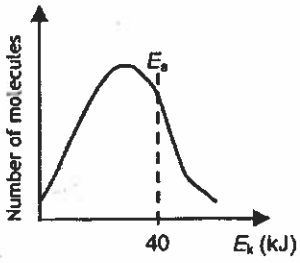
Graph 1



Graph 2



Graph 3



Graphs 2 and 3 represent the same reaction as in graph 1 but under different conditions. Which of the following statements is TRUE about the changes seen in graphs 2 and 3?

A) Graph 2: increase in temperature; Graph 3: increase in concentration
B) Graph 2: use of inhibitor; Graph 3: increase in concentration
C) Graph 2: use of catalyst; Graph 3: decrease in temperature
D) Graph 2: use of catalyst; Graph 3: increase in temperature

MC ans	
1	D
2	A
3	D
4	C
5	C
6	B
7	A
8	C

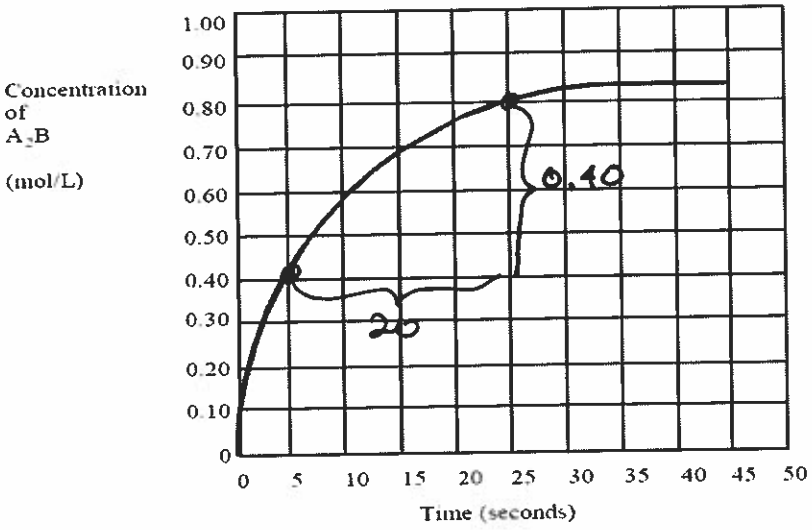
16

9. Examine the following hypothetical chemical reaction.

$$2\,A_{(g)} + B_{(g)} \rightarrow A_2B_{(g)}$$

The graph below shows the formation of the product A_2B over time, at a constant temperature and pressure.

The Molar Concentration of A_2B Formed as a Function of Time



Determine the average rate of the reaction for *change in concentration of* ***reactant A*** between 5 and 25 seconds in mol/L·s.

$$\text{rate} = \frac{0.40}{20} = 0.02\ \frac{\text{mol } A_2B}{L \cdot s}$$

$$\frac{0.8 - 0.4}{25 - 5}$$

$\times 2$

$$0.04\ \frac{\text{mol } A}{L \cdot s}$$

/4

/20

10. Bromopropane is a solvent that is used in glues, asphalt production, and dry cleaning. When bromopropane reacts with NaOH, 1-propanol is produced. This reaction is shown below.

pure liquid [100%] $CH_3CH_2CH_2Br_{(l)} + OH^-_{(aq)} \rightarrow CH_3CH_2CH_2OH_{(l)} + Br^-_{(aq)}$

State 2 ways in which the rate of this reaction could be increased. In each case explain your answer using collision theory. (not catalyst)

1. ↑ [NaOH]

Explanation:

2	1	0

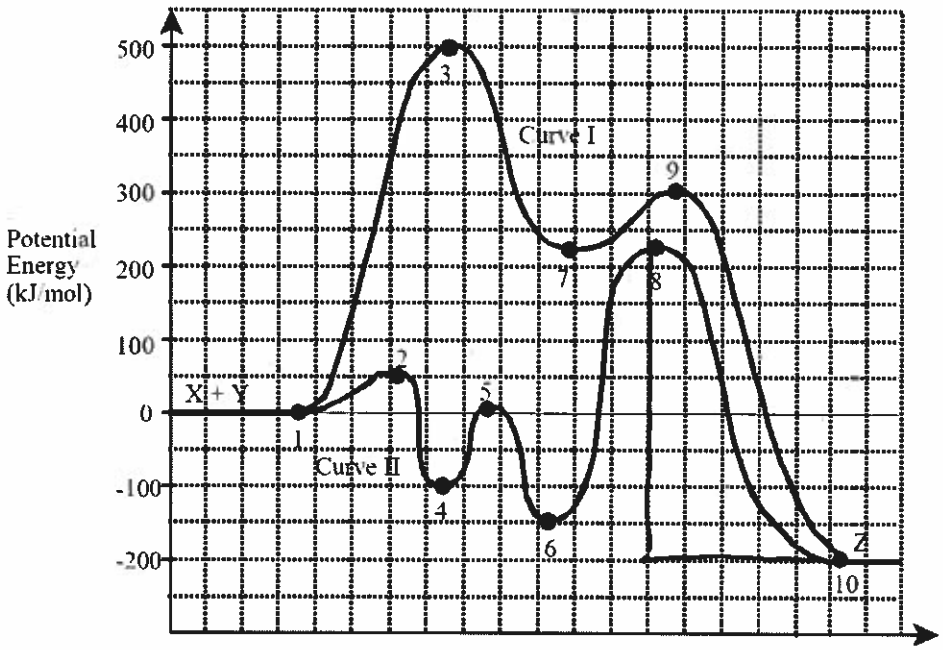
2. ↑ T

Explanation:

2	1	0

4

12. The graph below shows two potential energy curves for a hypothetical reaction.
The reaction is: **X + Y ↔ Z**



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The two curves show the reaction pathways with and without the addition of a catalyst.

a) How many steps exist in the reaction mechanism for the **forward catalyzed** reaction? 3

b) What numbered points on the graph represent the **rate determining steps** for the **forward uncatalyzed** and **catalyzed** reactions respectively? 3 and 8

c) What is the activation energy of the **forward uncatalyzed** reaction? 500 kJ/mol

d) What is the activation energy of the **reverse catalyzed** reaction ~425 kJ/mol

e) What is the ΔH of the **reverse** reaction ΔH = prod − react = 0 − (−200) = +200 +200 kJ/mol

10

13. The following results were obtained in experiments designed to study the rate of a reaction between reactants A and B.

Experiment	Initial Concentration (mol/L) [A]	[B]	Rate of appearance of AB (mol/L·s)
1	0.018	0.016	0.095
2	0.036	0.016	0.76
3	0.018	0.032	0.19

A) Find the rate law for this equation calculation based on the results above.
B) Then calculate the rate constant k (no units).

$$\frac{\text{rate 2}}{\text{rate 1}} = \frac{k(0.036)^x(0.016)^y}{k(0.018)^x(0.016)^y} \qquad \frac{\text{rate 3}}{\text{rate 1}} = \frac{k(0.018)^x(0.032)^y}{k(0.018)^x(0.016)^y}$$

$$\frac{0.76}{0.095} = \left(\frac{0.036}{0.018}\right)^x \qquad \frac{0.19}{0.095} = \left(\frac{0.032}{0.016}\right)^y$$

$$8 = 2^x \qquad 2 = 2^y \qquad 4$$

$$x = 3 \qquad y = 1$$

$$\text{rate} = k[A]^3[B]^1$$

$$0.095 = k(0.018)^3(0.016)^1 \qquad 1$$

$$0.095 = k(9.3312 \times 10^{-8})$$

$$k = 1.0 \times 10^6 \ \frac{L^3}{mol^3 \cdot s}$$