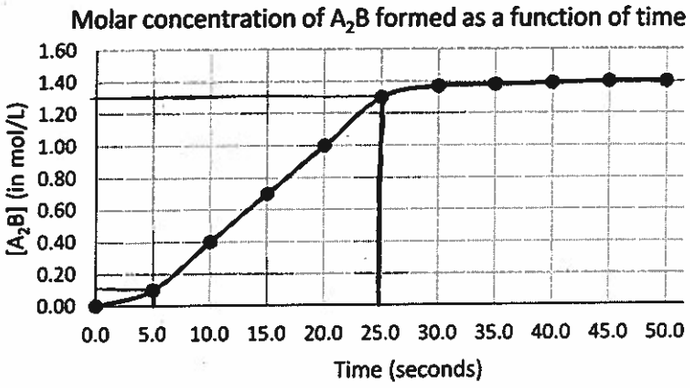
Chemical Kinetics Quiz Version 6 Name: answers

1. 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.



a) Determine the average rate of the reaction of $A_2B_{(g)}$ production between 5.0 & 25.0 seconds in mol/L•s.

rate = [products]/time
= (1.30 mol/L − 0.10 mol/L)/(25.0 − 5.0)
= 1.20 mol/L / 20.0 s
= 0.06 mol/L•s
∴ 0.0600 mol/L•s ✓

b) Determine the average rate of A consumption in the same time period.

$rate_A$ = 0.0600 mol/L•s (2)
= 0.120 mol/L•s
∴ −0.120 mol/L•s ✓

4

2. **In the presence of water, sodium peroxide forms sodium hydroxide and oxygen gas.**
$2\ Na_2O_{2(s)} + 2\ H_2O_{(l)} \rightarrow 4\ NaOH_{(aq)} + O_{2(g)}$
It takes 12 seconds for the rxn to completely use 0.33 moles of $Na_2O_{2(s)}$ at 99.9 kPa & 27°C.

a) What is the rate of $Na_2O_{2(s)}$ consumption in mol/s?

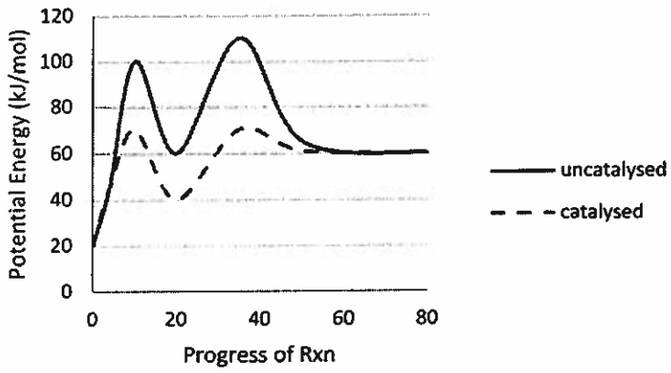
$rate = \frac{\Delta mol}{t}$
$= \frac{0.33\ mol}{12\ s}$
$= 0.02750\ mol/s$
rate = −0.028 mol/s
or
-2.8×10^{-2} mol/s

b) What is the rate of O_2 production in L/s ?

① 0.33 mol / 2 = 0.165 mol of O_2
② PV = nRT
99.9(V) = 0.165 mol (8.31)(27 + 273)
V = 4.117567568 L
③ $rate = \frac{L}{s}$
$= \frac{4.117567568\ L}{12\ s}$
= 0.34313063 L/s
∴ 0.34 L/s ✓

4

3. Use the graph below to answer the questions.



a) What is the ΔH of the forward rxn? 40 kJ/mol

b) What is the overall activation energy of the for the uncatalysed rxn?? ∴ 90 kJ/mol
110 − 20 = 90

c) What is the activation energy of the rate determining step for the uncatalysed rxn?
100 − 20 = 80 ∴ 80 kJ/mol

d) What is the activation energy of the rate limiting step for the catalysed rxn?
70 − 20 = 50 ∴ 50 kJ/mol

✓ 4

4. Given this reaction: $Mg^{2+} + 2\ OH^- \rightarrow Mg(OH)_2$

a) Write the predicted rate equation.
$rate \propto [Mg^{2+}][OH]^2$ or $rate = k[Mg^{2+}][OH^-]^2$

b) What would happen to the rate of this reaction if $[Mg^{2+}]$ were quadrupled?
× 4

c) What would happen to the rate of this reaction if $[Mg^{2+}]$ were cut in half & $[OH^-]$ were doubled?
$(\frac{1}{2})(2)^2$
$(\frac{1}{2})(4)$

2

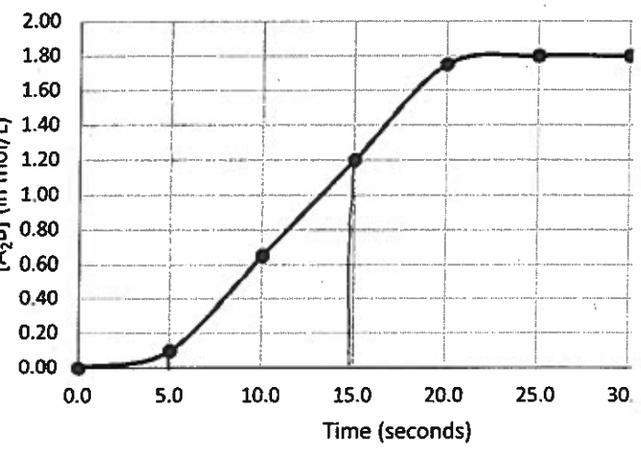
Chemical Kinetics Quiz Version 7 Name: Ans

15

1. 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.

Molar concentration of A_2B formed as a function of time



a) Determine the average rate of the reaction of $A_2B_{(g)}$ production between 5.0 and 15.0 seconds in mol/L•s.

$$\text{rate} = \frac{\Delta[\text{products}]}{\Delta \text{time}} = \frac{(1.20 - 0.10)}{(15.0 - 5.0)} = \frac{1.10}{10.0}$$

$= 0.11$ mol/L·s

∴ rate = 0.110 mol/L·s

b) Determine the average rate of A consumption in the same time period.

$$\frac{2\ A_{(g)}}{1\ A_2B} = \frac{x}{0.110}$$

$x = -0.220$ mol/L·s

4

2. **In the presence of water, sodium peroxide forms sodium hydroxide and oxygen gas.**

$$2\ Na_2O_{2(s)} + 2\ H_2O_{(l)} \rightarrow 4\ NaOH_{(aq)} + O_{2(g)}$$

It takes 15 seconds for the rxn to completely use 0.55 moles of $Na_2O_{2(s)}$ at 99.9 kPa & 25°C.

a) What is the rate of $Na_2O_{2(s)}$ consumption in mol/s?

$$\text{rate} = \frac{\#\text{ mol } Na_2O_{2(s)}}{\Delta t} = \frac{0.55\text{ mol}}{15}$$

$= 0.036666$ mol/s

∴ rate = −0.037 mol/s

b) What is the rate of O_2 production in L/s ?

$$\frac{2\text{ mol } Na_2O_{2(s)}}{1\text{ mol } O_{2(g)}} = \frac{0.55\text{ mol}}{x}$$

$x = 0.275$ mol $O_{2(g)}$

$PV = nRT$

$(99.9)(V) = (0.275)(8.31)(298)$

$V = 6.816862$ L

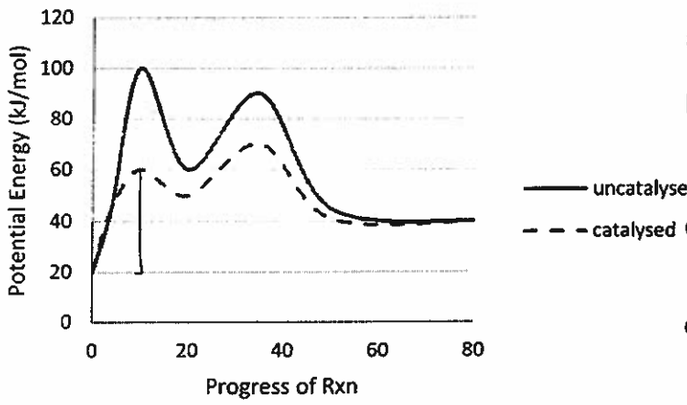
$$\text{rate} = \frac{6.816862}{15}$$

$= 0.4544575$ L/s

∴ rate = 0.45 L/s

4

3. Use the graph below to answer the questions.



a) What is the ΔH of the forward rxn? +20 kJ/mol

b) What is the overall activation energy of the for the uncatalysed rxn??

$E_a = 80$ kJ/mol

c) What is the activation energy of the rate determining step for the uncatalysed rxn?

$E_a = 80$ kJ/mol

d) What is the activation energy of the rate limiting step for the catalysed rxn?

$E_a = 60 - 20 = 40$ kJ/mol

4

4. Given this reaction: $Mg^{2+} + 2\ OH^- \rightarrow Mg(OH)_2$

a) Write the predicted rate equation. $\text{rate} = K[Mg^{2+}][OH^-]^2$

b) What would happen to the rate of this reaction if $[Mg^{2+}]$ were cut in half? $\text{rate} = [\frac{1}{2}][1]^2 = \frac{1}{2}$ halve

c) What would happen to the rate of this reaction if $[Mg^{2+}]$ were doubled & $[OH^-]$ were doubled?

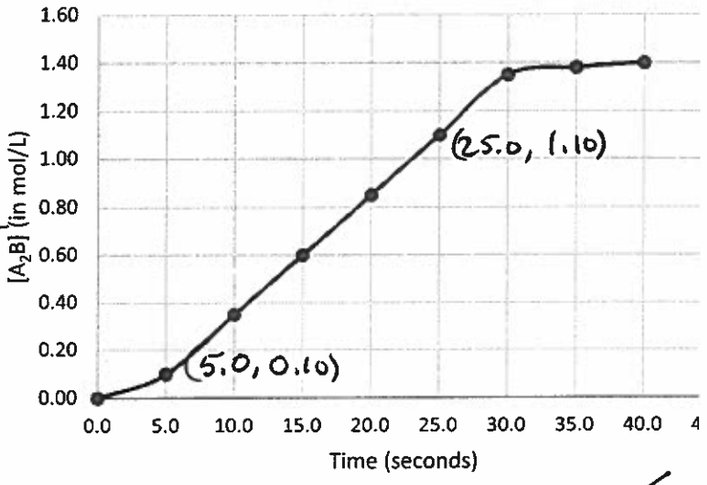
$\text{rate} = K[2][2]^2 = 8$ it would be 8 x bigger

3

Chemical Kinetics Quiz Version 8 Name: Answers. 15.

1. 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.

Molar concentration of A_2B formed as a function of time.



a) Determine the average rate of the reaction of $A_2B_{(g)}$ production between 5.0 and 25.0 seconds in mol/L•s.

$$\text{rate} = \frac{[A_2B]}{t} = \frac{1.10 - 0.10}{25.0 - 5.0} = \frac{1.00}{20.0}$$

$$= 5.0 \times 10^{-2} \frac{\text{mol}}{\text{L}\cdot\text{s}}$$

b) Determine the average rate of A consumption in the same time period.

1 : 2 ratio

$$5.0 \times 10^{-2} \times 2 = 0.10 \frac{\text{mol}}{\text{L}\cdot\text{s}}$$

or

$$-1.0 \times 10^{-1} \frac{\text{mol}}{\text{L}\cdot\text{s}}$$

4

2. **In the presence of water, sodium peroxide forms sodium hydroxide and oxygen gas.**
$2\ Na_2O_{2(s)} + 2\ H_2O_{(l)} \rightarrow 4\ NaOH_{(aq)} + O_{2(g)}$
It takes 12.5 seconds for the rxn to completely use 0.545 moles of $Na_2O_{2(s)}$ at 99.9 kPa & 25°C.

a) What is the rate of $Na_2O_{2(s)}$ consumption in mol/s?

$$\text{rate} = \frac{\Delta \text{mol}}{t}$$

$$= \frac{0.545}{12.5}$$

$$= 0.04360$$

$$= 4.36 \times 10^{-2} \frac{\text{mol}}{\text{s}}$$

b) What is the rate of O_2 production in L/s ?

4

2:1 $\quad \frac{0.545}{2} = 0.2725$ mol O_2

$$V = \frac{nRT}{P}$$

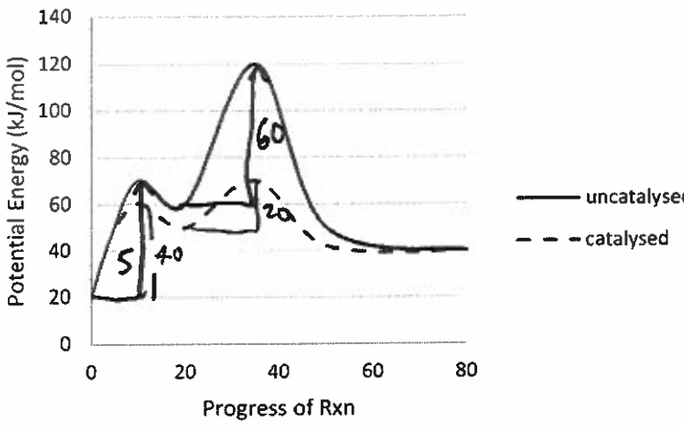
$$= \frac{(0.2725)(8.31)(298)}{99.9}$$

$$V = 6.755\ \text{L}$$

$0.540 \frac{\text{L}}{\text{s}}$ or $5.40 \times 10^{-1} \frac{\text{L}}{\text{s}}$

$$\text{rate} = \frac{\Delta [O_2]}{t} = \frac{6.755}{12.5} = 0.5404 \frac{\text{L}}{\text{s}}$$

3. Use the graph below to answer the questions.



a) What is the ΔH of the forward rxn? 20 kJ/mol
40 − 20

b) What is the overall activation energy of the for the uncatalysed rxn??
120 − 20 = 100 kJ/mol

c) What is the activation energy of the rate determining step for the uncatalysed rxn?
60 kJ/mol

d) What is the activation energy of the rate limiting step for the catalysed rxn?
40 kJ/mol

4

3

4. Given this reaction: $Mg^{2+} + 2\ OH^- \rightarrow Mg(OH)_2$

a) Write the predicted rate equation. $\text{rate} = k[Mg^{2+}][OH^-]^2$ also accept rate $= k[Mg^{2+}][OH^-]^2$

b) What would happen to the rate of this reaction if $[OH^-]$ were doubled? ×4

c) What would happen to the rate of this reaction if $[Mg^{2+}]$ tripled & $[OH^-]$ doubled?

$3 \times 2^2 = 3 \times 4 = 12$ times