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|---|---|
| Posting ID: 423376 | |
| Course: CHE 107 2015 SU | |
| Instructor: Lisa Blue | |

**Question #:** 1

Given the reaction $C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(g)$, select **all** of the correct expressions of the rate law.

A.

$$\text{Rate} = -\frac{1}{5}\frac{\Delta[O_2]}{\Delta t}$$

B.

$$\text{Rate} = \frac{\Delta[C_3H_8]}{\Delta t}$$

C.

$$\text{Rate} = 3\frac{\Delta[CO_2]}{\Delta t}$$

D.

$$\text{Rate} = \frac{1}{4}\frac{\Delta[H_2O]}{\Delta t}$$

**Question #:** 2

Given the reaction $Cl_2(g) + 3\ F_2(g) \rightarrow 2\ ClF_3(g)$, select the **two** options that complete the table below.

| Rate | $\frac{\Delta[Cl_2]}{\Delta t}$ | $\frac{\Delta[F_2]}{\Delta t}$ | $\frac{\Delta[ClF_3]}{\Delta t}$ |
|---|---|---|---|
| | $-0.006$ M/s | | $0.012$ M/s |

A.

$$\text{Rate} = 0.006\ \text{M/s}$$

B.

$$\text{Rate} = -0.006\ \text{M/s}$$

C.

$$\frac{\Delta[F_2]}{\Delta t} = -0.018\ \text{M/s}$$

D.

$$\frac{\Delta[F_2]}{\Delta t} = 0.012\ \text{M/s}$$

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**Question #:** 3

The rate law for the reaction

A →product

has the form

rate = $k[A]^n$

For each description below, provide the value of the exponent $n$. Possible values are $n$ = 0, 1, 2 or 3.

When [A] is doubled, the reaction rate increases by a factor of four. $n$ = __1__

When [A] is tripled, the reaction rate does not change. $n$ = __2__

When [A] is quadrupled (increased by a factor of four), the reaction rate quadruples. $n$ = __3__

1. _______
2. _______
3. _______

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**Question #:** 4

The decomposition of azomethane, $CH_3N_2CH_3$, at 300 °C follows first-order kinetics with a rate constant of $k = 2.55 \times 10^{-3}\ s^{-1}$. How long must the reaction run for the final concentration of azomethane to be 16% of the initial concentration?

$$CH_3N_2CH_3(g) \rightarrow N_2(g) + C_2H_6(g)$$

A. 110 minutes
B. 760 minutes
C. 12.0 minutes
D. 3.00 minutes

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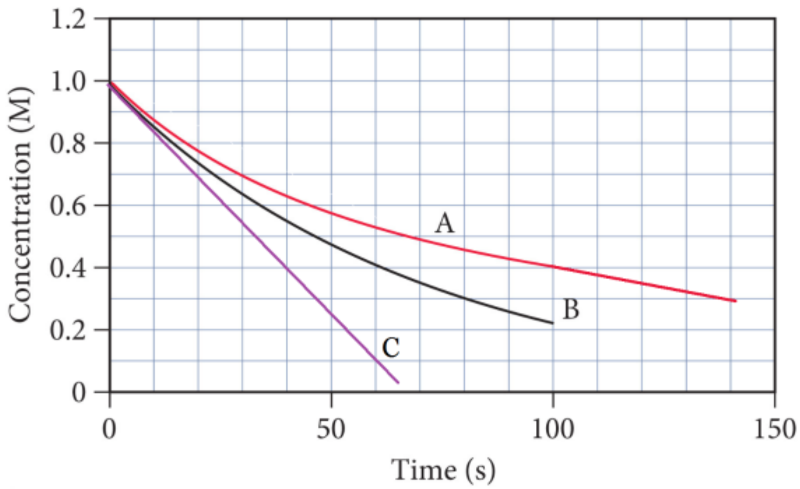
**Question #:** 5

Identify the order of each reaction based on the graph below.




Reaction A is __1__ order.
Reaction B is __2__ order.
Reaction C is __3__ order.

1. ________
2. ________
3. ________

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**Question #:** 6

Consider the second-order reaction below. Calculate the half-life for this reaction when the starting concentration of $NO_2$ is 0.50 M.

$$2\ NO_2(g) \rightarrow 2\ NO(g) + O_2(g) \quad k = 0.34\ M^{-1}s^{-1}$$

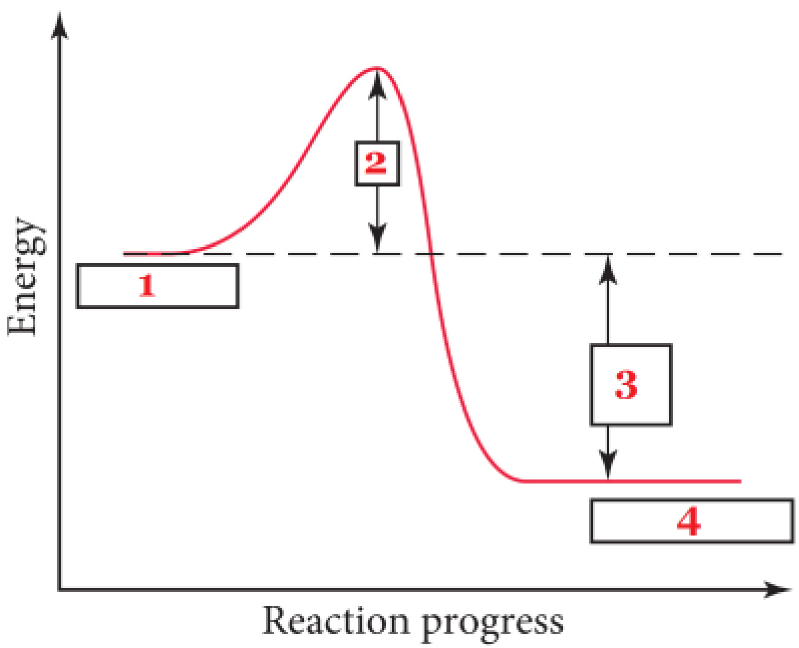
A. 0.64 seconds
B. 19 seconds
C. 5.9 seconds
D. 1.3 seconds

---

**Question #:** 7

The diagram shows the energy of a system as the reaction progresses. Label the diagram using the possible choices listed after each blank.

__1__ [reactants, products]
__2__ [Ea, delta H]
__3__ [Ea, delta H]
__4__ [reactants, products]
The reaction is __5__ [endothermic, exothermic].

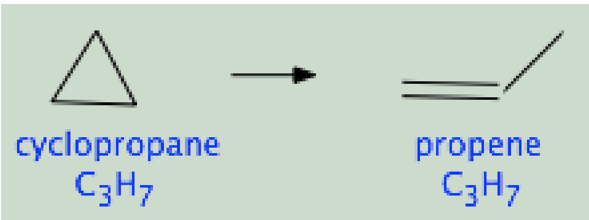



1. _______
2. _______
3. _______
4. _______
5. _______

---

**Question #:** 8

The isomerization of cyclopropane to propene has an activation energy of 273 kJ/mol. When the reaction is run at 750 K, the rate constant, $k_1$, is $1.8 \times 10^{-4}\ s^{-1}$. What is the value of the rate constant, $k_2$, at 850 K?




A. $3.1 \times 10^{-2}\ s^{-1}$
B. $1.2 \times 10^{-8}\ s^{-1}$
C. $4.1 \times 10^{-4}\ s^{-1}$
D. $2.7 \times 10^{-3}\ s^{-1}$

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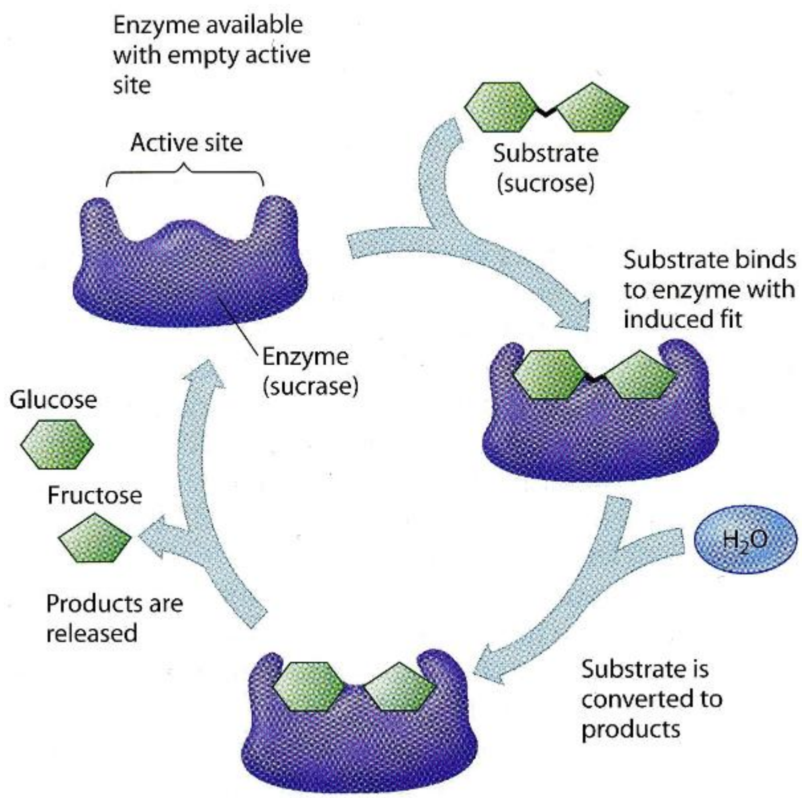
**Question #:** 9

In the figure below, the sucrase enzyme functions as a biological __1__, which speeds up the reaction rate by __2__ [raising, lowering] the activation energy, $E_a$, for the reaction. At body temperature, the uncatalyzed reaction __3__ [does, does not] proceed to break sucrose down into glucose and fructose.




1. ________
2. ________
3. ________

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**Question #:** 10

Which choice best describes the functions of the selected reagents in the reaction mechanism below?

$S_2O_8^{2-} + 2\ Fe^{2+} \rightarrow 2\ SO_4^{2-} + 2\ Fe^{3+}$ fast step

$2\ Fe^{3+} + 2\ I^{-} \rightarrow 2\ Fe^{2+} + I_2$ slow step

$S_2O_8^{2-} + 2\ I^{-} \rightarrow 2\ SO_4^{2-} + I_2$ overall reaction

A. $Fe^{2+}$ = catalyst, $Fe^{3+}$ = reaction intermediate
B. $Fe^{3+}$ = catalyst, $Fe^{2+}$ = reaction intermediate
C. $S_2O_8^{2-}$ = catalyst, $SO4^{2-}$ = reaction intermediate
D. $I^{-}$ = catalyst, $I_2$ = reaction intermediate

**Question #:** 11

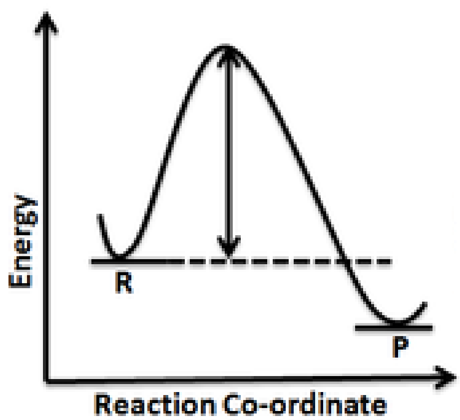
Which **graph** best describes the reaction below?

$S_2O_8^{2-} + 2\,Fe^{2+} \rightarrow 2\,SO_4^{2-} + 2\,Fe^{3+}$ fast step

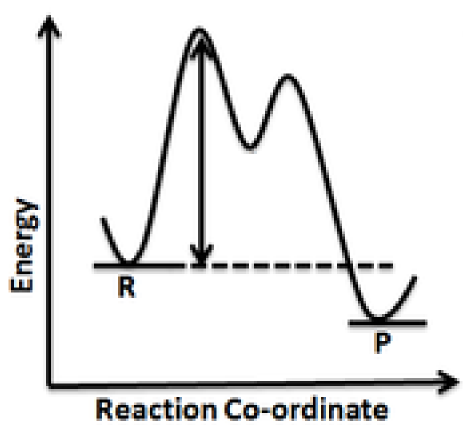
$2\,Fe^{3+} + 2\,I^{-} \rightarrow 2\,Fe^{2+} + I_2$ slow step

$S_2O_8^{2-} + 2\,I^{-} \rightarrow 2\,SO_4^{2-} + I_2$ overall reaction

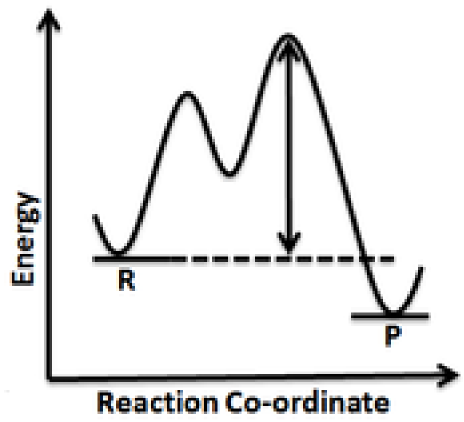
A.



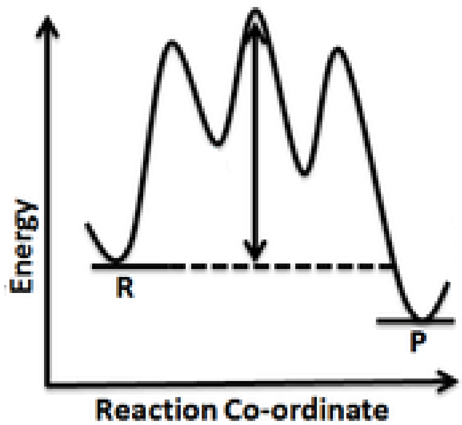

B.




C.




D.

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**Question #:** 12

Starting with pure $CH_4(g)$, the reaction below reaches a state of dynamic equilibrium. Which one of the following statements about the system at equilibrium is **false**?

$$2\ CH_4(g) \rightleftarrows C_2H_2(g) + 3\ H_2(g) \quad K_c = 0.15$$

A. The concentration of $CH_4$ is twice the concentration of $C_2H_2$.
B. The rates of the forward and reverse reactions are equal.
C. The concentrations of the reactants and products remain constant.
D. The concentration of $H_2$ is three times the concentration of $C_2H_2$.

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**Question #:** 13

Initially, 2.0 M $SO_3(g)$ is added to a reaction vessel. Given the balanced chemical equation and $K_c$, what is true about the **equilibrium** concentrations of reactants and products?

$$2\,SO_3(g) \rightleftarrows 2\,SO_2(g) + O_2(g) \quad K_c = 4.08 \times 10^{-2}$$

A. The equilbrium favors neither reactants nor products, so appreciable amounts of $SO_3$, $SO_2$, and $O_2$ will all be present at equilibrium.
B. The equilbrium lies far to the right, so the concentrations of $SO_2$ and $O_2$ will be significantly higher than the concentration of $SO_3$.
C. The equilbrium lies far to the right, so the concentrations of $SO_2$ and $O_2$ will be significantly lower than the concentration of $SO_3$.
D. The equilbrium lies far to the left, so the concentrations of $SO_2$ and $O_2$ will be significantly lower than the concentration of $SO_3$.
E. The equilbrium lies far to the left, so the concentrations of $SO_2$ and $O_2$ will be significantly higher than the concentration of $SO_3$.

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**Question #:** 14

Given

$2\,SO_2(g) + O_2(g) \rightleftarrows 2\,SO_3(g) \qquad K_{P1} = 4.84$
$NO(g) + ½\,O_2(g) \rightleftarrows NO_2(g) \qquad K_{P2} = 0.25$

what is the value of $K_{P3}$ for

$SO_2(g) + NO_2(g) \rightleftarrows SO_3(g) + NO(g) \quad K_{P3} =$ __1__ ?

Report your answer to two significant figures.

1. ________

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**Question #:** 15

Given

$CO(g) + 2\,H_2(g) \rightleftarrows CH_3OH(g) \quad K_c = 26$ at 780 °C (1053 K)

what is the value of $K_p$ at 780 °C (1053 K)?

A. $3.48 \times 10^{-3}$
B. $9.64 \times 10^{5}$
C. $1.49 \times 10^{-5}$
D. $2.67 \times 10^{-2}$

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**Question #:** 16

At 1000 °C, limestone, $CaCO_3$, decomposes to quicklime, CaO, and carbon dioxide according to the equation

$CaCO_3(s) \rightleftarrows CaO(s) + CO_2(g)$

What is the $K_c$ expression for this reaction?

A. $K_c = [CO_2]$

B. $K_c = \frac{[CaO][CO_2]}{[CaCO_3]}$

C. $K_c = \frac{[CaO]}{[CaCO_3]}$

D. $K_c = \frac{[CO_2]}{[CaCO_3]}$

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**Question #:** 17

Initially, 0.0500 M each of $CO_2(g)$ and $H_2(g)$ are added to a reaction vessel. The system is allowed to reach equilibrium according to the reaction

$CO_2(g) + H_2(g) \rightleftarrows CO(g) + H_2O(g) \quad K_c = ?$

At equilibrium, the concentration of $CO_2$ is 0.0467 M. What is $K_c$ for this reaction?

A. $4.99 \times 10^{-3}$
B. $2.10 \times 10^{1}$
C. $3.40 \times 10^{-6}$
D. $9.08 \times 10^{-2}$

---

**Question #:** 18

The reaction

$I_2(g) + Cl_2(g) \rightleftarrows 2\ ICl(g)$

has an equilibrium constant, $K_p$ = 81.9 at a certain temperature. If the reaction quotient, $Q_p$ = 256 at that same temperature,

A. the reaction will proceed towards the reactants (to the left) to reach equilibrium.
B. the reaction will proceed towards the products (to the right) to reach equilibrium.
C. the reaction has reached equilibrium and no changes in concentrations occur.

---

**Question #:** 19

Given

$2\ NO(g) + 2\ H_2(g) \rightleftarrows N_2(g) + 2\ H_2O(g) \quad K_c = 6.5 \times 10^2$

If [NO] = [$H_2$] = 0.400 M and [$H_2O$] = 2.20 M at equilibrium, what is the equilibrium concentration of $N_2$?

A. 5.72 M
B. 0.249 M
C. 3.44 M
D. 18.1 M

---

**Question #:** 20

Given

$2\ NOCl(g) \rightleftarrows 2\ NO(g) + Cl_2(g) \quad K_c = 4.7 \times 10^{-4}$

what is the equilibrium concentration of NO when 2.0 moles of NOCl are injected into a 5.0 L reaction vessel?

A. $6.5 \times 10^{-5}$ M
B. $1.4 \times 10^{-3}$ M
C. $2.8 \times 10^{-4}$ M

D. $7.2 \times 10^{-2}$ M

---

**Question #:** 21

For this system at equilibrium,

$O_2(g) + 2\ H_2(g) \rightleftarrows 2\ H_2O(g) \quad \Delta H = -126$ kJ/mol

which way will the equilibrium shift for each of the changes below?

Cooling the reaction mixture __1__ [left, right, neither]

Adding $H_2O(g)$ __2__ [left, right, neither]

Adding $Ne(g)$ __3__ [left, right, neither]

Decreasing total pressure __4__ [left, right, neither]

1. _______
2. _______
3. _______
4. _______

---

**Question #:** 22

According to Brønsted-Lowry acid-base theory, in this reaction

$$C_5H_5N(aq) + H_2O(l) \rightleftarrows C_5H_5NH^+(aq) + OH^-(aq)$$

$H_2O$ acts as a(n) __1__ [acid, base].

$C_5H_5NH^+$ is the conjugate __2__ [acid, base] of $C_5H_5N$.

1. _______
2. _______

---

**Question #:** 23

Which of the following is(are) **strong** acid(s)? Select all that apply.

A. HBr
B. $HClO_4$
C. HF

D. $HNO_2$
E. HCN

---

**Question #:** 24

Which acid is the **weakest**?

A. arsenous acid, $H_3AsO_3$, $K_a$ = 5.1 × $10^{-10}$
B. hypochlorous acid, HOCl, $K_a$ = 2.9 ×$10^{-8}$
C. benzoic acid, $HC_7H_5O_2$, $K_a$ = 6.5 × $10^{-5}$
D. acetic acid, $HC_2H_3O_2$, $K_a$ = 1.8 × $10^{-5}$

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**Question #:** 25

Calculate the pH of pure water at 40 °C and report it to **two** places to the right of the decimal point: ___1___

$2\ H_2O(l) \rightleftarrows H_3O^+(aq) + OH^-(aq)\quad K_w = 2.92 \times 10^{-14}$ at 40 °C

Based on this information, is the autoionization of water endothermic or exothermic? ___2___

1. _______
2. _______

| | |
|---|---|
| Posting ID: | 423376 |
| Course: | CHE 107 2015 SU |
| Instructor: | Lisa Blue |

**Question #:** 1

Given the reaction $C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(g)$, select **all** of the correct expressions of the rate law.

✓A.

$$\text{Rate} = -\frac{1}{5}\frac{\Delta[O_2]}{\Delta t}$$

B.

$$\text{Rate} = \frac{\Delta[C_3H_8]}{\Delta t}$$

C.

$$\text{Rate} = 3\frac{\Delta[CO_2]}{\Delta t}$$

✓D.

$$\text{Rate} = \frac{1}{4}\frac{\Delta[H_2O]}{\Delta t}$$

**Question #:** 2

Given the reaction $Cl_2(g) + 3\ F_2(g) \rightarrow 2\ ClF_3(g)$, select the **two** options that complete the table below.

| Rate | $\frac{\Delta[Cl_2]}{\Delta t}$ | $\frac{\Delta[F_2]}{\Delta t}$ | $\frac{\Delta[ClF_3]}{\Delta t}$ |
|---|---|---|---|
| | $-0.006$ M/s | | 0.012 M/s |

✓A.

$$\text{Rate} = 0.006\ M/s$$

B.

$$\text{Rate} = -0.006\ M/s$$

✓C.

$$\frac{\Delta[F_2]}{\Delta t} = -0.018\ M/s$$

D.

$$\frac{\Delta[F_2]}{\Delta t} = 0.012\ M/s$$

---

**Question #:** 3

The rate law for the reaction

A →product

has the form

rate = $k[A]^n$

For each description below, provide the value of the exponent *n*. Possible values are $n$ = 0, 1, 2 or 3.

When [A] is doubled, the reaction rate increases by a factor of four. $n$ = __1__

When [A] is tripled, the reaction rate does not change. $n$ = __2__

When [A] is quadrupled (increased by a factor of four), the reaction rate quadruples. $n$ = __3__

1. 2
2. 0
3. 1

---

**Question #:** 4

The decomposition of azomethane, $CH_3N_2CH_3$, at 300 °C follows first-order kinetics with a rate constant of $k = 2.55 \times 10^{-3}\ s^{-1}$. How long must the reaction run for the final concentration of azomethane to be 16% of the initial concentration?

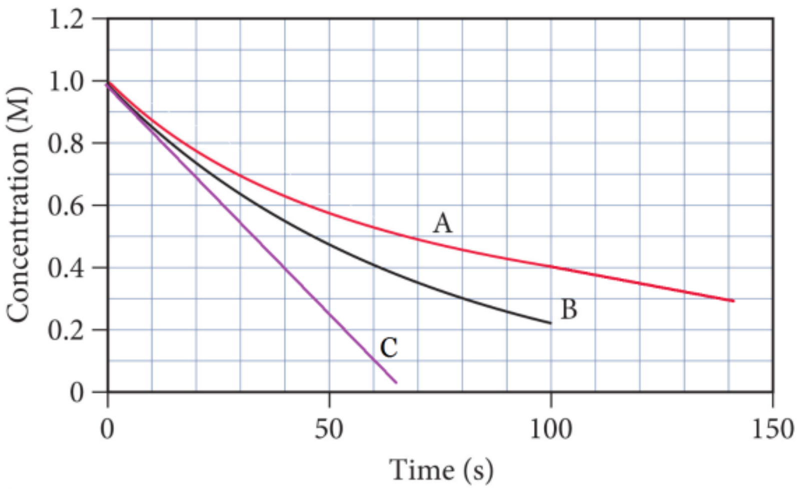
$$CH_3N_2CH_3(g) \rightarrow N_2(g) + C_2H_6(g)$$

A. 110 minutes
B. 760 minutes
✓C. 12.0 minutes
D. 3.00 minutes

---

**Question #:** 5

Identify the order of each reaction based on the graph below.




Reaction A is __1__ order.
Reaction B is __2__ order.
Reaction C is __3__ order.

1. second|Second|2|2nd|
2. first|First|1|1st|
3. zero|Zero|0|

---

**Question #:** 6

Consider the second-order reaction below. Calculate the half-life for this reaction when the starting concentration of $NO_2$ is 0.50 M.

$$2\ NO_2(g) \rightarrow 2\ NO(g) + O_2(g) \quad k = 0.34\ M^{-1}s^{-1}$$

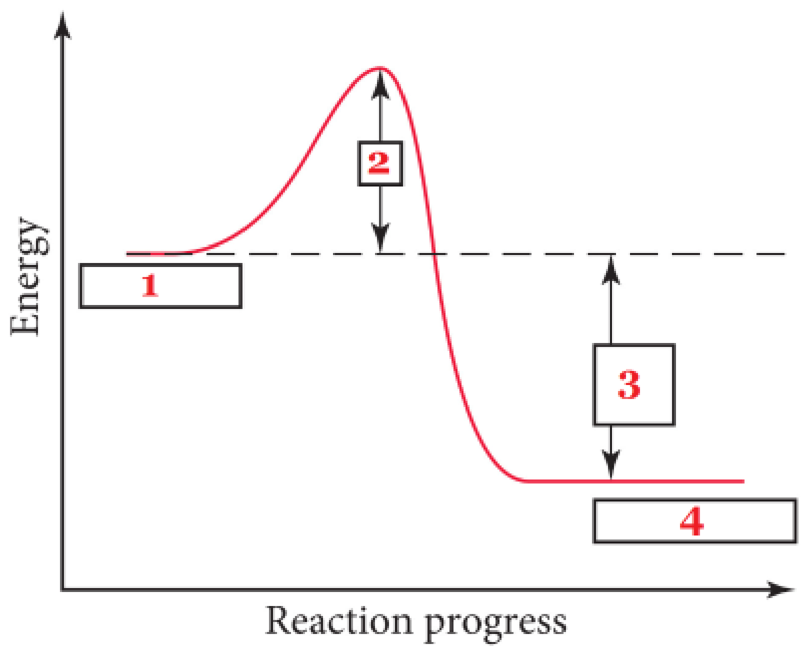
A. 0.64 seconds
B. 19 seconds
✓C. 5.9 seconds
D. 1.3 seconds

---

**Question #:** 7

The diagram shows the energy of a system as the reaction progresses. Label the diagram using the possible choices listed after each blank.

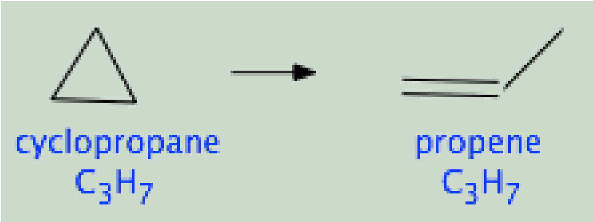
__1__ [reactants, products]
__2__ [Ea, delta H]
__3__ [Ea, delta H]
__4__ [reactants, products]
The reaction is __5__ [endothermic, exothermic].




1. reactants|Reactants|reactant|Reactant|
2. Ea|ea|EA|E a|
3. delta H|Delta H|delta h|deltaH|DeltaH|deltah|Deltah|
4. products|Products|product|Product|
5. exothermic|Exothermic|

**Question #:** 8

The isomerization of cyclopropane to propene has an activation energy of 273 kJ/mol. When the reaction is run at 750 K, the rate constant, $k_1$, is $1.8 \times 10^{-4}$ $s^{-1}$. What is the value of the rate constant, $k_2$, at 850 K?

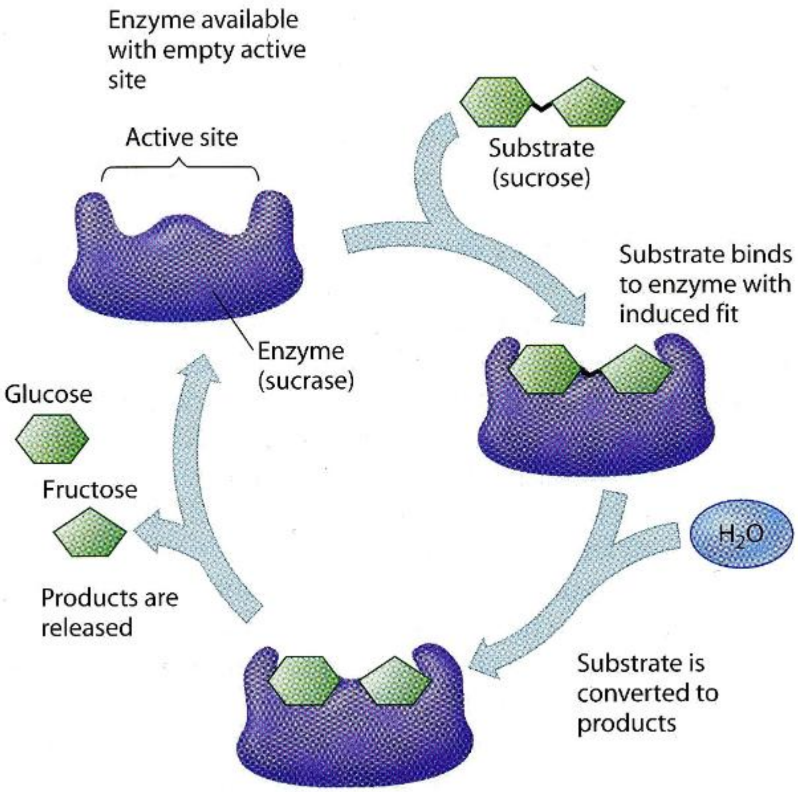



✓A. $3.1 \times 10^{-2}$ $s^{-1}$
B. $1.2 \times 10^{-8}$ $s^{-1}$
C. $4.1 \times 10^{-4}$ $s^{-1}$
D. $2.7 \times 10^{-3}$ $s^{-1}$

---

**Question #:** 9

In the figure below, the sucrase enzyme functions as a biological __1__, which speeds up the reaction rate by __2__ [raising, lowering] the activation energy, $E_a$, for the reaction. At body temperature, the uncatalyzed reaction __3__ [does, does not] proceed to break sucrose down into glucose and fructose.




1. catalyst|Catalyst|
2. lowering|Lowering|
3. does not|not|

---

**Question #:** 10

Which choice best describes the functions of the selected reagents in the reaction mechanism below?

$S_2O_8^{2-} + 2\,Fe^{2+} \rightarrow 2\,SO_4^{2-} + 2\,Fe^{3+}$ fast step
$2\,Fe^{3+} + 2\,I^{-} \rightarrow 2\,Fe^{2+} + I_2$ slow step

$S_2O_8^{2-} + 2\,I^{-} \rightarrow 2\,SO_4^{2-} + I_2$ overall reaction

✓A. $Fe^{2+}$ = catalyst, $Fe^{3+}$ = reaction intermediate
B. $Fe^{3+}$ = catalyst, $Fe^{2+}$ = reaction intermediate
C. $S_2O_8^{2-}$ = catalyst, $SO_4^{2-}$ = reaction intermediate
D. $I^{-}$ = catalyst, $I_2$ = reaction intermediate

**Question #:** 11

Which **graph** best describes the reaction below?

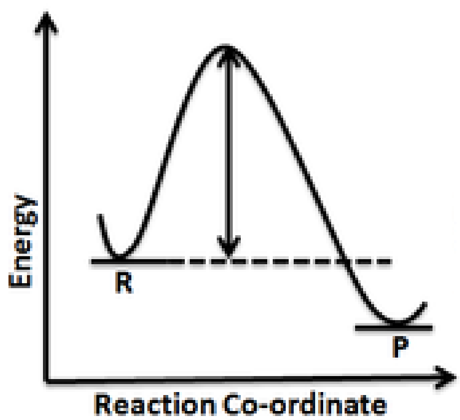
$S_2O_8^{2-} + 2\ Fe^{2+} \rightarrow 2\ SO_4^{2-} + 2\ Fe^{3+}$ fast step

$2\ Fe^{3+} + 2\ I^- \rightarrow 2\ Fe^{2+} + I_2$ slow step

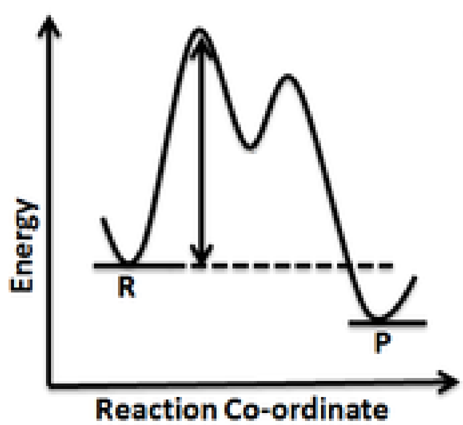
---

$S_2O_8^{2-} + 2\ I^- \rightarrow 2\ SO_4^{2-} + I_2$ overall reaction

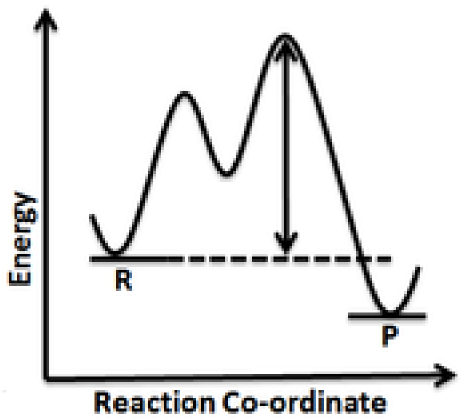
A.



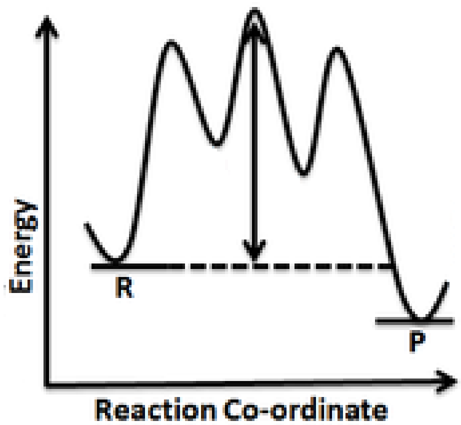

B.




✓C.




D.

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**Question #:** 12

Starting with pure $CH_4(g)$, the reaction below reaches a state of dynamic equilibrium. Which one of the following statements about the system at equilibrium is **false**?

$$2\ CH_4(g) \rightleftarrows C_2H_2(g) + 3\ H_2(g) \quad K_c = 0.15$$

✓A. The concentration of $CH_4$ is twice the concentration of $C_2H_2$.
B. The rates of the forward and reverse reactions are equal.
C. The concentrations of the reactants and products remain constant.
D. The concentration of $H_2$ is three times the concentration of $C_2H_2$.

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**Question #:** 13

Initially, 2.0 M $SO_3(g)$ is added to a reaction vessel. Given the balanced chemical equation and $K_c$, what is true about the **equilibrium** concentrations of reactants and products?

$$2\ SO_3(g) \rightleftarrows 2\ SO_2(g) + O_2(g) \quad K_c = 4.08 \times 10^{-2}$$

A. The equilibrium favors neither reactants nor products, so appreciable amounts of $SO_3$, $SO_2$, and $O_2$ will all be present at equilibrium.
B. The equilibrium lies far to the right, so the concentrations of $SO_2$ and $O_2$ will be significantly higher than the concentration of $SO_3$.
C. The equilibrium lies far to the right, so the concentrations of $SO_2$ and $O_2$ will be significantly lower than the concentration of $SO_3$.
✓D. The equilibrium lies far to the left, so the concentrations of $SO_2$ and $O_2$ will be significantly lower than the concentration of $SO_3$.
E. The equilibrium lies far to the left, so the concentrations of $SO_2$ and $O_2$ will be significantly higher than the concentration of $SO_3$.

---

**Question #:** 14

Given

$2\ SO_2(g) + O_2(g) \rightleftarrows 2\ SO_3(g) \qquad K_{P1} = 4.84$

$NO(g) + ½\ O_2(g) \rightleftarrows NO_2(g) \qquad K_{P2} = 0.25$

what is the value of $K_{P3}$ for

$SO_2(g) + NO_2(g) \rightleftarrows SO_3(g) + NO(g) \quad K_{P3} =$ __1__ ?

Report your answer to two significant figures.

1. 8.8

---

**Question #:** 15

Given

$CO(g) + 2\ H_2(g) \rightleftarrows CH_3OH(g) \quad K_c = 26$ at 780 °C (1053 K)

what is the value of $K_p$ at 780 °C (1053 K)?

✓A. $3.48 \times 10^{-3}$
B. $9.64 \times 10^{5}$
C. $1.49 \times 10^{-5}$
D. $2.67 \times 10^{-2}$

---

**Question #:** 16

At 1000 °C, limestone, $CaCO_3$, decomposes to quicklime, CaO, and carbon dioxide according to the equation

$CaCO_3(s) \rightleftarrows CaO(s) + CO_2(g)$

What is the $K_c$ expression for this reaction?

✓A.

$$K_c = [CO_2]$$

B.

$$K_c = \frac{[CaO][CO_2]}{[CaCO_3]}$$

C.

$$K_c = \frac{[CaO]}{[CaCO_3]}$$

D.

$$K_c = \frac{[CO_2]}{[CaCO_3]}$$

---

**Question #:** 17

Initially, 0.0500 M each of $CO_2(g)$ and $H_2(g)$ are added to a reaction vessel. The system is allowed to reach equilibrium according to the reaction

$CO_2(g) + H_2(g) \rightleftarrows CO(g) + H_2O(g) \quad K_c = ?$

At equilibrium, the concentration of $CO_2$ is 0.0467 M. What is $K_c$ for this reaction?

✓A. $4.99 \times 10^{-3}$

B. $2.10 \times 10^{1}$

C. $3.40 \times 10^{-6}$

D. $9.08 \times 10^{-2}$

---

**Question #:** 18

The reaction

$I_2(g) + Cl_2(g) \rightleftarrows 2\,ICl(g)$

has an equilibrium constant, $K_p$ = 81.9 at a certain temperature. If the reaction quotient, $Q_p$ = 256 at that same temperature,

✓A. the reaction will proceed towards the reactants (to the left) to reach equilibrium.
B. the reaction will proceed towards the products (to the right) to reach equilibrium.
C. the reaction has reached equilibrium and no changes in concentrations occur.

---

**Question #:** 19

Given

$2\,NO(g) + 2\,H_2(g) \rightleftarrows N_2(g) + 2\,H_2O(g) \quad K_c = 6.5 \times 10^2$

If [NO] = [$H_2$] = 0.400 M and [$H_2O$] = 2.20 M at equilibrium, what is the equilibrium concentration of $N_2$?

A. 5.72 M
B. 0.249 M
✓C. 3.44 M
D. 18.1 M

---

**Question #:** 20

Given

$2\,NOCl(g) \rightleftarrows 2\,NO(g) + Cl_2(g) \quad K_c = 4.7 \times 10^{-4}$

what is the equilibrium concentration of NO when 2.0 moles of NOCl are injected into a 5.0 L reaction vessel?

A. $6.5 \times 10^{-5}$ M
B. $1.4 \times 10^{-3}$ M
C. $2.8 \times 10^{-4}$ M

✓D. $7.2 \times 10^{-2}$ M

---

**Question #:** 21

For this system at equilibrium,

$O_2(g) + 2\,H_2(g) \rightleftarrows 2\,H_2O(g) \quad \Delta H = -126$ kJ/mol

which way will the equilibrium shift for each of the changes below?

Cooling the reaction mixture __1__ [left, right, neither]

Adding $H_2O(g)$ __2__ [left, right, neither]

Adding $Ne(g)$ __3__ [left, right, neither]

Decreasing total pressure __4__ [left, right, neither]

1. right|Right|R|r|
2. left|Left|L|l|
3. neither|niether|Neither|Niether|
4. left|Left|l|L|

---

**Question #:** 22

According to Brønsted-Lowry acid-base theory, in this reaction

$$C_5H_5N(aq) + H_2O(l) \rightleftarrows C_5H_5NH^+(aq) + OH^-(aq)$$

$H_2O$ acts as a(n) __1__ [acid, base].

$C_5H_5NH^+$ is the conjugate __2__ [acid, base] of $C_5H_5N$.

1. acid
2. acid

---

**Question #:** 23

Which of the following is(are) **strong** acid(s)? Select all that apply.

✓A. HBr
✓B. $HClO_4$
C. HF

D. $HNO_2$
E. HCN

---

**Question #:** 24

Which acid is the **weakest**?

✓A. arsenous acid, $H_3AsO_3$, $K_a = 5.1 \times 10^{-10}$
B. hypochlorous acid, HOCl, $K_a = 2.9 \times 10^{-8}$
C. benzoic acid, $HC_7H_5O_2$, $K_a = 6.5 \times 10^{-5}$
D. acetic acid, $HC_2H_3O_2$, $K_a = 1.8 \times 10^{-5}$

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**Question #:** 25

Calculate the pH of pure water at 40 °C and report it to **two** places to the right of the decimal point: ___1___

$2\ H_2O(l) \rightleftarrows H_3O^+(aq) + OH^-(aq) \quad K_w = 2.92 \times 10^{-14}$ at 40 °C

Based on this information, is the autoionization of water endothermic or exothermic? ___2___

1. 6.77
2. endothermic|Endothermic|endo|Endo|