Chemical Kinetics JEE Main PYQ - 3

Total Time: 25 Minute **Total Marks:** 40

Instructions

Instructions

1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Chemical Kinetics

1. If compound A reacts with B following first order kinetics with rate constant $2.011 \times 10^{-3} s^{-1}$ The time taken by A (in seconds) to reduce from $7\,g$ to $2\,g$ will be _____ (Nearest Integer) $[\log 5 = 0.698, \log 7 = 0.845, \log 2 = 0.301]$ **(+4, -1)**

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2. For the first order reaction $A \rightarrow B$, the half life is $30min$ The time taken for 75% completion of the reaction is min (Nearest integer) Given : $\log_g 2 = 03010\ \log 3 = 04771\ \log 5 = 06989$ **(+4, -1)**

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3. An organic compound undergoes first order decomposition If the time taken for the 60% decomposition is $540\,s$, then the time required for 90% decomposition will be is _____ s. (Nearest integer)
(Given: $\ln 10 = 2.3; \log 2 = 0.3$) **(+4, -1)**

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4. A first order reaction has the rate constant, $k = 46 \times 10^{-3} s^{-1}$ The number of correct statement/s from the following is/are _____ **(+4, -1)**
Given: $\log 3 = 0.48$
A. Reaction completes in $1000\,s$
B. The reaction has a half-life of $500\,s$
C. The time required for 10% completion is 25 times the time required for 90% completion
D. The degree of dissociation is equal to $(1 - e^{-kt})$
E. The rate and the rate constant have the same unit

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5. The number of correct statement/s from the following is **(+4, -1)**
A. Larger the activation energy, smaller is the value of the rate constant
B. The higher is the activation energy, higher is the value of the temperature coefficient
C. At lower temperatures, increase in temperature causes more change in the value of k than at higher temperature
D. A plot of $\ln k$ vs $\frac{1}{T}$ is a straight line with slope equal to $-\frac{E_a}{R}$

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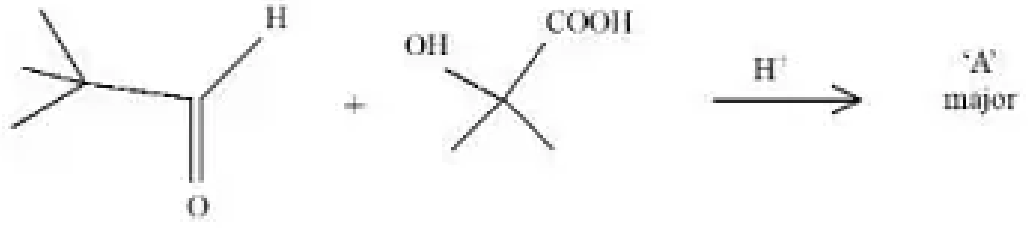
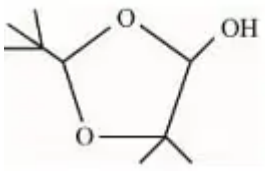
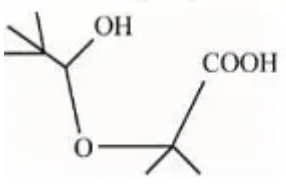
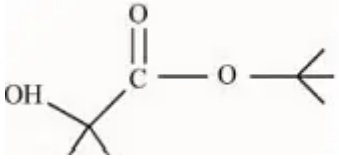
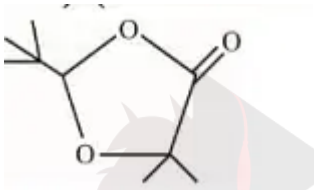
6. 'A' in the given reaction is **(+4, -1)**



a. 

b. 

c. 

d. 

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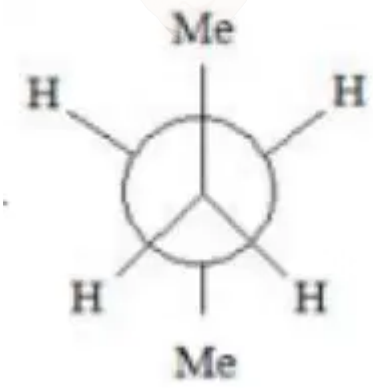
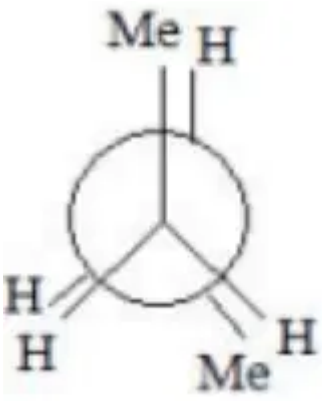
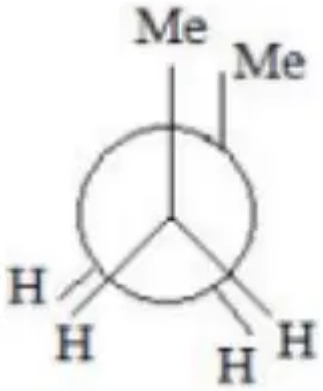
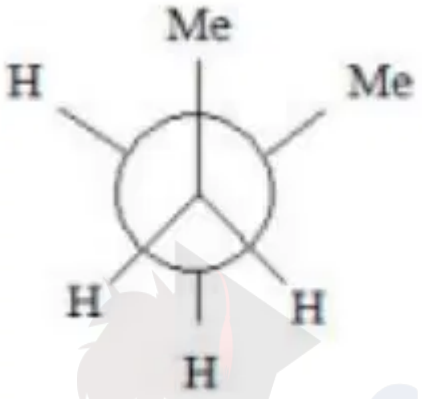
7. Which of the following conformations will be the most stable? **(+4, -1)**

a. 

b. 



c.



d.

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8. How many statements are correct: **(+4, -1)**

1. If there is no relation between rate constant and temperature, then activation energy is negative.
2. If the activation energy is zero, rate constant is temperature independent.
3. If rate constant increases with increase of temperature, activation energy is positive.
4. If rate constant decreases with increase in temperature, activation energy is negative.

a. 1 and 2

b. 2 and 3

c. 2, 3, and 4

d. 4

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9. Select the correct option: **(+4, -1)**

$2CO(g) + O_2(g) \rightarrow 2CO_2(g); \Delta H = -xKJ/mol$

$C(graphite) + O_2(g) \rightarrow CO_2(g); AH = -yKJ/mol$

Then AH for, $C(graphite) + \frac{1}{2}O_2(g) \rightarrow CO(g)$:

a. $x - \frac{y}{2}$

b. $x - \frac{2y}{2}$

c. $x + \frac{2y}{2}$

d. $\frac{x-y}{2}$

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10. NO_2 required for a reaction is produced by the decomposition of $N2O5$ in $CCl4$ as per the equation $2N2O5(g) -> 4NO2(g) + O2(g)$. The initial concentration of $N2O5$ is $3.00\,mol\ L^{-1}$ and it is $2.75\,mol\ L^{-1}$ after 30 minutes. The rate of formation of $NO2$ is : **(+4, -1)**

a. $\ce{2.083 \times 10^{-3} \; mol \; L^{-1} \; min^{-1}}$

b. $\ce{4.167 \times 10^{-3} \; mol \; L^{-1} \; min^{-1}}$

c. $\ce{8.333 \times 10^{-3} \; mol \; L^{-1} \; min^{-1}}$

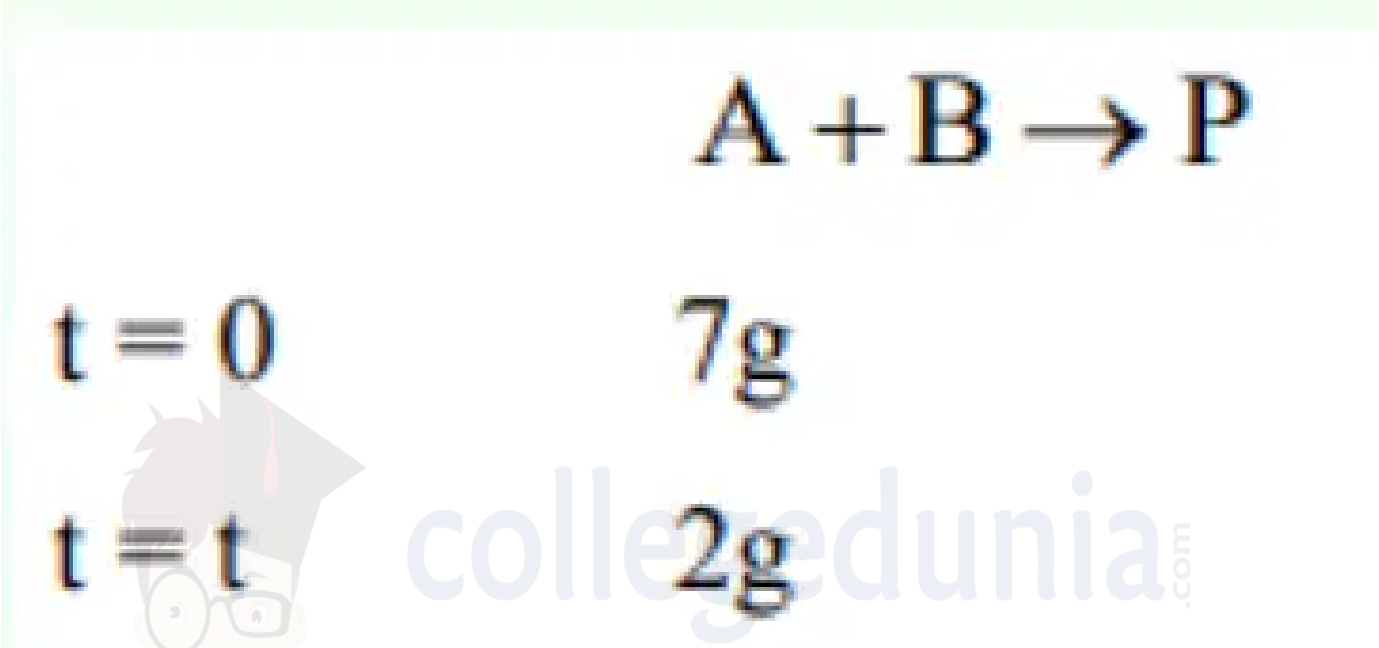
d. $\ce{1.667 \times 10^{-2} \; mol \; L^{-1} \; min^{-1}}$

Answers

1. **Answer: 623 - 623**

Explanation:

The correct answer is 623.



at constant volume

$t = \frac{2.303}{K} \log \frac{[A]_0}{[A]_t}$

$= \frac{2.303}{2 \cdot 011 \times 10^{-3}} \log \frac{7}{2}$

$= \frac{2 \cdot 303 \times 0 \cdot 544}{2 \cdot 011 \times 10^{-3}}$

$= 622.989$

≈ 623

Concepts:

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Factors Affecting The Reaction Rate:

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2. **Answer: 60 - 60**

Explanation:

The correct answer is 60.

$t_{1/2} = T_{50} = 30\,\text{min}$

$T_{75} = 2t_{1/2} = 30 \times 2 = 60\,\text{min}$

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3. **Answer: 1350 - 1350**

Explanation:

$$\frac{t_1}{t_2} = \frac{\frac{1}{K}\ln\frac{a_0}{0.4a_0}}{\frac{1}{K}\ln\frac{a_0}{0.1a_0}}$$
$$\frac{540}{t_2} = \frac{\ln\frac{10}{4}}{\ln 10}$$
$$\frac{540}{t_2} = \frac{\log 10 - \log 4}{\log 10}$$
$$\frac{540}{t_2} = \frac{1-0.6}{1}$$
$$\Rightarrow \frac{540}{t_2} = 0.4$$
$$\Rightarrow t_2 = \frac{540}{0.4} = 1350\,\text{sec}$$

So, the answer is 1350.

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4. Answer: 2 - 2

Explanation:

The correct answer is 2.

$t_{10\%} = \frac{1}{K}\ln\left(\frac{a}{a-x}\right) = \frac{1}{K}\ln\left(\frac{100}{90}\right)$

$t_{10\%} = \frac{2.303}{K}(\log 10 - \log 9)$

$t_{10\%} = \frac{2.093}{K} \times (0.04)$

Similarly

$t_{90\%} = \frac{1}{K}\ln\left(\frac{100}{10}\right)$

$t_{90\%} = \frac{2.303}{K}$

$\frac{t_{90\%}}{t_{10\%}} = \frac{1}{0.04} = 25$

$e^{kt} = \frac{a}{a-x}$

$\frac{a-x}{a} = e^{-kt}$

$1 - \frac{x}{a} = e^{-kt}$

$x = a\left(1 - e^{-kt}\right)$

$\alpha = \frac{x}{a} = \left(1 - e^{-kt}\right)$

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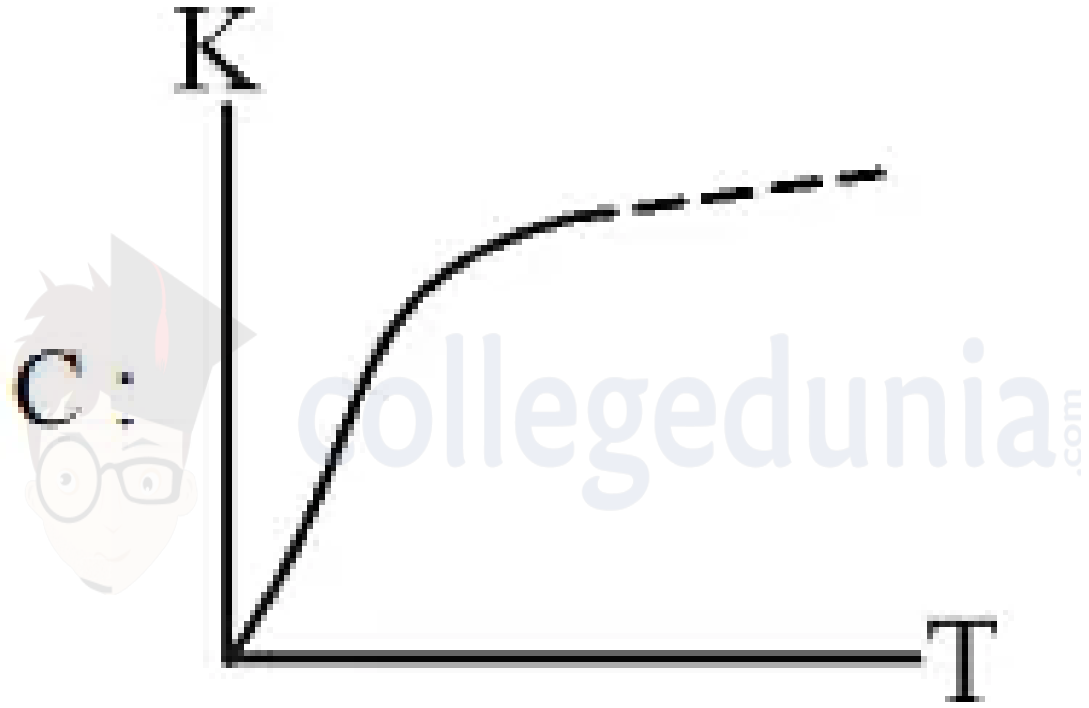
5. **Answer: 3 - 3**

Explanation:

The correct answer is 3



A:k=AA-RTEa
As Ea increases k decreases
B : Temperature coefficient =kTkT+10
Option (C) is wrong. Δk may be greater or lesser depending on temperature.
D:lnk=lnA-RTEa

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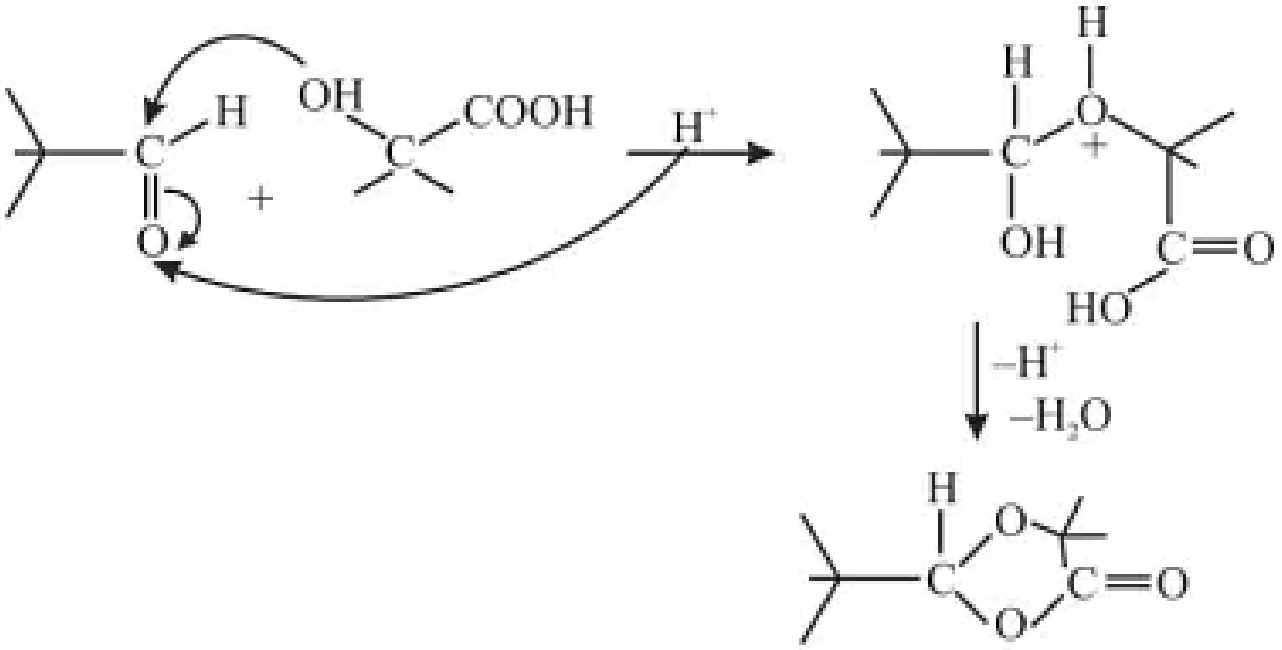
6. **Answer: d**

Explanation:

Correct answer is (d)



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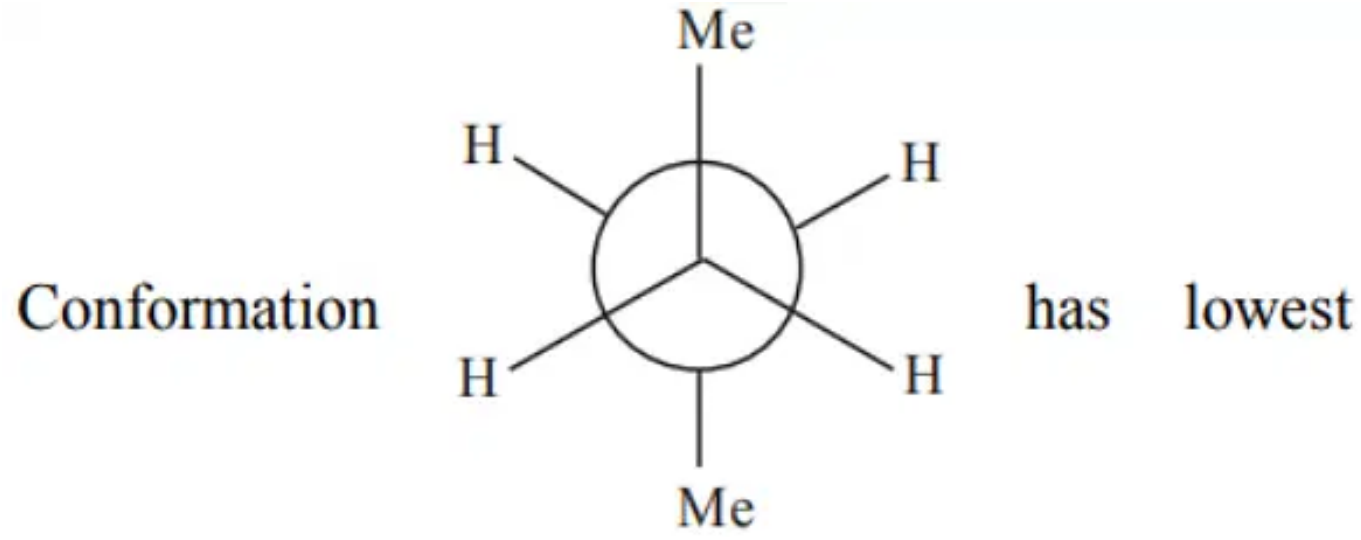
7. **Answer: a**

Explanation:



Vanderwaal and torsional strain. Hence it must be most stable.

So, the correct option is (A).

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8. **Answer: c**

Explanation:

The correct option is (C): 2, 3, and 4
$k = Ae^{-Ea/RT}$
$lnk = InA - \frac{E_a}{RT}$
Clearly,

if $E_a = 0$, k is temperature independent
if $E_a > 0$, k increases with increase in temperature
if $E_a < 0$, k decreases with increase in temperature
Therefore, 2, 3, and 4 is the right option.

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9. **Answer: b**

Explanation:

The correct option is (B): $x - \frac{2y}{2}$

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10. **Answer: d**

Explanation:

$2N_2O_5(g) -> 4NO_2(g) + O_2(g)$ $3.0M$ 2.75 M $\frac{-\Delta[N_2O_5]}{\Delta t} = \frac{0.25}{30}$ $\frac{1}{2} \times \frac{-\Delta[N_2O_5]}{\Delta t} = \frac{1}{4} \times \frac{-\Delta[N_2O_5]}{\Delta t} = \frac{1}{4} \times \frac{\Delta[NO_2]}{\Delta t}$ $\frac{\Delta[NO_2]}{\Delta t} = \frac{0.25}{30} \times 2 = 1.66 \times 10^{-2} M/\min$

Concepts:

1. Rate of a Chemical Reaction:

The rate of a chemical reaction is defined as the change in concentration of any one of the reactants or products per unit time.

Consider the reaction A → B,

Rate of the reaction is given by,

Rate = -d[A]/ dt=+d[B]/ dt

Where, [A] → concentration of reactant A

[B] → concentration of product B

(-) A negative sign indicates a decrease in the concentration of A with time.

(+) A positive sign indicates an increase in the concentration of B with time.

Factors Determining the Rate of a Reaction:

There are certain factors that determine the rate of a reaction:

1. Temperature
2. Catalyst
3. Reactant Concentration
4. Chemical nature of Reactant
5. Reactant Subdivision rate