Chemical Kinetics JEE Main PYQ - 1

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

Instructions

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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. For following reactions $A- > [700\,K][]Product$ $A- > [500\,K][\text{catalyst}]Product$ it was found that the E_a is decreased by 30 k J/mol in the presence of catalyst. If the rate remains unchanged, the activation energy for catalysed reaction is (Assume pre exponential factor is same): **(+4, -1)**

a. $198\,kJ/mol$

b. $105\,kJ/mol$

c. $75\,kJ/mol$

d. $135\,kJ/mol$

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2. The rate of a reaction doubles when its temperature changes from $300\,K$ to $310\,K$. Activation energy of such a reaction will be $(R = 8.314JK^{-1}\,mol^{-1}$ and $log\,2 = 0.301)$ **(+4, -1)**

a. $53.6\,kJ\,mol^{-1}$

b. $48.6\,kJ\,mol^{-1}$

c. $58.5\,kJ\,mol^{-1}$

d. $60.5\,kJ\,mol^{-1}$

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3. Higher order (> 3) reactions are rare due to **(+4, -1)**

a. low probability of simultaneous collision of all the reacting species

b. increase in entropy and activation energy as more molecules are involved

c. shifting of equilibrium towards reactants due to elastic collisions

d. loss of active species on collision

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4. At $518^{\circ}C$, the rate of decomposition of sample of gaseous acetaldehyde, initially at a pressure of 363 Torr, was 1.00 Torr s^{-1} when 5% had reacted and 0.5 Torr s^{-1} when 33% had reacted. The order of the reaction is - **(+4, -1)**

a. 2

b. 3

c. 1

d. 0

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5. Consider the given plots for a reaction obeying Arrhenius equation $(0^{\circ}C < T < 300^{\circ}C)$: (k and E_a are rate constant and activation energy, respectively) Choose the correct option : **(+4, -1)**

a. Both I and II are wrong

b. I is wrong but II is right

c. Both I and II are correct

d. I is right but II is wrong

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6. Decomposition of H_2O_2 follows a first order reaction. In fifty minutes the concentration of H_2O_2 decreases from 0.5 to $0.125\,M$ in one such decomposition. When the concentration of H_2O_2 reaches $0.05\,M$, the rate of formation of O_2 will be : **(+4, -1)**

a. $6.93 \times 10^{-2}\,mol\,min^{-1}$

b. $6.93 \times 10^{-4}\,mol\,min^{-1}$

c. $2.66\,L\,min^{-1}$ at STP

d. $1.34 \times 10^{-2} mol\,min^{-1}$

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7. For a first order reaction, $A \rightarrow P, t_{1/2}$ (half life) is 10 days. The time required for $\frac{1^{th}}{4}$ conversion of A (in days) is : (ln 2=0.693, ln 3=1.1) **(+4, -1)**

a. 5

b. 3.2

c. 4.1

d. 2.5

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8. For the reaction, $2A + B \rightarrow$ products, when the concentrations of A and B both where doubled , the rate of the reaction increased from $0.3\ mol\ L^{-1}s^{-1}$ to $2.4\ mol\ L^{-1}s^{-1}$. When the concentration of A alone is doubled, the rate increased from $0.3\ mol\ L^{-1}s^{-1}$ to $0.6\ mol\ L^{-1}s^{-1}$ Which one of the following statements is correct ? **(+4, -1)**

a. Order of the reaction with respect to B is 2

b. Order of the reaction with respect to A is 2

c. Total order of the reaction is 4

d. Order of the reaction with respect to B is 1

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9. A and B are two substances undergoing radioactive decay in a container The half life of A is $15min$ and that of B is $5\,min$ If the initial concentration of B is 4 times that of A and they both start decaying at the same time, how much time will it take for the concentration of both of them to be same? _____ min **(+4, -1)**

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10. $A \rightarrow B$ The above reaction is of zero order Half life of this reaction is 50 min The time taken for the concentration of A to reduce to one-fourth of its initial value is ____ min (Nearest integer) **(+4, -1)**

Answers

1. **Answer: c**

Explanation:

$K_1 = Ae^{\frac{Ea}{R \times 700}}$

$K_2 = A \times e^{\frac{(Ea-30)}{R \times 500}}$

For same rate $K_1 = K_2$

$e^{\frac{Ea}{700R}} = e^{\frac{(Ea-30)}{R \times 500}}$

$\frac{Ea}{700R} = \frac{Ea-30}{R \times 500}$

$5Ea = 7Ea - 210$
$210 = 2Ea$
$E_a = 105kJ/mole$
$E_a - 30 = 75$

The Correct Option is (C): $75\ KJ\ /mol$

Concepts:

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Read More: Chemical Kinetics MCQ

Factors Affecting The Reaction Rate:

- **The concentration of Reactants** - According to collision theory, which is discussed later, reactant molecules collide with each other to form products.
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---

2. **Answer: a**

Explanation:

From Arrhenius equation, $\log \frac{k_2}{k_1} = \frac{-E_a}{2.303R}\left(\frac{1}{T_2} - \frac{1}{t_1}\right)$

Given, $\frac{k_2}{k_1} = 2T_2 = 310K$

$T_1 = 300K$

On putting values,

$\Rightarrow log2 = \frac{-E_a}{2.303 \times 8.314}\left(\frac{1}{310} - \frac{1}{300}\right)$

$\Rightarrow E_a = 53598.6J \ = 53.6\, kJ\, mol^{-1}$

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3. **Answer: a**

Explanation:

molecularity and order > 3 is not possible because of low probability of simultaneous collision of all the reacting species.

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4. Answer: a

Explanation:

Assume the order of reaction with respect to acetaldehyde is x.

$$\text{Rate} = k\,[CH_3CHO]^x$$
$$1 = k\,[363 \times 0.95]^x$$
$$1 = k\,[344.85]^x \quad ...(i)$$
$$0.5 = k\,[363 \times 0.67]^x$$
$$0.5 = k\,[243.21]^x \quad ...(ii)$$

Divide equation (i) by (ii),

$$\frac{1}{0.5} = \left(\frac{344.85}{243.21}\right)^x$$
$$\Rightarrow 2 = (1.414)^x$$
$$\Rightarrow x = 2$$

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5. **Answer: c**

Explanation:

On increasing E_a, K decreases

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6. **Answer: b**

Explanation:

$t_{3/4} = 2 \times t_{1/2} = 50\,\text{min}$

i.e. $t_{1/2} = 25\,\text{min}$
$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{25}\,\text{min}^{-1}$

Rate of H_2O_2 decomposition $= k[H_2O_2]$
$= \frac{0.693}{25} \times 0.05 = -\frac{d[H_2O_2]}{dt}$
$H_2O_2 \longrightarrow H_2O + \frac{1}{2}O_2$
$-\frac{d[H_2O_2]}{dt} = 2\frac{d[O_2]}{dt}$
$\Rightarrow \frac{d[O_2]}{dt} = 6.93 \times 10^{-4}\text{mol}\,\text{min}^{-1}$

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7. **Answer: c**

Explanation:

$A \rightarrow P$

For first order $t_{1/2} = \frac{In2}{k} = 10$ days

For $t_{1/4} = \frac{In43}{k} = t$
$\Rightarrow \frac{In2}{2In2-In3} = \frac{10}{t}$
$t_{1/4} = \frac{(2\times0.693-1.1)}{0.693} \times 10 = 4.1$

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8. **Answer: a**

Explanation:

$r = K[A]^x[B]^y$

$\Rightarrow\ 8 = 2^3 = 2^{x+y}$

$\Rightarrow\ x + y = 3$ ...(1)

$\Rightarrow\ 2 = 2^x$

$\Rightarrow\ x = 1, y = 2$

Order w.r.t. $A = 1$

Order w.r.t. $B = 2$

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9. Answer: 15 - 15

Explanation:

The correct answer is 15.

$[A]_t = [A]_0 e^{-kt}$

For A : Let $[A]_t$ be y and $[A]_0$ be $x; k = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{15\,\text{min}}$

$y = xe^{-kt}$

$= xe^{-\left(\frac{\ln 2}{15}\right)t}$

For B: $[B]_t = [B]_0 e^{-kt}$

Let $[B]_t = y; [B]_0 = 4x; k = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{5\,\text{min}}$

$y = 4xe^{-\left(\frac{\ln 2}{5}\right)t}$

$\Rightarrow xe^{-\left(\frac{\ln 2}{15}\right)t} = 4xe^{-\left(\frac{\ln 2}{5}\right)t}$

$e^{t\left(\frac{\ln 2}{5}\frac{\ln 2}{15}\right)} = 4$

$t \times \left[\frac{\ln 2}{5} - \frac{\ln 2}{15}\right] = \ln 4$

$t \times \ln 2\left[\frac{1}{5} - \frac{1}{15}\right] = 2\ln 2$

$t = 15\,\text{min}$

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10. **Answer: 75 - 75**

Explanation:

The correct answer is 75.

Assume reaction starts with 1 mole A

$\left(t_{1/2}=\frac{a}{2k}, K=\frac{1}{2\times 50}\right.$

For 75% completion

$a-\frac{a}{4}=kt$

$t=\frac{3}{4}\frac{a}{k}=\frac{3}{4}\times\frac{100}{a}=75$

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