Chemical Kinetics JEE Main PYQ - 2

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. For the reaction, 3A + 2B → C + D, the differential rate law can be written as :   **(+4, −1)**

   a. $\frac{1}{3}\frac{d[A]}{dt} = \frac{d[C]}{dt} = k\,[A]^n\,[B]^m$

   b. $-\frac{d[A]}{dt} = \frac{d[C]}{dt} = k\,[A]^n\,[B]^m$

   c. $+\frac{1}{3}\frac{d[A]}{dt} = \frac{d[C]}{dt} = k\,[A]^n\,[B]^m$

   d. $-\frac{1}{3}\frac{d[A]}{dt} = \frac{d[C]}{dt} = k\,[A]^n\,[B]^m$

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2. If 50% of a reaction occurs in 100 second and 75% of the reaction occurs in 200 second, the order of this reaction is :   **(+4, −1)**

   a. 0

   b. 1

   c. 2

   d. 3

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3. N_2O_5 decomposes to NO_2 and O_2 and follows first order kinetics. After 50 minutes, the pressure inside the vessel increases from $50\,mm\,Hg$ to $87.5\,mm\,Hg$. The pressure of the gaseous mixture after 100 minute at constant temperature will be :   **(+4, −1)**

   a. $175.0\,mm\,Hg$

   b. $116.25\,mm\,Hg$

   c. $136.25\,mm\,Hg$

   d. $106.25\,mm\,Hg$

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4. The rate coefficient (k) for a particular reactions is $1.3 \times 10^{-4}\,M^{-1}\,s^{-1}$ at $100°C$, and $1.3 \times 10^{-3}\,M^{-1}s^{-1}$ at $150°C$ What is the energy of activation (E_a) $(in\ kJ)$ for this reaction ? $(R = \text{molar gas constant} = 8.314\,JK^{-1}\,mol^{-1})$ **(+4, −1)**

a. 16

b. 60

c. 99

d. 132

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5. The rate constant of a zero order reaction is $2.0 \times 10^{-2}\, mol\, L^{-1}\, s^{-1}$. If the concentration of the reactant after 25 seconds is $0.5\, M$. What is the initial concentration ? **(+4, -1)**

a. $0.5\, M$

b. $1.25\, M$

c. $12.5\, M$

d. $1.0\, M$

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6. The rate of a reaction quadruples when the temperature changes from 300 to $310\, K$. The activation energy of this reaction is : (Assume activation energy and pre-exponential factor are independent of temperature; $ln\, 2 = 0.693; R = 8.314\, J\, mol^{-1}\, K^{-1}$) **(+4, -1)**

a. $107.2\, kJ\, mol^{-1}$

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

c. $26.8\, kJ\, mol^{-1}$

d. $214.4\, kJ\, mol^{-1}$

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7. A student has studied the decomposition of a gas AB_3 at 25°C. He obtained the following data. **(+4, -1)**

p(mmHg)	50	100	200	400
relative $t_{1/2}(s)$	4	2	1	0.5

The order of the reaction is...........

a. 1

b. 0.5

c. 0 (zero)

d. 2

---

8. Given below are two statements :   (+4, −1)

Statement I : Sulphanilic acid gives esterification test for carboxyl group

Statement II : Sulphanilic acid gives red colour in Lassigne's test for extra element detection In the light of the above statements, choose the most appropriate answer from the options given below :

a. Both Statement I and Statement II are correct

b. Both Statement I and Statement II are incorrect

c. Statement I is incorrect but Statement II is correct

d. Statement I is correct but Statement II is incorrect

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9. $A \rightarrow B$ The rate constants of the above reaction at $200K$ and $300K$ are $0.03 \, \text{min}^{-1}$ and $0.05 \, \text{min}^{-1}$ respectively The activation energy for the reaction is __ J (Nearest integer) (Given : $\ln 10 = 2.3$ (+4, −1)

$R = 8.3 \, JK^{-1} \, mol^{-1}$

$\log 5 = 0.70$

$\log 3 = 0.48$

$\log 2 = 0.30$)

10. The rate constant for a first order reaction is $20\,\text{min}^{-1}$ The time required for the initial concentration of the reactant to reduce to its $\frac{1}{32}$ level is $\_\_\_ \times 10^{-2}\,\text{min}$ (Nearest integer)

    (Given: $\ln 10 = 2.303$ $\log 2 = 0.3010$)

(+4, –1)

Answers

1. **Answer: d**

Explanation:

$$\text{Rate} = -\frac{1}{3}\frac{d(A)}{dt} = -\frac{1}{2}\frac{d(B)}{dt} = \frac{d(C)}{dt} = \frac{d(D)}{dt}$$

$$\text{Rate} = K(A)^n(B)^n$$
$$-\frac{1}{3}\frac{d(A)}{dt} = -\frac{1}{2}\frac{d(B)}{dt} = \frac{d(C)}{dt} = \frac{d(D)}{dt}$$
$$= K(A)^n(B)^m$$

$$\text{so } -\frac{1}{3}\frac{d(A)}{dt} = \frac{d(C)}{dt}$$
$$= K(A)^n(B)^m$$

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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- **Temperature –** If the temperature is increased, the number of collisions between reactant molecules per second. Increases, thereby increasing the rate of the reaction.
- **Effect Of Solvent –** The nature of the solvent also depends on the reaction rate of the solute particles.
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2. Answer: b

Explanation:

For a first order reaction $k = \frac{2.303}{t} \log \frac{a}{a-x}$ At $100\,s: k = \frac{2.303}{100} \log \frac{100}{100-50}$ $k = \frac{2.303}{100} \log 2 = \frac{2.303 \times 0.3010}{100} = 0.00693\,min^{-1}$ At $200\,s: k = \frac{2.303}{200} \log \frac{100}{100-75}$ $k = \frac{2.303}{200} \log 4 = \frac{2.303 \times 0.6020}{200} = 0.00693\,min^{-1}$ As rate constant is same at $100\,s$ and $200\,s$, therefore, order of reaction is 1.

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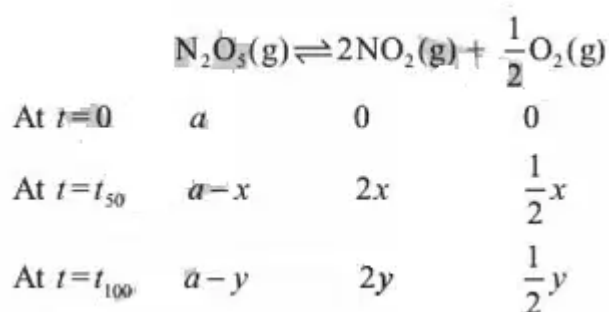- **Catalyst -** Catalysts alter the rate of the reaction by changing the reaction mechanism.

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3. **Answer: d**

Explanation:

The decomposition reaction is

$$N_2O_3(g) \rightleftharpoons 2NO_2(g) + \frac{1}{2}O_2(g)$$

At $t=0$	a	0	0
At $t=t_{50}$	$a-x$	$2x$	$\frac{1}{2}x$
At $t=t_{100}$	$a-y$	$2y$	$\frac{1}{2}y$

We know $a = 50\,mm\,Hg$ At $t = t_{50\,min}$ $.a - x + 2x + \frac{1}{2}x = 87.5$ $a + \frac{3}{2}x = 87.5$ $\frac{3}{2}x = 87.5 - 50 = 37.5 \Rightarrow x = \frac{37.5 \times 2}{3} = 25$ For first order reaction, $kt = 2.303 \log\left(\frac{a}{a-x}\right)$ At $50\,min$, $kt = 2.303 \log\left(\frac{50}{50-25}\right)$ $kt = 2.303 \log 2 \Rightarrow k = \frac{2.303 \times 0.3010}{50}$ At $100\,min$ $kt = 2.303 \log\left(\frac{a}{a-y}\right)$ $100 \times \frac{2.303 \times 0.3010}{50} = 2.303 \log\left(\frac{50}{a-y}\right)$ $2 \times 0.3010 = \log\left(\frac{50}{a-y}\right)$ $\frac{50}{a-y} = 4$ $a - y = \frac{50}{4} = 12.5$ $50 - y = 12.5 \Rightarrow y = 37.5$ Therefore, total pressure at $100min$ can be calculated as Total pressure $= a - y + 2y + \frac{1}{2}y = a + \frac{3}{2}y = 50 + \frac{3}{2} \times 37.5 = 106.25\,mm\,Hg$

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4. Answer: b

Explanation:

According to Arrhenius equation $log\frac{k_2}{k_1} = \frac{E_a}{2.303\,R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$ $log\frac{1.3\times10^{-3}}{1.3\times10^{-4}} = \frac{E_a}{2.303\times8.314}\left[\frac{1}{373} - \frac{1}{423}\right]$ $1 == \frac{E_a}{2.303\times8.314}\left[\frac{1}{373} - \frac{1}{423}\right]$ $E_a = 60\,kJ/mole$

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5. **Answer: d**

Explanation:

For a zero order reaction Rate constant $= k = \frac{a-x}{t}$ $2 \times 10^{-2} = \frac{a-0.5}{25} a = 05 = 0.5$ $a = 1.0\,M$

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6. **Answer: a**

Explanation:

$$4 = e^{\frac{Ea}{R}\left\{\frac{1}{300} - \frac{1}{310}\right\}} \quad \ln(4) = \frac{Ea}{R}\left\{\frac{10}{300 \times 310}\right\} \quad Ea = \frac{0.693 \times 2 \times 8.314 \times 300 \times 310}{10} = 107165.79\,J = 107.165\,KJ$$

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7. Answer: d

Explanation:

The correct answer is (D) : 2

$$t_{\frac{1}{2}} \propto \left(P_o\right)^{1-n}$$

$$\frac{\left(t_{\frac{1}{2}}\right)_1}{\left(t_{\frac{1}{2}}\right)_2} = \frac{\left(P_0\right)_1^{1-n}}{\left(P_{0_2}\right)_2^{1-n}}$$

$$\Rightarrow \left(\frac{4}{2}\right) = \left(\frac{50}{100}\right)^{1-n}$$

$$\Rightarrow 2 = \left(\frac{1}{2}\right)^{1-n}$$

$$\Rightarrow 2 = \left(2\right)^{n-1}$$

$$\Rightarrow n-1 = 1$$

$$\Rightarrow n = 2$$

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8. **Answer: c**

Explanation:

$$H_2N - \bigcirc - \underset{\underset{O}{\overset{\overset{O}{\parallel}}{\parallel}}}{S} - OH$$

Sulphanilic acid
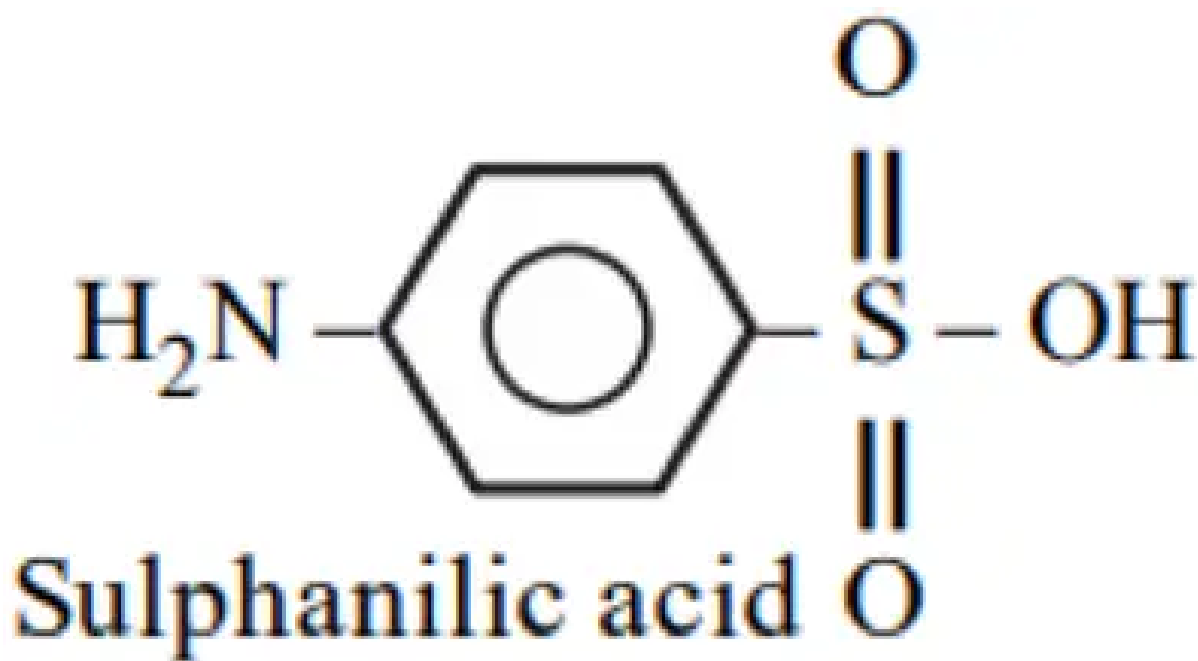
Does not show esterification test.
Presence of both sulphur and nitrogen give red colour in Lassigne's test.

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9. **Answer: 2520 - 2520**

Explanation:

The correct answer is 2520.

$\log \frac{K_{300}}{K_{200}} = \frac{E_a}{2.3 \times 8.314} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$

$\log \frac{0.05}{0.03} = \frac{Ea}{2.305 \times 8.314} \times \left[\frac{1}{200} - \frac{1}{300} \right]$

$E_a = 2519.88J \Rightarrow E_a = 2520J$

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10. **Answer: 17 - 17**

Explanation:

$C = \frac{C_o}{2^n} = \frac{C_o}{32}$

$n = 5$

$t = 5t_{1/2}$

$= \frac{5 \times 0.693}{20} = \frac{0.693}{4}$

$= 0.17325 \, \text{min} = 17.325 \times 10^{-2} \, \text{min}$

So, the correct answer is 17.

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