

Questions with Answer Keys

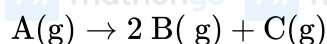
MathonGo

Q1 - 2024 (01 Feb Shift 1)

The ratio of $\frac{^{14}\text{C}}{^{12}\text{C}}$ in a piece of wood is $\frac{1}{8}$ part that of atmosphere. If half life of ^{14}C is 5730 years, the age of wood sample is _____ years.

Q2 - 2024 (01 Feb Shift 2)

The following data were obtained during the first order thermal decomposition of a gas A at constant volume:

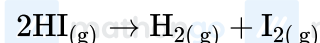


S.No	Time/s	Total pressure/(atm)
1.	0	0.1
2.	115	0.28

The rate constant of the reaction is _____ $\times 10^{-2} \text{ s}^{-1}$ (nearest integer)

Q3 - 2024 (27 Jan Shift 1)

Consider the following data for the given reaction



	1	2	3
HI (molL ⁻¹)	0.005	0.01	0.02
Rate (molL ⁻¹ s ⁻¹)	7.5×10^{-4}	3.0×10^{-3}	1.2×10^{-2}

The order of the reaction is _____

Q4 - 2024 (27 Jan Shift 2)

Time required for completion of 99.9% of a First order reaction is _____ times of half life ($t_{1/2}$) of the reaction.

Q5 - 2024 (29 Jan Shift 1)

For a reaction taking place in three steps at same temperature, overall rate constant $K = \frac{K_1 K_2}{K_3}$. If E_{a1} , E_{a2} and E_{a3} are 40, 50 and 60 kJ/mol respectively, the overall E_a is _____ kJ/mol.

Q6 - 2024 (29 Jan Shift 2)

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Questions with Answer Keys

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The half-life of radioisotopic bromine - 82 is 36 hours. The fraction which remains after one day is _____
 $\times 10^{-2}$.
 (Given $\text{antilog } 0.2006 = 1.587$)

Q7 - 2024 (30 Jan Shift 1)

The rate of first order reaction is $0.04 \text{ mol L}^{-1} \text{ s}^{-1}$ at 10 minutes and $0.03 \text{ mol L}^{-1} \text{ s}^{-1}$ at 20 minutes after initiation. Half life of the reaction is _____ minutes. (Given $\log 2 = 0.3010$, $\log 3 = 0.4771$)

Q8 - 2024 (30 Jan Shift 2)

NO_2 required for a reaction is produced by decomposition of N_2O_5 in CCl_4 as by equation



The initial concentration of N_2O_5 is 3 mol L^{-1} and it is 2.75 mol L^{-1} after 30 minutes.

The rate of formation of NO_2 is $x \times 10^{-3} \text{ mol L}^{-1} \text{ min}^{-1}$, value of x is _____

Q9 - 2024 (31 Jan Shift 1)

Integrated rate law equation for a first order gas phase reaction is given by (where P_i is initial pressure and P_t is total pressure at time t)

$$(1) k = \frac{2.303}{t} \times \log \frac{P_i}{(2P_i - P_t)}$$

$$(2) k = \frac{2.303}{t} \times \log \frac{2P_i}{(2P_i - P_t)}$$

$$(3) k = \frac{2.303}{t} \times \log \frac{(2P_i - P_t)}{P_i}$$

$$(4) k = \frac{2.303}{t} \times \frac{P_i}{(2P_i - P_t)}$$

Q10 - 2024 (31 Jan Shift 2)

$r = k[A]$ for a reaction, 50% of A is decomposed in 120 minutes. The time taken for 90% decomposition of A is _____ minutes.

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Questions with Answer Keys

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Solutions

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Q1

$$\lambda t = \ln \frac{(^{14}\text{C}/^{12}\text{C})_{\text{atmosphere}}}{(^{14}\text{C}/^{12}\text{C})_{\text{wood sample}}}$$

As per the question,

$$\frac{(^{14}\text{C}/^{12}\text{C})_{\text{wood}}}{(^{14}\text{C}/^{12}\text{C})_{\text{atmosphere}}} = \frac{1}{8}$$

So, $\lambda t = \ln 8$

$$\frac{\ln 2}{t_{1/2}} t = \ln 8$$

$$t = 3 \times t_{1/2} = 17190 \text{ years}$$

Q2



$$t = 0 \quad 0.1$$

$$t = 115 \text{ sec} \quad 0.1 - x \quad 2x \quad x$$

$$0.1 + 2x = 0.28$$

$$2x = 0.18$$

$$x = 0.09$$

$$K = \frac{1}{115} \ln \frac{0.1}{0.1 - 0.09}$$

$$= 0.0200 \text{ sec}^{-1}$$

$$= 2 \times 10^{-2} \text{ sec}^{-1}$$

Q3

$$\text{Let, } R = k[\text{HI}]^n$$

using any two of given data,

$$\frac{3 \times 10^{-3}}{7.5 \times 10^{-4}} = \left(\frac{0.01}{0.005} \right)^n$$

$$n = 2$$

Q4

$$\frac{t_{99.9\%}}{t_{1/2}} = \frac{\frac{2.303}{k} \left(\frac{a}{a-x} \right)}{\frac{2.303}{k} \log 2} = \frac{\log \left(\frac{100}{100-99.9} \right)}{\log 2} = \frac{\log 10^3}{\log 2} = \frac{3}{0.3} = 10$$

Q5

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Solutions

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$$K = \frac{K_1 \cdot K_2}{K_3} = \frac{A_1 \cdot A_2}{A_3} \cdot e^{-\frac{(E_{a1} + E_{a2} - E_{a3})}{RT}}$$

$$A \cdot e^{-E_a/RT} = \frac{A_1 A_2}{A_3} \cdot e^{-\frac{(E_{a1} + E_{a2} - E_{a3})}{RT}}$$

$$E_a = E_{a1} + E_{a2} - E_{a3} = 40 + 50 - 60 = 30 \text{ kJ/mole}$$

Q6

Half life of bromine $-82 = 36$ hours

$$t_{1/2} = \frac{0.693}{K}$$

$$K = \frac{0.693}{36} = 0.01925 \text{ hr}^{-1}$$

1st order rxn kinetic equation

$$t = \frac{2.303}{K} \log \frac{a}{a-x}$$

$$\log \frac{a}{a-x} = \frac{t \times K}{2.303} \quad (t = 1 \text{ day} = 24 \text{ hr})$$

$$\log \frac{a}{a-x} = \frac{24 \text{ hr} \times 0.01925 \text{ hr}^{-1}}{2.303}$$

$$\log \frac{a}{a-x} = 0.2006$$

$$\frac{a}{a-x} = \text{antilog}(0.2006)$$

$$\frac{a}{a-x} = 1.587$$

If $a = 1$

$$\frac{1}{1-x} = 1.587 \Rightarrow 1-x = 0.6301 = \text{Fraction remain}$$

after one day

Q7

(

$$0.04 = k[A]_0 e^{-k \times 10 \times 60} \quad \dots (1)$$

$$0.03 = k[A]_0 e^{-k \times 20 \times 60} \quad \dots (2)$$

)

(1)/(2)

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Solutions

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$$\frac{4}{3} = e^{600k(2-1)}$$

$$\frac{4}{3} = e^{600k}$$

$$\ln \frac{4}{3} = 600k$$

$$\ln \frac{4}{3} = 600 \times \frac{\ln 2}{t_{1/2}}$$

$$t_{1/2} = 600 \frac{\ln 2}{\ln \frac{4}{3}} \text{sec}$$

$$t_{1/2} = 600 \times \frac{\log 2}{\log 4 - \log 3} \text{sec.} = 10 \times \frac{0.3010}{0.6020 - 0.477} \text{min}$$

$$t_{1/2} = 24.08 \text{ min}$$

Ans. 24

Q8

Rate of reaction (ROR)

$$= -\frac{1}{2} \frac{\Delta [\text{N}_2\text{O}_5]}{\Delta t} = \frac{1}{4} \frac{[\text{NO}_2]}{\Delta t} = \frac{\Delta [\text{O}_2]}{\Delta t}$$

$$\text{ROR} = -\frac{1}{2} \frac{\Delta [\text{N}_2\text{O}_5]}{\Delta t} = -\frac{1}{2} \frac{(2.75 - 3)}{30} \text{ mol L}^{-1} \text{ min}^{-1}$$

$$\text{ROR} = -\frac{1}{2} \frac{(-0.25)}{30} \text{ mol L}^{-1} \text{ min}^{-1}$$

$$\text{ROR} = \frac{1}{240} \text{ mol L}^{-1} \text{ min}^{-1}$$

$$\text{Rate of formation of NO}_2 = \frac{\Delta [\text{NO}_2]}{\Delta t} = 4 \times \text{ROR}$$

$$= \frac{4}{240} = 16.66 \times 10^{-3} \text{ mol L}^{-1} \text{ min}^{-1} \simeq 17 \times 10^{-3}$$

Q9



$$P_i \quad 0 \quad 0$$

$$P_i - x \quad x \quad x$$

$$P_t = P_i + x$$

$$P_i - x = P_i - P_t + P_i$$

$$= 2P_i - P_t$$

$$K = \frac{2.303}{t} \log \frac{P_i}{2P_i - P_t}$$

Q10

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Solutions

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$$r = k[A]$$

So, order of reaction = 1

$$t_{1/2} = 120 \text{ min}$$

For 90% completion of reaction

$$\Rightarrow k = \frac{2.303}{t} \log \left(\frac{a}{a-x} \right)$$

$$\Rightarrow \frac{0.693}{t_{1/2}} = \frac{2.303}{t} \log \frac{100}{10}$$

$$\therefore t = 399 \text{ min.}$$

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