Marks 4

- At a certain temperature the following data were collected for the decomposition of HI.

$$2HI \rightarrow H_2 + I_2$$

Experiment	Initial [HI] (mol L^{-1})	Initial rate of reaction (mol L^{-1} s^{-1})
1	1.0×10^{-2}	4.0×10^{-6}
2	2.0×10^{-2}	1.6×10^{-5}
3	3.0×10^{-2}	3.6×10^{-5}

Determine the rate law for the reaction.

What is the value of the rate constant for the decomposition of HI?

Answer:

Marks 7

- Four experiments were conducted to discover how the initial rate of consumption of BrO_3^- ions in the reaction below varied as the concentrations of the reactants were changed.

$$BrO_3^- + 5Br^- + 6H^+ \rightarrow 3Br_2 + 3H_2O$$

Experiment	Initial concentration (mol L^{-1})			Initial rate (mol L^{-1} s^{-1})
	BrO_3^-	Br^-	H^+	
1	0.10	0.10	0.10	1.2×10^{-3}
2	0.20	0.10	0.10	2.4×10^{-3}
3	0.10	0.30	0.10	3.5×10^{-3}
4	0.20	0.10	0.15	5.4×10^{-3}

Use the experimental data in the table above to determine the order of the reaction with respect to *each* reactant.

What is the rate of formation of Br_2 when $[BrO_3^-] = [Br^-] = [H^+] = 0.10$ M?

Write the rate law for the reaction and determine the value of the rate constant, *k*.

Marks 7

- Nitrogen monoxide, a noxious pollutant, reacts with oxygen to produce nitrogen dioxide, another toxic gas:

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

The following rate data were collected at 225 ^oC.

Experiment	$[NO]_0$ (M)	$[O_2]_0$ (M)	Initial rate, $-d[O_2]/dt$, (M s^{-1})
1	1.3×10^{-2}	1.1×10^{-2}	1.6×10^{-3}
2	1.3×10^{-2}	2.2×10^{-2}	3.2×10^{-3}
3	2.6×10^{-2}	1.1×10^{-2}	6.4×10^{-3}

Determine the rate law for the reaction.

Calculate the value of the rate constant at 225 ^oC.

Answer:

Calculate the rate of appearance of NO_2 when $[NO] = [O_2] = 6.5 \times 10^{-3}$ M.

Answer:

Suggest a possible mechanism for the reaction based on the form of the rate law. Explain your answer.

Marks 5

- 2-Bromo-2-methylpropane reacts with hydroxide ions to give 2-methyl-2-propanol.

$$(CH_3)_3CBr + OH^- \rightarrow (CH_3)_3COH$$

The following rate data were collected at 55 °C.

Experiment	$[(CH_3)_3CBr]_0$ (M)	$[OH^-]_0$ (M)	Initial rate ($d[(CH_3)_3COH]/dt$, M s^{-1})
1	0.050	0.10	5.0×10^{-4}
2	0.20	0.10	2.0×10^{-3}
3	0.20	0.30	2.0×10^{-3}

Determine the rate law for the reaction.

Calculate the value of the rate constant at 55 °C.

Answer:

Suggest a possible mechanism for the reaction based on the form of the rate law. Explain your answer.

	Marks
The reaction is exothermic. Draw the potential energy *vs* reaction coordinate diagram for this mechanism, labelling all species that can be isolated.	**2**

Marks 5

- Nitric oxide, a noxious pollutant, and hydrogen react to give nitrous oxide and water according to the following equation.

$$2NO(g) + H_2(g) \rightarrow N_2O(g) + H_2O(g)$$

The following rate data were collected at 225 ^oC.

Experiment	$[NO]_0$ (M)	$[H_2]_0$ (M)	Initial rate (d[NO]/dt, M s^{-1})
1	6.4×10^{-3}	2.2×10^{-3}	2.6×10^{-5}
2	1.3×10^{-2}	2.2×10^{-3}	1.0×10^{-4}
3	6.4×10^{-3}	4.4×10^{-3}	5.1×10^{-5}

Determine the rate law for the reaction.

Calculate the value of the rate constant at 225 ^oC.

Answer:

Calculate the rate of appearance of N_2O when $[NO] = [H_2] = 6.6 \times 10^{-3}$ M.

Answer:

Suggest a possible mechanism for the reaction based on the form of the rate law.
Explain your answer.

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Marks 7

- The major pollutants NO(g), CO(g), NO_2(g) and CO_2(g) are emitted by cars and can react according to the following equation.

$$NO_2(g) + CO(g) \rightarrow NO(g) + CO_2(g)$$

The following rate data were collected at 225 ^oC.

Experiment	$[NO_2]_0$ (M)	$[CO]_0$ (M)	Initial rate ($d[NO_2]/dt$, M s^{-1})
1	0.263	0.826	1.44×10^{-5}
2	0.263	0.413	1.44×10^{-5}
3	0.526	0.413	5.76×10^{-5}

Determine the rate law for the reaction.

Calculate the value of the rate constant at 225 ^oC.

Answer:

Calculate the rate of appearance of CO_2 when $[NO_2] = [CO] = 0.500$ M.

Answer:

Suggest a possible mechanism for the reaction based on the form of the rate law. Explain your answer.

Marks

- 2-Propanol can oxidised to acetone using $Cr_2O_7^{2-}$ in acidic solution as indicated in the reaction below. The rate of decrease of the $Cr_2O_7^{2-}$ ion under a certain set of conditions is 3.0 mol L^{-1} s^{-1}. **4**

$$3CH_3CH(OH)CH_3 + Cr_2O_7^{2-} + 8H^+ \rightarrow 3CH_3COCH_3 + 2Cr^{3+} + 7H_2O$$

What is the rate of increase in the concentration of Cr^{3+}?

What is the rate of decrease in the concentration of 2-propanol?

The rate law for this reaction is: $Rate = k\,[Cr_2O_7^{2-}][CH_3CH(OH)CH_3][H^+]^2$

Complete the following table by writing *increase*, *decrease* or *no change* in the box to indicate how the rate of the reaction is affected by each of the following changes.

Increase in $[CH_3CH(OH)CH_3]$	
Increase in $[CH_3COCH_3]$	
Increase in pH	
Increase in temperature	

- Complete the following table. **4**

Formula	Systematic name	Oxidation state of transition metal	Number of *d*-electrons
$K_2[Pt(CN)_4]$			
$[Co(H_2O)_6]Cl_2$			

	Marks
• Explain in terms of their electronic configurations and ionisation energies why the alkali metals (Group 1) are powerful *reducing* agents.	**2**
• The half-life for the first order decomposition of $N_2O_5(g)$ is 6.00×10^4 s at 20 °C. Calculate the rate constant, k, at this temperature.	**3**
$k =$	
What percentage of the N_2O_5 molecules will have reacted after one hour?	
ANSWER:	