Chemical Kinetics Concepts Achievement Test (CKCAT)
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Related Papers:


Question-1:

The following reaction occurs at room temperature (298 K):

\[ \text{Y} \text{ (aq)} + \text{P} \text{ (aq)} \rightarrow \text{J} \text{ (aq)} \]

The reaction is set up under two different sets of initial conditions:

First set of conditions
- Initial amount of Y = 10 mL, 2 mol/L
- Initial amount of P = 10 mL, 2 mol/L

Second set of conditions
- Initial amount of Y = 20 mL, 2 mol/L
- Initial amount of P = 20 mL, 2 mol/L

These two identical beakers contain different amount of substances of Y and P. In each of the two cases compare the reaction rates.

(i) What would you say about the rate of these reactions?

Tick ONE box (✓)

- The reaction under first set of conditions is faster than the reaction under second set of conditions
- The rates of reactions are the same
- The reaction under second set of conditions is faster than the reaction under first set of conditions

(ii) Explain your answer by providing reasons to support the claim you are making.
Question 2:
Consider a reaction where two chemicals ‘W’ and ‘J’ react to form ‘Z’

\[ W_{(aq)} + J_{(aq)} \rightarrow Z_{(aq)} \]

The teacher drew a graph showing how the concentration of \( W \) changes with time.

The teacher asks students to use the graph to draw a graph for the reaction rate against time.

(i) How would the reaction rate change against time?

Tick ONE box (\( \checkmark \))

(A) The reaction rate increases
(B) The reaction rate decreases
(C) The reaction rate increases and then remains constant
(D) The reaction rate is constant
(E) The reaction rate increases and then decreases

(ii) Explain your answer by providing reasons to support the claim you are making.

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Question-3:

The following reaction occurs at room temperature (298 K):

\[ T_{(aq)} + D_{(aq)} \rightarrow R_{(aq)} \]

The reaction is set up under two different sets of initial conditions:

**First set of conditions**

- Initial amount of \( T = 10 \) mL, 2 mol/L
- Initial amount of \( D = 10 \) mL, 2 mol/L

**Second set of conditions**

- Initial amount of \( T = 10 \) mL, 2 mol/L
- Initial amount of \( D = 10 \) mL, 2 mol/L

Both beakers contain **same amount of** chemical species of \( T \) and \( D \), however as can be seen from drawings the shapes of the beakers are different. In each of the two cases compare the reaction rates.

(i) What would you say about **the rate** of these reactions?

*Tick ONE box (✓)*

- The reaction under first set of conditions is **faster** than the reaction under second set of conditions
- The rates of reactions are **the same**
- The reaction under second set of conditions is **faster** than the reaction under first set of conditions

(ii) Explain your answer by providing reasons to support the claim you are making.

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Some students did an experiment to find out the order of the reaction below:

$$2\text{NO}_\text{(g)} \xrightarrow{Pt} \text{N}_2\text{(g)} + \text{O}_2\text{(g)} \quad \Delta H < 0 \text{ (Exothermic)}$$

They measured the concentration of nitrogen monoxide (NO) regularly over time. This graph shows how the concentration of NO changes as time passes.

**a- (i)** After interpreting the graph, what would you say about this reaction? *Tick ONE box (√)*

- The reaction is zero order with respect to ‘NO’ and thus the rate expression for the reaction is: $r_{\text{NO}} = k [\text{NO}]^0 = k$
- The reaction is first order with respect to ‘NO’ and thus the rate expression for the reaction is: $r_{\text{NO}} = k [\text{NO}]^1$
- The reaction is second order with respect to ‘NO’ and thus the rate expression for the reaction is: $r_{\text{NO}} = k [\text{NO}]^2$

**a- (ii)** Explain your answer by providing reasons to support the claims you are making.

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**b- (i)** What would you say about the rate of this reaction? How would the reaction rate change against time? *Tick ONE box (√)*

- The reaction rate increases
- The reaction rate decreases
- The reaction rate increases and then remains constant
- The reaction rate is constant
- The reaction rate increases and then decreases

**b- (ii)** Explain your answer by providing reasons to support the claims you are making.

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These two identical vessels contain **different reactants**. In each of the two cases compare the reaction rates.

(i) What would you say about the rate of these reactions? *Tick ONE box (√)*

- Reaction 1 is **faster** than Reaction 2
- The rates of reactions are **the same**
- Reaction 2 is **faster** than Reaction 1
- It **is not possible to compare** the rates of these reactions, because there is not enough information given in the question.

(ii) Explain your answer by providing reasons to support the claims you are making.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Reaction</th>
<th>ΔH</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C(g) + P(g) \rightarrow B(g)$</td>
<td>Reaction 1</td>
<td>ΔH &lt; 0 (Exothermic)</td>
<td>Volume of vessel = 1 L, Initial temperature = 298 K, Initial amount of C = 1 mol, Initial amount of P = 1 mol</td>
</tr>
<tr>
<td>$G(g) + V(g) \rightarrow Q(g)$</td>
<td>Reaction 2</td>
<td>ΔH &gt; 0 (Endothermic)</td>
<td>Volume of vessel = 1 L, Initial temperature = 298 K, Initial amount of G = 1 mol, Initial amount of V = 1 mol</td>
</tr>
</tbody>
</table>
Question-6:

When a house was newly built both the hot and the cold water pipes in the kitchen were shiny. After a while, the outside of these pipes had become dull and rusty (covered with a thin, brown coating).

(i) What would you say about these pipes?

Tick ONE box (√)

☐ The outside of the cold water pipe would get rustier than the outside of the hot water pipe.

☐ Both water pipes would get same amount of rust on them.

☐ The outside of the hot water pipe would get rustier than the outside of the cold water pipe.

(ii) Explain your answer by providing reasons to support the claims you are making.

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Question-7:

The chemical equations given below represent two hypothetical reactions. Consider these two reactions that have different activation energies \( (E_a) \) occur at the same temperature:

<table>
<thead>
<tr>
<th>Reaction 1</th>
<th>Reaction 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Y_{(aq)} + P_{(aq)} \rightarrow C_{(aq)} ) ( E_a = 92 \text{ kJ.mol}^{-1} )</td>
<td>( T_{(aq)} + V_{(aq)} \rightarrow Z_{(aq)} ) ( E_a = 480 \text{ kJ.mol}^{-1} )</td>
</tr>
</tbody>
</table>

(i) What would you say about the rate of these reactions? Tick ONE box (\( \checkmark \))

- Reaction 1 is faster than Reaction 2
- The rates of reactions are the same
- Reaction 2 is faster than Reaction 1
- It is not possible to compare the rates of these reactions, because there is not enough information given in the question.

(ii) Explain your answer by providing reasons to support the claims you are making.

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Question-8:

\[ 2\text{NO}_2(g) + \text{Cl}_2(g) \rightleftharpoons 2\text{NOCl}_2(g) \quad \Delta H < 0 \text{ (Exothermic)} \]

How the following condition would affect the rate of this reaction.

(i) Increasing the initial temperature of the system

- will increase only the rate of forward reaction
- will increase only the rate of reverse reaction
- will increase both the rate of forward and reverse reactions
- will decrease only the rate of forward reaction
- will decrease only the rate of reverse reaction
- will decrease both the rate of forward and reverse reactions

(ii) Explain your answer by providing reasons to support the claims you are making.

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Question-9:

The following reaction occurs at room temperature (298 K):

\[ \text{M}_{(aq)} + \text{Z}_{(aq)} \rightarrow \text{G}_{(aq)} \]

Some students measured the concentration of the product G regularly over time. The data is as follows:

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Concentration of G (mol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0.02</td>
</tr>
<tr>
<td>6</td>
<td>0.04</td>
</tr>
<tr>
<td>9</td>
<td>0.06</td>
</tr>
<tr>
<td>12</td>
<td>0.08</td>
</tr>
</tbody>
</table>

(i) How would the reaction rate change against time?

Tick ONE box (√)

(A) The reaction rate increases
(B) The reaction rate decreases
(C) The reaction rate increases and then remains constant
(D) The reaction rate is constant
(E) The reaction rate increases and then decreases

(ii) Explain your answer by providing reasons to support the claim you are making.

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**Question-10:**

Consider a reaction where two chemicals ‘X’ and ‘Y’ react to form ‘Q’. For this reaction, the equation for without a catalyst is presented below. The following figure shows a pathway for the uncatalysed reaction.

\[
X_{(aq)} + Y_{(aq)} \rightarrow Q_{(aq)} \quad \Delta H < 0 \text{ (Exothermic)}
\]

The equation for this reaction with ‘W’ catalyst is presented as follows:

\[
X_{(aq)} + Y_{(aq)} \stackrel{W_{(aq)}}{\rightarrow} Q_{(aq)}
\]

Read the following statements based on the information given above and tick ONE box (✓) for each statement as ‘CORRECT’, ‘INCORRECT’ or ‘I DON’T KNOW’. Explain your answer by providing reasons to support the claim you are making.

<table>
<thead>
<tr>
<th>Statements</th>
<th>(A) CORRECT</th>
<th>(B) INCORRECT</th>
<th>(C) DON’T KNOW</th>
<th>..........because..........</th>
</tr>
</thead>
<tbody>
<tr>
<td>The catalyst gives energy to the reaction, therefore it increases the activation energy ( (E_a) ) of the reaction.</td>
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<td></td>
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<td>..................................................</td>
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<tr>
<td>At the end of the reaction, the catalyst does not change.</td>
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<td></td>
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<td>..................................................</td>
</tr>
<tr>
<td>During the reaction, the catalyst does not react with any of the reactants present and it does not change at the end of the reaction.</td>
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<td>..................................................</td>
</tr>
<tr>
<td>The catalyst changes the rate constant ( (k) ) of the reaction.</td>
<td></td>
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<td>..................................................</td>
</tr>
<tr>
<td>The catalyst changes pathways of the reaction in a way that the activation energy ( (E_a) ) of the reaction is lowered.</td>
<td></td>
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<td>..................................................</td>
</tr>
<tr>
<td>The catalyst changes the mechanism of the reaction. The catalysed reaction occurs in more than one step.</td>
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<td>..................................................</td>
</tr>
<tr>
<td>The catalyst does not change the mechanism of the reaction. Therefore, the catalysed reaction also occurs in one step.</td>
<td></td>
<td></td>
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<td>..................................................</td>
</tr>
<tr>
<td>The catalyst does not change the enthalpy of the reaction ( (\Delta H) ).</td>
<td></td>
<td></td>
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<td>..................................................</td>
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</tbody>
</table>
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