**MC RESULTS**

<table>
<thead>
<tr>
<th></th>
<th>Cluster 1</th>
<th>Cluster 2</th>
<th>Cluster 3</th>
<th>Cluster 4</th>
<th>Cluster 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>316</td>
<td>188</td>
<td>71</td>
<td>168</td>
<td>120</td>
<td>863</td>
</tr>
<tr>
<td>NO</td>
<td>151</td>
<td>5</td>
<td>20</td>
<td>6</td>
<td>53</td>
<td>235</td>
</tr>
</tbody>
</table>

QUESTION: Are there conditions under which a non-spontaneous reaction can become spontaneous?

For this question, the total sample of 1098 students' responses were placed into five clusters. Students with similar ideas fall into the same clusters. The three clusters and the percentage of students in each cluster are shown in the pie chart below. Summary names were assigned to each cluster.

Cluster 1: Misc. Arguments 42.5%
Cluster 2: Increase Temperature 17.6%
Cluster 3: Catalyst 8.3%
Cluster 4: Change in temperature 15.8%
Cluster 5: Change in conditions 15.8%

Examples of student responses:

**Cluster Number and Title**

<table>
<thead>
<tr>
<th>Cluster Number</th>
<th>Examples of student responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Misc. Arguments</td>
<td>I guessed I have no idea and I have never heard of spontaneous reactions before. Because it may or may not.</td>
</tr>
<tr>
<td>2: Increase Temperature</td>
<td>If you increase the temperature during some non-spontaneous reactions it may become spontaneous.</td>
</tr>
<tr>
<td>3: Catalyst</td>
<td>If there was a catalyst that sped up the reaction to make it happen when it normally wouldn't. I believe it is possible if there is a catalyst involved.</td>
</tr>
<tr>
<td>4: Change Temperature</td>
<td>For some non-spontaneous chemical reactions by changing the temperature the reaction can become spontaneous. Sometimes by changing the temperature you can make a non spontaneous become spontaneous.</td>
</tr>
<tr>
<td>5: Change in Conditions</td>
<td>A non-spontaneous chemical reaction can become spontaneous under different conditions because if the non-spontaneous chemical reaction is in some type of material fluid etc. where it may be able to become spontaneous due to that type of material fluid the reactions are either spontaneous or non-spontaneous and are not effected by different conditions.</td>
</tr>
</tbody>
</table>