Le Chatelier's Principle Worksheet #2

1) In the following reaction, will the \([H_2]\) increase or decrease when equilibrium is reestablished after these stresses are applied?

\( \text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g}) + 22 \text{kJ} \)

- \( \text{NH}_3(\text{g}) \) is added
- \( \text{N}_2(\text{g}) \) is removed
- Pressure is increased
- Temperature is increased

2) In which direction, left or right, will the equilibrium shift if the following changes are made?

\( 2 \text{NO}(\text{g}) + \text{H}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}(\text{g}) + \text{H}_2\text{O}(\text{g}) + 36 \text{kJ} \)

- \( \text{NO} \) is added
- The system is cooled
- \( \text{H}_2 \) is removed
- Pressure is increased
- \( \text{N}_2\text{O} \) is added
- \( \text{H}_2 \) is removed

3) In this reaction: \( \text{CO}_2(\text{g}) + \text{H}_2(\text{g}) + \text{heat} \rightleftharpoons \text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g}) \)

Is heat absorbed or released by the forward reaction? ____________

In which direction will the equilibrium shift if these changes are made?

- \( \text{CO} \) is added
- Temperature is increased
- \( \text{CO}_2 \) is added
- System is cooled
- \( \text{H}_2 \) is removed
- Pressure is increased
- Catalyst is added

4) In this reaction: \( 2 \text{NO}(\text{g}) + \text{H}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}(\text{g}) + \text{H}_2\text{O}(\text{g}) + \text{heat} \)

What will happen to the \([\text{H}_2\text{O}]\) when equilibrium is reestablished after these stresses are applied?

- Temperature is increased
- A catalyst is added
- Pressure is decreased
- \( \text{NO} \) is added
- \( \text{N}_2\text{O} \) is removed
5) How would an increase in pressure affect the \([H_2]\) in the following reactions?

\[2 \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \leftrightarrow 2 \text{H}_2\text{O} (\text{g})\]

\[4 \text{H}_2(\text{g}) + \text{Fe}_3\text{O}_4(\text{s}) \leftrightarrow 3 \text{Fe} (\text{s}) + 4 \text{H}_2\text{O} (\text{l})\]

\[\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \leftrightarrow 2 \text{HCl} (\text{g})\]

6) State Le Chatelier’s Principle in your own words.

7) The reaction of iron(III) oxide with carbon monoxide occurs in a blast furnace when iron ore is reduced to iron metal:

\[\text{Fe}_2\text{O}_3(\text{s}) + 3 \text{CO} (\text{g}) \leftrightarrow 2 \text{Fe} (\text{l}) + 3 \text{CO}_2 (\text{g})\]

Use Le Chatelier’s Principle to predict the direction of reaction when an equilibrium mixture is disturbed by:

Adding \(\text{CO} (\text{g})\) __________

Removing \(\text{CO}_2 (\text{g})\) __________

Adding \(\text{Fe}_2\text{O}_3 (\text{s})\) __________

8) For the reaction, \(\text{PCl}_5(\text{g}) \leftrightarrow \text{PCl}_3 (\text{g}) + \text{Cl}_2 (\text{g})\) \(\Delta H_{\text{rxn}} = +111 \text{ kJ}\). Fill in the following table.

<table>
<thead>
<tr>
<th>Change</th>
<th>Shifts Reaction Which Way?</th>
</tr>
</thead>
<tbody>
<tr>
<td>add (\text{PCl}_5)</td>
<td></td>
</tr>
<tr>
<td>remove (\text{Cl}_2)</td>
<td></td>
</tr>
<tr>
<td>add (\text{Ar})</td>
<td></td>
</tr>
<tr>
<td>decrease V (or increase P)</td>
<td></td>
</tr>
<tr>
<td>increase T</td>
<td></td>
</tr>
<tr>
<td>add catalyst</td>
<td></td>
</tr>
</tbody>
</table>

9) For the reaction: \(2\text{HI}(\text{g}) \leftrightarrow \text{H}_2(\text{g}) + \text{I}_2(\text{g})\) \(\Delta H_{\text{rxn}} = -51.8\text{kJ}\). Fill in the following table:

<table>
<thead>
<tr>
<th>Change</th>
<th>Shifts Reaction Which Way?</th>
</tr>
</thead>
<tbody>
<tr>
<td>add (\text{H}_2)</td>
<td></td>
</tr>
<tr>
<td>remove (\text{HI})</td>
<td></td>
</tr>
<tr>
<td>add (\text{Ne})</td>
<td></td>
</tr>
<tr>
<td>increase V (decrease P)</td>
<td></td>
</tr>
<tr>
<td>decrease T</td>
<td></td>
</tr>
</tbody>
</table>