1. (10 pts) Find the standard heat of reaction for the following reaction:

\[ A_2B + 2D \rightarrow BD_2 + 2A \quad \Delta \hat{H}^o_{r} (\text{rxn } 1) = ? \]

given the following reaction data:

\[ A_2B + 2C \rightarrow 2AC + B \quad \Delta \hat{H}^o_{r} (\text{rxn } 2) = -7 \text{ kJ/mol} \]
\[ A_2B + 2DC \rightarrow BC_2 + 2AD \quad \Delta \hat{H}^o_{r} (\text{rxn } 3) = -10 \text{ kJ/mol} \]
\[ 2AD + BC_2 \rightarrow 2AC + BD_2 \quad \Delta \hat{H}^o_{r} (\text{rxn } 4) = 5 \text{ kJ/mol} \]
\[ A + DC \rightarrow AC + D \quad \Delta \hat{H}^o_{r} (\text{rxn } 5) = -12 \text{ kJ/mol} \]
\[ BC_2 + 2D \rightarrow BD_2 + 2C \quad \Delta \hat{H}^o_{r} (\text{rxn } 6) = -6 \text{ kJ/mol} \]
\[ BC_2 + 2D \rightarrow B + 2DC \quad \Delta \hat{H}^o_{r} (\text{rxn } 7) = -8 \text{ kJ/mol} \]

2. (30 pts) 100 moles of a 10 mol\% HCl solution at 25°C is mixed with 100 moles of 50 mol\% HCl solution at 25°C. How much heat needs to be added or removed so that the mixture comes out at 25°C?

3. (10 pts) What is the standard heat of formation of liquid methyl ethyl ketone?

4. (10 pts) What is the standard heat of combustion of vapor Phenol?
5. (40 pts) A stream containing 30 mol% $A_2B$ and 70 mol% $BC$ at 25°C is passed through a preheater at a rate of 100 mols/sec and then fed to a reactor where it undergoes the reaction, 

$$6 A_2B + 4BC \rightarrow 2AC_2 + 10AB$$

The reactor is jacketed with high pressure steam to supply heat at a rate of 3000 (kW). The effluent from reactor is then used to heat the feed in the preheater. The reactor effluent then provide heat to the feed via the preheater and then exits at a temperature 80°C. What is the fractional conversion of $A_2B$?

Data:

<table>
<thead>
<tr>
<th></th>
<th>$\Delta H^\circ$ (kJ/mol)</th>
<th>Cp (kJ/(mol °C))</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_2B$</td>
<td>-100</td>
<td>0.125</td>
</tr>
<tr>
<td>$BC$</td>
<td>-80</td>
<td>0.25</td>
</tr>
<tr>
<td>$AC_2$</td>
<td>-70</td>
<td>0.10</td>
</tr>
<tr>
<td>$AB$</td>
<td>-20</td>
<td>0.05</td>
</tr>
</tbody>
</table>

![Figure 1](image.png)

6. (Bonus: 10 pts) What is the molecular weight of the mixture obtained by adding 100 moles of 30 wt% H$_2$SO$_4$ solution in water to 300 moles of 10 wt% H$_2$SO$_4$ solution in water?