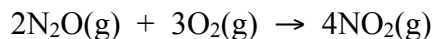


- Consider the following reaction:



Calculate  $\Delta G^\circ$  for this reaction given the following data.



**Marks**  
**3**

Using  $\Delta_r G^\circ = \sum \Delta_f G^\circ(\text{products}) - \sum \Delta_f G^\circ(\text{reactants})$ , the free energy changes in the 3 reactions are, respectively:

$$\Delta_r G^\circ(1) = 4\Delta_f G^\circ(\text{NO}_2(\text{g})) - 2\Delta_f G^\circ(\text{N}_2\text{O}(\text{g}))$$

$$\Delta_r G^\circ(2) = 2\Delta_f G^\circ(\text{N}_2\text{O}(\text{g})) - 4\Delta_f G^\circ(\text{NO}(\text{g})) = -139.56 \text{ kJ mol}^{-1}$$

$$\Delta_r G^\circ(3) = 2\Delta_f G^\circ(\text{NO}_2(\text{g})) - 2\Delta_f G^\circ(\text{NO}(\text{g})) = -69.70 \text{ kJ mol}^{-1}$$

Mathematically, the combination  $2\Delta_r G^\circ(3) - \Delta_r G^\circ(2)$  leads to  $\Delta_r G^\circ(1)$ :

$$2\Delta_r G^\circ(3) = 4\Delta_f G^\circ(\text{NO}_2(\text{g})) - 4\Delta_f G^\circ(\text{NO}(\text{g}))$$

$$\Delta_r G^\circ(2) = 2\Delta_f G^\circ(\text{N}_2\text{O}(\text{g})) - 4\Delta_f G^\circ(\text{NO}(\text{g}))$$

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$$2\Delta_r G^\circ(3) - \Delta_r G^\circ(2) = 4\Delta_f G^\circ(\text{NO}_2(\text{g})) - 2\Delta_f G^\circ(\text{N}_2\text{O}(\text{g})) = \Delta_r G^\circ(1)$$


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$$\begin{aligned} \Delta_r G^\circ(1) &= 2\Delta_r G^\circ(3) - \Delta_r G^\circ(2) = [(2 \times -69.70) - (-139.56)] \text{ kJ mol}^{-1} \\ &= 0.16 \text{ kJ mol}^{-1} \end{aligned}$$

Answer:  $0.16 \text{ kJ mol}^{-1}$