Marks

- Calculate $\Delta G°$ for the reaction: $2N_2O(g) + 3O_2(g) \rightarrow 4NO_2(g)$ **2**

Data: $4NO(g) \rightarrow 2N_2O(g) + O_2(g)$ $\Delta G° = –139.56$ kJ mol$^{–1}$

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$ $\Delta G° = –69.70$ kJ mol$^{–1}$

Using $\Delta_r G° = \sum\Delta_f G°$(products) – $\sum\Delta_f G°$(reactants), the free energy changes in the 3 reactions are, respectively:

(1) $\Delta_r G° = 4\Delta_f G°(NO_2(g)) - 2\Delta_f G°(N_2O(g))$

(2) $\Delta_r G° = 2\Delta_f G°(N_2O(g)) - 4\Delta_f G°(NO(g)) = -139.56$ kJ mol^{-1}

(3) $\Delta_r G° = 2\Delta_f G°(NO_2(g)) - 2\Delta_f G°(NO(g)) = -69.70$ kJ mol^{-1}

Taking 2 × (3) – (2) gives:

$2 \times [2\Delta_f G°(NO_2(g)) - 2\Delta_f G°(NO(g))] - [2\Delta_f G°(N_2O(g)) - 4\Delta_f G°(NO(g))]$
$= (2 \times [-69.70] – [-139.56])$ kJ mol^{-1}`

$4\Delta_f G°(NO_2(g)) - 2\Delta_f G°(N_2O(g)) = +0.16$ kJ mol^{-1}

From above, this is equal to the $\Delta_r G°$ for reaction (1) as required.

Answer: **+0.16 kJ mol^{-1}**

- Good wine will turn to vinegar if it is left exposed to air because the alcohol is oxidised to acetic acid. The equation for the reaction is: **2**

$$CH_3CH_2OH(l) + O_2(g) \rightarrow CH_3COOH(l) + H_2O(l)$$

Calculate $\Delta S°$ for this reaction in J K$^{–1}$ mol$^{–1}$.

Data:

	$S°$ (J K$^{–1}$ mol$^{–1}$)		$S°$ (J K$^{–1}$ mol$^{–1}$)
$C_2H_5OH(l)$	161	$CH_3COOH(l)$	160.
$O_2(g)$	205.0	$H_2O(l)$	69.96

Using $\Delta_r S° = \sum S°$(products) – $\sum\Delta S°$(reactants),

$\Delta_r S° = [S°(CH_3COOH(l) + S°(H_2O(l)] – [S°(CH_3CH_2OH(l) + S°(O_2)]$
$= ([160. + 69.96] – [161 + 205.0])$ J K^{-1} mol^{-1}
$= -136$ J K^{-1} mol^{-1}

Answer: **-136 J K^{-1} mol^{-1}**