Marks 3

- Consider the following reaction and associated thermochemical data?

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

Data:

Compound	$NO_2(g)$	$N_2O_4(g)$
$\Delta_f H°$ / kJ mol^{-1}	33	9
$S°$ / J K^{-1} mol^{-1}	240	304

What is the expression for the equilibrium constant, K_c, for this reaction?

$$\boldsymbol{K_c = \frac{[N_2O_4(g)]}{[NO_2(g)]^2}}$$

What are the values of $\Delta H°$ and $\Delta S°$ for the reaction?

Using $\Delta H° = \sum \Delta_f H°$(products) – $\sum \Delta_f H°$(reactants), the enthalpy change is:

$\Delta H° = 2\Delta_f H°$(products) - $\Delta_f H°$(reactants)
= (9 – 2 × 33) kJ mol^{-1} = -57 kJ mol^{-1}

Using $\Delta S° = \sum S°$(products) – $\sum S°$(reactants), the entropy change is:

$\Delta S° = 2S°$(products) - $S°$(reactants)
= (304 – 2 × 240) kJ mol^{-1} = -176 J K^{-1} mol^{-1}

$\Delta H°$ = **-57 kJ mol^{-1}**	$\Delta S°$ = **-176 J K^{-1} mol^{-1}**

What is the value of $\Delta G°$ for the reaction at 298 K?

Using $\Delta G° = \Delta H° - T\Delta H°$:

$\Delta G° = (-57 \times 10^3$ J mol^{-1}) – (298 K)(-176 J K^{-1} mol^{-1})
= -5000 J mol^{-1} = -5 kJ mol^{-1}

$\Delta G°$ = **-5 kJ mol^{-1}**

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.