$2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$

	25°C	727°C
	298 K	1000 K
$k\ (M^{-1}s^{-1})$	3.82×10^{-11}	2.64×10^{3}
K	4.65×10^{-13}	49.85

← from $\Delta H°$ & $S°$ (at 25°C) and $\Delta G°$ and K @ 1000K. -32.5
If $\Delta H°$ and $S°$ @ 1000K,
$\Delta G° = -36$ and $K = 75.95$

$A = 2\times10^{9}\ M^{-1}s^{-1}$

$E_a = 112.55\ kJ\ mol^{-1}$

at 25°C: $\Delta H° = 114.1\ kJ\ mol^{-1}$; $\Delta S° = 147\ J\ mol^{-1}\ K^{-1}$

$\Delta G°(1000K) = -32.5\ kJ\ mol^{-1}$

at 1000 K: $\Delta H° = 116.9\ kJ\ mol^{-1}$; $\Delta S° = 153\ J\ mol^{-1}\ K^{-1}$

$\Delta G°(1000K) = -36\ kJ\ mol^{-1}$

Find equilibrium concentrations at 1000K $[NO_2] = 1.0\ M$

x is too big here. I will demonstrate.

	$2NO_2(g)$	$\rightleftharpoons 2NO(g)$	$+ O_2(g)$
I	1.0	0	0
C	−2x	+2x	+x
E	1.0 − 2x	2x	x

$$\frac{[NO]^2[O_2]}{[NO_2]^2} = K$$

$$\frac{(2x)^2(x)}{(1.0-2x)^2} = 49.85$$

small x approx → $4x^3 = 49.85$

$x = 2.318$ ← unphysical! but will test anyway

Test x: $\frac{2(2.318)}{1.0}\times100\% = 463\%$ TOO BIG!

$$4x^3 = 49.85(1.0 - 4x + 4x^2)$$

$$4x^3 = 49.85 - 199.4x + 199.4x^2$$

$$4x^3 - 199.4x^2 + 199.4x - 49.85 = 0$$

$x_1 = 0.456$ $x_2 = 0.559$ $x_3 = 48.83$

$[NO_2]_{eq} = 1.0 - 2(0.456)$
$= 0.088\ M$

$[NO]_{eq} = 2(0.456)$
$= 0.912\ M$

$[O_2]_{eq} = 0.456\ M$

Can we still avoid the cubic even though small 'x' did not work?
Try starting with all products! (Convert all reactants to products). So... $[NO_2]_i = 0\ M$, $[NO]_i = 1.0\ M$, $[O_2]_i = 0.5\ M$

	$2NO_2(g)$	$\rightleftharpoons 2NO(g)$	$+ O_2(g)$
I	0	1.0	0.5
C	+2x	−2x	−x
E	2x	1.0 − 2x	0.5 − x

$$\frac{[NO]^2[O_2]}{[NO_2]^2} = K$$

$$\frac{(1.0-2x)^2(0.5-x)}{(2x)^2} = 49.85$$

$(1.0 - 4x + 4x^2)(0.5 - x) = 199.4x^2$

$0.5 - x - 2x - 4x^2 + 2x^2 - 4x^3 = 199.4x^2$

$4x^3 + 201.4x^2 + 3x - 0.5 = 0$

$x_1 = -50.3$ $x_2 = -0.05$ $x_3 = 0.0429$

small x approx → $\frac{(1.0)^2(0.5)}{(2x^2)} = 49.85$

$0.5 = 49.85(4x^2)$

$0.5 = 199.4x^2$

$x = 0.0500$

Test x (< 5%)

$\frac{2(0.0500)}{1}\times100\% = 10\%$ TOO BIG!

$\frac{2(0.0500)}{0.5}\times100\% = 20\%$ TOO BIG!

$[NO_2]_{eq} = 2(0.0429)$
$= 0.0858\ M$

$[NO]_{eq} = 1.0 - (2\cdot0.0429)$
$= 0.9142\ M$

$[O_2]_{eq} = 0.5 - 0.0429$
$= 0.457\ M$

STILL DID NOT WORK :(