Equilibrium Written Response Key:

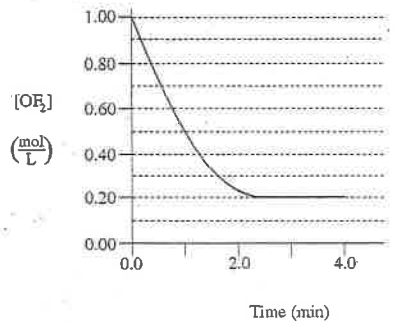
1.

2. **(4 marks)**

Consider the following equilibrium:

$$O_2(g) + 2F_2(g) \rightleftarrows 2OF_2(g)$$

Initially, OF_2 was placed in a 1.00 L container and allowed to react. The amount of OF_2 was monitored over 4.0 minutes and the following graph was produced:



Calculate the value of K_{eq}.

Solution:

For Example:

	$O_2(g)$	+	$2F_2(g)$	$\rightleftarrows$	$2OF_2(g)$
[I]	0		0		1.00 M
[C]	+0.40		+0.80 M		−0.80 M
[E]	0.40		0.80		0.20

← 2 marks

$$K_{eq} = \frac{[OF_2]^2}{[O_2][F_2]^2}$$

$$= \frac{(0.20)^2}{(0.40)(0.80)^2}$$ ← 1 mark

$$= 0.16$$ ← 1 mark

2.

2. Consider the equilibrium: $CO_2(g) + H_2(g) \rightleftarrows CO(g) + H_2O(g)$ $K_{eq} = 1.60$

Initially, 8.2 mol of CO and 8.2 mol of H_2O are placed in a 2.0 L container and allowed to react. Calculate the equilibrium concentrations of CO_2 and CO. **(4 marks)**

Solution:

For Example:

$$[CO] = [H_2O] = \frac{8.2\text{ mol}}{2.0\text{ L}} = 4.1\text{M}$$

	$CO_2(g)$	+	$H_2(g)$	$\rightleftarrows$	$CO(g)$	+	$H_2O(g)$
[I]	0		0		4.1		4.1
[C]	$+x$		$+x$		$-x$		$-x$
[E]	x		x		$4.1-x$		$4.1-x$

← 1 mark

$$K_{eq} = \frac{[CO][H_2O]}{[CO_2][H_2]}$$

$$\sqrt{1.60} = \sqrt{\frac{(4.1-x)^2}{x^2}}$$ ← 1 mark

$x = 1.8$ ← 1 mark

$[CO_2] = 1.8\text{ M}$, $[CO] = 4.1 - x = 2.3\text{M}$ ← 1 mark

3.

2. Consider the following equilibrium:

$$N_{2(g)} + O_{2(g)} \rightleftarrows 2NO_{(g)} \qquad K_{eq} = 8.1 \times 10^{-3}$$

A 2.0 L container is filled with 0.15 mol N_2, 0.15 mol O_2 and 0.050 mol NO. Does the [NO] increase or decrease as equilibrium is established? Support your answer with appropriate calculations. (4 marks)

Solution:

For Example:

$K_{eq} = \dfrac{[NO]^2}{[N_2][O_2]} = 8.1 \times 10^{-3}$ ← $\frac{1}{2}$ mark

Trial $K_{eq} = \dfrac{(0.025)^2}{(0.075)(0.075)} = 0.11$ ← $1\frac{1}{2}$ marks

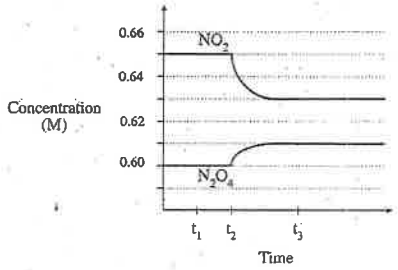
Trial $K_{eq} > K_{eq}$ so reaction proceeds to the left ← 1 mark

[NO] decreases ← 1 mark

4.

2. Consider the following diagram for the equilibrium:

$$N_2O_{4(g)} \rightleftarrows 2NO_{2(g)} \qquad \Delta H = +59\ kJ$$



a) Calculate the value of K_{eq} at t_1. (1 mark)

Solution:

For Example:

$K_{eq} = \dfrac{[NO_2]^2}{[N_2O_4]} = \dfrac{(0.65)^2}{0.60} = 0.70$ } ← 1 mark

b) Calculate the value of K_{eq} at t_3. (1 mark)

Solution:

For Example:

$K_{eq} = \dfrac{(0.63)^2}{0.61} = 0.65$ } ← 1 mark

c) What stress was applied at time t_2 ? Explain. (2 marks)

Solution:

For Example:

Stress: Temperature was decreased ← 1 mark

Explanation: because K_{eq} decreased. ← 1 mark

The appearance of the graph is consistent with a temperature shift.