



AP[®] Chemistry 2003 Sample Student Responses Form B

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1A,

CHEMISTRY
Section II
(Total time—90 minutes)

Part A
Time—40 minutes
YOU MAY USE YOUR CALCULATOR FOR PART A.

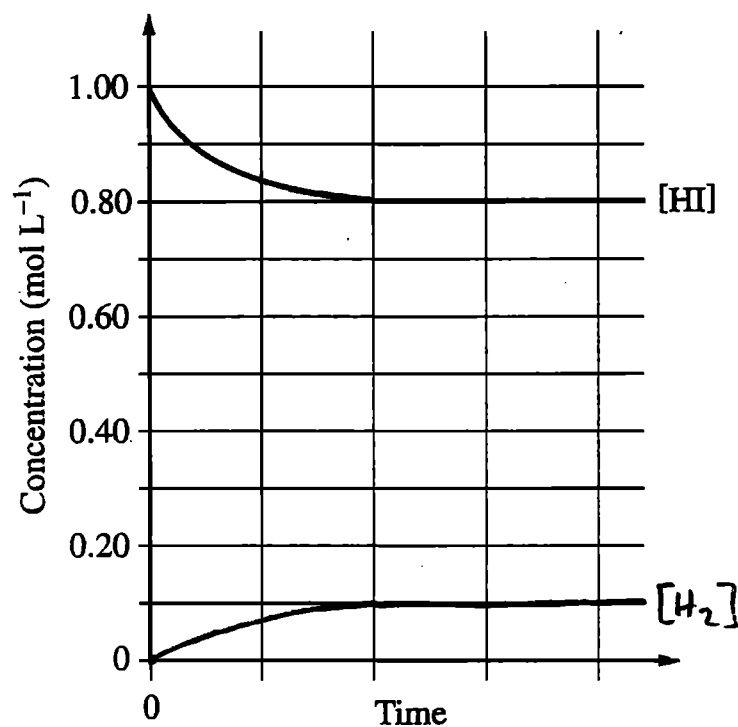
CLEARLY SHOW THE METHOD USED AND THE STEPS INVOLVED IN ARRIVING AT YOUR ANSWERS. It is to your advantage to do this, since you may obtain partial credit if you do and you will receive little or no credit if you do not. Attention should be paid to significant figures.

Be sure to write all your answers to the questions on the lined pages following each question in this booklet. Do NOT write your answers on the lavender insert.

Answer Question 1 below. The Section II score weighting for this question is 20 percent.



1. After a 1.0 mole sample of $\text{HI}(g)$ is placed into an evacuated 1.0 L container at 700. K, the reaction represented above occurs. The concentration of $\text{HI}(g)$ as a function of time is shown below.



- (a) Write the expression for the equilibrium constant, K_c , for the reaction.
- (b) What is $[\text{HI}]$ at equilibrium?

GO ON TO THE NEXT PAGE.

1A₂

- (c) Determine the equilibrium concentrations of $\text{H}_2(\text{g})$ and $\text{I}_2(\text{g})$.
- (d) On the graph above, make a sketch that shows how the concentration of $\text{H}_2(\text{g})$ changes as a function of time.
- (e) Calculate the value of the following equilibrium constants at 700. K.
- (i) K_c
- (ii) K_p
- (f) At 1,000 K, the value of K_c for the reaction is 2.6×10^{-2} . In an experiment, 0.75 mole of $\text{HI}(\text{g})$, 0.10 mole of $\text{H}_2(\text{g})$, and 0.50 mole of $\text{I}_2(\text{g})$ are placed in a 1.0 L container and allowed to reach equilibrium at 1,000 K. Determine whether the equilibrium concentration of $\text{HI}(\text{g})$ will be greater than, equal to, or less than the initial concentration of $\text{HI}(\text{g})$. Justify your answer.

$$a) K_c = \frac{[\text{I}_2][\text{H}_2]}{[\text{HI}]^2}$$

$$b) [\text{HI}] = 0.80 \text{ M}$$

$$c) n(\text{H}_2) = n(\text{I}_2) = n(\text{HI}) \div 2 = CV/2 = \frac{(0.20)(1.0)}{2} = 0.10 \text{ mol}$$

$$\Rightarrow [\text{I}_2] = [\text{H}_2] = \frac{n}{V} = \frac{0.10}{1.0} = \boxed{0.10 \text{ M}}$$

$$e) i) K_c = \frac{[0.10][0.10]}{[0.80]^2} = 0.015625 = \boxed{16. \times 10^{-3}}$$

$$ii) K_p = K_c (RT)^{\Delta n} = 0.015625 (0.0821 \times 700)^{(2-2)} = \boxed{16. \times 10^{-3}}$$

$$f) Q = \frac{(0.50)(0.10)}{(0.75)^2} = \frac{4}{45} = \boxed{8.9 \times 10^{-2}}$$

$Q > K_c$ therefore the backward reaction is favoured to reach equilibrium $\Rightarrow [\text{HI}]$ will increase $\Rightarrow [\text{HI}] > \text{initial}$

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1 B₁

CHEMISTRY
Section II
(Total time—90 minutes)

Part A
Time—40 minutes
YOU MAY USE YOUR CALCULATOR FOR PART A.

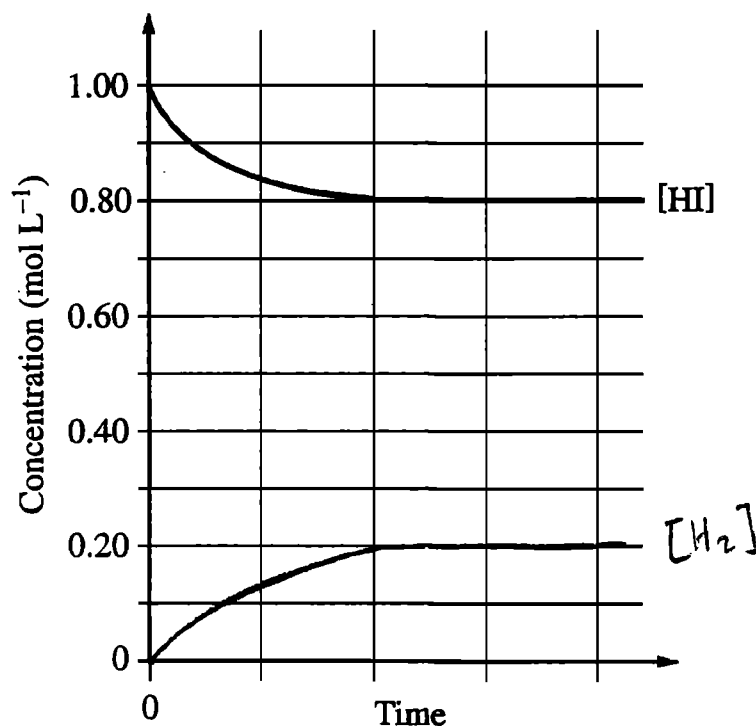
CLEARLY SHOW THE METHOD USED AND THE STEPS INVOLVED IN ARRIVING AT YOUR ANSWERS. It is to your advantage to do this, since you may obtain partial credit if you do and you will receive little or no credit if you do not. Attention should be paid to significant figures.

Be sure to write all your answers to the questions on the lined pages following each question in this booklet. Do NOT write your answers on the lavender insert.

Answer Question 1 below. The Section II score weighting for this question is 20 percent.



1. After a 1.0 mole sample of $\text{HI}(g)$ is placed into an evacuated 1.0 L container at 700. K, the reaction represented above occurs. The concentration of $\text{HI}(g)$ as a function of time is shown below.



- (a) Write the expression for the equilibrium constant, K_c , for the reaction.
- (b) What is $[\text{HI}]$ at equilibrium?

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1 B 2

- (c) Determine the equilibrium concentrations of $H_2(g)$ and $I_2(g)$.
- (d) On the graph above, make a sketch that shows how the concentration of $H_2(g)$ changes as a function of time.
- (e) Calculate the value of the following equilibrium constants at 700. K.
- (i) K_c
- (ii) K_p
- (f) At 1,000 K, the value of K_c for the reaction is 2.6×10^{-2} . In an experiment, 0.75 mole of $HI(g)$, 0.10 mole of $H_2(g)$, and 0.50 mole of $I_2(g)$ are placed in a 1.0 L container and allowed to reach equilibrium at 1,000 K. Determine whether the equilibrium concentration of $HI(g)$ will be greater than, equal to, or less than the initial concentration of $HI(g)$. Justify your answer.

A) $K_c = \frac{[H_2][I_2]}{[HI]^2}$

B) Using the graph, the concentration of HI is 0.80 mol L^{-1}

C) $[H_2] = [I_2] = x$

$$x = 1.0 \text{ mol L}^{-1} - 0.80 \text{ mol L}^{-1}$$

$$= 0.2 \text{ mol L}^{-1}$$

e) $K_c = \frac{(0.2)^2}{(0.8)^2}$

$$= 0.06$$

$$= 6 \times 10^{-2}$$

~~D)~~

$$K_p = K_c (RT)^{\Delta n}$$

$$= 6 \times 10^{-2} (8.31 \cdot 700 \text{ K})^{2-2}$$



$$= 6 \times 10^{-2}$$

$$K_c = \frac{[H_2][I_2]}{[HI]^2}$$

$$= \frac{0.10 \times 0.50}{(0.75)^2}$$

$$= 0.089$$

$$= 8.9 \times 10^{-2}$$

This is higher than the K_c given which means the

~~concentr~~ the reverse reaction is favored to increase the

concentration of HI to keep the constant, 2.6×10^{-2} .

Thus, the concentration of HI is greater than the initial concentration.

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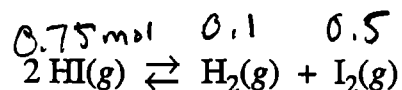
CHEMISTRY
Section II
(Total time—90 minutes)

Part A
Time—40 minutes
YOU MAY USE YOUR CALCULATOR FOR PART A.

CLEARLY SHOW THE METHOD USED AND THE STEPS INVOLVED IN ARRIVING AT YOUR ANSWERS. It is to your advantage to do this, since you may obtain partial credit if you do and you will receive little or no credit if you do not. Attention should be paid to significant figures.

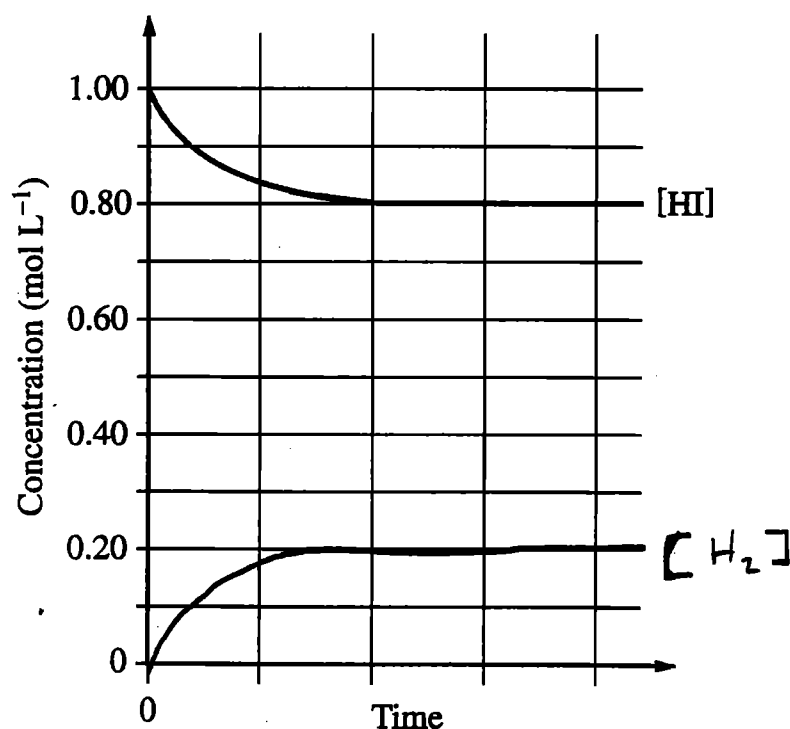
Be sure to write all your answers to the questions on the lined pages following each question in this booklet. Do NOT write your answers on the lavender insert.

Answer Question 1 below. The Section II score weighting for this question is 20 percent.



1,000%
1.0 L

1. After a 1.0 mole sample of HI(g) is placed into an evacuated 1.0 L container at 700. K, the reaction represented above occurs. The concentration of HI(g) as a function of time is shown below.



- (a) Write the expression for the equilibrium constant, K_c , for the reaction.
- (b) What is [HI] at equilibrium?

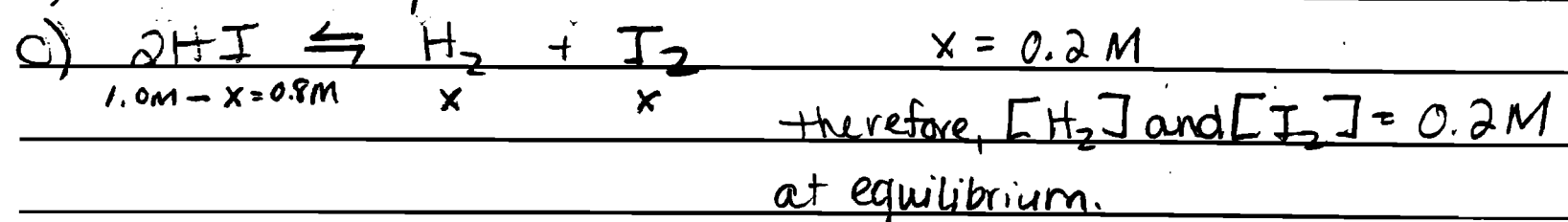
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1C₂

- (c) Determine the equilibrium concentrations of H₂(g) and I₂(g).
- (d) On the graph above, make a sketch that shows how the concentration of H₂(g) changes as a function of time.
- (e) Calculate the value of the following equilibrium constants at 700. K.
 - (i) K_c
 - (ii) K_p
- (f) At 1,000 K, the value of K_c for the reaction is 2.6 × 10⁻². In an experiment, 0.75 mole of HI(g), 0.10 mole of H₂(g), and 0.50 mole of I₂(g) are placed in a 1.0 L container and allowed to reach equilibrium at 1,000 K. Determine whether the equilibrium concentration of HI(g) will be greater than, equal to, or less than the initial concentration of HI(g). Justify your answer.

$$a) K_c = \frac{[H_2][I_2]}{[HI]}$$

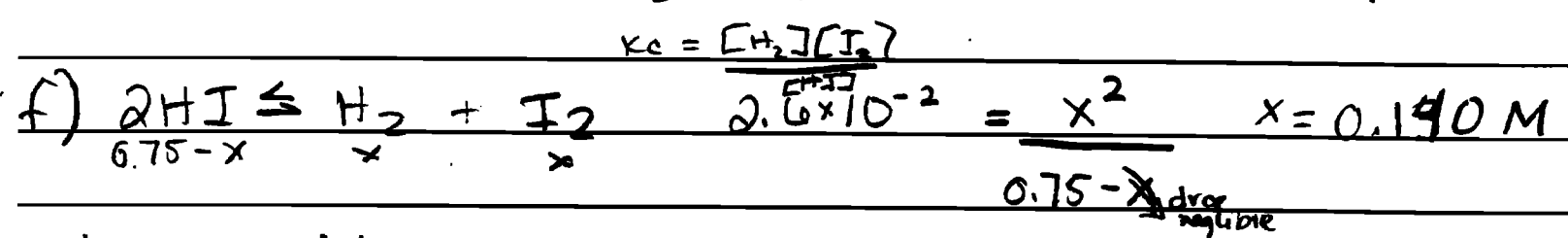
$$b) [HI] \text{ at equilibrium} = 0.80 M$$



$$e) (i) K_c = \frac{[0.2M][0.2M]}{[1.0M - 0.2M]} = 0.05 = K_c$$

$$(ii) K_p = K_c (RT)^{\Delta n} \quad \Delta n = (2 \text{ mols}) - (2 \text{ mols}) = 0$$

$$K_p = (0.05) \left(8.31 \frac{J}{mol \cdot K} \right) (700K)^0 \quad K_p = (0.05)(1) = 0.05 = K_p \text{ also}$$



This would decrease the molarity because 0.140 M would be subtracted from 0.75 M.