AP Chemistry
2000 Student Samples

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A1

Part A
Time—40 minutes

YOU MAY USE YOUR CALCULATOR FOR PART A.

CLEARLY SHOW THE METHOD USED AND STEPS INVOLVED IN ARRIVING AT YOUR ANSWERS. It is to your advantage to do this, because you may earn 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.

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

$$2\,H_2S(g) \rightleftarrows 2\,H_2(g) + S_2(g)$$

1. When heated, hydrogen sulfide gas decomposes according to the equation above. A 3.40 g sample of $H_2S(g)$ is introduced into an evacuated rigid 1.25 L container. The sealed container is heated to 483 K, and 3.72×10^{-2} mol of $S_2(g)$ is present at equilibrium.

(a) Write the expression for the equilibrium constant, K_c, for the decomposition reaction represented above.

(b) Calculate the equilibrium concentration, in mol L^{-1}, of the following gases in the container at 483 K.

(i) $H_2(g)$

(ii) $H_2S(g)$

(c) Calculate the value of the equilibrium constant, K_c, for the decomposition reaction at 483 K.

(d) Calculate the partial pressure of $S_2(g)$ in the container at equilibrium at 483 K.

(e) For the reaction $H_2(g) + \frac{1}{2}\,S_2(g) \rightleftarrows H_2S(g)$ at 483 K, calculate the value of the equilibrium constant, K_c.

1. a) $K_c = \dfrac{[H_2]^2[S_2]}{[H_2S]^2}$

b) 3.40 g H_2S | 1 mol H_2S / 34.0758 g H_2S | .0998 mol H_2S initially

For every mole of S_2 produced, 2 moles of H_2 are produced and 2 moles of H_2S disappear

ADDITIONAL PAGE FOR ANSWERING QUESTION 1.

i. $[H_2] = \frac{3.72 \times 10^{-2} \text{ mol} \times 2}{1.25 \text{ L}} = .0595 \text{ M}$ (at equilibrium)

ii mol $H_2S = .0998 \text{ mol} - 3.72 \times 10^{-2} \times 2 = .0254 \text{ mol}$ (at eq)

$[H_2S] = \frac{.0254 \text{ mol}}{1.25 \text{ L}} = .0203 \text{ M}$

c. $K_c = \frac{[H_2]^2[S_2]}{[H_2S]^2} = \frac{[.0595]^2 (3.72 \times 10^{-2}/1.25)}{(.0203)^2} = .256$

d. $PV = nRT \qquad P = \frac{nRT}{V}$

$P_{S_2} = \frac{3.72 \times 10^{-2} \text{ mol} \quad .0821 \text{ L atm mol}^{-1}\text{K}^{-1} \quad 483 \text{ K}}{1.25 \text{ L}}$

$= 1.18 \text{ atm}$

e. $K_c = \frac{[H_2S]}{[S_2]^{\frac{1}{2}}[H_2]} = \frac{1}{\left(\frac{[H_2][S_2]^{\frac{1}{2}}}{[H_2S]}\right)} = \frac{1}{\left(\frac{[H_2]^2[S_2]}{[H_2S]}\right)^{\frac{1}{2}}}$

$K_c = \frac{1}{(.256)^{\frac{1}{2}}} = 1.98$

GO ON TO THE NEXT PAGE.

B1

CHEMISTRY—SECTION II
(Total time—90 minutes)

Part A
Time—40 minutes

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   (d) Calculate the partial pressure of $S_2(g)$ in the container at equilibrium at 483 K.

   (e) For the reaction $H_2(g) + \frac{1}{2}\,S_2(g) \rightleftarrows H_2S(g)$ at 483 K, calculate the value of the equilibrium constant, K_c.

A $K_c = \dfrac{[H_2]^2[S_2]}{[H_2S]^2}$

B) $n_{H_2S} = 34.0$ g $\quad [H_2S]_0 = \left(\frac{3.4}{34.0}\right)/1.25 = 0.08$ M

	$2H_2S$	$\rightleftarrows 2H_2$	$+S_2$
$[\,]_0$	.08	0	0
$\Delta[\,]$	-2(.0298)	2(.0298)	+.0298
$[\,]_{eq}$	.0204	.0596	.0298

i $[H_2] = 0.0596$ M

ii $[H_2S] = 0.020$ M

ADDITIONAL PAGE FOR ANSWERING QUESTION 1.

C) $K_c = \frac{0.0596^2 \cdot 0.0372}{0.020^2}$

$K_c = \boxed{.330}$

D) $PV = nRT$

$P = \frac{nRT}{V}$

$P = \frac{3.72\times10^{-2}(.0821)(483)}{1.25L}$

$P = \boxed{1.18\ atm}$

E) $K_c = \frac{[H_2S]}{[H_2][S_2]^{1/2}}$

$K = \frac{[.08]}{[.02][.0372]^{1/2}} = \boxed{20.74}$

C1

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Time—40 minutes

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(d) Calculate the partial pressure of $S_2(g)$ in the container at equilibrium at 483 K.

(e) For the reaction $H_2(g) + \frac{1}{2} S_2(g) \rightleftarrows H_2S(g)$ at 483 K, calculate the value of the equilibrium constant, K_c.

(a) $K_c = \dfrac{[H_2]^2[S_2]}{[H_2S]^2}$

	$2H_2S$	$\rightleftarrows$ $2H_2$	S_2
(b) Initial	0.8M	0	0
Change	$-2x$	$+2x$	$+x$
Equilibrium	.74048	0.05952	0.02976

MM $H_2S = 2+32$ $3.4 \times \frac{1}{34} = 0.1$ moles $/1.25L$ $.0372/1.25$

ADDITIONAL PAGE FOR ANSWERING QUESTION 1.

(i) $[H_2] = 0.060$

(ii) $[S_2] = 0.030$

(c) $K_c = \frac{[0.06]^2[0.03]}{[0.24]^2} = 1.972 \times 10^{-4}$

(d) $P_A = P_{total} \cdot X_2 \quad X_n = \frac{\text{moles A}}{\text{moles total}}$

(e) $H_2(g) + \frac{1}{2} S_2(g) \rightleftharpoons H_2S(g)$ @ 438K

equilibrium constant: $K_{c_{reverse}} = \frac{1}{K_c} \quad K_c = \frac{[3.024]}{[0.05][0.015]^{1/2}}$

$K_c = 100.77$