

AP[®] CHEMISTRY
2008 SCORING GUIDELINES (Form B)

Question 1

Answer the following questions regarding the decomposition of arsenic pentafluoride, $\text{AsF}_5(g)$.

(a) A 55.8 g sample of $\text{AsF}_5(g)$ is introduced into an evacuated 10.5 L container at 105°C .

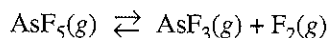
(i) What is the initial molar concentration of $\text{AsF}_5(g)$ in the container?

$\text{mol AsF}_5 = 55.8 \text{ g AsF}_5 \times \frac{1 \text{ mol AsF}_5}{169.9 \text{ g AsF}_5} = 0.328 \text{ mol}$ $[\text{AsF}_5]_i = \frac{0.328 \text{ mol AsF}_5}{10.5 \text{ L}} = 0.0313 \text{ M}$	<p>One point is earned for the correct molar mass.</p> <p>One point is earned for the correct concentration.</p>
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(ii) What is the initial pressure, in atmospheres, of the $\text{AsF}_5(g)$ in the container?

$PV = nRT$ $P = \frac{0.328 \text{ mol} \times 0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1} \times 378 \text{ K}}{10.5 \text{ L}} = 0.969 \text{ atm}$	<p>One point is earned for the correct substitution.</p> <p>One point is earned for the correct pressure.</p>
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At 105°C , $\text{AsF}_5(g)$ decomposes into $\text{AsF}_3(g)$ and $\text{F}_2(g)$ according to the following chemical equation.



(b) In terms of molar concentrations, write the equilibrium-constant expression for the decomposition of $\text{AsF}_5(g)$.

$K = \frac{[\text{AsF}_3][\text{F}_2]}{[\text{AsF}_5]}$	<p>One point is earned for the correct equation.</p>
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(c) When equilibrium is established, 27.7 percent of the original number of moles of $\text{AsF}_5(g)$ has decomposed.

(i) Calculate the molar concentration of $\text{AsF}_5(g)$ at equilibrium.

$100.0\% - 27.7\% = 72.3\%$ $[\text{AsF}_5] = 0.723 \times 0.0313 \text{ M} = 0.0226 \text{ M}$	<p>One point is earned for the correct concentration.</p>
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Question 1 (continued)

(ii) Using molar concentrations, calculate the value of the equilibrium constant, K_{eq} , at 105°C.

$[\text{AsF}_3] = [\text{F}_2] = 0.277 \times [\text{AsF}_5]$ $= 0.277 \times 0.0313 \text{ M} = 0.00867 \text{ M}$ $K_{eq} = \frac{[\text{AsF}_3][\text{F}_2]}{[\text{AsF}_5]} = \frac{[0.00867][0.00867]}{[0.0226]} = 0.00333$	<p>One point is earned for setting $[\text{AsF}_3] = [\text{F}_2]$.</p> <p><u>Note:</u> the point is not earned if the student indicates that $[\text{AsF}_3] = [\text{F}_2] = [\text{AsF}_5]$.</p> <p>One point is earned for the correct calculation of $[\text{AsF}_3]$ and $[\text{F}_2]$.</p> <p>One point is earned for the correct calculation of K_{eq}.</p>
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(d) Calculate the mole fraction of $\text{F}_2(\text{g})$ in the container at equilibrium.

$\text{mol AsF}_5 = 0.0226 \text{ M} \times 10.5 \text{ L} = 0.237 \text{ mol}$ $\text{mol F}_2 = \text{mol AsF}_3 = 0.00867 \text{ M} \times 10.5 \text{ L} = 0.0910 \text{ mol}$ $\text{mol fraction F}_2 = \frac{\text{mol F}_2}{\text{mol F}_2 + \text{mol AsF}_3 + \text{mol AsF}_5}$ $= \frac{0.0910}{0.0910 + 0.0910 + 0.237} = 0.217$ <p>OR</p> $\text{mol fraction F}_2 = \frac{0.00864}{0.00864 + 0.00864 + 0.0226} = 0.217$	<p>One point is earned for the correct calculation of the mole fraction of $\text{F}_2(\text{g})$.</p>
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