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| Chemistry 504 | April 2018 | Name: |  |  |  |  |  |
| ***I.C.E. TABLE PRACTICE SHEET*** | First name |  | Last Name (required) |  | Group # |

1. 3.00 moles of N2 gas and 1.00 mole of H2 gas are combined in a 1.00 L reaction vessel. At equilibrium 0.663 moles of H2 remain. What are the resulting concentrations? What is the Kc value of this reaction?

**N2(g) + 3H2(g) ⇔ 2 NH3(g)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **N2(g)** | **H2(g)** | **NH3(g)** |
| I |  |  |  |
| C |  |  |  |
| E |  |  |  |

 Calculation of Kc

2. Find the equilibrium constant, Kc, for the following equilibrium. The initial concentrations of AB and A2D are 0.30 M before they are mixed and when equilibrium is reached, the equilibrium concentration of A2D is 0.20 M. Use an ICE table for your calculation.

**2 AB (g) + C2D (s) ↔ A2D (g) + 2 CB (s)**

3. At 650°C, the reaction below has a Kcvalue of 0.771. If 2.00 mol of both hydrogen and carbon dioxide are placed in a 4.00 L container and allowed to react, what will be the equilibrium concentrations of all four gases?

H2 (g) + CO2 (g) ↔ CO(g) + H2O (g)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | H2 (g) | CO2 (g) | CO(g) | H2O (g) |
| I |  |  |  |  |
| C |  |  |  |  |
| E |  |  |  |  |

4. For the system, if we start with 0.010 mol/L of H2 and I2 and 0.096 mol/L of HI, what are their concentrations at equilibrium given that Kc = 0.016?

2HI(g) ↔ H2 (g) + I2 (g)

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| Chemistry 504 | April 2018 | Name: | **ANSWER** |  | **KEY** |
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1. 3.00 moles of N2 gas and 1.00 mole of H2 gas are combined in a 1.00 L reaction vessel. At equilibrium 0.663 moles of H2 remain. What are the resulting concentrations? What is the Kc value of this reaction?

**N2(g) + 3H2(g) ⇔ 2 NH3(g)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **N2(g)** | **3 H2(g)** | **2 NH3(g)** |
| I | **3.00 mol/L** | **1.00 mol/L** | **0 mol/L** |
| C | **-0.112 mol/L** | **-0.337 mol/L** | **0.225 mol/L** |
| E | **2.88 mol/L** | **0.663 mol/L** | **0.225 mol/L** |

 Calculation of Kc

$$K\_{c}= \frac{[NH\_{3}]^{2}}{\left[N\_{2}\right][H\_{2}]^{3}} = \frac{(0.225\frac{mol}{L})^{2}}{(2.88\frac{mol}{L})(0.663\frac{mol}{L})^{3}} = \frac{0.0506 \frac{mol^{2}}{L^{2}}}{0.839 \frac{mol^{4}}{L^{4}}} = 0.0603 \frac{L^{2}}{mol^{2}}$$

So, Kc = 6.03 × 10 -2 (unit is not required)

2. Find the equilibrium constant, Kc, for the following equilibrium. The initial concentrations of AB and A2D are 0.30 M before they are mixed and when equilibrium is reached, the equilibrium concentration of A2D is 0.20 M. Use an ICE table for your calculation.

**2 AB (g) + C2D (s) ↔ A2D (g) + 2 CB (s)**

|  |  |  |
| --- | --- | --- |
|  | 2 AB | A2D |
| **I** | 0.30 mol/L | 0.30 mol/L |
| **C** | +0.20 mol/L | -0.10 mol/L |
| **E** | 0.50 mol/L | 0.20 mol/L |

$K\_{c}= \frac{[A\_{2}D]}{[AB]^{2}} = \frac{(0.20\frac{mol}{L})}{(0.50\frac{mol}{L})^{2}} = \frac{0.20 \frac{mol}{L}}{0.25 \frac{mol^{2}}{L^{2}}} = 0.80 \frac{L}{mol}$(unit not required)

This is a tricky one. You can ignore the two columns of the solid ingredients; they will have no effect on Kc. We are told in the problem that was some product before the reaction began, so we cannot assume it to be zero. When you work out the change for the A2D it is negative, even though it is supposedly a product. This means that the change for AB is the negative of a negative (ie. It’s positive!) The setup for Kc is still the same, though, with [A2D] on top and [AB] on the bottom.

3. At 650°C, the reaction below has a Kcvalue of 0.771. If 2.00 mol of both hydrogen and carbon dioxide are placed in a 4.00 L container and allowed to react, what will be the equilibrium concentrations of all four gases?

H2 (g) + CO2 (g) ↔ CO(g) + H2O (g)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | H2 (g) | CO2 (g) | CO(g) | H2O (g) |
| I | **0.500 mol/L** | **0.500 mol/L** | **0.00 mol/L** | **0.00 mol/L** |
| C | **-x** | **-x** | **x** | **+x** |
| E | **(0.500-x) mol/L** | **(0.500-x) mol/L** | **x mol/L** | **x mol/L** |

$$K\_{c}= \frac{\left[CO\right]\left[H\_{2}O\right]}{\left[H\_{2}\right]\left[CO\_{2}\right]} ∴ 0.771=\frac{\left[x\right]\left[x\right]}{\left[(0.500-x\right]\left[0.500-x\right]} $$

$$0.771= \frac{x^{2}}{(0.500-x)^{2}} or √0.771= \frac{x^{}}{(0.500-x)^{}}$$

$$0.771 (0.500-x)^{2}= x^{2} \sqrt{0}.771\left(0.500-x\right)=x$$

$0.771\left(0.25-1.00x+x^{2}\right)=x^{2}$ **0.439-0.878x = x**

$-0.229x^{2}-0.771x+0.193=0$ **x = 0.234**

Use quadratic formula to find solutions: x=-3.60 and **x=0.234** (only the second is valid)

The concentration of hydrogen (H2) and carbon dioxide (CO2) will both be **0.266 mol/L**

The concentration of carbon monoxide (CO) and water (H2O) will both be **0.234 mol/L**

4. For the system, if we start with 0.010 mol/L of H2 and I2 and 0.096 mol/L of HI, what are their concentrations at equilibrium given that Kc = 0.016?

2HI(g) ↔ H2 (g) + I2 (g)

|  |  |  |  |
| --- | --- | --- | --- |
|  | 2 HI | H2 | I2 |
| I | 0.096 mol/L | 0.010 mol/L | 0.010 mol/L |
| C | -2x | + x | + x |
| E | 0.096 - 2x mol/L | 0.010 + x mol/L | 0.010 + x mol/L |

$$K\_{c}= \frac{\left[H\_{2}\right]\left[I\_{2}\right]}{\left[HI\right]^{2}} ∴ 0.016=\frac{\left[0.01+x\right]^{2}}{\left[(0.096-2x\right]^{2}}$$

**0.016(0.096-2x)2=(0.010+x)2**

**0.016(0.00922 - 0.384x + 4x2) = 0.00010 + 0.02x + x2**

**0.000148-0.00614x + 0.064x2= 0.00010 + 0.02x + x2**

**0.936x2 + 0.0261x - 0.000048 = 0**

**Solutions to the quadratic formula: x = 0.00173** or x= -0.0296 **(only the first is valid)**

The concentration of hydrogen (H2) and iodine (I2) are both 0.01+0.00173 = **0.012 mol/L**

The concentration of hydrogen iodide (HI) is 0.096 – (2×0.00173) = **0.094 mol/L**