

This print-out should have 16 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

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**001 10.0 points**

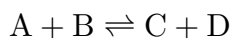
What is the main overall driving force for any spontaneous reaction or change? Consider only the reaction system, not the surroundings.

1. To maximize electrostatic interactions.
2. To release heat energy.
3. To obey the laws of gravity.
4. To maximize entropy.
5. To lower the available free energy.

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**002 10.0 points**

When the chemical reaction



is at equilibrium,

1. the forward reaction has stopped.
2. the sum of the concentrations of A and B equals the sum of the concentrations of C and D.
3. both the forward and reverse reactions have stopped.
4. the reverse reaction has stopped.
5. neither the forward nor the reverse reactions have stopped.
6. all four concentrations are equal.

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**003 10.0 points**

Explain why equilibrium constants are dimensionless.

1. Every concentration or pressure that enters into  $K_c$  or  $K_p$  is really divided by the cor-

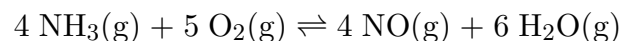
responding concentration or pressure of the substance in its standard state.

2. They are dimensionless because the pressures or concentrations we put in are all for the substances in their standard states.
3. They are dimensionless because concentrations and pressures have no units.
4. The statement is not true. Equilibrium constants have units that involve some multiple of atmospheres or moles per liter.
5. They are not really dimensionless but we must treat them as such in order to be able to take  $\ln K$  in the expression  $\Delta G^0 = -RT \ln K$ .

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**004 10.0 points**

The expression for  $K_c$  for the reaction at equilibrium is



1.  $[\text{NH}_3]^4 [\text{O}_2]^5$
2.  $\frac{[\text{NH}_3]^4 [\text{O}_2]^5}{[\text{NO}]^4 [\text{H}_2\text{O}]^6}$
3.  $[\text{NO}]^4 [\text{H}_2\text{O}]^6$
4.  $\frac{[\text{NO}]^4 [\text{H}_2\text{O}]^6}{[\text{NH}_3]^4 [\text{O}_2]^5}$

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**005 10.0 points**

Consider the following reactions at 25°C:

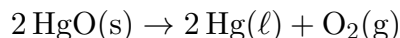
<u>reaction</u>	<u><math>K_c</math></u>
$2 \text{NO}(\text{g}) \rightleftharpoons \text{N}_2(\text{g}) + \text{O}_2(\text{g})$	$1 \times 10^{30}$
$2 \text{H}_2\text{O}(\text{g}) \rightleftharpoons 2 \text{H}_2(\text{g}) + \text{O}_2(\text{g})$	$5 \times 10^{-82}$
$2 \text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2 \text{CO}_2(\text{g})$	$3 \times 10^{91}$

Which compound is most likely to dissociate and give  $\text{O}_2(\text{g})$  at 25°C?

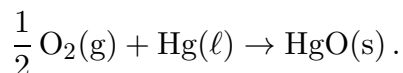
1. NO
2.  $\text{CO}_2$
3. CO

4. H<sub>2</sub>O**006 10.0 points**

At 600°C, the equilibrium constant for the reaction



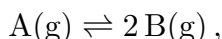
is 2.8. Calculate the equilibrium constant for the reaction



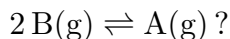
1. -1.7
2. 0.36
3. 1.1
4. 1.7
5. 0.60

**007 10.0 points**

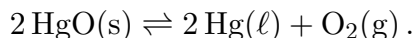
If  $K_c = 7.63 \times 10^5$  for the reaction



what is  $K_c$  for the reaction written as

**008 10.0 points**

Consider the reaction

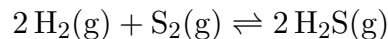


What is the form of the equilibrium constant  $K_c$  for the reaction?

1.  $K_c = [\text{O}_2]$
2.  $K_c = \frac{[\text{Hg}]^2 [\text{O}_2]}{[\text{HgO}]^2}$
3.  $K_c = \frac{[\text{O}_2]}{[\text{HgO}]^2}$
4. None of the other answers is correct.

5.  $K_c = [\text{Hg}]^2 [\text{O}_2]$ **009 10.0 points**

$K_c = 2.6 \times 10^8$  at 825 K for the reaction



The equilibrium concentration of H<sub>2</sub> is 0.0020 M and that of S<sub>2</sub> is 0.0010 M. What is the equilibrium concentration of H<sub>2</sub>S?

1. 1.02 M
2. 0.10 M
3. 0.0010 M
4. 10 M

**010 10.0 points**

A mixture of PCl<sub>5</sub>(g) and Cl<sub>2</sub>(g) is placed into a closed container. At equilibrium it is found that [PCl<sub>5</sub>] = 0.71 M, [Cl<sub>2</sub>] = 0.25 M and [PCl<sub>3</sub>] = 0.11 M.

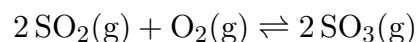


What is the value of  $K_c$  for the reaction?

1. 0.0387324
2. 46
3. 0.0774648
4. 0.0193662
5. 0.116197

**011 10.0 points**

At 1000 K the equilibrium pressure of the three gases in one mixture



were found to be 0.562 atm SO<sub>2</sub>, 0.101 atm O<sub>2</sub>, and 0.332 atm SO<sub>3</sub>. Calculate the value of  $K_p$  for the reaction as written.

1. 0.171

2. 0.289

3. 5.83

4. 2.64

5. 3.46

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**012 10.0 points**

A 2.000 liter vessel is filled with 4.000 moles of  $\text{SO}_3$  and 6.000 moles of  $\text{O}_2$ . When the reaction



comes to equilibrium a measurement shows that only 1.000 mole of  $\text{SO}_3$  remains. How many moles of  $\text{O}_2$  are in the vessel at equilibrium?

1. 7.500 mol

2. 7.000 mol

3. 12.000 mol

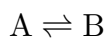
4. 3.750 mol

5. None of these is correct.

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**013 10.0 points**

Suppose the reaction



has an equilibrium constant of 1.0 and the initial concentrations of A and B are 0.5 M and 0.0 M, respectively. Which of the following is the correct value for the final concentration of A?

1. 0.250 M

2. 1.00 M

3. None of these is correct.

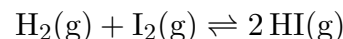
4. 0.500 M

5. 1.50 M

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**014 10.0 points**

Suppose the reaction



has an equilibrium constant  $K_c = 49$  and the initial concentration of  $\text{H}_2$  and  $\text{I}_2$  is 0.5 M and  $\text{HI}$  is 0.0 M. Which of the following is the correct value for the final concentration of  $\text{HI}(\text{g})$ ?

1. 0.219 M

2. 0.778 M

3. 0.599 M

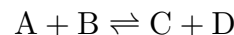
4. 0.389 M

5. 0.250 M

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**015 10.0 points**

At  $T = 700^\circ\text{C}$ ,  $K_c = 121$  for the gas-phase reaction



Starting with 1.72 moles each of A and B in a 5.00 liter container, what will be the equilibrium concentration of C at this temperature?

Answer in units of M

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**016 10.0 points**

Consider the reaction



If the initial concentration of  $\text{Ni}(\text{CO})_4(\text{g})$  is 1.0 M, and  $x$  is the equilibrium concentration of  $\text{CO}(\text{g})$ , what is the correct equilibrium relation?

$$1. K_c = \frac{x}{1.0 - \frac{x}{4}}$$

$$2. K_c = \frac{x^5}{1.0 - \frac{x}{4}}$$

$$3. K_c = \frac{x^4}{1.0 - \frac{x}{4}}$$

$$4. K_c = \frac{x^4}{1.0 - 4x}$$

$$5. K_c = \frac{4x}{1.0 - 4x}$$