Chem 1020 Sample Challenge Questions for Exam 6 (Modules 15B, 16, & 17) 5/02

You should study your drill quizzes, study your Handbook modules, and review your drill quizzes BEFORE working these problems. When working them you should do so under exam conditions, i.e. alone, using only a calculator and periodic table, and waiting until you have completely finished before checking your answers.

1. If a saturated solution of the base $M(OH)_2$ has a pH of 11.00, what is the K_{sp} of $M(OH)_2$?

   (CHALLENGE QUESTION)

   A. $1.0*10^{-30}$ B. $5.0*10^{-10}$ C. $2.0*10^{-12}$ D. $1.0*10^{-12}$ E. $5.0*10^{-8}$

2. For the reaction below, $\Delta H^\circ = 246$ kJ/mol and $\Delta S^\circ = -137$ J/Kmol. What is the equilibrium constant at 298 K?

   $3\ O_2(g) = 2\ O_3(g)$ **(CHALLENGE QUESTION)**

   A. $2.7*10^{-51}$ B. $4.1*10^{-49}$ C. $8.3*10^{-27}$ D. $5.4*10^{-51}$ E. $9.2*10^{-49}$

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3. Four metals, labeled A, B, C and D react with each other in the following way: (N.R. means no reaction occurs)
(CHALLENGE QUESTION)

$A + B^+ \rightarrow$ N.R.	$B + C^+ \rightarrow$ N.R.
$B + D^+ \rightarrow B^+ + D$	$C + D^+ \rightarrow C^+ + D$
$C + A^+ \rightarrow C^+ + A$	$D + A^+ \rightarrow D^+ + A$

On the basis of this information, what is the order of the metals in increasing reducing strength?

A. B < D < A < C B. C < B < D < A C. D < B < C < A
D. D < C < A < B E. A < D < B < C

4. To calculate ΔG under nonstandard conditions, we use $\Delta G = \Delta G^\circ + RT\ln Q$. What is ΔG for the following reaction at 298 K when the partial pressure of NO is 0.10 atm and the partial pressure of NOBr is 2.0 atm?
(CHALLENGE QUESTION)

$2\ NO(g) + Br_2(liq) = 2\ NOBr(g)$ ΔG° is -8.3 kJ/mol.

A. -1.9 kJ/mol B. -0.88 kJ/mol C. 0.70 kJ/mol D. 6.5 kJ/mol E. 15 kJ/mol

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1. If a saturated solution of the base $M(OH)_2$ has a pH of 11.00, what is the K_{sp} of $M(OH)_2$? **(CHALLENGE QUESTION)**

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B

$pH = 11$

$pOH = 14 - pH = 14 - 11 = 3$

$[OH^-] = 10^{-pOH} = 10^{-3} M$

$M(OH)_2(s) \rightleftharpoons M^{2+}(aq) + 2OH^-(aq)$

		0	0
i	a		
Δ	$-\frac{10^{-3}}{2}$	$\frac{10^{-3}}{2}$	10^{-3}
f	$a-\frac{10^{-3}}{2}$	$\frac{10^{-3}}{2}$	10^{-3}

$K_{sp} = [M^{2+}][OH^-]^2$

$K_{sp} = \left(\frac{10^{-3}}{2}\right)(10^{-3})^2 =$

$K_{sp} = 5 * 10^{-10}$

2. For the reaction below, $\Delta H° = 246$ kJ/mol and $\Delta S° = -137$ J/Kmol. What is the equilibrium constant at 298 K?

$3\ O_2(g) = 2\ O_3(g)$ **(CHALLENGE QUESTION)**

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D

$\Delta G = \Delta H - T\Delta S$

$\Delta G° = 246\frac{kJ}{mol} * \frac{1000J}{1kJ} - (298K)\left(-137\frac{J}{K\,mol}\right) =$

$\Delta G° = 246000\frac{J}{mol} + 40826\frac{J}{mol} = 2.87 * 10^5\ J/mol$

and

$\Delta G° = -RT\ln K \Rightarrow K = e^{-\Delta G°/RT}$

$K = e^{-(2.87*10^5\frac{J}{mol})/(8.314\frac{J}{mol\,K})(298K)}$

$K = e^{-115.77} = 5.4 * 10^{-51}$

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A. B < D < A < C B. C < B < D < A C. D < B < C < A
D. D < C < A < B E. A < D < B < C

E

Eqn ① tells us B > A
② " " B > D
③ " " C > A
④ " " C > B
⑤ " " C > D
⑥ " " D > A

these two show C > B > A
these two show B > D > A

∴ C > B > D > A

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D

$$K_p = \frac{P_{NOBr}^2}{P_{NO}^2} = \frac{(2.0\,atm)^2}{(0.10\,atm)^2} = 400$$

$$\Delta G_r = \Delta G_r^\circ + RT\ln K$$

$$\Delta G_r = -8.3\,\frac{kJ}{mol} + \left(8.314\,\frac{J}{K\,mol}\right)(298\,K)(\ln 400)\left(\frac{1\,kJ}{1000\,J}\right) =$$

$$= 6.5\,\frac{kJ}{mol}$$