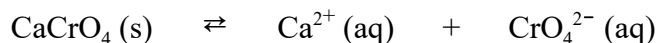


Name \_\_\_\_\_ Rec. TA/time \_\_\_\_\_

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Show **ALL** your work or **EXPLAIN** to receive full credit.  $R = 0.08206 \text{ L}\cdot\text{atm/mol}\cdot\text{K} = 8.314 \text{ J/mol}\cdot\text{K}$

1. (9 pts) For the following reaction  $K_c$  equals  $7.10 \times 10^{-4}$ , at  $25^\circ\text{C}$ .



a) (4 pts) What are the **equilibrium** concentrations of  $\text{Ca}^{2+}$  and  $\text{CrO}_4^{2-}$  if solid  $\text{CaCrO}_4$  is placed in water to form a saturated solution at  $25^\circ\text{C}$ ? (**Show the ICE table. State any assumptions made and check your percent error.**) **This part was on quiz 4.**

b) (1 pts) For the system at equilibrium, what happens when  $\text{CaCl}_2(\text{s})$ , a soluble compound, is added?? (i.e. does the equilibrium shift and if so in what direction? If no shift then why not.) **EXPLAIN!**

c) (1 pts) For the system at equilibrium, what happens when **water** is **added** to the system? (i.e. does the equilibrium shift and if so in what direction? If no shift then why not.) **EXPLAIN!**

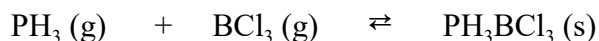
d) (1 pts) For the system at equilibrium, what happens when part of the  $\text{CaCrO}_4$  is **removed**? (i.e. does the equilibrium shift and if so in what direction? If no shift then why not.) **EXPLAIN!**

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1. (Cont.)

e) (2 pts) Assuming the above reaction is endothermic, what happens when the temperature increases? (i.e. does the equilibrium shift and if so in what direction? If no shift then why not.) Also, what happens to the value of K? **EXPLAIN!**

2. (9 pts) For the following reaction  $K_c$  equals  $5.35 \times 10^2$  at  $80^\circ\text{C}$ .



a) (4pts) What are the **equilibrium** concentrations of  $\text{PH}_3$  and  $\text{BCl}_3$  if 1.000 mole of each is placed in a 0.500-L vessel and allowed to react until equilibrium is reached? (**Show the ICE table. When appropriate, state any assumptions made and check your percent error.**) This part was on quiz 4.

b) (1 pt) For the system at equilibrium, what happens to the reaction when the **pressure** is **increased** by adding Ne (an inert gas) at **constant temperature** and **volume**? (i.e. does the equilibrium shift and if so in what direction? If no shift then why not.) **EXPLAIN!**

c) (1 pt) For the system at equilibrium, what happens to the reaction when  $\text{PH}_3$  is **added**? (i.e. does the equilibrium shift and if so in what direction? If no shift then why not.) **EXPLAIN!**

d) (1 pt) For the system at equilibrium, what happens to the reaction when **all** the  $\text{PH}_3\text{BCl}_3$  is **removed**? (i.e. does the equilibrium shift and if so in what direction? If no shift then why not.) **EXPLAIN!**

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2. (Cont.)

e) (2 pts) Assuming the above reaction is exothermic, what happens when the temperature decreases? (i.e. does the equilibrium shift and if so in what direction? If no shift then why not.) Also, what happens to the value of K? **EXPLAIN!**

3. (2 pts) What is(are) the difference(s) between the **Arrhenius** and **Bronsted-Lowry** definitions of a **base**? **Not on quiz.**

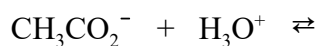
4. (3 pts) What is the **conjugate acid** of  $\text{H}_2\text{P}_2\text{O}_7^{2-}$ ?

5. (4 pts) Predict the products of the following acid-base reaction and whether the equilibrium lies to the left (more reactants at equilibrium) or the right (more products at equilibrium). **EXPLAIN!**

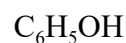
a)



b)



6. (2 pts) Which of the following are **strong** acids or **strong** bases? (Circle all that apply.)



7. (5 pts) A saturated solution of  $\text{Ca}(\text{OH})_2$  has a  $[\text{Ca}^{2+}]$  of 0.15 M. What is the pH of the solution? (atomic weights: Ca = 40.08, O = 16.00, H = 1.008)

8. (5 pts) Calculate the pH of an aqueous solution that is 0.0030 M in  $\text{HCl}(\text{aq})$  and 0.0060 M in  $\text{HBr}(\text{aq})$ .

9. (4 pts)  $\text{D}_2\text{O}(\ell)$  is deuterium oxide, or better known as “heavy water”.  $\text{D}_2\text{O}(\ell)$  has an equilibrium dissociation constant,  $K_D$  (along the lines of  $K_w$  for water) of  $8.90 \times 10^{-16}$  at  $20.0^\circ\text{C}$ . Answer the following using this information.

a) Calculate  $[\text{D}^+]$  and  $[\text{OD}^-]$  for  $\text{D}_2\text{O}$  at this temperature.

b) What is the pD of this liquid? (Hint: pD is a pX function, like pH)?

c) What is the  $\text{p}K_D$  of  $\text{D}_2\text{O}$ ?

10. (5 pts) The  $K_w$  for water is  $9.6 \times 10^{-14}$  at  $60^\circ\text{C}$ . Answer the following **TWO** questions.

a) What is the pH of a neutral solution at  $60^\circ\text{C}$ ? **Show all work or explain!**

b) If a solution at  $60^\circ\text{C}$  has  $\text{pH} = 7.00$  is it acidic, basic, or neutral? **Explain!**

# USEFUL INFORMATION

$$R = 0.08206 \text{ L-atm/mol-K} = 8.3145 \text{ J/mol-K}$$

	IA	IIA	IIIB	IVB	VB	VIB	VII	VIII	IX	X	XI	XII	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1.008 <b>H</b> 1																	4.003 <b>He</b> 2
2	6.941 <b>Li</b> 3	9.012 <b>Be</b> 4											10.811 <b>B</b> 5	12.011 <b>C</b> 6	14.007 <b>N</b> 7	15.999 <b>O</b> 8	18.998 <b>F</b> 9	20.179 <b>Ne</b> 10
3	22.990 <b>Na</b> 11	24.305 <b>Mg</b> 12											26.98 <b>Al</b> 13	28.09 <b>Si</b> 14	30.974 <b>P</b> 15	32.06 <b>S</b> 16	35.453 <b>Cl</b> 17	39.948 <b>Ar</b> 18
4	39.098 <b>K</b> 19	40.08 <b>Ca</b> 20	44.96 <b>Sc</b> 21	47.88 <b>Ti</b> 22	50.94 <b>V</b> 23	52.00 <b>Cr</b> 24	54.94 <b>Mn</b> 25	55.85 <b>Fe</b> 26	58.93 <b>Co</b> 27	58.69 <b>Ni</b> 28	63.546 <b>Cu</b> 29	65.38 <b>Zn</b> 30	69.72 <b>Ga</b> 31	72.59 <b>Ge</b> 32	74.92 <b>As</b> 33	78.96 <b>Se</b> 34	79.904 <b>Br</b> 35	83.80 <b>Kr</b> 36
5	85.47 <b>Rb</b> 37	87.62 <b>Sr</b> 38	88.91 <b>Y</b> 39	91.22 <b>Zr</b> 40	92.91 <b>Nb</b> 41	95.94 <b>Mo</b> 42	98 <b>Tc</b> 43	101.07 <b>Ru</b> 44	102.91 <b>Rh</b> 45	106.42 <b>Pd</b> 46	107.87 <b>Ag</b> 47	112.41 <b>Cd</b> 48	114.82 <b>In</b> 49	118.69 <b>Sn</b> 50	121.75 <b>Sb</b> 51	127.60 <b>Te</b> 52	126.90 <b>I</b> 53	131.39 <b>Xe</b> 54
6	132.91 <b>Cs</b> 55	137.33 <b>Ba</b> 56	138.91 <b>La</b> 57	178.39 <b>Hf</b> 72	180.95 <b>Ta</b> 73	183.85 <b>W</b> 74	186.21 <b>Re</b> 75	190.23 <b>Os</b> 76	192.22 <b>Ir</b> 77	195.08 <b>Pt</b> 78	196.97 <b>Au</b> 79	200.59 <b>Hg</b> 80	204.38 <b>Tl</b> 81	207.2 <b>Pb</b> 82	208.98 <b>Bi</b> 83	209 <b>Po</b> 84	210 <b>At</b> 85	222 <b>Rn</b> 86
7	223 <b>Fr</b> 87	226.03 <b>Ra</b> 88	227.03 <b>Ac</b> 89	261 <b>Rf</b> 104	262 <b>Ha</b> 105	263 <b>Sg</b> 106	262 <b>Ns</b> 107	265 <b>Hs</b> 108	266 <b>Mt</b> 109	269 <b>Uu</b> 110	272 <b>Uub</b> 111	277 <b>Uut</b> 112						

Lanthanide Series	140.12 <b>Ce</b> 58	140.91 <b>Pr</b> 59	144.24 <b>Nd</b> 60	145 <b>Pm</b> 61	150.36 <b>Sm</b> 62	151.96 <b>Eu</b> 63	157.25 <b>Gd</b> 64	158.93 <b>Tb</b> 65	162.50 <b>Dy</b> 66	164.93 <b>Ho</b> 67	167.26 <b>Er</b> 68	168.93 <b>Tm</b> 69	173.04 <b>Yb</b> 70	173.04 <b>Lu</b> 71
Actinide Series	232.04 <b>Th</b> 90	231.04 <b>Pa</b> 91	238.03 <b>U</b> 92	237.05 <b>Np</b> 93	<b>Pu</b> 94	<b>Am</b> 95	<b>Cm</b> 96	<b>Bk</b> 97	<b>Cf</b> 98	<b>Es</b> 99	<b>Fm</b> 100	<b>Md</b> 101	<b>No</b> 102	<b>Lr</b> 103

A PERIODIC CHART OF THE ELEMENTS  
(Based on <sup>12</sup>C)