

- Directions: (1) Put your name on PART 1 and your name and signature on PART 2 of the exam where indicated.
- (2) Sign the Aggie Code on PART 2 of this exam.
- (3) Each multiple choice question is actually 2 questions on your scanning sheet. If you are sure of an answer, **put the same answer down for both questions** for 5 pts. If you cannot decide between two answers, put your best answer down for the first (odd) question and the other answer down for the second (even) question. If you get the first one correct you'll get 3 pts; if you get the second one correct you'll get 2 pts. If there is an ambiguous multiple choice question, use the last page to explain your answer.
- (4) Do NOT write on the envelope.
- (5) When finished, put everything in the envelope and wait to be excused. At the table, take everything out of the envelope. You can pick up the multiple choice part with the answers outside my office after 10 am on Wednesday.
- (6) There are a total of 60 questions (33 actual questions) with 2 bonus points.

## PART 1

**1&2.** Which is the correct  $K_c$  expression for the equilibrium:  $P_4(s) + 6H_2(g) \rightleftharpoons 4PH_3(g)$  ?

(a)  $K_c = \frac{4[PH_3]}{[P_4] + 6[H_2]}$

(b)  $K_c = \frac{[PH_3]^4}{[P_4][H_2]^6}$

(c)  $K_c = \frac{[P_4][H_2]^6}{[PH_3]^4}$

(d)  $K_c = \frac{[PH_3]^4}{[H_2]^6}$

(e)  $K_c = \frac{4[PH_3]}{6[H_2]}$

**3&4.** Determine the oxidation state of chromium in the chromate ion,  $CrO_4^{2-}$ ?

(a) +2

(b) +3

(c) +4

(d) +5

(e) +6

**5&6.** Which of the following pairs of liquids are NOT miscible?

(a)  $H_2O / CCl_4$

(b)  $CCl_4 / CHCl_3$

(c)  $CH_3CH_2OH / H_2O$

(d)  $CH_3CH_2OH / CH_3OH$

(e)  $C_6H_6 / CCl_4$

**7&8.** Which statement(s) list(s) the substance with the lower entropy first and the higher entropy second?

(1)  $KCl(s) < K^+(aq) + Cl^-(aq)$

(2)  $CH_3CH_2CH_3 < CH_3CH_3$

(3)  $H_2O(l) \text{ at } 20^\circ C < H_2O(s) \text{ at } -40^\circ C$

(a) 2 only

(b) 3 only

(c) 1 only

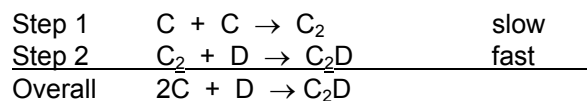
(d) 1,2 only

(e) 1,3 only

**9&10.** Consider 0.1 M solutions of these weak acids. The strongest of these weak acids is:

- (a)  $\text{HNO}_2$       (b)  $\text{CH}_3\text{COOH}$       (c)  $\text{CHOOH}$       (d)  $\text{HClO}$       (e)  $\text{HBrO}$

**11&12.** Consider the gas phase reaction:  $2\text{C} + \text{D} \rightarrow \text{C}_2\text{D}$ , which occurs by the following mechanism:



The rate law expression must be Rate = \_\_\_\_\_.

- (a)  $k[\text{D}]$       (b)  $k[\text{C}]^2[\text{D}]$       (c)  $k[\text{C}][\text{D}]$       (d)  $k[\text{C}]^2$       (e)  $k[\text{C}]$

**13&14.** A 0.10 M solution of a substance has  $\text{pH} = 3$ . That substance is most likely a:

- (a) strong acid      (b) weak acid      (c) strong base      (d) weak base      (e) sugar

**15&16.** For  $\text{Al}(\text{OH})_3$ , the relationship between  $K_{\text{sp}}$  and  $s$ , the molar solubility in mol/L, is

- (a)  $K_{\text{sp}} = s^{1/2}$       (b)  $K_{\text{sp}} = s^2$       (c)  $K_{\text{sp}} = 4s^3$   
(d)  $K_{\text{sp}} = 8s^4$       (e)  $K_{\text{sp}} = 27s^4$

**17&18.** Consider the following gaseous phase system at equilibrium:



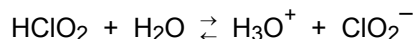
Which of the following changes will INCREASE the amount of  $\text{NO}_2$  at equilibrium?

- (a) decreasing the volume of the container  
(b) removing  $\text{N}_2\text{O}_4(g)$   
(c) adding  $\text{N}_2(g)$   
(d) adding a catalyst  
(e) increasing the temperature

**19&20.** Which of the following statements is FALSE?

- (a) A reaction is spontaneous if  $\Delta S_{\text{system}}$  increases.
- (b) Hess' Law calculation allows you to calculate the enthalpy involved in a reaction.
- (c) If a reaction is exothermic, heat is being released.
- (d) Endothermic processes are those with  $\Delta H > 0$ .
- (e)  $\Delta S_{\text{universe}} = \Delta S_{\text{surroundings}} + \Delta S_{\text{system}}$

**21&22.** For the system given below, Bronsted would classify basic species as:



- (a)  $\text{HClO}_2$  and  $\text{H}_2\text{O}$
- (b)  $\text{H}_3\text{O}^+$  and  $\text{ClO}_2^-$
- (c)  $\text{HClO}_2$  and  $\text{H}_3\text{O}^+$
- (d)  $\text{H}_2\text{O}$  and  $\text{ClO}_2^-$
- (e)  $\text{HClO}_2$  and  $\text{ClO}_2^-$

**23&24.** The following solutions are mixed in equal volumes. Which will give (a) buffer solution(s)?

- (1) 0.1 M HBr and 0.1 M KBr
- (2) 0.1 M HBr and 0.1 M KBrO
- (3) 0.1 M HBrO and 0.1 M KBr
- (4) 0.1 M HBrO and 0.1 M KBrO

- (a) 2,3
- (b) 1,2
- (c) 4
- (d) 3,4
- (e) 1

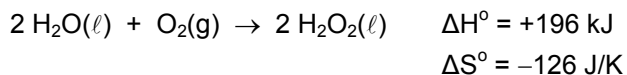
**25&26.** Which of the following statements concerning chemical kinetics is TRUE?

- (a) Catalysts do not participate in a reaction.
- (b) Activation energy for a forward reaction will change with increasing temperature.
- (c) An increase in temperature will change the appearance of a potential energy diagram.
- (d) The rate of a reaction increases with increasing temperature.
- (e) To have an effective collision, the reactants only need to collide with a certain minimum amount of energy.

**27&28.** Of the following species, which is the STRONGEST reducing agent?

- (a) V
- (b)  $\text{Sn}^{2+}$
- (c)  $\text{Au}^{3+}$
- (d) Cu
- (e)  $\text{Co}^{2+}$

**29&30.** Consider the following reaction and choose the correct statement:



- (a) The reaction is spontaneous at all temperatures.
- (b) The reaction is nonspontaneous at all temperatures.
- (c) The reaction becomes spontaneous as the temperature increases.
- (d) The reaction becomes spontaneous as the temperature decreases.
- (e) The temperature does not influence the spontaneity of any reaction.

**31&32.** For the standard voltaic cell using  $\text{Fe}^{2+}/\text{Fe}$  and  $\text{Au}^{3+}/\text{Au}$  electrode compartments, which of the following statements is FALSE?

- (a) The initial concentration of  $\text{Fe}^{2+}$  ions in the half cell must be 1.0 M.
- (b) The standard cell potential is 1.94 V.
- (c) The gold electrode is labeled “-”.
- (d) The electron flow through the external wire is from the iron electrode to the gold electrode.
- (e) The iron electrode is the anode.

**33&34.** What is the pH of a  $8.2 \times 10^{-4}$  M HCl?

- (a) 2.35      (b) 4.51      (c) 4.72      (d) 3.09      (e) 3.17

**35&36.** What concentration of  $\text{Pb}^{2+}$  will initiate precipitation in a solution that is 0.10 M NaCl?

- (a)  $1.7 \times 10^{-2}$  M      (b)  $1.7 \times 10^{-5}$  M      (c)  $1.7 \times 10^{-7}$  M  
(d)  $1.7 \times 10^{-4}$  M      (e)  $1.7 \times 10^{-3}$  M

**37&38.** What is the enthalpy change of the reaction below at 298 K and 1 atm pressure?

	$\text{CO}_2(\text{g})$	+	$2\text{H}_2\text{S}(\text{g})$	$\rightarrow$	$\text{CS}_2(\ell)$	+	$2\text{H}_2\text{O}(\ell)$
$\Delta H_{\text{f}298}^{\circ}$ (kJ/mol)	-394.0		-20.2		+89.5		-286.0

- (a) +144 kJ      (b) +227 kJ      (c) -461.7 kJ      (d) -48.1 kJ      (e) -311.6 kJ

**39&40.** If 6.22 grams of glucose,  $\text{C}_6\text{H}_{12}\text{O}_6$  are dissolved in 22.5 grams of water, what will be the boiling point of the resulting solution?  $K_b$  for water =  $0.512\text{ }^{\circ}\text{C}/\text{m}$

- (a)  $101.64^{\circ}\text{C}$       (b)  $100.42^{\circ}\text{C}$       (c)  $99.21^{\circ}\text{C}$       (d)  $100.79^{\circ}\text{C}$       (e)  $101.41^{\circ}\text{C}$

**41&42.** Rate data were collected for the following reaction at a particular temperature. What is the correct rate law expression?



Experiment	[X] <sub>initial</sub>	[Y] <sub>initial</sub>	Initial Rate of Reaction
1	0.60 M	0.20 M	0.050 M/s
2	0.30 M	0.20 M	0.025 M/s
3	0.60 M	0.40 M	0.20 M/s

- (a) Rate =  $k[X][Y]$                       (b) Rate =  $k[X]^2[Y]$                       (c) Rate =  $k[X][Y]^2$   
(d) Rate =  $k[X]^2[Y]^2$                       (e) Rate =  $k[X]^2$

**43&44.** Calculate the standard cell potential for the cell: Cd/CdSO<sub>4</sub> (1 M) || CuSO<sub>4</sub> (1 M) /Cu

- (a) +0.74 V      (b) +0.32 V      (c) +0.06 V      (d) +0.45 V      (e) +0.82 V

**45&46.** What is the pH of a 0.30 M HCN solution?

- (a) 1.85      (b) 4.96      (c) 3.81      (d) 3.44      (e) 6.13

**47&48.** Consider the following equilibrium reaction:



If the initial concentration of BrF in a closed container is 1.00 M, what will be the concentration of BrF after the system finally reaches equilibrium?

- (a) 0.661 M      (b) 0.500 M      (c) 0.287 M      (d) 0.147 M      (e) 0.788 M

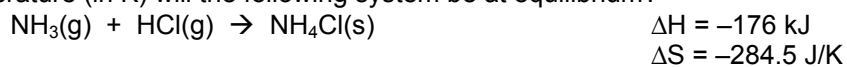
**49&50.** At the equivalence point in the titration of hydrofluoric acid with sodium hydroxide, the salt concentration was 0.450 M. What was the pH at the equivalence point?

- (a) 2.95      (b) 8.40      (c) 10.18      (d) 11.55      (e) 12.10

**51&52.** What will happen when equal volumes of 0.20 M of  $\text{Mg}(\text{NO}_3)_2$  and 0.000020 M of  $\text{Na}_2\text{CO}_3$  are mixed?

- (a) no precipitate will occur because  $Q_{sp} > K_{sp}$
- (b) no precipitate will occur because  $Q_{sp} < K_{sp}$
- (c) a precipitate will occur because  $Q_{sp} > K_{sp}$
- (d) a precipitate will occur because  $Q_{sp} < K_{sp}$
- (e) the mixture will explode

**53&54.** At what temperature (in K) will the following system be at equilibrium?



- (a) 467 K
- (b) 582 K
- (c) 619 K
- (d) 634 K
- (e) 680 K

**55.** Do the on-line assessment on SurveyMonkey. The directions were sent to your neo account. Completion will give you 5 pts on this final. Deadline is **11:45pm tonight!**

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## PART 2

Please read and sign: "On my honor, as an Aggie, I have neither given nor received unauthorized aid on this exam." \_\_\_\_\_

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- 56.** Draw the electrolytic cell that results when two inert electrodes are put into an aqueous solution of KBr and connected to a battery. The observations are:
- (1) bromine liquid is evolved at one electrode.
  - (2) H<sub>2</sub> gas is evolved at the other electrode and the solution becomes more basic around the electrode.

- (3 pts) Which is the anode and what is the anodic reaction?  
(3 pts) Which is the cathode and what is the cathodic reaction?  
(1 pt) What is the sign on each electrode?  
(1 pt) Show the direction of the electron flow.  
(2 pts) What is the overall reaction?

- (5 pts) **57.** Calculate the potential (in volts) for the non-standard voltaic cell when the following two half-cells are connected:
- Anode: Pb electrode in 0.10 M Pb<sup>2+</sup> solution  
Cathode: Ag electrode in 1.0 x 10<sup>-4</sup> M Ag<sup>+</sup> solution

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(5 pts) **58.** What average current (in amperes) must be maintained to electroplate 39.4 grams of gold per hour from a solution containing gold(III) ion?

(5 pts) **59.** A buffer is prepared by mixing 200 mL of 0.300 M nitrous acid and 400 mL of 0.200 M sodium nitrite. What is the pH of the final solution after 150.0 mL of 0.100 M HCl is added? (5 pts)

(5 pts) **60.** Balance the following redox reaction in acidic solution:  $\text{NO(g)} + \text{PbO}_2\text{(s)} \rightarrow \text{Pb}^{2+}\text{(aq)} + \text{NO}_3^-\text{(aq)}$

**Please circle**

**2 Bonus Pts:** (i) How many years of high school chemistry did you take? 0 ½ 1 1½ 2 2½ 3 3½ more  
(ii) How many years were there between your last chem course in high school and your first university chem course? 0 1 2 3 4 5 more than 5

# SCRAP PAPER OR COMMENTS ON THIS EXAM

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