Chemistry 1A Fall 2017

Name____________________ Student ID __________________

Midterm Exam 3

You will have 120 minutes to complete this exam. Please fill in the bubble that corresponds to the correct answer on the answer sheet. Only your answer sheet will be graded.

Each question has only one correct answer unless otherwise specified in the question. You are allowed to use the provided equation sheet and periodic table to help you answer the questions.

While all questions have been taken from the online database, specific details such as an element or number may have been changed and answers may have been switched around. Please read each question carefully. Good luck!!

1. The reaction A + B $\rightleftharpoons$ X + Y
has K = 997 at 472 K. At equilibrium, ____________.

A) [products] > [reactants]
B) [products] < [reactants]
C) [products] = [reactants]
D) Only products exist
E) Only reactants exist

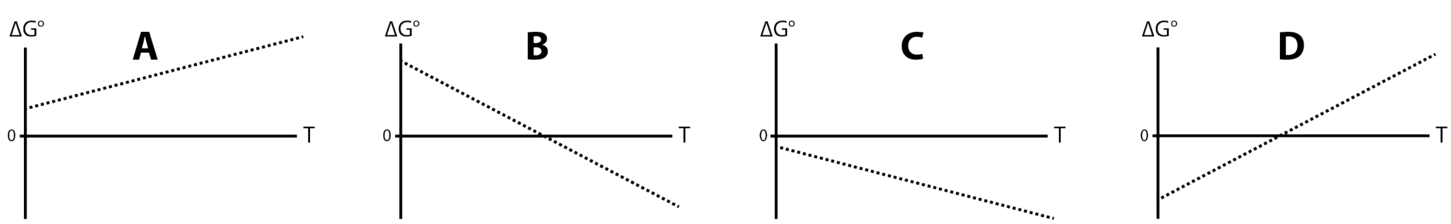
2. The gaseous reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ is at equilibrium when the volume is suddenly halved (i.e., the total pressure is doubled). Which is true of the reaction quotient Q relative to the equilibrium constant K at the instant that the volume changes?

A) $Q = \frac{1}{4}K$ B) $Q = \frac{1}{2}K$ C) $Q = K$ D) $Q = 2K$ E) $Q = 4K$

3. At 25 °C, NO_2 undergoes an exothermic dimerization reaction:

$$2\ NO_2(g) \rightleftharpoons N_2O_4(g)$$

Which of the following could be a plot of ΔG^0 vs. T for this reaction?

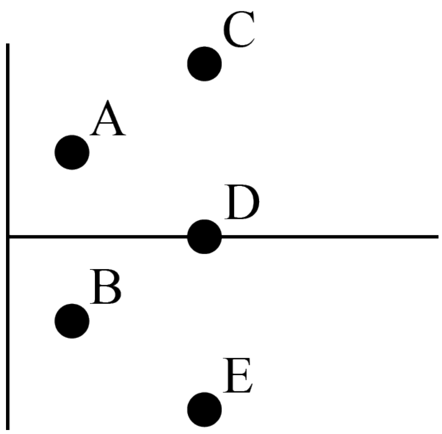


E. None of these

4) How much heat (in kJ) is released when 50 g of ethanol (C_2H_5OH) is combusted with excess oxygen? (Choose the closest answer)

A) 1271 B) 1359 C) 1492 D) 1595 E) 1645

5) The correct plot for lnK vs 1/T for H_2O (l) ⇌ H_2O (s) would pass through which pair of points?



A) (A,C)   B) (A,D)   C) (B,D)   D) (B,E)   E) just D

6) Which is the boiling point of benzene in °C given that ΔH of vaporization is 31 kJ/mol and ΔS of vaporization is 90 J/mol K?

A) 3   B) 15   C) 71   D) 100   E) 344

7) A 10.0 gram sample of a compound (MM = 156 g/mol) decomposes in aqueous solution in a perfect calorimeter (zero heat capacity) containing 100.0 ml of water (heat capacity = 4.18 J/g-°C). The temperature is observed to change from 25°C to 35°C. What is the enthalpy of decomposition for this compound (in kJ/mol)?

A) -65.2   B) -4.18   C) -.267   D) 4.18   E) 65.2

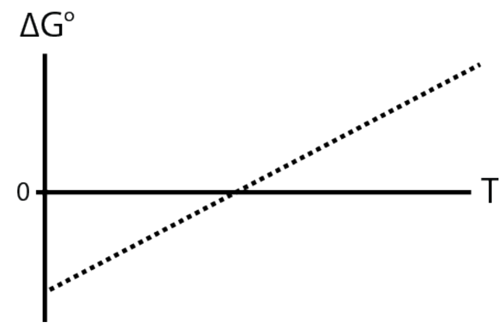
8) What is the pH of a 2.10 M solution of acetic acid (pK_a = 4.75 at 298 K) ?

A) 1.1   B) 2.21   C) 4.42   D) 7   E) 11.65

9) Aspirin is a weak acid with a pKa of 2.5. If a buffered solution of aspirin with a pH of 2.5 is diluted by a factor of 10, what is the new pH?

A) 1.5   B) 2.5   C) 3.5   D) between 2.5 and 3.5   E) 7

10) To which reaction could the following plot of ΔG^0 vs. T correspond?



A) H_2O (l) ⇌ H_2O (g)
B) $CaCO_3$ (s) ⇌ CaO (s) + CO_2 (g)
C) H_2O_2 (l) ⇌ H_2O (l) + O_2 (g)
D) CaO (s) + CO_2 (g) ⇌ $CaCO_3$ (s)
E) CO_2 (g) ⇌ C (s) + O_2 (g)

11) Consider the following reaction:

$$N_2 + 3\ H_2 \rightleftharpoons 2\ NH_3$$

If the equilibrium constant for this reaction is 4.2 x 10^8 at 298 K and at equilibrium at this temperature the partial pressures of N_2 and H_2 in a closed container are 0.01 atm and 0.03 atm, respectively, what is the partial pressure of NH_3 in the container (in atmospheres)?

A) 0.02 B) 2 C) 1.13

D) 10.6 E) 113

12) I_2 (0.50 mol) and Br_2 (0.50 mol) were placed in a 1.00 L flask and allowed to reach equilibrium. At equilibrium, the flask contains 0.84 mol of IBr. What is the value of K in terms of the concentrations of the gases for the reaction below?

$$I_2\ (g) + Br_2\ (g) \rightleftharpoons 2\ IBr\ (g)$$

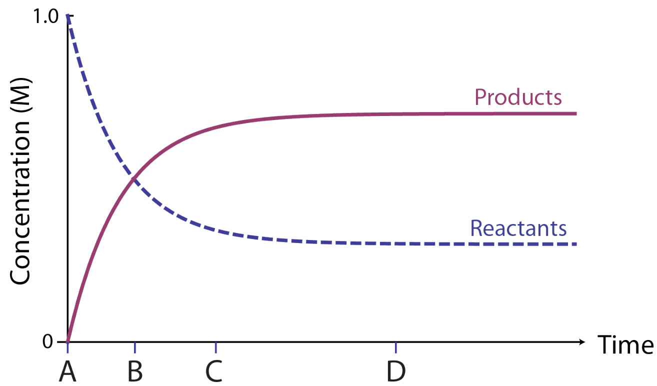
A) 2.8 B) 4 C) 6.1 D) 11 E) 110

13) A solution of HBr (which is a strong acid) has a pH = 2.5 and is then diluted by a factor of 100 with water. The new pH is:

A) 0.5 B) 2.5 C) 4.5

D) 7 E) I need to know the pKa

14) At which of the following points on the graph below is $Q = 1$?



E. All of the above

15) For the exothermic formation of ammonia,

$$N_2\ (g) + 3\ H_2\ (g) \rightleftharpoons 2\ NH_3\ (g)$$

which will act to favor the formation of ammonia?

A) High volume B) High pressure C) High temperature

D) All of these E) None of these

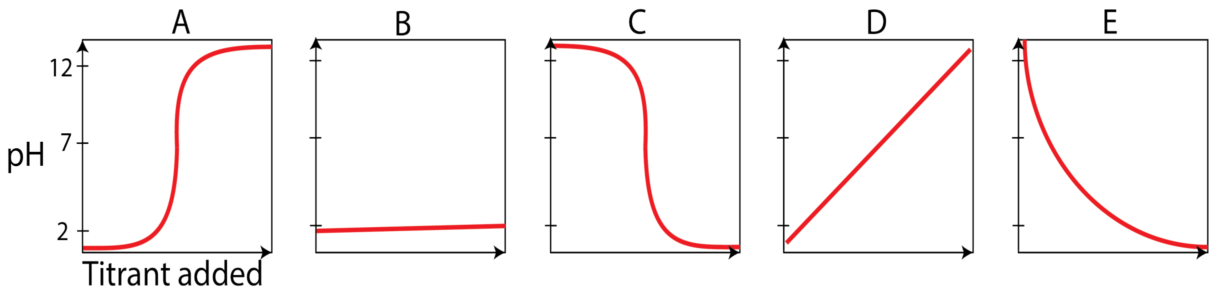
16) Given the reaction $A + B \rightleftharpoons C + D$ with all reactants and products in their standard states: if $K = 0.5$, then

A) $\Delta G^o < 0$ and $Q > K$
B) $\Delta G^o < 0$ and $Q < K$
C) $\Delta G^o < 0$ and $Q = 0 = K$
D) $\Delta G^o > 0$ and $Q > K$
E) $\Delta G^o > 0$ and $Q < K$

17) What is the pH of 0.001 M HCl?

A) 1 B) 2 C) 3 D) 4 E) 7

18) Which of the following plots depicts the titration of 1M HNO_3 (strong acid) with 1M NaOH (strong base)?



19) A buffer, made up of a mixture of acetic acid (CH_3COOH) (pKa = 4.75) and potassium acetate (CH_3COO^-), has a pH = 4.27. The [CH_3COO^-]/[CH_3COOH] ratio in this buffer is:

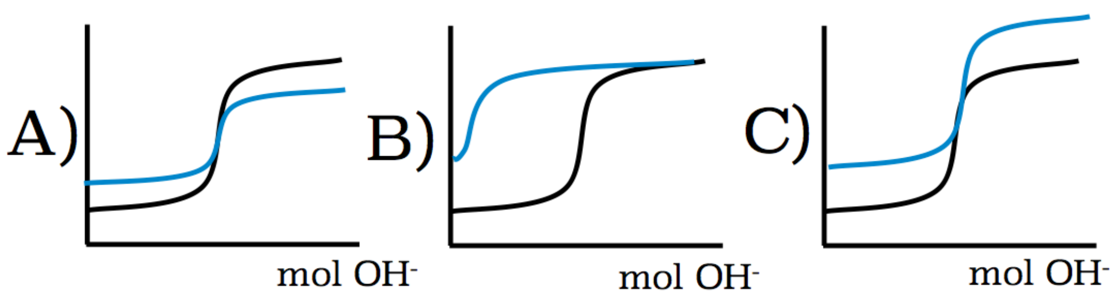
A) 3.01 B) 1.61 C) 1

D) 0.331 E) 0.618

20) You have two different solutions of acid. One solution contains the weak acid HA, and the other solution contains the strong acid HB. You find that both solutions have the same concentration of H_3O^+ at equilibrium. Which relationship is true about these two solutions at equilibrium?

A) [HB] = [HA] B) [HB] > [HA] C) [HB] < [HA]

21) Shown in black is the titration of a solution of HNO_3 (pKa <1) with a NaOH solution. Which blue curve shows the titration of a dilution of the original HNO_3 solution by a factor of 10?



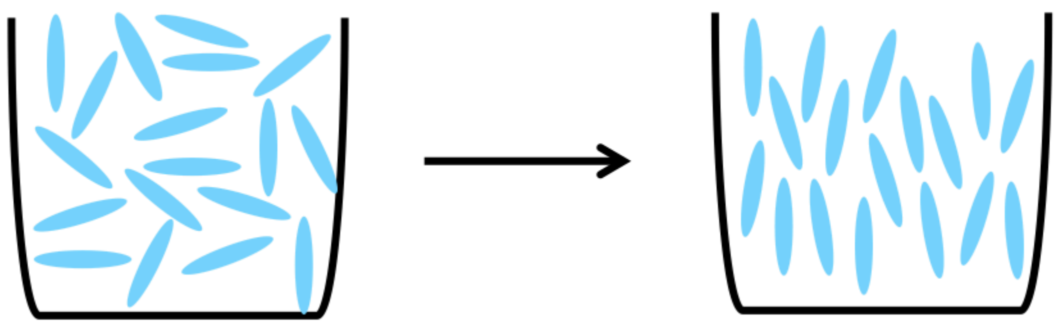
22) The temperature for the exothermic reaction between the brown gas NO_2 and the colorless gas N_2O_4 is raised

$$2NO_2\,(g) \rightleftharpoons N_2O_4\,(g)$$

What happens to the color intensity at equilibrium?

A) Increases B) Decreases C) Stays the same

23) In the spontaneous transition from an isotropic (disordered) liquid to a nematic (ordered) liquid crystal



which is the driving force?

A) $\Delta H < 0$ B) $\Delta S < 0$ C) $\Delta S > 0$

24) Consider an indicator that is blue when in the acid form and pink in its conjugate base form. At pH 6.5, [blue] = 0.00015 M and [pink] = 0.01 M. What is the pKa of the indicator?

A) 2.21 B) 3.75 C) 4.68 D) 5.88 E) 6.11

25) What is the relationship between the masses of the remaining compounds after 26 g of C_2H_2 gas reacts with 320 g of oxygen to form CO_2 and H_2O?

A) $CO_2 = O_2 = H_2O$
B) $O_2 > CO_2 > H_2O$
C) $H_2O > O_2 > CO_2$
D) $H_2O > CO_2 > O_2$
E) $H_2O > CO_2 = O_2$

26) For the reaction: $C_2H_6(g) \rightleftharpoons C_2H_4(g) + H_2(g)$,
ΔH° is 137 kJ and ΔS° is 120 J/K.

This reaction will be:

A) spontaneous at all temperatures
B) spontaneous only at high temperatures
C) spontaneous only at low temperature
D) nonspontaneous at all temperatures
E) unreliable

27) HA_1 and HA_2 are two weak acids with dissociation constants Ka_1 and Ka_2 respectively. Based on the following reaction at equilibrium:

$HA_1 + A_2^- \rightleftharpoons HA_2 + A_1^-$ $\qquad$ $K = 0.157$

Which of the following must be true?

A) $Ka_1 > Ka_2$ $\qquad$ B) $Ka_1 = Ka_2$ $\qquad$ C) $Ka_1 < Ka_2$

D) $Ka_1/Ka_2 = K_w$ $\qquad$ E) $Ka_2/Ka_1 = K_w$

28) Consider the following reaction, which is a purple solution at equilibrium when 50 mL 0.10 M Co^{2+} is mixed with 100 mL 12.0 M Cl^-:

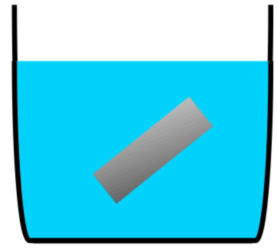
$$\underset{\text{pink}}{Co^{2+}(aq)} + 4\,Cl^-(aq) \rightleftharpoons \underset{\text{blue}}{CoCl_4^{2-}(aq)}$$

If you add concentrated HCl (aq) to this purple solution, what will happen to the color?

A) Nothing will happen (the solution will stay purple)
B) The solution will turn pink.
C) The solution will turn blue.

29) What is the relative magnitude of the temperature change when 1 kg of hot Fe (c_p ~0.45 J/g-K) is dropped in 1 kg cool water (c_p 4.18 J/g-K)?

	Specific J/g*K	***Molar J/mol*K***
metals		~25
H_2O (l)	4.184	75.3



A) $|\Delta T_{Fe}| > |\Delta T_{H2O}|$ B) $|\Delta T_{Fe}| = |\Delta T_{H2O}|$ C) $|\Delta T_{Fe}| < |\Delta T_{H2O}|$

30) You prepare a 1.00 M solution of acetic acid (CH_3COOH) and a 1.00 M solution of iodic acid (HIO_3). The K_a for acetic acid is 1.8×10^{-5} and the K_a for iodic acid is 1.7×10^{-1}. Which solution has the highest concentration of H_3O^+ and why?

A) CH_3COOH: It is a stronger acid than iodic acid and fully dissociates to give more H_3O^+ in solution.
B) HIO_3: It is a stronger acid than acetic acid, and dissociates to give more H_3O^+ in solution.
C) Neither: Both solutions have a concentration of 1.00 M H_3O^+.
D) Neither: The concentration of CH_3COOH is equal to the concentration of HIO_3.

31) A typical hot tub contains about 650 L of water. How much energy is required to raise the temperature of the hot tub from 20°C to 100°C? The heat capacity of water is 4.18 J/g-°C.

A) 220 kJ B) 2.5×10^8 kJ C) 220 J D) 440 kJ E) 2.2×10^5 kJ

32) Which is true for the following exothermic reaction at 1 atm?

$$A\,(s) + B\,(l) \rightleftharpoons C\,(l) + D\,(g)$$

A) Proceeds spontaneously at all temperatures
B) Proceeds spontaneously at no temperatures
C) Proceeds spontaneously at high temperature
D) Proceeds spontaneously at low temperatures
E) Proceeds spontaneously only at 0 K