國立高雄大學

107 學年度第二學期

理學院

普通化學會考

June 19, 2019 (Wednesday)

17:30 PM ~ 19:30 PM

姓名: _____ **學號:** _____

－作答注意事項－

考試時間：120分鐘

總分：100分

作答方式：

- 選擇題用 2B 鉛筆在「答案卡」上作答；更正時，應以橡皮擦擦拭，切勿使用修正液（帶）。
- 未依規定畫記答案卡，致無法辨識答案；其後果由考生自行承擔。
- 答案卷每人一張，不得要求增補。
- 第 1 題至第 4 題為多選題，每題五分，多選或少選擇一個選項扣兩分，該題分數扣完之後不再倒扣。
- 第 5 題至第 25 題為單選題。

參考資料

一、元素週期表

hydrogen 1 H 1.0079																	helium 2 He 4.0026
lithium 3 Li 6.941	beryllium 4 Be 9.0122											boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305											aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 ✶	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 ✶✶	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	ununnilium 110 Uun [271]	unununium 111 Uuu [272]	ununbium 112 Uub [277]		ununquadium 114 Uuq [289]			

二、理想氣體常數、亞佛加厥常數、法拉第常數

R = 8.314 J/mol·K = 0.0821 L·atm/K·mol; Avogadro's number = 6.022×10^{23}; F= 96485 C/ mol

Multiple choices

For Question 1~4, there may be more than one correct answer.

1. Which of the following statements is ***TRUE***? (5 points)
   (A) The differential rate law shows how the rate of a reaction depends on concentrations.
   (B) The integrated rate law shows how the concentrations of species in the reaction depend on time.
   (C) A catalyst is a substance that speed up a reaction without being consumed.
   (D) A catalyst speed up a reaction by lowering the energy difference, ΔE, between products and reactants.
   (E) For a second-order reaction, $t_{1/2}$ is independent of the initial concentration.

2. Which of the following statements is ***TRUE***? (5 points)
   (A) Equilibrium is not a static but is a highly dynamic situation.
   (B) When the reaction quotient (Q) is greater than K, the system must shift to the left, in order to obtain equilibrium.
   (C) Increase the temperature of an exothermic reaction at equilibrium, the equilibrium must shift to right.
   (D) Addition of a catalyst has no effect on the equilibrium position.
   (E) When temperature is increased for an exothermic reaction at equilibrium, the value of K for the reaction will increase.

3. Which of the following statements is ***FALSE***? (5 points)
   (A) In Arrhenius model, acid produce H^+ in solution.
   (B) In Brønsted -Lowry model, an acid is a proton donor.
   (C) In Lewis model, a Lewis acid is an electron-pair donor.
   (D) A strong acid yields a strong conjugated base.
   (E) For the titration of any acid, the pH at the equivalent point is 7.

4. Which of the following statements is ***FALSE***? (5 points)
   (A) In an endothermic process, heat flows from the surrounding into the system, and $\Delta H<0$
   (B) A process (at constant T and P) is spontaneous in the direction in which the free energy decreases.
   (C) The entropy of a perfect crystal at 0°C is zero.
   (D) The enthalpy of formation (ΔH_f°) of an element in its standard state is defined as zero.
   (E) When ΔH is positive and ΔS is negative for a reaction, the reaction must be spontaneous at all temperature.

For Question 5~25, each question has only one correct answer.

5. The reaction of $(CH_3)_3CBr$ with hydroxide ion proceeds with the formation of $(CH_3)_3COH$

$$(CH_3)_3CBr(aq) + OH^-(aq) \longrightarrow (CH_3)_3COH(aq) + Br^-(aq)$$

The following data were obtained at 55°C.

Exp.	$[(CH_3)_3CBr]_0$ (mol/L)	$[OH^-]_0$ (mol/L)	Initial Rate (mol/L)
1	0.10	0.10	1.0×10^{-3}
2	0.20	0.10	2.0×10^{-3}
3	0.10	0.20	1.0×10^{-3}
4	0.30	0.20	?

What will the initial rate (in mol/L·s) be in Experiment 4? (3 points)

(A) 3.0×10^{-3}
(B) 6.0×10^{-3}
(C) 9.0×10^{-3}
(D) 1.8×10^{-3}
(E) none of these

6. At a given temperature, the reaction below is at equilibrium when $[CS_2] = 0.050\ M$, $[Cl_2] = 0.25\ M$, $[CCl_4] = 0.15\ M$, and $[S_2Cl_2] = 0.35\ M$.
What would be the direction of the reaction when the reactants and products have the following concentrations: $CS_2 = 0.15\ M$, $Cl_2 = 0.22\ M$, $CCl_4 = 0.31\ M$, and $S_2Cl_2 = 0.36\ M$? (3 points)

$$CS_2(g) + 3Cl_2(g) \rightleftharpoons CCl_4(g) + S_2Cl_2(g)$$

(A) to the right
(B) to the left
(C) no change
(D) cannot predict unless we know the temperature
(E) cannot predict unless we know whether the reaction is endothermic or exothermic

7. For a certain process at 355 K, $\Delta G = -12.1$ kJ and $\Delta H = -9.2$ kJ. Calculate the ΔS for the process. (3 points)
(A) 0 J/K mol
(B) 8.2 J/K mol
(C) –8.2 J/K mol
(D) –25.9 J/K mol
(E) 25.9 J/K mol

8. Consider the reaction

$$C(s) + CO_2(g) \rightleftharpoons 2CO_2(g)$$

At 1273 K, the K_p value is 167.5. What is the $P(CO)$ at equilibrium if the $P(CO_2)$ is 0.25 atm at this temperature? (3 points)

(A) 3.2 atm
(B) 0.130 atm
(C) 13 atm
(D) 6.5 atm
(E) 9.2 atm

9. The following question refers to the following system:

$$3Ag(s) + NO_3^-(aq) + 4H^+(aq) \longrightarrow 3Ag^+(aq) + NO(g) + 2H_2O(l)$$

$$\text{Anode reaction: } Ag \longrightarrow Ag^+(aq) + e^- \qquad \varepsilon^\circ = -0.7990\ V$$

$$\text{Cathode reaction: } NO_3^-(aq) + 4H^+(aq) + 3e^- \longrightarrow NO(g) + 2H_2O(l) \qquad \varepsilon^\circ = 0.9637\ V$$

Determine the standard cell potential. (3 points)

(A) –1.7627 V
(B) 0.1647 V
(C) 2.0921 V
(D) 3.5254 V
(E) 0.5876 V

10. In the following nuclear equation, identify the missing product: (3 points)

$$^{43}_{20}Ca + \alpha \rightarrow ? + {}^{1}_{1}H$$

(A) $^{46}_{22}Ti$

(B) $^{46}_{21}Sc$

(C) $^{44}_{22}Ti$

(D) $^{42}_{18}Ar$

(E) none of these

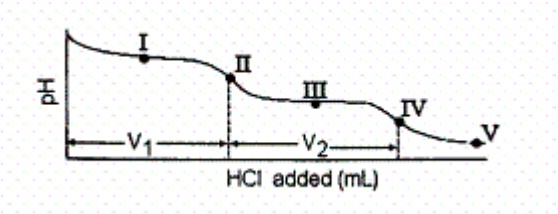
Question 11~12, consider the following information about the diprotic acid, ascorbic acid. (H_2As

for short, molar mass 176.1), pK_{a1}= 4.10 (K_{a1}= 7.9×10^{-5}), pK_{a2}= 11.79 (K_{a2}= 1.6×10^{-12})

$$H_2As \rightleftharpoons HAs^- + H^+$$

$$HAs^- \rightleftharpoons As^{2-} + H^+$$

The titration curve for disodium ascorbate, Na_2As, with standard HCl is shown below:



11. What major species is (are) present at point III? (3 points)

(A) As^{2-} and HAs^-

(B) HAs^- only

(C) HAs^- and H_2As

(D) H_2As only

(E) H_2As and H^+

12. What is the pH at point III? (3 points)

(A) 4.10

(B) 7.95

(C) 11.79

(D) 12.39

(E) 13.45

13. Tabulated below are initial rate data for the reaction

$$2Fe(CN)_6^{3-} + 2I^- \longrightarrow 2Fe(CN)_6^{4-} + I_2$$

Run	$[Fe(CN)_6^{3-}]_0$ (M)	$[I^-]_0$ (M)	$[Fe(CN)_6^{4-}]_0$ (M)	$[I_2]_0$ (M)	Initial Rate (M/s)
1	0.01	0.01	0.01	0.01	1 x 10^{-5}
2	0.01	0.02	0.01	0.01	2 x 10^{-5}
3	0.02	0.02	0.01	0.01	8 x 10^{-5}
4	0.02	0.02	0.02	0.01	8 x 10^{-5}
5	0.02	0.02	0.02	0.02	8 x 10^{-5}

What is the experimental rate law? (3 points)

(A) $\frac{\Delta[I_2]}{\Delta t} = k[Fe(CN)_6^{3-}]^2[I^-]^2[Fe(CN)_6^{4-}]^2[I_2]$

(B) $\frac{\Delta[I_2]}{\Delta t} = k[Fe(CN)_6^{3-}]^2[I^-][Fe(CN)_6^{4-}][I_2]$

(C) $\frac{\Delta[I_2]}{\Delta t} = k[Fe(CN)_6^{3-}]^2[I^-]$

(D) $\frac{\Delta[I_2]}{\Delta t} = k[Fe(CN)_6^{3-}][I^-]^2$

(E) $\frac{\Delta[I_2]}{\Delta t} = k[Fe(CN)_6^{3-}]^3[I^-]^2$

14. A 0.012 mol sample of Na_2SO_4 is added to 400 mL of each of two solutions. One solution contains 1.5×10^{-3} *M* $BaCl_2$; the other contains 1.5×10^{-3} *M* $CaCl_2$. Given that K_{sp} for $BaSO_4 = 1.5\times10^{-9}$ and K_{sp} for $CaSO_4 = 6.1\times10^{-5}$. (4 points)

(A) $BaSO_4$ would precipitate but $CaSO_4$ would not.

(B) $CaSO_4$ would precipitate but $BaSO_4$ would not.

(C) Both $BaSO_4$ and $CaSO_4$ would precipitate.

(D) Neither $BaSO_4$ nor $CaSO_4$ would precipitate.

(E) Not enough information is given to determine if precipitation would occur.

15. Consider the following reaction:

$$2HF(g) \rightleftharpoons H_2(g) + F_2(g)$$

Given 1.00 mole of HF(*g*), 0.291 mole of H_2(*g*), and 0.750 mole of F_2(*g*) are mixed in a 5.00 L flask, determine the reaction quotient, *Q* (4 points)

(A) $Q = 0.0437$

(B) $Q = 0.218$

(C) $Q = 0.0546$

(D) $Q = 2.04$

(E) $Q = 20.6$

16. What concentration of acetic acid (CH_3COOH, $K_a = 1.80\times10^{-5}$) has the same pH as that of 5.01×10^{-3} *M* HCl? (4 points)

(A) 16.7 *M*

(B) 12.6 *M*

(C) 1.39 *M*

(D) 5.01×10^{-3} *M*

(E) 1.39×10^{3} *M*

17. The K_{sp} of $PbSO_4$ is 1.3×10^{-8}. Calculate the solubility (in mol/L) of $PbSO_4$ in a 0.0054 *M* solution of Na_2SO_4. (4 points)

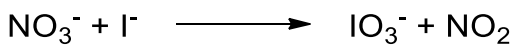
(A) 7×10^{-11} *M*
(B) 5.8×10^{-12} *M*
(C) 2.4×10^{-6} *M*
(D) 1.3×10^{-8} *M*
(E) 1.6×10^{-3} *M*

18. A 100 mL sample of 0.2 *M* $(CH_3)_3N$ ($K_b = 5.33\times10^{-5}$) is titrated with 0.2 *M* HCl. What is the pH at the equivalence point? (4 points)
(A) 2.6
(B) 8.6
(C) 10.7
(D) 5.4
(E) 7.0

19. The concentration of OH^- in a saturated solution of $Mg(OH)_2$ is 3.62×10^{-4} *M*. Calculate the K_{sp} of $Mg(OH)_2$. (4 points)
(A) 6.6×10^{-8}
(B) 4.7×10^{-11}
(C) 1.3×10^{-7}
(D) 3.6×10^{-4}
(E) 2.4×10^{-11}

20. For the reaction A + B → C + D, ΔH = +40 kJ and ΔS = +50 J/K. Under what temperature condition is the reaction spontaneous? (4 points)
(A) spontaneous at temperatures less than 10 K
(B) spontaneous at temperatures greater than 800 K
(C) spontaneous only at temperatures between 10 K and 800 K
(D) spontaneous at all temperatures
(E) nonspontaneous at all temperatures

21. The following reaction (***unbalance***) occurs in aqueous acid solution: (5 points)



In the ***balanced*** equation the coefficient of NO_3^- is:
(A) 2
(B) 3
(C) 4
(D) 5

(E) 6

22. Nickel is electroplated from a $NiSO_4$ solution. A constant current of 2.33 *A* is applied by an external power supply. How long will it take to deposit 100 g of Ni? (Atomic mass of Ni = 58.69.) (5 points)
(A) 39.1 h
(B) 19.5 h
(C) 42.9 min
(D) 130.7 s
(E) 2.57 s

23. An archaeological sample contains 0.622 g of lead-206 and 2.198 g of uranium-238. Assume that all the lead now present in the rock came from the radioactive decay of the uranium and that no appreciable amounts of other radioactive nuclides are present in the sample. The decay rate constant for the uranium is 1.54×10^{-10}/year. What is the age of the sample? (5 points)
(A) 9.1×10^{9} years
(B) 7.98×10^{8} years
(C) 1.84×10^{9} years
(D) 7.26×10^{9} years
(E) none of these

24. The following question refers to a solution that contains 1.56 *M* hydrofluoric acid, HF ($K_a = 7.2\times10^{-4}$), and 3.00 *M* hydrocyanic acid, HCN ($K_a = 6.2\times10^{-10}$).
Determine the $[CN^-]$ at equilibrium. (5 points)
(A) 1.9×10^{-9} *M*
(B) 3.4×10^{-2} *M*
(C) 5.5×10^{-8} *M*
(D) 6.2×10^{-10} *M*
(E) none of these

25. You have solutions of 0.200 *M* HNO_2 and 0.200 *M* KNO_2 (K_a for $HNO_2 = 4.00\times10^{-4}$). A buffer of pH 3.000 is needed. What volumes of HNO_2 and KNO_2 are required to make 1 liter of buffered solution? (5 points)
(A) 500 mL of each
(B) 286 mL HNO_2; 714 mL KNO_2
(C) 413 mL HNO_2; 587 mL KNO_2
(D) 714 mL HNO_2; 286 mL KNO_2
(E) 587 mL HNO_2; 413 mL KNO_2