

臺灣綜合大學系統 115 學年度學士班轉學生聯合招生考試試題

科目名稱	普通化學 A	類組代碼	共同考科
		科目碼	E0017

※本項考試依簡章規定所有考科均「不可」使用計算機。 本科試題共計 2 頁

計算及問答題：（100 分）

1. (20 points total) A student was testing the content of lithium metal (Li) in a commercial lithium battery. He opened a lithium battery carefully in a safe environment, weighed it to obtain 0.3415 g and put it in a plastic syringe. He added deionized water through the end of the syringe in a fume hood in a well-ventilated laboratory and saw gas evolution. Using the syringe to measure the volume of the gas, 31 mL of the gas has formed. He then transferred the aqueous solution to an Erlenmeyer flask, and the solution was titrated with standardized 0.600 M HCl(aq) and it required 4.27 mL to reach the end point.

(A) (4 points) Write and balance the reaction. What is the gas that has evolved?

(B) (4 points) Based on your answer to (A), assuming that the evolved gas is an ideal gas and the vapor pressure of H₂O is negligible, what is the number of moles of gas that has formed?

(C) (4 points) Based on your answer to (B), calculate the mass of lithium in the lithium battery.

(D) (4 points) Write and balance the titration reaction.

(E) (4 points) Use your answer to (D) to calculate the mass of lithium in the lithium battery.

2. (17 points total) Given the following equation:

$$\text{MnO}_4^-(\text{aq}) + \text{Fe}^{2+}(\text{aq}) \rightarrow \text{Mn}^{2+}(\text{aq}) + \text{Fe}^{3+}(\text{aq})$$

(A) (1 point) What element is being oxidized?

(B) (1 point) What element is being reduced?

(C) (5 points) Write the balanced oxidation half reaction in acidic solution.

(D) (5 points) Write the balanced reduction half reaction in acidic solution.

(E) (5 points) Give the overall balanced redox equation in acidic solution.

3. (15 points total) Caffeine is an organic molecule that consists of carbon, hydrogen, nitrogen, and oxygen. When 0.1920 g caffeine is burned in an excess of oxygen, 0.3482 g carbon dioxide and 0.0891 g water are formed. Caffeine is 28.84% nitrogen by mass, and its molar mass is between 190 and 200 g/mol.

(A) (3 points) What is the mass of carbon in this sample of caffeine?

(B) (3 points) What is the mass of hydrogen in this sample of caffeine?

(C) (3 points) What is the mass of nitrogen in this sample of caffeine?

(D) (3 points) What is the mass of oxygen in this sample of caffeine?

(E) (3 points) What is the molecular formula of caffeine?

4. (10 points) The standard enthalpy of formation (ΔH_f°) for graphite and diamond are 0 and 2 kJ/mol, respectively. The standard entropy (S°) for graphite and diamond are 6 and 2 J/mol·K, respectively. Use the above data, calculate the free energy change for the conversion of diamond to graphite at 300 K.

5. (10 points) Draw the unit cells of (A) simple cubic, (B) body-centered cubic, and (C) face-centered cubic and indicate how many atoms there are in a unit cell. Which one is the closest packed structure?

6. (12 points) Construct the molecular orbital diagram for F₂ and use the diagram to calculate the bond order of F₂⁺, F₂, and F₂⁻, how many unpaired electrons are there in each molecule or ions?

7. (16 points) Draw the Lewis structures that minimize each atom's formal charge for the following molecules or ions. Indicate the shape of the central atom of the molecules and ions.

(A) SCN⁻ (B) CO₂ (C) H₂SO₄ (D) SF₄

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本科試題共計 2 頁

1 H 1.008																	2 He 4.003
3 Li 6.94	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57/71	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89/103	104 Rf (267)	105 Db (268)	106 Sg (271)	107 Bh (272)	108 Hs (270)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Nh (284)	114 Fl (289)	115 Mc (288)	116 Lv (293)	117 Ts (294)	118 Og (294)

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.2	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
89 Ac (227)	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)