國立彰化師範大學 100 學年度碩士班招生考試試題

系所：化學系　　　　　　　　　　　　　　　　科目：無機化學與分析化學

☆☆請在答案紙上作答☆☆　　　　　　　　　　　　　　　　

第一部分：無機與分析化學（無機部份，共 50 分）

1. Give Lewis dot structures and sketch the shapes of (a) ICl_2^- (b) $ClOF_4^-$ (8%)
2. Determine the point groups for (a) ethylene (b) acetylene (6%)
3. On the basis of molecular orbitals, predict the shortest bond lengths of O_2^-, O_2 and O_2^+. Give your explanation. (6%)
4. Sketch all isomers of $[Pt(en)_2Cl_2]^{2+}$, where en = ethylenediamine. (6%)
5. Predict the number of unpaired electrons for (a) $Co(H_2O)_6]^{2+}$ (b) a square-planar d^7 ion (6%)
6. Determine the ground terms for (a) high spin and low spin d^5 (*Oh* symmetry) (b) d^4 (*Td* symmetry) (6%)
7. Determine the valance electron counts for the transition metals in the following complexes (a) $[Fe(CO)_4]^{2-}$ (b) $(\eta^3\text{-}C_3H_5)(\eta^5\text{-}C_5H_5)Fe(CO)$. (6%)
8. N_2 has molecular orbitals rather similar to those of CO, would you expect N_2 to be a stronger or weaker π acceptor than CO? (6%)

第二部分：無機與分析化學（分析部分，共 50 分）

1. The contents of mercury in the SRM soil sample measured by ICP-MS are 3.17, 3.19, 3.21, 3.19, 3.17 and 3.21 ppm. You are developing a label-free nanoparticle based optic-sensor for determination of Hg^{2+} ions. The measured values are 3.29, 3.22, 3.30, 3.01 and 3.23 ppm, respectively. Does your answer differ significantly from the answer by ICP-MS at the 95% confidence level? (15%)
2. Soil sample containing Pb^{2+} ions gave a signal of 4.27 mV in an atomic emission analysis. Then 5.00 mL of 2.08 M Pb^{2+} ions were added to 95.0 mL of soil sample. This spiked soil sample gave a signal of 6.50 mV. Find $[Pb^{2+}]$ in the original soil sample. (5%)
3. Consider a saturated solution of $SrSO_4$ in which following reactions are considered:

   $SrSO_{4(s)} \leftrightarrows Sr^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$　　　　($K_{sp} = 3.2 \times 10^{-7}$)

   $SO_4^{2-}{}_{(aq)} + H_2O \leftrightarrows HSO_4^-{}_{(aq)} + OH^-_{(aq)}$　　　　($K_b = 9.8 \times 10^{-13}$)

   Find the concentration of $Sr^{2+}_{(aq)}$ in the solution if the pH is fixed at 2.50. (Assume $[H_2SO_4] = 0$). (10%)
4. In 298 K, Given:

   $2IO_3^- + I^- + 12H^+ + 10\,e^- \leftrightarrows I_3^- + 6\,H_2O$　　　　($E^o = 1.210$ V)

   $I_3^- + 2e^- \leftrightarrows 3I^-$　　　　($E^o = 0.535$ V)

   (1) Write the balanced reaction of IO_3^- and I^- producing I_3^- in acidic solution. (5%)
   (2) Calculate E^o, ΔG^o, and K for the balanced reaction. (9%)
   (3) Calculate E and ΔG if the solution $[IO_3^-]=0.010$ M, $[I^-]=0.010$ M, $[I_3^-]=1.0\times10^{-4}$ M, and buffered at pH 6. (6%)

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Useful information:

$$G_{exp} = \frac{|questionable \quad value - \bar{x}|}{s}, \quad F_{exp} = \frac{s_1^2}{s_2^2}, \quad \nu = \left\{ \frac{(s_1^2/n_1 + s_2^2/n_2)^2}{\frac{(s_1^2/n_1)^2}{n_1+1} \; \frac{(s_2^2/n_2)^2}{n_2+1}} \right\} - 2$$

$$t_{(exp)} = \frac{|\bar{x}-\mu|\sqrt{N}}{s}, \quad t_{(exp)} = \frac{|\bar{x}_1-\bar{x}_2|}{S_p}\sqrt{\frac{n_1 n_2}{n_1+n_2}}, \quad t_{(exp)} = \frac{|\bar{x}_1-\bar{x}_2|}{\sqrt{s_1^2/n_1+s_2^2/n_2}}$$

$$S_p = \sqrt{\frac{s_1^2(n_1-1)+s_2^2(n_2-1)}{n_1+n_2-2}}$$

Number of observations	G (95% confidence)
4	1.463
5	1.672
6	1.822
7	1.938
8	2.032
9	2.110
10	2.176
11	2.234
12	2.285
15	2.409
20	2.557

	Confidence level (%)						
Degrees of freedom	50	90	95	98	99	99.5	99.9
1	1.000	6.314	12.706	31.821	63.656	127.321	636.578
2	0.816	2.920	4.303	6.965	9.925	14.089	31.598
3	0.765	2.353	3.182	4.541	5.841	7.453	12.924
4	0.741	2.132	2.776	3.747	4.604	5.598	8.610
5	0.727	2.015	2.571	3.365	4.032	4.773	6.869
6	0.718	1.943	2.447	3.143	3.707	4.317	5.959
7	0.711	1.895	2.365	2.998	3.500	4.029	5.408
8	0.706	1.860	2.306	2.896	3.355	3.832	5.041
9	0.703	1.833	2.262	2.821	3.250	3.690	4.781
10	0.700	1.812	2.228	2.764	3.169	3.581	4.587
15	0.691	1.753	2.131	2.602	2.947	3.252	4.073
20	0.687	1.725	2.086	2.528	2.845	3.153	3.850
25	0.684	1.708	2.060	2.485	2.787	3.078	3.725
30	0.683	1.697	2.042	2.457	2.750	3.030	3.646
40	0.681	1.684	2.021	2.423	2.704	2.971	3.551
60	0.679	1.671	2.000	2.390	2.660	2.915	3.460
120	0.677	1.658	1.980	2.358	2.617	2.860	3.373
∞	0.674	1.645	1.960	2.326	2.576	2.807	3.291

Degrees of freedom for s_2	Degrees of freedom for s_1													
	2	3	4	5	6	7	8	9	10	12	15	20	30	∞
2	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.5	19.5
3	9.55	9.28	9.12	9.01	8.94	8.89	8.84	8.81	8.79	8.74	8.70	8.66	8.62	8.53
4	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.75	5.63
5	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.50	4.36
6	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.81	3.67
7	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.58	3.51	3.44	3.38	3.23
8	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.08	2.93
9	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.86	2.71
10	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.84	2.77	2.70	2.54
11	3.98	3.59	3.36	3.20	3.10	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.57	2.40
12	3.88	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.47	2.30
13	3.81	3.41	3.18	3.02	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.38	2.21
14	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.31	2.13
15	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.25	2.07
16	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.19	2.01
17	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.15	1.96
18	3.56	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.11	1.92
19	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.07	1.88
20	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.04	1.84
30	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.84	1.62
∞	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.46	1.00