

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Inorganic Chemistry (50 points)

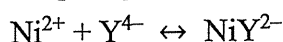
- (1) Describe the following structure types in terms of sphere packings and anion and cation coordination (12 pts)
- NaCl
 - NaAs
 - ZnS
 - CaF₂
- (2) Answer the following questions:
- Ag₂S or AgCl is much less soluble? Why? (4 pts).
 - Name and draw the shape associated with the following molecule using VSEPR theory. (4 pts)
XeF₆
- (3) Draw the models of the following molecules and answer the questions (a) to (d) for each of them (15 pts):
ethylene IOF₃ B(OH)₃ (Planar)
- Does the molecule have an axis of symmetry? If so, is it 2-fold, 3-fold, or what?
 - Does the molecule have an inversion center?
 - Does the molecule have any mirror planes? If so, how many?
 - What is the point group of the molecule?
- (4) Based on molecular orbital theory, draw the molecular orbitals of CO (include all atomic orbitals and label all the orbitals, e.g., 1s, 2p_x, σ_{2s}, π_{2py}, etc). Fill the resulting orbitals with electrons (9 pts)
- (5) Give the dⁿ count and the total valence electron count at the metal for the following compounds. (6 pts)
- CpMo(CO)₃Cl
 - W(CH₃)₆

Analytical Chemistry (50 points)

(1) 0.100 M acetic acid solution at 25 °C can dissociate 1.34%. Calculate K_a of acetic acid. (10 pts)

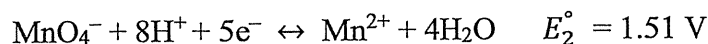
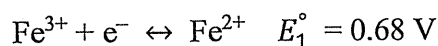
(2) A sample of 0.5662 g of an unknown ionic compound containing chloride ions is dissolved in water and treated with an excess of AgNO_3 . If the mass of the AgCl precipitate that forms is 1.0882 g, what is the percent of Cl (by mass) in the original compound? (10 pts)

(3) Calculate $[\text{Ni}^{2+}]$ at equilibrium in NiY^{2-} solution (0.0150 M) at a) pH = 3 and b) pH = 8. (10 pts)



$$K_{MY} = \frac{[\text{NiY}^{2-}]}{[\text{Ni}^{2+}][\text{Y}^{4-}]} = 4.2 \times 10^{18}$$

(4) A 0.1 M solution (40 mL) containing Fe^{2+} is titrated with a 0.1 M KMnO_4 solution. The reaction is as follows:



Assume that during the titration the solution has a constant concentration of 1 M. Calculate E_{cell} vs. standard hydrogen electrode, when 15 mL of 0.1 M KMnO_4 is added. (10 pts)

(5) Sodium iodide is added into a solution mixture containing 0.10 M $\text{Pb}(\text{NO}_3)_2$ and 0.10 M AgNO_3 . When Ag^+ precipitates as AgI at 99%, will PbI_2 also precipitate? Why? Show all calculations (K_{sp} of $\text{AgI} = 8.3 \times 10^{-17}$ and K_{sp} of $\text{PbI}_2 = 7.1 \times 10^{-9}$). (10 pts)

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																		
1	H Hydrogen 1.01	3	Li Lithium 6.94	4	Be Beryllium 9.01	5	B Boron 10.81	6	C Carbon 12.01	7	N Nitrogen 14.01	8	O Oxygen 16.00	9	F Fluorine 19.00	10	Ne Neon 20.18																		
11	Na Sodium 22.99	12	Mg Magnesium 24.31	13	Al Aluminum 26.98	14	Si Silicon 28.09	15	P Phosphorus 30.97	16	S Sulfur 32.07	17	Cl Chlorine 35.45	18	Ar Argon 39.95																				
19	K Potassium 39.10	20	Ca Calcium 40.08	21	Sc Scandium 44.96	22	Ti Titanium 47.87	23	V Vanadium 50.94	24	Cr Chromium 51.99	25	Mn Manganese 54.94	26	Fe Iron 55.85	27	Co Cobalt 58.93	28	Ni Nickel 58.69	29	Cu Copper 63.55	30	Zn Zinc 65.38	31	Ga Gallium 69.72	32	Ge Germanium 72.63	33	As Arsenic 74.92	34	Se Selenium 78.97	35	Br Bromine 79.90	36	Kr Krypton 84.00
37	Rb Rubidium 85.47	38	Sr Strontium 87.62	39	Y Yttrium 88.91	40	Zr Zirconium 91.22	41	Nb Niobium 92.91	42	Mo Molybdenum 95.95	43	Tc Technetium 98.91	44	Ru Ruthenium 101.07	45	Rh Rhodium 102.91	46	Pd Palladium 106.42	47	Ag Silver 107.87	48	Cd Cadmium 112.41	49	In Indium 114.82	50	Sn Tin 118.71	51	Sb Antimony 121.76	52	Te Tellurium 127.6	53	I Iodine 126.90	54	Xe Xenon 131.29
55	Cs Cesium 132.91	56	Ba Barium 137.33	57-71	Lanthanides Lanthanum 138.91	72	Hf Hafnium 178.49	73	Ta Tantalum 180.95	74	W Tungsten 183.84	75	Re Rhenium 186.21	76	Os Osmium 190.23	77	Ir Iridium 192.22	78	Pt Platinum 195.09	79	Au Gold 196.97	80	Hg Mercury 200.59	81	Tl Thallium 204.38	82	Pb Lead 207.2	83	Bi Bismuth 208.98	84	Po Polonium [209]	85	At Astatine 209	86	Rn Radon 222.02
87	Fr Francium 223.02	88	Ra Radium 226.03	89-103	Actinides Actinium 227.03	104	Rf Rutherfordium [261]	105	Db Dubnium [262]	106	Sg Seaborgium [266]	107	Bh Bohrium [264]	108	Hs Hassium [265]	109	Mt Meitnerium [276]	110	Ds Darmstadtium [281]	111	Rg Roentgenium [280]	112	Cn Copernicium [285]	113	Nh Nihonium [286]	114	Fl Flerovium [289]	115	Mc Moscovium [289]	116	Lv Livermorium [293]	117	Ts Tennessine [294]	118	Og Oganesson [294]
57	La Lanthanum 138.91	58	Ce Cerium 140.12	59	Pr Praseodymium 140.91	60	Nd Neodymium 144.24	61	Pm Promethium [145]	62	Sm Samarium 150.36	63	Eu Europium 151.96	64	Gd Gadolinium 157.25	65	Tb Terbium 158.93	66	Dy Dysprosium 162.50	67	Ho Holmium 164.93	68	Er Erbium 167.26	69	Tm Thulium 168.93	70	Yb Ytterbium 173.05	71	Lu Lutetium 174.97						
89	Ac Actinium 227.03	90	Th Thorium 232.04	91	Pa Protactinium 231.04	92	U Uranium 238.03	93	Np Neptunium 237.05	94	Pu Plutonium 244.06	95	Am Americium 243.06	96	Cm Curium 247.07	97	Bk Berkelium 247.07	98	Cf Californium 251.08	99	Es Einsteinium [254]	100	Fm Fermium 257.10	101	Md Mendelevium 258.1	102	No Nobelium 259.10	103	Lr Lawrencium [262]						