

THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

SECOND SEMESTER EXAMINATION

CH222 – ADVANCED INORGANIC CHEMISTRY

MONDAY 25th OCTOBER 2021 8:20 AM

TIME ALLOWED: 2 HOURS

INFORMATION FOR CANDIDATES:

1. You will have 10 minutes to read the question paper. You **MUST NOT** begin writing in the answer book during this time.
2. **ANSWER ALL QUESTIONS.**
3. All answers **MUST** be written on the answer book provided
4. Calculators are permitted in the examination room. Lecture notes, notebooks plain papers and textbooks are **NOT** allowed.
5. Mobile phones are not allowed. **SWITCH OFF THE MOBILE PHONES.**
6. Show all workings and calculations in the answer book.
7. **DRAW the STRUCTURES** clear and visible.
8. **DO NOT** over write.
9. Write your name and number clearly on the front page. **DO IT NOW.**

MARKING SCHEME: Total 50 marks

1. (a) What are linkage isomers? Give ONE example.
- (b) Most of the nuclear reactions involving α - and β - emissions are accompanied by gamma ray emissions. Why?
- (c) What are mirror nuclei? Give ONE example.
- (f) Draw *cis*- and *trans*- geometrical isomer of $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$
- (8 marks)

2. (a) Calculate the Crystal Field Stabilization Energy (CFSE) for Fe^{3+} in an octahedral coordination complex (*No need of an entire crystal field splitting diagram*).
- (b) Give ANY FOUR postulates of Werner's coordination theory (WCT). How would you structurally represent $\text{CoF}_3 \cdot 6\text{NH}_3$ according to WCT?
- (c) Which 'factor' is responsible for the nuclear stability? In the 'zone of stability' curve, what happens if this 'factor' lies *above* and *below* the curve?
- (d) Use VBT (Valence Bond Theory) to $[\text{Co}(\text{CN})_6]^{3-}$ ion and deduce the shape, hybridization and magnetic property. Identify whether the complex is inner orbital or outer orbital complex.
- (e) What are the FOUR factors (*with respect to the properties of ligands*) that govern the stability of the complexes.
- (f) Compare the velocities and penetrating powers of alpha, beta and gamma rays.
- (g) Balance the following nuclear reactions:
- (i) ${}_{11}^{23}\text{Na} + {}_0^1\text{n} \rightarrow \underline{\hspace{2cm}} + \gamma$
- (ii) ${}_{7}^{14}\text{N} + \underline{\hspace{2cm}} \rightarrow {}_8^{17}\text{O} + {}_1^1\text{H}$
- (iii) $\underline{\hspace{2cm}} \rightarrow {}_{86}^{220}\text{Rn} + \text{alpha particle}$
- (iv) ${}_{56}^{133}\text{Ba} - {}_{-1}^0\text{e} \rightarrow \text{X-ray} + \underline{\hspace{2cm}}$
- (h) What are slow neutrons? How are they produced?

(32 marks)

3. (a) (i) Draw a NEAT and COMPLETE crystal field splitting diagram for $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$ and fill the electrons.
 (ii) Identify whether this complex is high or low spin.
 (iii) Calculate the Crystal Field Stabilization Energy (CFSE) for this complex.
- (b) Use the IUPAC rules and write the exact and proper formula for the following compounds:
- (i) Sodium tetrabromocuprate(II)
 (ii) Tricarbonyltrichloromolybdenum(III)
 (iii) *trans*-aquabis(ethylenediamine)fluorocobalt(III) nitrate
 (iv) Di- μ -chlorobis[diammineplatinum(II)] bromide

(10 marks)

DATA SHEET

Periodic Table of the Elements

1 H 1.01																	18 He 4.00																														
3 Li 6.94	2 Be 9.01											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 32.07	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 51.99	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 98.91	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.6	53 I 126.90	54 Xe 131.29																														
55 Cs 132.91	56 Ba 137.33	57-71	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po [208.98]	85 At 209.99	86 Rn 222.02																														
87 Fr 223.02	88 Ra 226.03	89-103	104 Rf [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [269]	109 Mt [270]	110 Ds [281]	111 Rg [280]	112 Cn [285]	113 Nh [286]	114 Fl [289]	115 Mc [289]	116 Lv [293]	117 Ts [294]	118 Og [294]																														
<table border="1" style="width: 100%; text-align: center;"> <tbody> <tr> <td>57 La 138.91</td> <td>58 Ce 140.12</td> <td>59 Pr 140.91</td> <td>60 Nd 144.24</td> <td>61 Pm 144.91</td> <td>62 Sm 150.36</td> <td>63 Eu 151.96</td> <td>64 Gd 157.25</td> <td>65 Tb 158.93</td> <td>66 Dy 162.50</td> <td>67 Ho 164.93</td> <td>68 Er 167.26</td> <td>69 Tm 168.93</td> <td>70 Yb 173.06</td> <td>71 Lu 174.97</td> </tr> <tr> <td>89 Ac 227.03</td> <td>90 Th 232.04</td> <td>91 Pa 231.04</td> <td>92 U 238.03</td> <td>93 Np 237.05</td> <td>94 Pu 244.06</td> <td>95 Am 243.06</td> <td>96 Cm 247.07</td> <td>97 Bk 247.07</td> <td>98 Cf 251.08</td> <td>99 Es [254]</td> <td>100 Fm 257.10</td> <td>101 Md 258.1</td> <td>102 No 259.10</td> <td>103 Lr [262]</td> </tr> </tbody> </table>																		57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 144.91	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.06	71 Lu 174.97	89 Ac 227.03	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu 244.06	95 Am 243.06	96 Cm 247.07	97 Bk 247.07	98 Cf 251.08	99 Es [254]	100 Fm 257.10	101 Md 258.1	102 No 259.10	103 Lr [262]
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