NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, APPLIED SCIENCES AND NATURAL RESOURCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION: BACHELOR OF SCIENCE HONOURS	
QUALIFICATION CODE: 08BOSH	**LEVEL:** 8
COURSE CODE: BBC811S	**COURSE NAME:** BIOINORGANIC AND BIOPHYSICAL CHEMISTRY
SESSION: JULY 2022	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

SUPPLEMENTARY/SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	DR. EUODIA HESS
MODERATOR:	DR. LIKIUS DANIEL

INSTRUCTIONS
1. Answer ALL the questions. 2. Write clearly and neatly. 3. Number the answers clearly 4. All written work must be done in blue or black ink and sketches can be done in pencil 5. No books, notes and other additional aids are allowed

THIS QUESTION PAPER CONSISTS OF 4 PAGES (Including this front page, list of useful constants and Periodic Table)

SECTION A [60]

QUESTION 1: [10]

What are the biological roles/functions of the following metals:

a) Co
b) Cu
c) Na
d) Ca
e) K

QUESTION 2: [10]

What are the donor atoms according to the hard soft acid base (HSAB) theory? Explain with examples if they hard, soft or intermediate.

QUESTION 3: [40]

3.1 In medicine the use of metal ions and their associated complexes is widespread. Among Metal ions commonly used over the centuries were Hg^{2+} for treatment of syphilis, Mg^{2+} for intestinal disorders and Fe^{2+} for anaemia. Today one of the leading anticancer drug is cis-$[Pt(NH_3)_2Cl_2]$, cisplatin, which was first approved for use in 1978.

i) Against which type(s) of cancer is cisplatin effective? (3)
ii) Draw the structure of cisplatin. (2)
iii) How does cisplatin function as a anticancer drug? (3)
iv) What are the disadvantages of using cisplatin as an anticancer drug? (2)

3.2 Name three other platinum drugs that are utilized as an anticancer drug and for each drug answer question i – iv for them as well. (30)

SECTION B: [40]

QUESTION 1: [10]

The kinetics of CO_2 hydration catalysed by the enzyme carbonic anhydrase is as follows:

$$CO_2 + H_2O \leftrightarrow HCO_3^- + H^+$$

The following initial reaction rates for the hydration reaction were obtained for an initial enzyme concentration of 2.3 nM and temperature of 0.5 °C :

Rate ($M\ s^{-1}$)	$[CO_2]$ (mM)
2.78×10^{-5}	1.25
5.00×10^{-5}	2.5
8.33×10^{-5}	5.0
1.67×10^{-4}	20.0

QUESTION 2: [10]

2.1 Obtain a balanced chemical equation and calculate the standard electrochemical potential for reduction of Fe^{3+} to Fe by Zn metal ($Zn^{2+} \rightarrow$ Zn $E^0 = -0.7618$ V ; $Fe^{3+} \rightarrow$ Fe $E^0 = -0.037$ V). (5)

2.2 The enzyme glutathione reductase replenishes the cell's supply of GSH regenerating two molecules of GSH from single molecule of oxidized gluthione (GSSH), using NADPH as a source of two reducing equivalents. A typical cellular $NADP^+/NADPH$ ratio is 0.005, calculate the equilibrium cellular concentration of GSSG at pH 7 and 25°C, if GSH concentration is 4 mM. ($GSSG + 2H^+ + 2e^- \rightarrow 2\ GSH\ E^0 = -0.240$ V; $NADP^+ + H^+ + 2e^- \rightarrow NADPH\ E^0 = -0.339$ V). (5)

QUESTION 3: **[10]**

For the hydrolysis of ATP, standard conditions do not prevail in the cellular environment. In the Cell, typical concentrations of ATP, ADP and inorganic phosphate are c_{ATP} = 1850 μM, c_{ADP} = 138 μM, and c_{pi} = 1.00 mM. Calculate the Gibbs energy of hydrolysis in the cellular environment, assuming pH = 7 and T = 310 K.

QUESTION 4: **[10]**

The enthalpy of melting ice at 1 bar is 6.007 kJ/mol; the density of water at 0 °C is 999.9 kg m^{-3}, While that of ice is 915.0 kg m^{-3}. Assuming ΔV_m^{fusion} and ΔH_m^{fusion} are constant, determine the freezing point of water at 100 bar.

END OF EXAMINATION

USEFUL CONSTANTS:

Gas constant, R = 8.3145 J · mol^{-1} · K^{-1} = 0.083145 dm^3 · bar · mol^{-1} · K^{-1} = 0.08206 L atm mol^{-1} · K^{-1}

1 Pa · m^3 = 1 kPa.L = 1 N · m = 1 J

1 atm = 101 325 Pa = 760 mmHg = 760 torr

Faradays constant = 96,485 C/mol

Avogadro's Number, N_A = 6.022 x 10^{23} mol^{-1}

Planck's constant, h = 6.626 x 10^{-34} Js

Speed of light, c = 2.998 x 10^8 ms^{-1}

PERIODIC TABLE OF THE ELEMENTS

1																	18
1 **H** 1.00794	2											13	14	15	16	17	2 **He** 4.00260
3 **Li** 6.941	4 **Be** 9.01218											5 **B** 10.81	6 **C** 12.011	7 **N** 14.0067	8 **O** 15.9994	9 **F** 18.9984	10 **Ne** 20.179
11 **Na** 22.9898	12 **Mg** 24.305	3	4	5	6	7	8	9	10	11	12	13 **Al** 26.9815	14 **Si** 28.0855	15 **P** 30.9738	16 **S** 32.06	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.0983	20 **Ca** 40.08	21 **Sc** 44.9559	22 **Ti** 47.88	23 **V** 50.9415	24 **Cr** 51.996	25 **Mn** 54.9380	26 **Fe** 55.847	27 **Co** 58.9332	28 **Ni** 58.69	29 **Cu** 63.546	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.9216	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.8
37 **Rb** 85.4678	38 **Sr** 87.62	39 **Y** 88.9059	40 **Zr** 91.22	41 **Nb** 92.9064	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.906	46 **Pd** 106.42	47 **Ag** 107.868	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.69	51 **Sb** 121.75	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.29
55 **Cs** 132.905	56 **Ba** 137.33	71 **Lu** 174.967	72 **Hf** 178.49	73 **Ta** 180.948	74 **W** 183.85	75 **Re** 186.207	76 **Os** 190.2	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.967	80 **Hg** 200.59	81 **Tl** 204.383	82 **Pb** 207.2	83 **Bi** 208.908	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.025	103 **Lr** (260)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (264)	108 **Hs** (265)	109 **Mt** (268)	110 Uun (269)	111 Uuu (272)	112 Uub (269)		114 Uuq		116 Uuh		118 Uuo

Lanthanides:	57 **La** 138.906	58 **Ce** 140.12	59 **Pr** 140.908	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.925	66 **Dy** 162.50	67 **Ho** 161.930	68 **Er** 167.26	69 **Tm** 166.934	70 **Yb** 173.04
Actinides:	89 **Ac** 227.028	90 **Th** 232.038	91 **Pa** 231.036	92 **U** 238.029	93 **Np** 237.048	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)