NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH AND APPLIED SCIENCES

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: JUNE 2019	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

FIRST 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

PERMISSABLE MATERIALS

Non-programmable calculators

ATTACHMENTS

1. List of useful constants
2. Periodic Table

THIS QUESTION PAPER CONSISTS OF 5 PAGES (Including this front page, list of useful constants and Periodic Table)

SECTION A [50]

QUESTION 1: [12]

List the general characteristics of Hard, Intermediate and Soft Ligands along with the classification of metal ions and ligands of importance in biological inorganic chemistry.

QUESTION 2: [9]

a) Why is chelation important in medicine? (3)
b) Why are corrins and pophyrins regarded as an important class of natural chelator molecules? (6)

QUESTION 3: [16]

a) Which of the 20 amino acids are potential metal ligands? (10)
b) Which of the low molecular weight inorganic anions bind to Fe^{3+} in proteins? (2)
c) Which metals are inserted into the tetrapyrrole nucleus of corrins and porphyrins to form vitamin B_{12} and other cobalamine cofactors, haem, chlorophyll and coenzyme F_{430} respectively? (4)

QUESTION 4: [3]

What is the difference between catabolism and anabolism processes? Include equations in your answer.

QUESTION 5: [10]

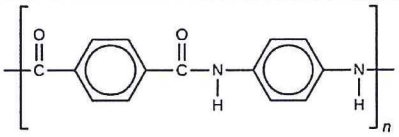
Name the five methods used to study metals in biological systems and include which metals they detect.

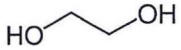
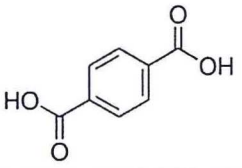
SECTION B: [50]

QUESTION 1: [20]

a) Distinguish briefly between the terms **condensation polymerisation** and **addition polymerisation**. (2)

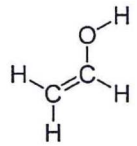
b) Draw the structure of the missing compound in the following polymerisation reactions (A – C) and state whether the resulting polymer is a condensation polymer or addition polymer. (4)

A	(i) _____	+	(ii) _____	→	

B		+		→	(iii) _____

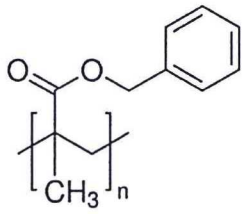
c) What is the number average degree of polymerisation (DP) of each of the following? (4)

(i) Polyvinyl alcohol (PVA) with number-average molecular weight of 150 000.



Monomer

(ii) Poly(benzyl methacrylate) with number-average molecular weight of 100 000.



d) Considering the following water treatment *Moringa oleifera* seed biopolymer size fractions of a given sample:

Fraction	Number of Chains, N_i	Molecular Weight, M_i
1	500	5,000
2	100	10,000
3	3	1,000,000

i) Calculate the number-average molecular weight ($\overline{M}_n$), weight-average molecular weight ($\overline{M}_w$) and z-average molecular weight ($\overline{M}_z$) of the polymer. (6)

ii) Which average molecular weight did the 3 chains of the molecular weight 1,000,000 most significantly affect and why? (1)

iii) Calculate the polydispersity index (PDI) and comment on the result. (2)

iv) Comment the relative magnitudes of the molecular weights, i.e. $\overline{M}_n$, $\overline{M}_w$ and $\overline{M}_z$. (1)

QUESTION 2: **[10]**

The enthalpy of melting of ice at 1bar is 6.007 kJ/mol; the density of water at 0°C is 999.9 kg/m^3, while that of ice is 915.o kg/m^3. Assuming $\Delta_{fus}V_m$ and $\Delta_{fus}H_m$ are constant, determine the freezing point of water at 100 bar.

QUESTION 3: **[20]**

a) Determine the diffusion coefficient of for Ar (σ = 3.6 x 10^{-19} m^2) at 298 K and a pressure of 1.00 atm. (10)

b) Under identical temperature and pressure conditions, the diffusion coefficient of He is four times larger than that of Ar. Determine the ratio of the collisional cross-sections. (10)

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

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)