NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH AND APPLIED SCIENCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION: BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	**LEVEL:** 5
COURSE NAME: GENERAL CHEMISTRY 1B	**COURSE CODE:** GNC502S
SESSION: NOVEMBER 2019	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	DR. EUODIA HESS DR. MARIUS MUTORWA
MODERATOR:	DR. JULIEN LUSILAO

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 12 PAGES (Including this front page and attachments)

SECTION A [50]

QUESTION 1: Multiple Choice Questions [50]

- *There are 25 multiple choice questions in this section. Each question carries 2 marks.*
- *Answer ALL questions by selecting the letter of the correct answer.*
- *Choose the best possible answer for each question, even if you think there is another possible answer that is not given.*

1. Which of the following is true regarding the relative molar rates of disappearance of the reactants and the appearance of the products?

$$2NO\ (g) + 2H_2\ (g) \rightarrow N_2\ (g) + 2H_2O\ (g)$$

I. N_2 appears at the same rate that H_2 disappears.

II. H_2O appears at the same rate that NO disappears.

III. NO disappears at the same rate that H_2 disappears.

A. **I** only
B. **I** and **II** only
C. **I** and **III** only
D. **II** and **III** only
E. **I**, **II**, and **III**

2. For the reaction $2A + B \rightarrow C$, experimental data were collected for three trials:

Experiment	[A] (M)	[B] (M)	Initial Rate Appearance of C ($M\ sec^{-1}$)
1	0.40	0.20	5.5×10^{-3}
2	0.80	0.20	5.5×10^{-3}
3	0.40	0.40	2.2×10^{-2}

What is the rate law of the reaction?

A. Rate = $k[A][B]$
B. Rate = $k[A]^0[B]^2$
C. Rate = $k[A]^2[B]^2$
D. Rate = $k[A]^2[B]^0$
E. Rate = $k[A][B]^2$

3. For a reaction A + B → C + D, the energy of activation and enthalpy change of reaction were found to be 80 kJ mol^{-1} and + 20 kJ mol^{-1}, respectively. What is the value of the activation energy for the reverse reaction?

   A. + 60 kJ mol^{-1}
   B. + 100 kJ mol^{-1}
   C. – 80 kJ mol^{-1}
   D. + 20 kJ mol^{-1}
   E. Insufficient information

4. Write the appropriate equilibrium constant expression, K_c, for the following reaction:

$$2CO(g) + O_2(g) \leftrightharpoons 2CO_2(g)$$

   A. $K_c = k[CO]^2[O_2]$

   B. $K_c = \dfrac{[CO_2]}{[CO][O_2]}$

   C. $K_c = \dfrac{[CO]^2[O_2]}{[CO_2]}$

   D. $K_c = \dfrac{[CO_2]^2}{[CO][O_2]}$

   E. $K_c = \dfrac{[CO_2]^2}{[CO]^2[O_2]}$

5. Suppose we rewrite the balanced reaction in Question 4 as:

$$CO(g) + ½\ O_2(g) \leftrightharpoons CO_2(g)$$

   What would be the equilibrium constant, K'_C, for this reaction?

   A. Same(i.e. $K_c' = K_c$)
   B. $K_c' = (K_c)^{½}$
   C. $K_c' = K_c/2$
   D. $K_c' = K_c^2$
   E. $K_c' = 1/ K_c$

6. If K_{eq} is small, it indicates that equilibrium occurs:

   A. At a low product concentration
   B. At a high product concentration
   C. After considerable time
   D. With the help of a catalyst
   E. With no forward reaction

7. For which one of the following equilibrium equations will K_p be equal to K_c?

   A. $PCl_5(g) \leftrightharpoons PCl_3(g) + Cl_2(g)$

   B. $COCl_2(g) \leftrightharpoons CO(g) + Cl_2(g)$

   C. $H_2(g) + I_2(g) \leftrightharpoons 2HI(g)$

   D. $3H_2(g) + N_2(g) \leftrightharpoons 2NH_3(g)$

   E. $2SO_3(g) \leftrightharpoons 2SO_2(g) + O(g)$

8. Consider the following equilibrium:

$$H_2(g) + I_2(g) \leftrightharpoons 2HI(g)$$

   At equilibrium $[H_2] = 0.00220$ M, $[I_2] = 0.00220$ M, and $[HI] = 0.0156$ M. The value of the K_c is

   A. 3.10×10^{-4}

   B. 1.99×10^{-2}

   C. 5.03×10^{1}

   D. 3.22×10^{3}

   E. 1

9. Arrhenius would define a base as:

   I. Something which yields hydroxide ions in solution

   II. A proton acceptor

   III. An electron pair donor

   A. I, II, and III

   B. I and III

   C. II only

   D. I only

   E. I and II

10. In the equilibrium expression for the reaction $BaSO_4(s) \leftrightharpoons Ba^{2+}(aq) + SO_4^{2-}(aq)$, K_{sp} is equal to:

   A. $\dfrac{[Ba^{2+}][SO_4^{2-}]}{[BaSO_4]}$

   B. $\dfrac{[BaSO_4]}{[Ba^{2+}][SO_4^{2-}]}$

C. $[Ba^{2+}][SO_4^{2-}]$

D. $\frac{[Ba^{2+}][SO_4^{2-}]}{BaSO_4}$

E. None of the above

11. Calculate the concentration (mol/L) of a solution of $Ba(OH)_2$ that has a pH of 12.7?

A. 1.0×10^{-13}

B. 5.0×10^{-2}

C. 2.0×10^{-13}

D. 2.5×10^{-2}

E. 1.27×10^{1}

12. A buffer solution was prepared by mixing 100 mL of a 1.2 M NH_3 solution and 400 mL of a 0.5 M NH_4Cl solution. What is the pH of this buffer solution, assuming a final volume of 500 mL and $K_b = 1.8 \times 10^{-5}$?

A. 1.08

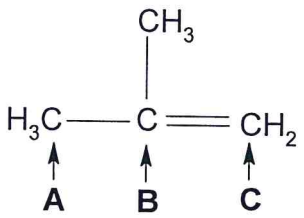
B. 4.96

C. 5.8

D. 9.03

E. 8

13. What kind of hybridization do you expect for each of the carbon atoms indicated in 2-methylpropene?



A. **A** is sp^3; **B** is sp; **C** is sp

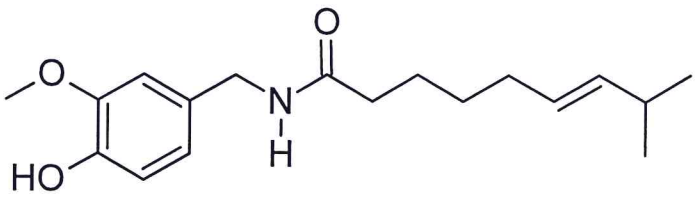
B. **A** is sp^3; **B** is sp^2; **C** is sp^2

C. **A** is sp^2; **B** is sp^3; **C** is sp^2

D. **A** is sp; **B** is sp^3, **C** is sp^3

E. **A** is sp^2; **B** is sp; **C** is sp^2

14. The structure below is that of Capsaicin, the pungent substance in chilli peppers.



The functional groups of the above structure include:

A. amide; ester; alcohol; alkene

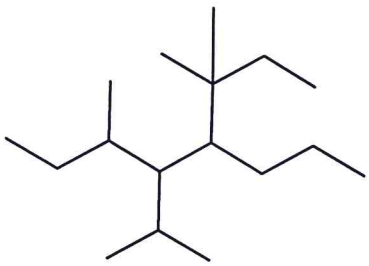
B. ether; amide, alkyne; alcohol

C. alcohol; ester; ether; amine

D. ester; carboxylic acid; alkene; alcohol

E. amine; ester; alkene; alcohol

15. What is the correct IUPAC name for the compound shown below?



A. 3-methyl-4-(1-methylethyl)-5-(propyl)-6-(dimethyl) octane

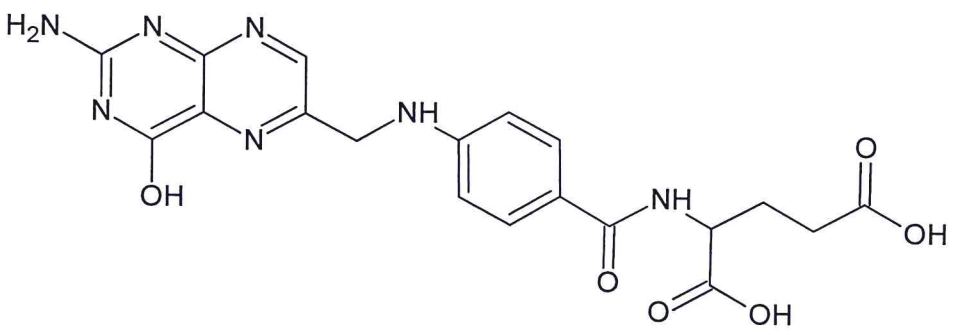
B. 4-isopropyl-3-methyl-tert-pentylnonane

C. 4-(1,1-dimethylpropyl)-5-(1-methylethyl)-6-(methyl) nonane

D. 3-methyl-4-(1-methylethyl)-5-(1,1-dimethylpropyl) nonane

E. 3-methyl-4-(1,1-dimethyl)-5-(1,1-dimethylpropyl) nonane

16. The line-bond structure shown below is the compound Folic Acid, an essential vitamin that the body uses to make DNA and metabolise amino acids.



The correct molecular (or condensed) formula for Folic Acid is:

A. $C_{19}H_{19}N_7O_4$

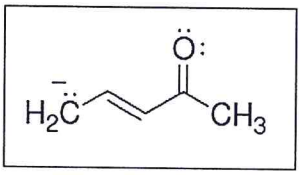
B. $C_{19}H_7N_7O_6$

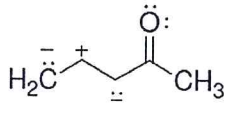
C. $C_{19}H_{13}N_7O_6$

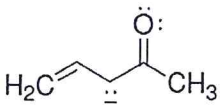
D. $C_{19}H_{19}N_7O_6$

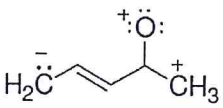
E. $C_{19}H_{33}N_7O_6$

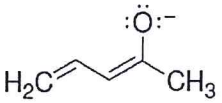
17. Which one of the structures in a to d is NOT a valid resonance structure for the anion in the box below?



a. 

b. 

c. 

d. 

A. a

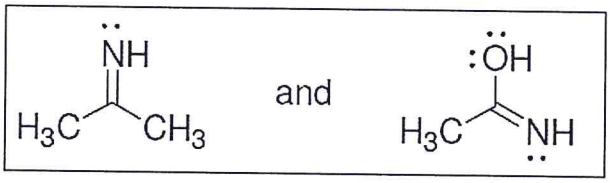
B. b

C. c

D. d

E. e

18. How are the molecules in the following pair related?



A. They are constitutional isomers

B. They are stereoisomers

C. They are resonance structures

D. Conformational isomers

E. They are unrelated

19. Which of the following molecules contain both covalent and ionic bonds?

CH_3OH	Na_2CO_3	NH_4Cl	$NaCl$
I	II	III	IV

A. I and II

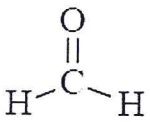
B. II and IV

C. I, II and IV

D. II and III

E. II, III and IV

20. Which of the molecules below are polar?

$H_2C{=}CH_2$		CH_2Cl_2	$H_3C{-}CH_3$	CH_3OH
I	II	III	IV	V

A. III, IV and V

B. I and IV

C. II, III and V

D. I and III

E. I, II, III and V

21. What is the electron configuration for the Fe^{3+} ion?

A. $[Ar]4s^1 3d^6$

B. $[Ar]4s^0 3d^7$

C. $[Ar]4s^0 3d^5$

D. $[Ar]4s^2 3d^9$

E. $[Ne]3s^2 3p^{10}$

22. Using the VSEPR model, the molecular geometry of the central atom in tetrafluoroborate ion is _____.

A. trigonal planar

B. square pyramidal

C. square planar

D. trigonal bipyramidal

E. octahedral

23. The electron domain and molecular geometry of BrO_2^- is _____.

A. tetrahedral and trigonal planar

B. tetrahedral and bent

C. trigonal planar and trigonal planar

D. trigonal pyramidal and linear

E. trigonal pyramidal and seesaw

24. The hybridizations of bromine in BrF_5 and of arsenic in AsF_5 are _____ and _____, respectively.

A. sp^3d^2, sp^3d

B. sp^3, sp^3d

C. sp^3d, sp^3d^2

D. sp^3d, sp^3

E. sp^3d^2, sp^3d^2

25. A valid Lewis structure of _____ cannot be drawn without violating the octet rule.

A. PO_4^{3-}

B. SeF_4

C. CF_4

D. SiF_4

E. NF_3

END OF SECTION A

SECTION B: [50]

QUESTION 1 [8]

Considering the following reaction: $2SO_3\,(g) \leftrightharpoons 2SO_2\,(g) + O_2\,(g)$ $\Delta H° = +197$ kJ
What will happen to the number of moles (increase, decrease or remain the same) of SO_3 in equilibrium with SO_2 and O_2 in each of the following cases?

a. Oxygen gas is added. (2)

b. The pressure is increased by decreasing the volume of the reaction container. (2)

c. The temperature is decreased. (2)

d. Gaseous sulphur dioxide is removed. (2)

QUESTION 2 [10]

2.1 In a NaOH solution, $[OH^-]$ is 2.9×10^{-4} M. Calculate the pH of the solution. (2)

2.2 Calculate the pH of a:

a. 1.0×10^{-3} M HCl solution (4)

b. 0.020 M $Ba(OH)_2$ solution (4)

QUESTION 3 [7]

3.1 Balance the following half reactions:

a. $CrO_4^{2-}(aq) \rightarrow Cr(OH)_3(s)$ (in basic medium) (3)

b. $HNO_2\,(aq) \rightarrow NH_4^+\,(aq)$ (in acidic medium) (3)

3.2 Find the oxidation number of Cr in $K_2Cr_2O_7$ (1)

QUESTION 4 [12]

A molecular compound is composed of 60.4% Xe, 22.1% O and 17.5% F, by mass. If the molecular weight is 217.3 amu:

4.1 What is the molecular formula? (5)

4.2 Draw the most dominant Lewis structure of the compound? (3)

4.3 Predict the molecular geometry using VSEPR model. (2)

4.4 Describe the bonding using valence bond theory. (2)

QUESTION 5 **[8]**

5.1 Arrange the bonds in each of the following sets in order of increasing bond polarity. (4)

a. C-F; O-F and Be-F

b. O-Cl; S-Br and C-P

5.2 Draw all possible resonance structures of the following molecules. (4)

a. SeO_2

b. $C_2O_4^-$

QUESTION 6 **[5]**

6.1 The molecule AsF_3 has a dipole moment of 2.59D. Which of the geometries are possible: trigonal planar, trigonal pyramidal or T-Shaped? Explain your choice of answer. (3)

6.2 What is the formal charge of the central atom in the SiF_6^{2-} ion? (2)

THE END

GOODLUCK

USEFUL CONSTANTS:

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

$1\ Pa \cdot m^3 = 1\ kPa.L = 1\ N \cdot m = 1\ J$

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

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

Planck's constant, $h = 6.626 \times 10^{-34}\ Js$

Speed of light, $c = 2.998 \times 10^8\ ms^{-1}$

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)