



**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: JANUARY 2020	PAPER: THEORY
DURATION: 3 HOURS	MARKS: 100

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

INSTRUCTIONS
<ol style="list-style-type: none">1. Answer ALL the questions.2. Write clearly and neatly.3. Number the answers clearly4. All written work must be done in blue or black ink and sketches can be done in pencil5. No books, notes and other additional aids are allowed

THIS QUESTION PAPER CONSISTS OF 12 PAGES (Including this front page and attachments)

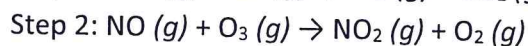
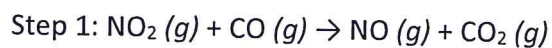
SECTION A**[50]****QUESTION 1: Multiple Choice Questions****[50]**

- *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. To which of the following causes could the slow rate of a chemical reaction be attributed to?

- A. a low activation energy
- B. a high activation energy
- C. the presence of a catalyst
- D. the temperature is high
- E. the concentrations of the reactants are high

2. The steps below represent a proposed mechanism for the catalysed oxidation of CO by O₃.



What are the overall products of the catalysed reaction?

- A. CO₂ and O₂
- B. NO and CO₂
- C. NO₂ and O₂
- D. NO and O₂
- E. NO₂ and CO₂

3. The oxidation number of each chromium atom in Cr₂O₇²⁻ is:

- A. +5
- B. +6
- C. +7
- D. +12
- E. None of the above

4. In which of the following unbalanced reactions does chromium undergo oxidation?

- A. $\text{Cr}^{3+} \rightarrow \text{Cr}$
- B. $\text{Cr}^{3+} \rightarrow \text{Cr}^{2+}$
- C. $\text{Cr}^{3+} \rightarrow \text{Cr}_2\text{O}_7^{2-}$
- D. None of the above
- E. $\text{Cr}^{3+} \rightarrow \text{Cr}^0$

5. For which of the following chemical changes does the heat of reaction (ΔH) correspond to a heat of formation ($\Delta H_{\text{formation}}$)?

- A. $\text{N} (g) + 3 \text{H} (g) \rightarrow \text{NH}_3 (g)$
- B. $\text{N}_2 (g) + 3 \text{H}_2 (g) \rightarrow 2 \text{NH}_3 (g)$
- C. $\text{C} (g) + \text{O} (g) \rightarrow \text{C}$
- D. $\frac{1}{2} \text{N}_2 (g) + \frac{3}{2} \text{H}_2 (g) \rightarrow \text{NH}_3 (g)$
- E. None of the above

6. The pH of a $1.25 \times 10^{-3} \text{ M}$ NaOH solution is:

- A 7.00
- B 2.90
- C 11.10
- D 10.90
- E 3.10

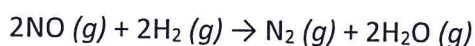
7. Which of the following describes the relationship between $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$?

- A. $[\text{H}_3\text{O}^+][\text{OH}^-] = 14.00$
- B. $[\text{H}_3\text{O}^+] + [\text{OH}^-] = 14.00$
- C. $[\text{H}_3\text{O}^+][\text{OH}^-] = 1.0 \times 10^{-14}$
- D. $[\text{H}_3\text{O}^+] + [\text{OH}^-] = 1.0 \times 10^{-14}$
- E. None of the above

8. A buffer solution was prepared by mixing 100 mL of a 1.2M NH₃ solution and 400 mL of a 0.5M NH₄Cl solution. What is the pH of this buffer solution, assuming a final volume of 500 mL and K_b = 1.8 x 10⁻⁵?

- A. 1.08
- B. 4.96
- C. 5.8
- D. 9.03
- E. 8

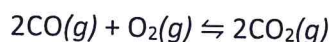
9. Which of the following is true regarding the relative molar rates of disappearance of the reactants and the appearance of the products?



- I. N₂ appears at the same rate that H₂ disappears.
- II. H₂O appears at the same rate that NO disappears.
- III. NO disappears at the same rate that H₂ disappears.

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

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



- A. K_c = k[CO]₂[O₂]
- B. K_c = [CO₂] / [CO] [O₂]
- C. K_c = [CO]² [O₂] / [CO₂]
- D. K_c = [CO₂]² / [CO]² [O₂]
- E. None of the above

11. Which two bonds are least similar in polarity?

- A. Al-Cl and I-Br
- B. O-F and Cl-F
- C. B-F and Cl-F
- D. I-Br and Si-Cl
- E. C-Cl and Ge-Cl

12. In the Lewis structure of HCO_3^- , the formal charge on H is _____ and the formal charge on C is _____.

- A. -1, -1
- B. 0, 0
- C. 0, -1
- D. +1, -1
- E. -1, +1

13. How many different types of resonance structures can be drawn for the ion SO_3^{2-} where all atoms satisfy the octet rule?

- A. 1
- B. 2
- C. 3
- D. 4
- E. 5

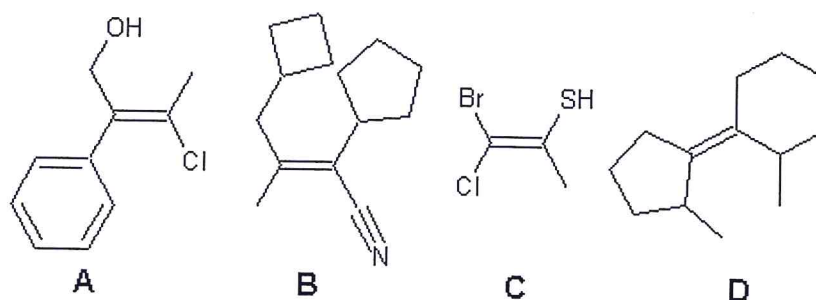
14. After drawing the Lewis dot structure of HOClO_2 , pick the INCORRECT statement of the following.

- A. The oxygen bonded to the hydrogen has two lone pairs.
- B. The oxygens not bonded to hydrogen have three lone pairs.
- C. The O-Cl bonds are all double bonds.
- D. The H-O bond is a single bond.
- E. Chlorine has a full octet.

15. Which of the pairs of molecules below have the same hybridization on the central atom? (The central atom is underlined in each molecule.)

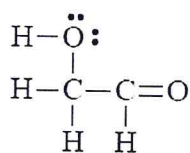
- A. C O_2 , C H_4
- B. H_2 C O , B eH_2
- C. B Cl_3 , HN O
- D. H_2 O, HF
- E. N H_3 , HN O

16. Find the correct stereochemistry for the following alkenes:

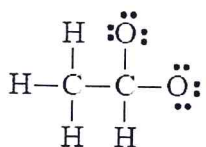


- A. A is Z, B is Z, C is E, D is E
 B. A is Z, B is E, C is Z, D is E
 C. A is E, B is E, C is Z, D is E
 D. A is E, B is E, C is Z, D is Z
 E. A is Z, B is Z, C is E, D is Z

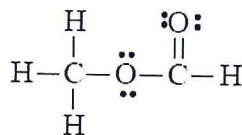
17. Which is the correct Lewis structure for acetic acid ($\text{CH}_3\text{CO}_2\text{H}$)?



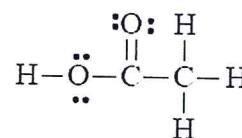
a)



b)



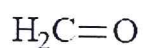
c)



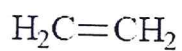
d)

- A. a
 B. b
 C. c
 D. d
 E. none of the above

18. For which of the structures below does carbon show the correct orbital hybridization?



sp
I



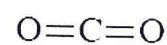
sp^2
II



sp^2
III



sp
IV



sp
V

- A. II, IV and V
 B. II, III and IV
 C. I, II and III
 D. I, IV and V
 E. II, IV and V

19. Which of the following statements concerning lattice energy is incorrect?

- A. MgO has a larger lattice energy than NaF.
- B. The lattice energy for a solid with 2+ and 2- ions should be two times that for a solid with 1+ and 1- ions.
- C. MgO has a larger lattice energy than LiF.
- D. Lattice energy is often defined as the change in energy that occurs when an ionic solid is separated into isolated ions in the gas phase.
- E. All of these are true.

20. Which of the following compounds has the most ionic bonding (i.e. has the highest percentage of ionic character)?

- A. CaF_2
- B. LiI
- C. OF_2
- D. CsF
- E. LiF

21. What is the C—C—H bond angle in H_2CCO ?

- A. 109°
- B. 180°
- C. 120°
- D. 90°
- E. 45°

22. Which of the following statements is correct concerning the electron configuration $[\text{Ne}]3s^13p^1$?

- A. It may represent a ground-state electron configuration of a Al^+ cation.
- B. It may represent an excited-state electron configuration of a Mg atom.
- C. It may represent an excited-state electron configuration of a Ne^- anion.
- D. It may represent a ground-state electron configuration of a Mg^+ cation.
- E. None of the above is correct

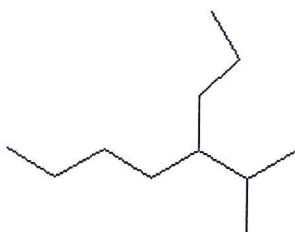
23. A nonpolar bond will form between two _____ atoms of _____ electronegativity.

- A. different, opposite
- B. identical, different
- C. different, different
- D. identical, equal
- E. None of the above is correct

24. Which of the following compounds does not contain a C=O bond?

- A. Ketones
- B. Aldehydes
- C. Esters
- D. Ethers
- E. All contain the C=O bond

25. Give the IUPAC name for the following structure.



- A. 2-methyl-3-ethylheptane
- B. 3-ethyl-2methylheptane
- C. 5-isopropyloctane
- D. 4-isopropyloctane
- E. 2-methyl-3-propylheptane

END OF SECTION A

SECTION B:**[50]****QUESTION 1:****[5]**

Assign the oxidation states for the **underlined atom** in each of the following:

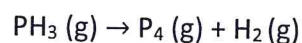
- NiO₂
- Fe₃O₄
- XeOF₄
- (NH₄)₂HPO₄
- CO

QUESTION 2:**[5]**

A buffer solution contains 0.25 M NH₃ ($K_b = 1.8 \times 10^{-5}$) and 0.40 M NH₄Cl. Calculate the pH of the solution.

QUESTION 3:**[10]**

- What are the factors affecting reaction rates? (4)
- Relate the rates for the disappearance of reactants and formation of products for the following reaction: (3)



- Sucrose (C₁₂H₂₂O₁₁) decomposes to fructose and glucose in acid solution with rate law:

$$\text{Rate} = k[\text{C}_{12}\text{H}_{22}\text{O}_{11}] \quad k = 0.216 \text{ h}^{-1} \text{ at } 25^\circ\text{C}$$

What is the half-life of sucrose at this temperature? (3)

QUESTION 4:**[5]**

NO₂ can exist in equilibrium with colourless gas N₂O₄. $K_c = 170$ at 298K.

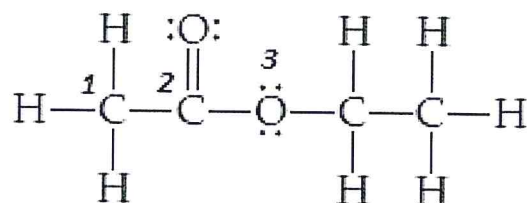


Suppose the concentration of NO₂ is 0.015 M and concentration of N₂O₄ is 0.025 M.

- If the system is not in equilibrium, will Q be larger than, smaller than or equal to K_c? (2)
- In which direction will the reaction proceed to achieve equilibrium? (3)

QUESTION 5:**[9]**

Consider the Lewis structure for ethyl acetate below, used as a solvent and aroma enhancer.

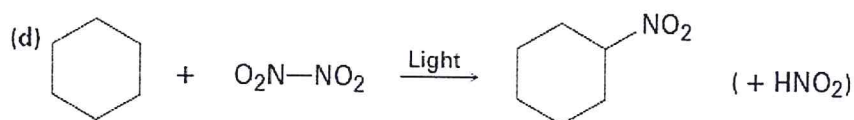
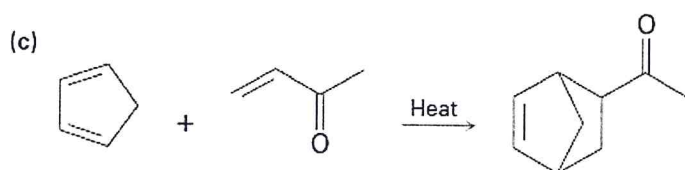
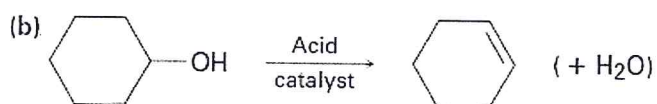


5.1 How many valence electrons are used to make the sigma bonds in the molecule? (3)

5.2 What is the hybridization at each of the numbered atoms (i.e. C1, C2 and O3)? (6)

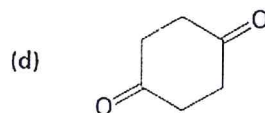
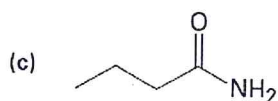
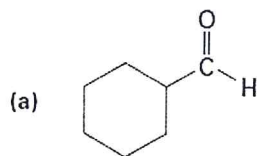
QUESTION 6**[8]**

Many classes of organic compounds undergo characteristic types of reactions. Identify the type of organic reaction for the transformations below. (8)



QUESTION 7**[8]**

Identify the functional groups in the following molecules.

(8)**THE END****GOODLUCK****USEFUL CONSTANTS:**

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

$$1 \text{ Pa} \cdot \text{m}^3 = 1 \text{ kPa} \cdot \text{L} = 1 \text{ N} \cdot \text{m} = 1 \text{ J}$$

$$1 \text{ atm} = 101\,325 \text{ Pa} = 760 \text{ mmHg} = 760 \text{ torr}$$

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

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

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

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 1.00794	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	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	57 Lu 174.967	58 Hf 178.49	59 Ta 180.948	60 W 183.85	61 Re 186.207	62 Os 190.2	63 Ir 192.22	64 Pt 195.08	65 Au 196.967	66 Hg 200.59	67 Tl 204.383	68 Pb 207.2	69 Bi 208.908	70 Po (209)	71 At (210)	72 Rn (222)														
87 Fr (223)	88 Ra 226.025	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)	103 Lr (260)	104 Rf (261)	105 Sg (263)	106 Bh (264)	107 Hs (265)	108 Mt (268)	109 Uu (269)	110 Uub (269)	111 Uuc (272)	112 Uub (269)	113 Uuq (272)	114 Uuq (272)	115 Uuh (272)	116 Uuh (272)	117 Uuq (272)	118 Uuo (272)

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
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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)
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