UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF CHEMICAL SCIENCES
NATIONAL DIPLOMA: ANALYTICAL CHEMISTRY

MODULE: CETXTB1
CHEMISTRY 1

CAMPUS: DFC

NOVEMBER EXAMINATION 2019

DATE: 19/11/2019 **SESSION: 12:30**

ASSESSOR: **PROF OA AROTIBA**

INTERNAL MODERATOR: **Dr D NKOSI**

DURATION: 170 MINUTES **MARKS: 110**

NUMBER OF PAGES: **5**

INSTRUCTIONS: **ANSWER ALL QUESTIONS IN PEN. GIVE ALL NUMERICAL ANSWERS TO THE CORRECT NUMBER OF SIGNIFICANT FIGURES AND WITH APPROPRIATE UNITS. SHOW ALL CALCULATIONS.**

REQUIREMENTS: **ANSWER SCRIPT**

QUESTION 1

1.1 In a reaction, CO_2 is produced at standard temparature and pressure (STP), and it occupied a container that has length, width and height of 0.500 m, 0.500 m and 0.500 m respectively. How many molecules of CO_2 were produced in the reaction?
[1 m = 10 dm; 1 dm^3 = 1 L; 1 mole of a gas at STP = 22.4 L] (6)

1.2 The combustion of 1.38 g of a compound which contains C, H, O and N yields 1.72 g of CO_2 and 1.18 g of H_2O. Another sample of the compound with a mass of 22.34 g is found to contain 6.75 g of O. What is the empirical formula of the compound? (11)

1.3 Ammonia (NH_3) and oxygen gas combine to form nitrogen monoxide (NO) and water by the chemical reaction:

$NH_3(g) + O_2(g) \rightarrow NO(g) + H_2O(l)$ (**Unbalanced**)

If 80 g of ammonia are reacted with 100 g of oxygen

1.3.1 Identify the limiting reagent (show your calculation). (4)
1.3.2 How many grams of the excess reacting reagent remains at completion of the reaction? (4)
1.3.3 If the amount of NO produced was 50 g, calculate the percentage yield. (4)
1.3.4 Give four reasons for the difference observed between the actual yield and the theoretical yield in **Question 1.3.3**. (4)

1.4 An impure sample of NaCl, which weighed 0.50 g, gave on treatment with excess of $AgNO_3$ solution, 0.90 g of AgCl as precipitate. Calculate the percentage purity of the sample. (5)

[38]

QUESTION 2

2.1 Define an **acid** according to Brønsted and Lowry. (2)

2.2 What is the difference between a strong acid and a concentrated acid? (4)

2.3 In an art restoration project, a conservator prepares copper-plate etching solutions by diluting concentrated HNO_3 to a concentration of 0.30 *M* at 25 °C. Calculate the **pH**, **[OH^-]**, and **pOH** of this solution. (6)

2.4 Predict the net direction and whether K_c is greater or less than 1 for each of the following reactions: [Assume equal initial concentrations of all species. You may use Figure 1 (on the data sheet page) as a guide].

2.4.1 $H_2PO_4^-(aq) + NH_3(aq) \rightleftharpoons HPO_4^{2-}(aq) + NH_4^+(aq)$ (2)
2.4.2 $H_2O(l) + HS^-(aq) \rightleftharpoons OH^-(aq) + H_2S(aq)$ (2)

2.5 Propanoic acid (CH_3CH_2COOH, which we simplify as HA) is a carboxylic acid whose salts are used to retard mold growth in foods. What is the percentage dissociation of 0.10 *M* concentration of this acid? ($K_a = 1.3 \times 10^{-5}$) (7)

2.6 Dimethylamine, $(CH_3)_2NH$, a key intermediate in detergent manufacture, has a $K_b = 5.9 \times 10^{-4}$. What is the pH of a 1.5 *M* aqueous solution of $(CH_3)_2NH$ given the equation below:

$$(CH_3)_2NH(aq) + H_2O(l) \rightleftharpoons (CH_3)_2NH_2^+(aq) + OH^-(aq)$$

(8)

[31]

QUESTION 3

3.1 What is the main idea or concept behind the valence shell electron pair repulsion (VSEPR) theory? (3)

3.2 The molecular geometry of ammonia is tetrahedral. However, its molecular shape is trigonal pyramidal. Explain the reason(s) behind this difference. (4)

3.3 Water is generally regarded as a universal solvent.

3.3.1 Draw the Lewis structure illustrating the bonds in a single water molecule. (2)
3.3.2 Draw and name the molecular shape of water. (4)

3.4 If chlorine substitutes all the hydrogen atoms in a methane molecule, CCl_4 (carbon tetrachloride) is formed. A singe C-Cl bond is regarded as a polar bond or a dipole, however CCl_4 is a non-polar molecule. Explain the reason for this non-polar nature. (4)

3.5 Predict, <u>with reason(s)</u>, whether SO_2 is a polar or non-polar molecule. (4)

[21]

QUESTION 4

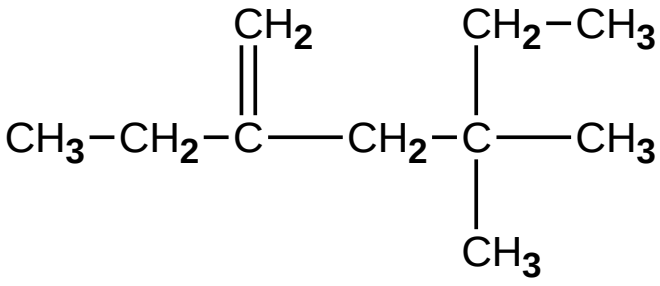
What are the periodic trends of the following properties on the periodic table? Please explain the reason(s) for your answers.

4.1 Atomic radius (6)
4.2 Ionisation energy (6)

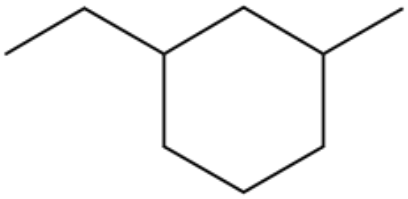
[12]

QUESTION 5

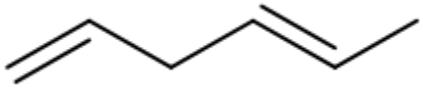
Name the following organic compounds:



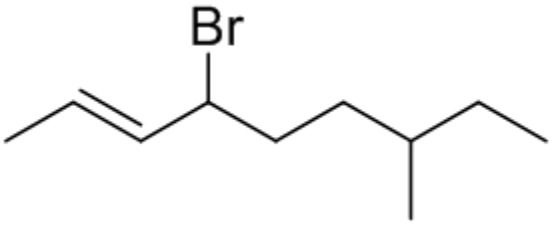
5.1 (2)



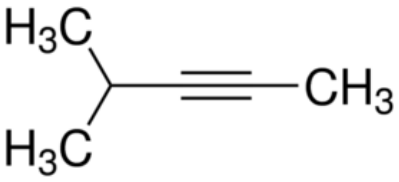
5.2 (2)



5.3 (2)



5.4 (2)



5.5 (2)

[10]

----------END OF QUESTIONS----------

DATA SHEET

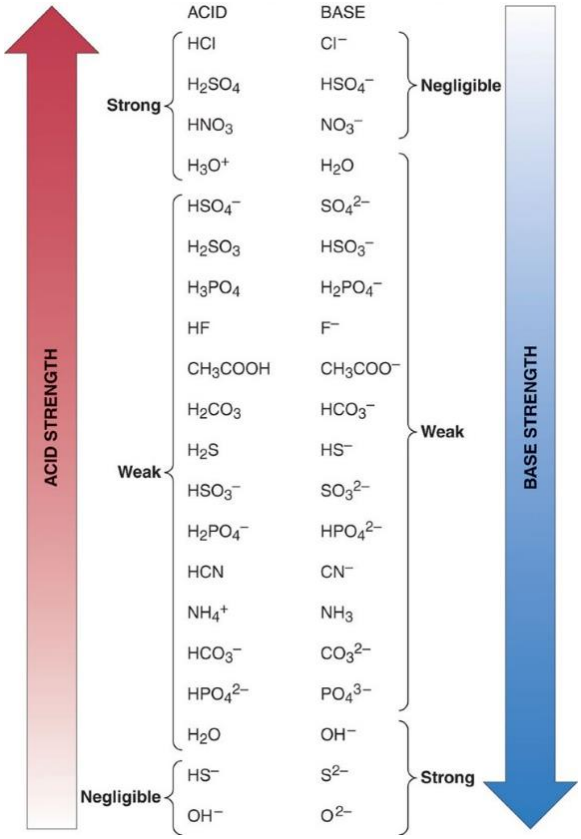


Figure 1: Strengths of conjugate acid-base pair

Periodic Table

Atomic Number 2 He 4.0026 Atomic Weight

1 H 1.0079																	2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.179
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	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 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.03	89 Ac 227.03															

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 146.92	62 Sm 150.36	63 Eu 151.97	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 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (234)	96 Cm (247)	97 Bk 247	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)