



## **FACULTY OF SCIENCE**

### **DEPARTMENT OF CHEMICAL SCIENCES**

#### **B Eng Tech in Engineering Metallurgy / Extraction Metallurgy**

**MODULE     CETM1A1**

**CAMPUS     DFC**

#### **MAJOR TEST 2**

**DATE: 24/05/2021**

**SESSION:     08H00 – 10:00**

**ASSESSOR**

**Dr. MC FOTSING**

**INTERNAL MODERATOR**

**MR P.P MONAMA**

**DURATION     120 MINUTES**

**TOTAL MARKS 70**

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**NUMBER OF PAGES: 4 PAGES, INCLUDING 1 ANNEXURE**

**INSTRUCTIONS:     ANSWER ALL QUESTIONS IN THE ANSWER SCRIPT PROVIDED.**

**GIVE ALL NUMERICAL ANSWERS TO THE CORRECT    NUMBER    OF  
SIGNIFICANT FIGURES AND WITH APPROPRIATE UNITS.**

**CONSULT THE DATA SHEET AND THE PERIODIC TABLE FOR ALL  
SUPPLEMENTARY INFORMATION.**

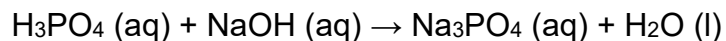
**CALCULATORS ARE PERMITTED (ONLY ONE PER STUDENT).**

**REQUIREMENTS:     ANSWER SCRIPT**

**QUESTION 1**

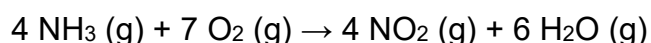
Choose the right answer.

1. When the following equation is balanced, the coefficient of  $\text{H}_3\text{PO}_4$  is \_\_\_\_\_.



- A) 1  
B) 2  
C) 3  
D) 4  
E) 0
2. There are \_\_\_\_\_ molecules of methane in 0.123 mol of methane ( $\text{CH}_4$ ).
- A) 5  
B)  $2.46 \times 10^{-2}$   
C)  $2.04 \times 10^{-25}$   
D)  $7.40 \times 10^{22}$   
E) 0.615
3. How many grams of oxygen are in 65 g of  $\text{C}_2\text{H}_2\text{O}_2$ ?
- A) 18  
B) 29  
C) 9.0  
D) 36  
E) 130
4. What is the empirical formula of a compound that contains 49.4% K, 20.3% S, and 30.3% O by mass?
- A)  $\text{KSO}_2$   
B)  $\text{KSO}_3$   
C)  $\text{K}_2\text{SO}_4$   
D)  $\text{K}_2\text{SO}_3$   
E)  $\text{KSO}_4$
5. A compound is composed of only C, H, and O. The combustion of a 0.519-g sample of the compound yields 1.24 g of  $\text{CO}_2$  and 0.255 g of  $\text{H}_2\text{O}$ . What is the empirical formula of the compound?
- A)  $\text{C}_6\text{H}_6\text{O}$   
B)  $\text{C}_3\text{H}_3\text{O}$   
C)  $\text{CH}_3\text{O}$   
D)  $\text{C}_2\text{H}_6\text{O}_5$   
E)  $\text{C}_2\text{H}_6\text{O}_2$

6. The combustion of ammonia in the presence of excess oxygen yields  $\text{NO}_2$  and  $\text{H}_2\text{O}$ :



The combustion of 28.8 g of ammonia consumes \_\_\_\_\_ g of oxygen.

- A) 94.9  
B) 54.1  
C) 108  
D) 15.3  
E) 28.8
7. The molecular weight of the acetic acid ( $\text{CH}_3\text{CO}_2\text{H}$ ) is \_\_\_\_\_ amu.  
A) 60  
B) 48  
C) 44  
D) 32  
E) 22
8. The mass % of F in the binary compound  $\text{KrF}_2$  is \_\_\_\_\_.  
A) 18.48  
B) 45.38  
C) 68.80  
D) 81.52  
E) 31.20
9. In the Lewis symbol for a fluorine atom, there are \_\_\_\_\_ paired and \_\_\_\_\_ unpaired electrons.  
A) 4, 2  
B) 4, 1  
C) 2, 5  
D) 6, 1  
E) 0, 5
10. Based on the octet rule, phosphorus most likely forms a \_\_\_\_\_ ion.  
A)  $\text{P}^{3+}$   
B)  $\text{P}^{3-}$   
C)  $\text{P}^{5+}$   
D)  $\text{P}^{5-}$   
E)  $\text{P}^+$
11. The electron configuration of the  $\text{S}^{2-}$  ion is \_\_\_\_\_.  
A)  $[\text{Ar}]3s^23p^6$   
B)  $[\text{Ar}]3s^23p^2$   
C)  $[\text{Ne}]3s^23p^2$   
D)  $[\text{Ne}]3s^23p^6$   
E)  $[\text{Kr}]3s^2 2p^6$

12. The ability of an atom in a molecule to attract electrons is best quantified by the \_\_\_\_\_.
- A) paramagnetism
  - B) diamagnetism
  - C) electronegativity
  - D) electron change-to-mass ratio
  - E) first ionization potential
13. Given the electronegativities below, which covalent single bond is most polar?  
Element: H C N O  
Electronegativity: 2.1 2.5 3.0 3.5
- A) C–H
  - B) N–H
  - C) O–H
  - D) O–C
  - E) O–N
14. The ion  $\text{NO}^-$  has \_\_\_\_\_ valence electrons.
- A) 15
  - B) 14
  - C) 16
  - D) 10
  - E) 12
15. The Lewis structure of  $\text{PF}_3$  shows that the central phosphorus atom has \_\_\_\_\_ nonbonding and \_\_\_\_\_ bonding electron pairs.
- A) 2, 2
  - B) 1, 3
  - C) 3, 1
  - D) 1, 2
  - E) 3, 3
16. According to VSEPR theory, if there are four electron domains in the valence shell of an atom, they will be arranged in a(n) \_\_\_\_\_ geometry.
- A) octahedral
  - B) linear
  - C) tetrahedral
  - D) trigonal planar
  - E) trigonal bipyramidal

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17. Which of the following compounds would you expect to be ionic?
- A)  $\text{H}_2\text{O}$
  - B)  $\text{CO}_2$
  - C)  $\text{SrCl}_2$
  - D)  $\text{SO}_2$
  - E)  $\text{H}_2\text{S}$
18. Which species below is the nitrate ion?
- A)  $\text{NO}_2^-$
  - B)  $\text{NH}_4^+$
  - C)  $\text{NO}_3^-$
  - D)  $\text{N}_3^-$
  - E)  $\text{N}^{3-}$
19. Which one of the following compounds is copper(I) chloride?
- A)  $\text{CuCl}$
  - B)  $\text{CuCl}_2$
  - C)  $\text{Cu}_2\text{Cl}$
  - D)  $\text{Cu}_2\text{Cl}_3$
  - E)  $\text{Cu}_3\text{Cl}_2$
20. The hybridization of the carbon atom in carbon dioxide is \_\_\_\_\_.
- A)  $sp$
  - B)  $sp^2$
  - C)  $sp^3$
  - D)  $sp^3d$
  - E)  $sp^3d^2$
21. In order to produce  $sp^3$  hybrid orbitals, \_\_\_\_\_ s atomic orbital(s) and \_\_\_\_\_ p atomic orbital(s) must be mixed.
- A) one, two
  - B) one, three
  - C) one, one
  - D) two, two
  - E) two, three
22. There are \_\_\_\_\_  $\sigma$  and \_\_\_\_\_  $\pi$  bonds in the  $\text{H}_2\text{C}=\text{C}=\text{CH}_2$  molecule.
- A) 4, 2
  - B) 6, 4
  - C) 2, 2
  - D) 2, 6
  - E) 6, 2
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**QUESTION 2**

2.1 Calculate the percentage by mass of oxygen in the following compounds:

2.1.1 Morphine,  $C_{17}H_{19}NO_3$  (2)

2.1.2 Cocaine,  $C_{17}H_{21}NO_4$  (2)

2.2 The empirical formula of the following compounds is given. What is the molecular formula of each of the following compounds?

2.2.1 Empirical formula  $CH_2$ , molar mass = 84 g/mol (2)

2.2.2 Empirical formula  $NH_2Cl$ , molar mass = 51.5 g/mol (2)

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**[8]****QUESTION 3**

When benzene ( $C_6H_6$ ) reacts with bromine ( $Br_2$ ), bromobenzene ( $C_6H_5Br$ ) is obtained:



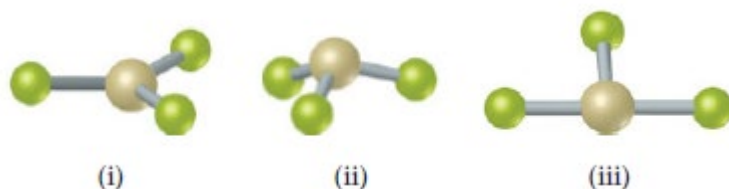
3.1 When 30.0 g of benzene reacts with 65.0 g of bromine, what is the theoretical yield of bromobenzene? (6)

3.2 If the actual yield of bromobenzene is 42.3 g, what is the percentage yield? (4)

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**[10]****QUESTION 4**

The figure that follows shows ball-and-stick drawings of three possible shapes of an  $AF_3$  molecule.



4.1 For each shape, give the electron-domain geometry on which the molecular geometry is based (6)

4.2 For each shape, how many nonbonding electron domains are there on atom A? (3)

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**[9]**

**QUESTION 5**

Which of the following compounds are ionic and which are molecular?

- a)  $\text{PF}_5$
- b)  $\text{NaI}$
- c)  $\text{SCl}_2$
- d)  $\text{Ca}(\text{NO}_3)_2$
- e)  $\text{FeCl}_3$
- f)  $\text{LaP}$
- g)  $\text{CoCO}_3$
- h)  $\text{N}_2\text{O}_4$

(8)

[8]

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**TOTAL MARKS : 79**

## Atomic Weight

58	59	60	61	62	63	64	65	66	67	68	69	70	71
<b>Ce</b> <i>140.12</i>	<b>Pr</b> <i>140.91</i>	<b>Nd</b> <i>144.24</i>	<b>Pm</b> <i>146.92</i>	<b>Sm</b> <i>150.36</i>	<b>Eu</b> <i>151.97</i>	<b>Gd</b> <i>157.25</i>	<b>Tb</b> <i>158.93</i>	<b>Dy</b> <i>162.50</i>	<b>Ho</b> <i>164.93</i>	<b>Er</b> <i>167.26</i>	<b>Tm</b> <i>168.93</i>	<b>Yb</b> <i>173.04</i>	<b>Lu</b> <i>174.97</i>
90	91	92	93	94	95	96	97	98	99	100	101	102	103
<b>Th</b> <i>232.04</i>	<b>Pa</b> <i>231.04</i>	<b>U</b> <i>238.03</i>	<b>Np</b> <i>237.05</i>	<b>Pu</b> <i>(244)</i>	<b>Am</b> <i>(234)</i>	<b>Cm</b> <i>(247)</i>	<b>Bk</b> <i>247</i>	<b>Cf</b> <i>(251)</i>	<b>Es</b> <i>(252)</i>	<b>Fm</b> <i>(257)</i>	<b>Md</b> <i>(258)</i>	<b>No</b> <i>(259)</i>	<b>Lr</b> <i>(260)</i>