FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY	
MODULE:	**CEM1A1E**
	CHEMICAL PRINCIPLES
CAMPUS:	APK
EXAM:	**JUNE/JULY 2019 SUPPLEMENTARY EXAM**
DATE:	JUNE/JULY 2019
SESSION:	MORNING
ASSESSORS:	DR T. BREDENKAMP, PROF. H KINFE, DR E. MMUTLANE, DR S. SANYASI
MODERATOR:	DR N. BINGWA
DURATION:	2 HOURS (120 minutes)
MARKS:	80

INSTRUCTIONS

(i) The examination is out of 80 marks and you have strictly 3 hours to complete it. No additional time will be given for any reason.

(ii) Only non-programmable scientific calculators are allowed for this exam. All other electronic devices must be switched off.

(iii) Read the entire question paper before you answer the questions.

(iv) This is a closed book examination. You are NOT allowed to have any book, memorandum, notes, paper, photographs, document or written/printed material other than the question paper and the answer books provided by the examiner/invigilator. If you need paper for rough work, an additional exam answer sheet will be given to you, which must be clearly labelled as **rough work: not for marking**, and handed in together with the question paper and all your answer books.

QUESTION 1 **[12]**

1.1 Perform the following calculations and give the answer to the correct number of significant figures.

a. (0.311 x 0.57) ÷ 5.93 (2)

b. 0.0015 x 554.6 + 1.032 (2)

1.2 A submicroscopic particle suspended in a solution has a volume of 2.8 nm^3. Convert this volume to liters. (3)

1.3 One litre of gasoline in an automobile's engine produces on the average 9.5 kg of carbon dioxide, which is a greenhouse gas, that is, it promotes the warming of Earth's atmosphere. Calculate the annual production of carbon dioxide in kilograms and µg if there are 40 million cars in ~~the~~ South Africa and each car covers a distance of 5000 km at a consumption rate of 20 km per litre. (5)

QUESTION 2 **[8]**

When 20.0 g of **A** was heated, 8.8 g of **B** was given off, leaving 10.2 g of **E**. The same quantity of B can also be prepared by a combination of 2.4 g of **C** and 3.2 g of **D**. The E can be electrolysed, after melting, to yield 8.0 g of **F** and 1.6 g of **G**, neither of which can be further decomposed by ordinary chemical means. Identify the lettered materials **A**, **B**, **E**, **F** and **G** as either an element or a compound and explain your decision.

QUESTION 3 **[4]**

3.1 Name the following compounds:

(a) $VSO_4 \bullet 7H_2O$ (1)

(b) SF_6 (1)

3.2 Give the molecular formula of each of the following compounds:

(a) Tin(IV) chromate (1)

(b) Thorium dicarbide (1)

QUESTION 4 **[6]**

A white powder suspected to be the illegal narcotic cocaine, is subjected to combustion analysis at the SAPS Forensic Science Laboratories and gave the following results:

C, 67.31%; H, 6.98%; O, 21.10% and the rest is Nitrogen.

Further analysis using a variety of scientific instruments confirmed the powder to be pure cocaine, with a molecular mass of 303.35294. Please work out the molecular formula of cocaine.

QUESTION 5 **[10]**

Rare-earth metals (REM), as defined by IUPAC, are the fifteen lanthanides in the Periodic Table, as well as scandium and yttrium. The rare-earth elements are often found together in several minerals. Examples of such minerals are **Gadolinite** with the composition $(Ce,La,Nd,Y)_2FeBe_2Si_2O_{10}$, **Euxenite** with the formula $(Y,Ca,Ce,U,Th)(Ti,Nb,Ta)_2O_6$, and **Blomstrandine** with the formula $(Y,Ca,Fe,Th)(Ti,Nb)_2(O,OH)_6$.

5.1 Which of the three minerals above contains more ytterbium by mass? Please show all your calculations. (5)

5.2 What mass of cerium, in kilograms, can be obtained from 1 ton of gadolinite? (5)

QUESTION 6 **[10]**

6.1 Between the elements, Nitrogen, Boron, Helium and Chlorine, which one is the most reactive? Write the reason for your answer. (2)

6.2 Would you expect strontium to be, chemically, more similar to calcium or rubidium and WHY?

6.3 What is the heaviest of the naturally occurring Noble gases? Write the name and the symbol. (1)

6.4 What is the heaviest element with a one letter atomic symbol? Write the name and the symbol. (1)

6.5 Among these ions of Nitrogen, which ion is largest in size? Provide a proper reason for your answer. (2)

N^{3-}, N^{3+}, N^{2-} and N^{5+}

6.6 Among these groups in the Periodic Table, which group will have the lowest first ionization energy? Provide a proper reason for your answer. (2)

Group III, Halogens, Noble gases, Alkaline earth metals and Alkali metals.

QUESTION 7 **[10]**

7.1 In each case of the two reactions shown below, one of the reactants acts as an acid. Identify it:

i) $CH_3COOH(aq)$ + _____ $\longrightarrow$ $CH_3COOH_2^+(aq) + ClO_4^-(aq)$ (1)

ii) $HCO_3^-(aq)$ + _____ $\longrightarrow$ $H_2O(l) + CO_2(g) + SO_4^{2-}(aq)$ (1)

7.2 Identify the acid-base conjugate pairs in the following reactions:

i) $HCO_3^-(aq) + H_3O^+(aq) \longrightarrow CO_2(g) + H_2O(l) + H_2O(l)$ (2)

ii) $H_2SO_4(aq) + HNO_3(aq) \longrightarrow HSO_4^-(aq) + NO_2^+(aq) + H_2O(l)$ (2)

7.3 Explain why in this process of electrolysis of water, the volume of gas collected over one electrode double that of gas collected over the other electrode? What are these two gases?

7.4 Glacial acetic acid, pure CH_3COOH (FW = 60.0), has a concentration of 17.54 M. If 85.5 mL of glacial acetic acid are diluted to 250.0 mL, what is the concentration of the acetic acid now? (2)

QUESTION 8 **[9]**

8.1 Consider the following unbalanced reactions occurring in aqueous solutions and write a complete balanced ionic equation and a net ionic equation for each reaction:

i. $Pb(NO_3)_2(aq) + LiCl(aq) \longrightarrow PbCl_2(s) + LiNO_3(aq)$ (2)

ii. $HBr(aq) + Ca(OH)_2(aq) \longrightarrow H_2O(l) + CaBr_2(aq)$ (2)

8.2 Classify each reaction as a synthesis, decomposition, single-displacement, or double-displacement. **1 mark each**

i. $Na_2O(s) + H_2O(l) \longrightarrow 2\ NaOH(aq)$ (1)

ii. $Ba(NO_3)_2(aq) + K_2SO_4(aq) \longrightarrow BaSO_4(s) + KNO_3(aq)$ (1)

iii. $2Al(s) + Fe_2O_3(s) \longrightarrow Al_2O_3(s) + 2Fe(g)$ (1)

8.3 Which of the reactions shown in **8.2** above are redox reactions? (2)

QUESTION 9 **[12]**

9.1 Consider the reaction between calcium oxide and carbon dioxide (6)

$CaO(s) + CO_2(g) \longrightarrow CaCO_3(s)$

Bongani allows 14.4 g of CaO and 13.8 g of CO_2 to react. When the reaction is finished, he collects 19.4 g of $CaCO_3$. Find

i. the limiting reactant,

ii. theoretical yield,

iii. percent yield.

9.2 How much of a 1.25 M sodium chloride solution in milliliters is required to completely precipitate all of the silver in 25.0 mL of a 0.45 M silver nitrate solution. (3)

9.3 A laboratory procedure calls for making 500.0 mL of a 1.4 M KNO_3 solution. How much KNO_3 in grams is needed? (3)

PERIODIC TABLE OF THE ELEMENTS