UNIVERSITY
OF
JOHANNESBURG

	DEPARTMENT OF CHEMICAL SCIENCES	
MODULE	**PSFT0B1** Physical Science for FET	
CAMPUS	**APK**	
EXAM	**JUNE TEST**	

DATE: 04 June 2019

Time: 12h30 – 15h30

ASSESSOR(S):

Dr J Noh

INTERNAL MODERATOR:

Dr E Marais

DURATION: 3 hours

MARKS: 100

NUMBER OF PAGES: 8

INSTRUCTIONS:

1. Answer all questions.

2. All answers should be reported to the correct number of significant figures.

3. Please ensure that you write your name and student number on all exam papers that you use.

4. The use of cell phones and other electronic communication devices is forbidden and they must be switched off. No data/image storing devices, including calculators capable of such, are permitted in this examination.

5. 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.

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<u>SECTION A (MULTIPLE CHOICE QUESTIONS)</u> **[10 MARKS]**

Please note that only one answer is correct.

1. After carrying out the following operations, how many significant figures are appropriate to show in the result? (1)

    $$(13.7 + 0.027) \div 8.221$$

    A) 1   B) 2   C) 3   D) 4   E) 5

2. One of the common intravenous fluids, called physiological saline, is a homogeneous mixture of NaCl in water. In this mixture, 0.89% of the mass is contributed by the NaCl. What mass of NaCl is found in 450. cm^3 of physiological saline? (Given: density of physiological saline = 1.005 g/cm^3) (2)

    A) 2.0 g   B) 4.0 g   C) 5.1 g   D) 508 g   E) 400 g

3. Which of the following represents a valid hypothesis? (1)

    A) Argon does not react with oxygen.
    B) Sodium metal reacts violently with water.
    C) Lead is soft and malleable.
    D) Nitrogen is a gas at room temperature.
    E) Metals tend to lose electrons.

4. All of the following are properties of tin. Which one is a *chemical* property of tin? (1)

    A) Tin can be hammered into a thin sheet.
    B) At –40°C a sheet of tin crumbles to a gray powder.
    C) Tin melts at 231.9°C.
    D) When a bar of tin is bent, it emits an audible "cry".
    E) Tin erodes when added to hydrochloric acid, and a clear gas forms.

5. Which of the following is an example of the law of multiple proportions? (1)

    A) A sample of chlorine is found to contain three times as much Cl-35 as Cl-37.
    B) Two different compounds formed from carbon and oxygen have the following mass ratios: 1.33 g O: 1 g C and 2.66 g O: 1 g C.
    C) Two different samples of table salt are found to have the same ratio of sodium to chlorine.
    D) The atomic mass of bromine is found to be 79.90 amu.
    E) Nitrogen dioxide always has a mass ratio of 2.28 g O: 1 g N.

6. Rutherford's experiment with alpha particle scattering by gold foil established that   (1)

    A) protons are not evenly distributed throughout an atom.
    B) electrons have a negative charge.
    C) electrons have a positive charge.
    D) atoms are made of protons, neutrons, and electrons.
    E) protons are 1840 times heavier than electrons.

7. An atom of helium has a mass about four times greater than that of an atom of hydrogen. Which choice makes the correct comparison of the relative numbers of helium and hydrogen atoms in equal masses of the two elements?   (1)

    A) There are about four times as many helium atoms as hydrogen atoms.
    B) There are about two times as many helium atoms as hydrogen atoms.
    C) The number of helium and hydrogen atoms is the same.
    D) There are about half as many helium atoms as hydrogen atoms.
    E) There are about one-fourth as many helium atoms as hydrogen atoms.

8. The element oxygen consists of three naturally occurring isotopes: ^{16}O, ^{17}O, and ^{18}O. The atomic mass of oxygen is 16.0 amu. What can be implied about the relative abundances of these isotopes?   (1)

    A) More than 50% of all O atoms are ^{17}O.
    B) Almost all O atoms are ^{18}O.
    C) Almost all O atoms are ^{17}O.
    D) The isotopes all have the same abundance, i.e. 33.3%.
    E) The abundances of ^{17}O and ^{18}O are very small.

9. Which one of the following does *not* represent 1.000 mol of the indicated substance?
    (1)
    A) 6.022×10^{23} carbon atoms
    B) nitrogen atoms in 14.0 g nitrogen gas molecules
    C) 65.39 g Zn metal
    D) 6.022×10^{23} chlorine gas molecules
    E) 12.01 g carbon atoms

SECTION B (THEORY AND PROBLEMS)   **[90 MARKS]**

QUESTION 1   **[13 MARKS]**

1.1   Describe the difference between an intensive and extensive property using examples. (2)

1.2   Hexane (C_6H_{14}, density = 0.766 g/cm^3), perfluorohexane (C_6F_{14}, density = 1.669 g/cm^3), and water are immiscible liquids; that is, they do not dissolve in one another. You place 10 mL of each in a graduated cylinder, along with pieces of high-density polyethylene (HDPE, density = 0.97 g/cm^3), polyvinyl chloride (PVC, density = 1.36 g/cm3), and Teflon (density = 2.3 g/cm^3). None of these common plastics dissolves in these liquids. Describe what you expect to see.   (3)

1.3   The smallest repeating unit of a crystal of common salt is a cube (called a unit cell) with an edge length of 0.563 nm.

    1.3.1   What is the volume of this cube in cubic nanometers?   (2)
    1.3.2   What is the volume of this cube in cubic centimeters? Show all steps in determining the answer.   (2)
    1.3.3   The density of NaCl is 2.17 g/cm^3. What is the mass of this smallest repeating unit ("unit cell")?   (2)
    1.3.4   Each repeating unit is composed of four NaCl units. What is the mass of one NaCl formula unit?   (2)

QUESTION 2   **[10 MARKS]**

2.1   What is key difference between an element and a compound?   (1)

2.2   Identify the mass law that each of the following observations demonstrates, and explain your reasoning:

    2.2.1   A sample of potassium chloride from Nigeria contains the same percent by mass of potassium as one from South Africa.   (1)
    2.2.2   A flashbulb contains magnesium and oxygen before use and magnesium oxide afterward, but its mass does not change.   (1)
    2.2.3   Arsenic and oxygen form one compound that is 65.2 mass% arsenic and another that is 75.8 mass % arsenic.   (1)

2.3   A chemist finds that 30.82 g of nitrogen will react with 17.60 g, 35.20 g, 70.40 g, or 88.00g of oxygen, respectively to form four different compounds. Calculate the mass of oxygen per gram of nitrogen in each compound and show how these calculations support Dalton's atomic theory?   (6)

QUESTION 3   **[9 MARKS]**

3.1   Why do the isotopes of the same element have the same atomic size?   (2)

3.2   Chlorine has two naturally occurring isotopes, ^{35}Cl (isotopic mass = 34.9689 amu) and ^{37}Cl (isotopic mass = 36.9659 amu). If chlorine has an atomic mass of 35.4527 amu, what is the percent abundance of each isotope?   (5)

3.3   An ion has 26 protons, 29 neutrons, and 23 electrons. Write the complete isotopic symbol for it including all relevant information.   (2)

QUESTION 4   **[9 MARKS]**

4.1   Correct each of the following false statements:

    4.1.1   In the modern periodic table, the elements are arranged in order of increasing atomic mass.   (1)

    4.1.2   Elements in a period have similar chemical properties.   (1)

    4.1.3   Elements can be classified as either metalloids or non-metals.   (1)

4.2   Fill in the blanks:

    4.2.1   The symbol and atomic number of the heaviest alkaline earth metal are _____ and _____.   (2)

    4.2.2   The name and atomic number of the lightest metalloid in Group 4A(14) are _____ and _____.   (2)

    4.2.3   The symbol and atomic mass of the halogen in Period 4 are _____ and _____.   (2)

QUESTION 5 [12 MARKS]

5.1 Describe the differences between ionic and molecular compounds. Give an example of each. (3)

5.2 Fill in the blanks in the following table:

Formula	Name	Mark
$Fe_3(PO_4)_2$	1)	(1)
$Al_2(SO_4)_3$	2)	(1)
3)	Ammonium carbonate	(1)
$KMnO_4$	4)	(1)
5)	Cobalt(II) nitrite	(1)

5.3 Write the name from the formula or the formula from the name. (4)
    5.3.1 HIO_4
    5.3.2 Cl_2O_7
    5.3.3   Barium chloride hexahydrate
    5.3.4   Carbonic acid

QUESTION 6 [13 MARKS]

6.1. Saccharin ($C_7H_5NO_3S$, molar mass = 183.18 g/mol) is more than 300 times sweeter than sugar. It was first made in 1987, when it was common practice for chemists to record the taste of any new substances they synthesized.

    6.1.1   If you ingest 125 mg of saccharin, how many moles of saccharin have you ingested? (1.5)

   6.1.2   What mass (mg) of carbon is contained in 125 mg of saccharin? (2.5)

6.2. The compound is composed of 39.0% O, 46.3 % F and the rest is carbon. The molar mass of the compound is 82.01 g/mol.

    6.2.1   Determine the empirical formulas of the compound. (7)

    6.2.2   Determine the molecular formulas of the compound. (2)

QUESTION 7   **[18 MARKS]**

7.1   The fizz produced when a tablet is dissolved in water is due to the reaction between sodium bicarbonate (molar mass: 84.01 g/mol) and citric acid (molar mass: 192.1 g/mol) as shown below:

$$3NaHCO_3(aq) + H_3C_6H_5O_7(aq) \rightarrow 3CO_2(g) + 3H_2O(l) + Na_3C_6H_5O_7(aq)$$
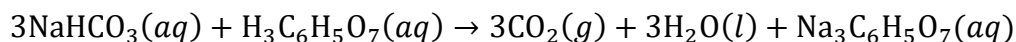
In a certain experiment 1.00 g of sodium bicarbonate and 1.00 g of citric acid are allowed to react.

7.1.1   How many grams of carbon dioxide form if the reaction goes to completion? (7)

7.1.2   How many grams of the excess reactant remain after the limiting reactant is completely consumed? (5)

7.1.3   If the actual yield of carbon dioxide is 0.312 g, what is the percentage yield? (2)

7.2   An experiment in your laboratory requires 500. mL of a 0.0200 M solution of Na_2CO_3 (molar mass: 105.99 g/mol). You are given solid Na_2CO_3, distilled water, and a 500. mL volumetric flask. Describe how to prepare the required solution. (4)

QUESTION 8   **[6 MARKS]**

Write **balanced** equations for each of the following. Indicate the correct phase labels $(s, l, g \ or \ aq)$.

8.1   When aqueous solutions of calcium chloride and sodium phosphate are mixed, solid calcium phosphate forms and sodium chloride remains in solution. (4)

8.2 $SO_2(g) + O_2(g) \rightarrow SO_3(g)$ (2)

END OF PAPER

PSFT0B1 DATA

<u>CONSTANTS:</u> N_A (Avogadro's number) $= 6.022 \times 10^{23}$

The Periodic Table

Period	1	2	3	4	5	6	7	8	9	10	11	12	13/III	14/IV	15/V	16/VI	17/VII	18/VIII
1	1 H 1.008																	2 He 4.003
2	3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	La-Lu	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po 210.0	85 At 210.0	86 Rn 222.0
7	87 Fr 223.0	88 Ra 226.0	Ac-Lr	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno	109 Une	......								

s block   *d* block   *p* block

Lanthanides

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 144.9	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0

Actinides

89 Ac 227.0	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu 239.1	95 Am 243.1	96 Cm 247.1	97 Bk 247.1	98 Cf 252.1	99 Es 252.1	100 Fm 257.1	101 Md 256.1	102 No 259.1	103 Lr 260.1

f block