THE OPEN UNIVERSITY OF SRI LANKA
B.Sc/B.Ed DEGREE PROGRAMME - 2011/2012
Level 4 - CMU2122/CME4122
INORGANIC CHEMISTRY
ASSIGNMENT TEST II (NBT)

13th October 2011 (Thursday) 4.00 – 5.30 p.m.

Part A - 20 Multiple Choice Questions (60 Marks)

Answer all questions
Select the most correct answer to each question given below and mark a cross ***X*** over the answer on the **given answer sheet.** Any answer with more than one ***X*** will not be counted. 1/6th of a mark will be deducted for each incorrect answer.

Avogadro Constant, L	$= 6.023 \times 10^{23}\ mol^{-1}$
Velocity of light, c	$= 3 \times 10^{8}\ m\ s^{-1}$
Mass of a hydrogen atom	= 1.007825 u
Mass of a neutron	= 1.008665 u
1 u	$= 1.661 \times 10^{-27}\ kg$
1 MeV	$= 1.6021 \times 10^{-13}\ J$

1. Which of the following nuclides will be expected to be **radioactive**?
$^{16}_{8}O$, $^{18}_{9}F$, $^{20}_{10}Ne$, $^{39}_{19}K$, $^{40}_{20}Ca$
(1) $^{16}_{8}O$ (2) $^{18}_{9}F$ (3) $^{20}_{10}Ne$ (4) $^{39}_{19}K$ (5) $^{40}_{20}Ca$

2. Following are the comments on the decay series:
$$^{238}_{92}U \xrightarrow{-\alpha} X \xrightarrow{x} {}^{234}_{91}Pa \xrightarrow{-\alpha} Z \rightarrow\rightarrow\rightarrow {}^{206}_{82}Pb$$
(a) It is (4n+2) decay series (b) X is $^{236}_{90}Th$
(c) x is $^{0}_{1}\beta$ (d) Z is $^{230}_{89}Ac$
The answer is
(1) (a) and (b) only (2) (b) and (c) only (3) (c) and (d) only
(4) (d) and (a) only (5) (a), (b) and (c) only

3. Predict the type of nuclear decay process for the radionuclide, $^{11}_{6}C$ from the following:
(a) electron emission (b) positron emission (c) electron capture (d) γ emission

The answer is
(1) (a) and (b) only (2) (b) and (c) only (3) (c) and (d) only
(4) (d) and (a) only (5) (a), (b) and (c) only

4. Identify the type of nuclear equation: ${}^{30}_{15}P \rightarrow {}^{30}_{14}Si + ?$

(1) α- decay (2) electron emission (3) positron emission

(4) electron capture (5) γ emission

5. A sample to be used for medical imaging is labeled with ${}^{18}F$, which has a half-life of 110 min. What percentage of the original activity in the sample remains after 300 min?

(1) 12.5% (2) 13.6% (3) 15.1%

(4) 17.5% (5) 33%

6. From among the radionuclides given below, which one can be used as a tracer in positron emission tomography (PET)? ${}^{13}_{6}C$, ${}^{18}_{9}F$, ${}^{19}_{9}F$, ${}^{16}_{8}O$, ${}^{18}_{8}O$

(1) ${}^{13}_{6}C$ (2) ${}^{18}_{9}F$ (3) ${}^{19}_{9}F$ (4) ${}^{16}_{8}O$ (5) ${}^{18}_{8}O$

7. If we start with 1.000 g of strontium-90, 0.953 g will remain after 2.00 yr. What is the half-life of strontium-90?

(1) 14.4 years (2) 23.8 years (3) 28.8 years

(4) 47.6 years (5) 57.6 years

8. Identify the nuclear reaction, ${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U^{*} \rightarrow {}^{140}Xe + {}^{94}Sr + 2{}^{1}_{0}n$

(a) neutron emission (b) positron emission (c) nuclear fission (d) chain reaction

The answer is

(1) (a) and (b) only (2) (b) and (c) only (3) (c) and (d) only

(4) (d) and (a) only (5) ((a), (b) and (c) only

9. What is the area of the body investigated using iodine-131 as a radiotracer?

(1) eyes (2) thyroid (3) heart (4) spleen (5) lungs

10. A certain rock is found to have ^{87}Rb: ^{87}Sr mass ratio of 1.00: 0.004. What is the age of the rock? ($t_{1/2}$ of ${}^{87}Rb$ is 4.8×10^{10} y).

(1) 1.20×10^{8} y (2) 1.59×10^{11} y (3) 2.77×10^{8} y

(4) 1.38×10^{8} y (5) 5.54×10^{8} y

11. Symmetry of a molecule is determined by

(i) its nuclear skeleton.

(ii) its electron density distribution.

(iii) the relative lengths of chemical bonds and the angles between chemical bonds.

The **correct** statements, out of (i), (ii) and (iii) above, are

(1) (i) and (ii) only. (2) (i) and (iii) only. (3) (ii) and (iii) only.

(4) All (i), (ii) and (iii). (5) None of the answers (1), (2), (3) or (4), is correct.

12. Identical configurations of a molecule are

(i) equivalent configurations.

(ii) nuclear configurations where similar nuclei occupy slightly different positions in space.

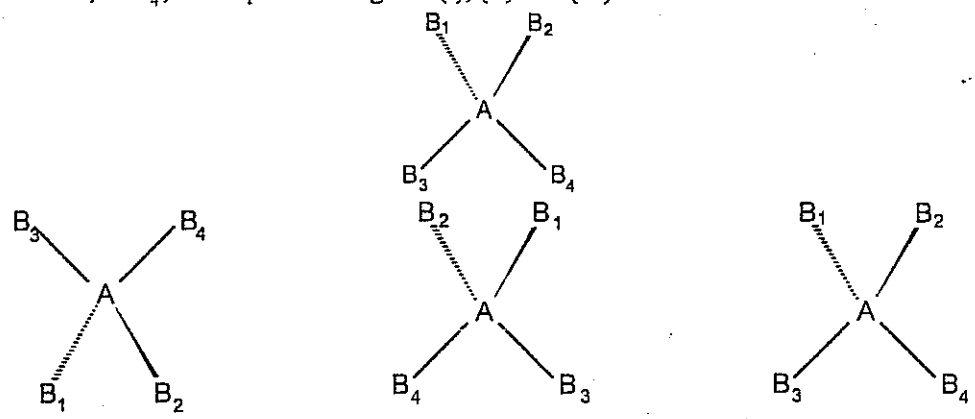
(iii) nuclear configurations where identical nuclei occupy identical positions in space.

The **correct** statement/s, out of (i), (ii) and (iii) above, is/are

(1) (ii) only. (2) (iii) only. (3) (i) and (ii) only.

(4) (i), and (iii) only (5) (ii) and (iii) only

13. The results of three operations on the following configuration of the perfect tetrahedral molecule, AB_4, are depicted in figures (i), (ii) and (iii).



(i) (ii) (iii)

The outcome/s which involve/s a symmetry operation, out of (i), (ii) and (iii) above, is/are

(1) (i) only. (2) (i) and (ii) only. (3) (i) and (iii) only.
(4) (ii) and (iii) only (5) None.

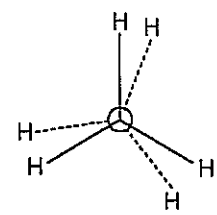
14 Consider the following statements.

(i) Only a limited number of rotation operations can be performed about an axis of rotation.
(ii) A given rotation operation (on a molecule) may not be a symmetry operation.
(iii) *Always*, we do not have to break chemical bonds (in a molecule) to bring about, physically, a rotation operation.

The **correct** statements, out of (i), (ii) and (iii) above, are

(1) (i) and (ii) only. (2) (i) and (iii) only. (3) (ii) and (iii) only.
(4) All (i), (ii) and (iii) (5) None of the answers (1), (2), (3) or (4), is correct.

15. Consider the following statements about the C-C bond axis of ethane in neither staggered nor eclipsed conformation, the Newmann projection formula of which is given below.



(i) It is an axis of rotation.
(ii) The order of this axis of rotation is 3.
(iii) There are an infinite number of rotational *symmetry* operations that can be performed about this axis.

The **correct** statements, out of (i), (ii) and (iii) above, are

(1) (i) and (ii) only. (2) (i) and (iii) only. (3) (ii) and (iii) only.
(4) All (i), (ii) and (iii) (5) None of the answers (1), (2), (3) or (4), is correct.

16. The *total* set of (different) axes of rotation in a molecule of benzene is

(1) C_6, $3C_2$ (2) C_6, $4C_2$ (3) C_6, $5C_2$
(4) C_6, $6C_2$ (5) None of the answers (1), (2), (3) or (4), is correct.

17. The principal axis of a $PtCl_4^{2-}$ ion is of order 4. Thus all the possible rotational symmetry operations about this axis bring about only 4 distinct outcomes. The set of rotational symmetry operations (about this axis) which brings about the four distinct outcomes is

(1) C_4^2, C_4^3, C_4^5, E (2) $C_4^1, C_4^4, C_4^5, C_4^2$ (3) $C_4^2, C_4^6, C_4^{10}, C_4^{14}$

(4) $C_4^1, C_4^5, C_4^9, C_4^{13}$ (5) None of the answers (1), (2), (3) or (4), is correct.

18. Consider the following statements.

(i) In a molecule, the nuclei of the same kind (i.e. having the same atomic and mass numbers), which are located out of a symmetry plane must appear in even number.

(ii) A symmetry plane always passes through a single nucleus of a kind in a molecule.

(iii) *Always* a reflection through a symmetry plane is a symmetry operation.

The **correct** statements, out of (i), (ii) and (iii) above, are

(1) (i) and (ii) only. (2) (i) and (iii) only. (3) (ii) and (iii) only.

(4) All (i), (ii) and (iii) (5) None of the answers (1), (2), (3) or (4), is correct.

19. The most complete description of the total set of symmetry planes in an ion of cyclopentadieneyl anion is

(1) $\sigma_v, 4\sigma_d$ (2) $\sigma_h, \sigma_v, 4\sigma_d$ (3) $\sigma_h, 5\sigma_d$

(4) $\sigma_h, 2\sigma_v, 3\sigma_d$ (5) None of the answers (1), (2), (3) or (4), is correct.

20. The numbers of reflection symmetry operations, which produce distinct outcomes that can be carried out with respect to each of the following symmetry planes

(i) σ_v of H_2O (ii) σ_h of $PtCl_4^{2-}$

(iii) σ_h of eclipsed ethane are given respectively by

(1) 2,2,1. (2) 1,2,2. (3) 2,1,1. (4) 2,2,2. (5) 2,1,2.

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B. Sc DEGREE PROGRAMME 2011/2012
CMU2122/CME4122 – INORGANIC CHEMISTRY- LEVEL 4
ASSIGNMENT TEST-II (Part A)

MCQ ANSWER SHEET: Mark a cross (X) over the most suitable answer.

Reg. No. _____ For Examiners Use

	Marks
Part A	
Part B	
Total %	

		Marks
Unanswered		
Correct Answers		
Wrong Answers		
Total		

1.	1	2	3	4	5	2.	1	2	3	4	5	3.	1	2	3	4	5
4.	1	2	3	4	5	5.	1	2	3	4	5	6.	1	2	3	4	5
7.	1	2	3	4	5	8.	1	2	3	4	5	9.	1	2	3	4	5
10.	1	2	3	4	5	11.	1	2	3	4	5	12.	1	2	3	4	5
13.	1	2	3	4	5	14.	1	2	3	4	5	15.	1	2	3	4	5
16.	1	2	3	4	5	17.	1	2	3	4	5	18.	1	2	3	4	5
19.	1	2	3	4	5	20.	1	2	3	4	5						

Part B- Structured Essay (40 Marks)

Answer all questions only in the SPACE PROVIDED. Attached sheets will not be graded.

1. (a) Write a balanced nuclear equation for each of the reactions described below:

(i) Positron emission by $^{15}_{8}O$ .....

(ii) β^- decay by $^{131}_{53}I$ .....

(iii) Electron capture by $^{40}_{19}K$ .....

(b) Carbon-11, used in medical imaging, has a half-life of 20.4 min. The carbon-11 nuclides are formed and the carbon atoms are then incorporated into an appropriate compound. The resulting sample is injected into a patient, and the medical image is obtained. If the entire process takes five half-lives, what percentage of the original carbon-11 remains at this time?

(c) (i) Define the term 'binding energy'.

(ii) Calculate the mass defect and average binding energy (in MeV) for lithium-7 of which the mass is 7.016003 u.

(d) Calculate the energy released in MeV per fusion in the process, $^{2}_{1}H + {}^{1}_{1}H \rightarrow {}^{3}_{2}He$, given that the atomic masses are $^{2}_{1}H$: 2.01410178 u, $^{1}_{1}H$: 1.007825 u and $^{3}_{2}He$: 3.0160492 u.

(e) Write complete nuclear equation for each of the following notations:

(i) ${}^{27}_{13}Al(n,\ )^{24}_{11}Na$ .....

(ii) ${}^{16}_{8}O(p,\alpha)$ .....

(iii) ${}^{10}_{5}B(\ ,\alpha)^{7}_{3}Li$ ..... (20 marks)

2. (a) Consider the trigonal pyramidal molecule, AB_3, whose structure is depicted in the diagram. As usual, the three B nuclei are numbered.

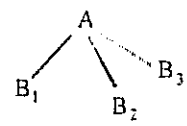


Figure 1

All three BAB angles are equal to each other.

(i) How many rotational symmetry <u>axes</u> are there in the above molecule? .....

(ii) Describe where it is/they are located.

.....

.....

(iii) What is/are its/their order/s?.....

(iv) How many symmetry <u>planes</u> are there in the above molecule? .....

(v) Describe where it is/they are located.

.....

.....

.....

(b) Now imagine changing the structure of AB_3 from that depicted in Figure 1 to that depicted in Figure 2 by keeping the AB bond lengths the same and making the BAB angles smaller but equal to each other.

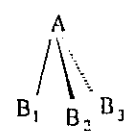


Figure 2

(i) How many rotational symmetry <u>axes</u> are there in the molecule shown in Figure 2?

.....

(ii) Describe where it is/they are located.

.....

.....

(iii) What is/are its/their order/s?.....

(iv) How many symmetry planes are there in the molecule shown in Figure 2?

.....

(v) Describe where it is/they are located.

.....

.....

.....

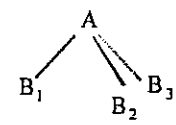
(vi) Can the rotational symmetry axis/axes and planes of symmetry in the molecule in Figure 2 be the same as those in the molecule in Figure 1? Briefly explain your answer.

.....

.....

.....

(c) Imagine changing the structure of AB_3 from that depicted in Figure 1 to that depicted in Figure 3 by keeping the AB bond lengths the same and making one BAB angle smaller than the other two which are kept equal to each other.



The bond angles have the relationship, $B_1AB_2 = B_1AB_3 > B_2AB_3$.

(i) How many rotational symmetry axes are there in the molecule shown in Figure 3?

.....

(ii) How many symmetry planes are there in the molecule shown in Figure 3?

.....

(iii) Describe where it is/they are located.

.....

.....

.....

(20 marks)

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CMU2122 / CME4122 – Inorganic Chemistry - Level 4
Assignment Test - II - Answer Guide

Part A – MCQ ANSWERS

1. (2)	**2.** (4)	**3.** (2)	**4.** (3)	**5.** (3)
6. (2)	**7.** (3)	**8.** (3)	**9.** (2)	**10.** (3)
11. (2)	**12.** (4)	**13.** (4)	**14.** (3)	**15.** (4)
16. (4)	**17.** (1)	**18.** (2)	**19.** (3)	**20.** (5)

(1) (a)

(i) ${}^{15}_{8}O \rightarrow {}^{0}_{1}\beta + {}^{15}_{7}N$ ${}^{0}_{1}\beta$ *or* ${}^{0}_{1}e$

(ii) ${}^{131}_{53}I \rightarrow {}^{0}_{-1}\beta + {}^{131}_{54}Xe$ ${}^{0}_{-1}\beta$ *or* ${}^{0}_{-1}e$

(iii) ${}^{40}_{19}K + {}^{0}_{-1}e \rightarrow {}^{40}_{18}Ar$

(b) $100\% \xrightarrow{t_{1/2}} 50\% \xrightarrow{t_{1/2}} 25\% \xrightarrow{t_{1/2}} 12.5\% \xrightarrow{t_{1/2}} 6.25\% \xrightarrow{t_{1/2}} 3.125\%$

Method II: You can use the following equations to calculate the percentage.

$$\lambda = \frac{0.693}{t_{1/2}} \qquad \ln \frac{N}{N_0} = -\lambda t$$

(c) (i) Energy released when the nucleus is assembled/formed from its constituent nucleons OR
Energy required to break up the nucleus into its individual nucleons.

(ii) ${}^{7}_{3}Li$ $(Z = 3, N = 4)$

Mass defect $\Delta m = Zm_H + Nm_N - M_{atom}$

$\Delta m = 3 \times 1.007825 + 4 \times 1.008665 - 7.016003\ u$

$= 0.042132\ u$

$E = mc^2 = 0.042132 \times 1.661 \times 10^{-27}\ kg \times (3 \times 10^8\ m\,s^{-1})^2$

$Total\ BE = 6.3 \times 10^{-12}\ J = 39.3\ MeV$

$Average\ BE = 39.3/7 = 5.61\ MeV$

(d)

$_{1}^{2}H + {}_{1}^{1}H \rightarrow {}_{2}^{3}He$ $\quad {}_{1}^{2}H : 2.01410178\ u$ $\quad {}_{1}^{1}H : 1.007825\ u$ $\quad {}_{2}^{3}He : 3.0160492\ u$

$$Change\ in\ the\ mass, \Delta m = (2.01410178\ u + 1.007825\ u) - 3.0160492\ u$$

$$= 0.00587758\ u$$

$$E = mc^2 = 0.00587758u \times 1.661 \times 10^{-27}\ kg \times (3 \times 10^8\ ms^{-1})^2$$

$$= 5.48\ MeV$$

(e) (i) ${}_{13}^{27}Al + {}_{0}^{1}n \rightarrow {}_{11}^{24}Na + {}_{2}^{4}\alpha$ $\quad ({}_{2}^{4}\alpha\ or\ {}_{2}^{4}He)$

(ii) ${}_{8}^{16}O + {}_{1}^{1}p \rightarrow {}_{2}^{4}\alpha + {}_{7}^{13}N$

(iii) ${}_{5}^{10}B + {}_{0}^{1}n \rightarrow {}_{2}^{4}\alpha + {}_{3}^{7}Li$

(2) (a).

(i) One

(ii) It passes through A and is perpendicular to the plane of the three B nuclei.

(iii) Three (iv) Three

(v) Passes through one B nucleus and A while bisecting the angle formed by the other two B nuclei at A.

(b)

(i) One (ii) It passes through A and is perpendicular to the plane of the three B nuclei

(iii) Three (iv) Three

(v) Passes through one B nucleus and A while bisecting the angle formed by the other two B nuclei at A.

(vi) Yes, In both cases the rotational axis is of order 3 and the three planes pass through it. Hence the angle between any two symmetry planes in both cases is the same at 120°. Therefore, the symmetry planes in the two molecules can be the same.

(c)

(i) Zero (ii) One

(iii) It passes through A and B_1 while bisecting the angle B_2AB_3.