NASSAU **FREEPORT**

THE COLLEGE OF THE BAHAMAS
THE SCHOOL OF NATURAL SCIENCES
AND
ENVIRONMENTAL STUDIES
FINAL EXAMINATION SPRING SEMESTER 01-2004
CHEMISTRY 235: INORGANIC CHEMISTRY

TIME: 3:00 Hours
CODE: R

INSTRUCTIONS TO CANDIDATES

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

This paper has 8pages There are twenty questions in section A , five questions in section B and four questions in sections C . Follow the specific directions given at the beginning of each section.

COMPLETE THE FOLLOWING CAREFULLY

LECTURER'S NAME : _____

SECTION NO. _____

STUDENT NUMBER _____

YOUR FULL NAME _____(PLEASE PRINT)

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(FOR OFFICIAL USE ONLY)

SECTION I: Multiple Choice Questions.

Carefully read each question, and then select the answer that best fits. Indicate your answer by shading in the appropriate letter on the multiple choice answer sheet. If you wish to change your answer, neatly erase the previous answer and mark in the new answer as directed.

1. What is the coordination number of an an atom in a crystal with simple cubic structure ?

   a. 4
   b. 6
   c. 8
   d. 12
   e. 1/8

2. How do you account for the observation that it is easier to break a C-C pi bond than it is to break a C-C sigma bond ?

   a. The pi bond lies along the bond axis.
   b. The sigma bond involved side-on overlap or orbitals .
   c. The pi bond involves less overlap of orbitals.
   d. The sigma bond involves less overlap of orbitals.
   e. More electrons are used in forming a sigma bond than in a pi bond.

3. Arrange the following atoms in order of increasing atomic volume.

   Al Si Na Mg

   a. Al Si Mg Na
   b. Si Na Mg Al
   c. Al Si Na Mg
   d. Na Mg Al Si
   e. Si Al Mg Na

4. Which of the following atoms has no unpaired valence electrons ?

   a. Ne
   b. C
   c. O
   d. N
   e. Fe

5. Select the ion that has the electron configuration $[Ar]3d^4$?

   a. Cr^{2+}
   b. Mn^{2+}
   c. K^+
   d. Fe^{3+}
   e. V^{3+}

6. The ion with the smallest diameter is :

   a. Br^-
   b. Cl^-
   c. I^-
   d. F^-
   e. O^{2-}

7. Which of the following acids has a S S double bond ?

   a. $H_2S_2O_8$
   b. $H_2S_2O_7$
   c. $H_2S_2O_3$
   d. $H_2S_2O_4$
   e. H_2SO4

8. The Lewis structure of N_2H_2 shows

   a. a nitrogen-nitrogen triple bond
   b. a nitrogen-nitrogen double bond

c. a nitrogen –nitrogen single bond with each nitrogen having a lone pair

d. a nitrogen –nitrogen single bond with each nitrogen having two lone pairs

e. each hydrogen has one lone pair

9. A sample of each of the following substances was heated over a Bunsen flame. Select the answer that correctly states all of the gaseous products when the named substances are heated.

a. Sodium carbonate – CO_2 released
b. Potassium nitrate – NO_2 and O_2 released
c. Hydrogen Iodide - H_2 and I_2 released
d. Magnesium hydroxide – O_2 released
e. Ammonium Chloride – no change released

10. A colorless solution of W, gives a white precipitate with sodium hydroxide solution. This ppt is soluble in excess hydroxide. The aqueous solution of W also forms a white ppt with cold dilute hydrochloric acid. Solid W gives a blue white flame test result. The solution of W gives no ppt.with either with barium nitrate solution or silver nitrate solution. The most likely identity of W is

a. Zinc chloride
b. Lead (II) nitrate
c. Zinc nitrate
d. Lead (II) chloride
e. Calcium nitrate

11. sp^2 hybridisation can be found in which of the following molecules ?

a. CH_2CH_2 ethene
b. CH_4 methane
c. H_2O water
d. NH_3 ammonia
e. CHCH ethyne

12. Arrange the following hydrides in order of increasing acid strength.

HI HF HCl HBr H_2O

a. HCl, HBr, H_2O, HI ,HF
b. HBr, H_2O, HI, HCl, HF
c. H_2O, HI, HBr, HCl, HF
d. H_2O, HF, HI, HBr., HCl
e. None of the above.

13. Tin is an element in group IV. Which of the following would NOT be an expected behavior of a compound of tin ?

a. SnO_2 is acidic.
b. $SnCl_4$ is a liquid at r.t.p.
c. SnH_4 is stable on heating.
d. $SnCl_4$ hydrolyses readily.
e. Sn has a stable oxidation state of 2+

14. The hydrated ions of Co^{2+} , Ni^{2+} ,Cu^{2+} and Zn^{2+} give solutions with the colors

a. blue , yellow, black and white
b. pink, green, blue and colorless
c. green, colorless, blue and colorless
d. pink, yellow, black and colorless
e. purple, green, royal blue, white

15. In the reaction between sodium thiosulfate and iodine illustrated below,

$2Na_2S_2O_3(aq) + I_2(aq) \rightarrow Na_2S_4O_6(aq) + 2NaI(aq)$

a. $S_2O_3^{2-}$ acts as an oxidizing agent.
b. I_2 is the electron donor.
c. I_2 acts as a reducing agent.
d. I_2 is reduced.
e. The oxidation number of the S decreases.

16. Which of the following is considered a bidentate ligand?

a.cyanide, CN^-
b. thiocyanate, SCN^-
c. oxalate, $C_2O_4^{2-}$
d.nitrite, NO_2^-
e.water H_2O

17. In the compound $[Ni(en)_2(H_2O)_2]SO_4$ (where en = ethylene diamine) the oxidation number and coordination number of nickel are, respectively:

a. 2 and 6
b. 4 and 6
c. 6 and 6
d. 2 and 4
e. 6 and 5

18. What is the most appropriate name for the species : $[Cu(NH_3)_4]Cl_2$?

a. dichlorotetraamminecuprate(II)
b. tetraamminecopper(II) chloride
c. copper(II)ammonium chloride
d. tetraaminocopper(II) chloride
e. tetra amminechloride cuprate (II)

19. Hydrogen bonding may be used to explain which of the following observations?

a. NaCl has a higher melting point than HCl.
b. CH_4 is a colorless gas at r.t.p.
c. Graphite is a good conductor of electricity.
d. NH_3 bonds readily with BF_3 to form H_3NBF_3
e. HF has a much higher boiling point that HCl .

20. A flame test can be used to identify all of the members of which group of elements ?

a. Cu, Na, Zn
b. K, Na, Fe
c. Ca, Ba, Mg
d. Na, Cu, Ba
e. Zn, Mg, Fe

SECTION B:Answer ALL of the questions in this section.

1.

a. Complete the table below. (3)

Compound	Oxidation number of the chlorine atom	Lewis structure
$HClO_2$		
$HClO_4$		

b. Compare the strengths of the two oxoacids in the table. (2)

c. Explain / discuss the factor(s) that contributes to this difference in strength. (3)

d. Explain the shape of the ClO_4^- with reference to the Valence Shell Electron Pair Repulsion theory : VSEPR (2)

e. Chlorine gas is said to undergo disproportionation in water. Illustrate this process with a relevant reaction equation. (2)

f. Explain briefly why it would be unwise to mix household bleach with acidic household cleaning products. (1)

_____

_____

2.a. Group 1 compounds typically have high melting and boiling points. Account for this observation. (2)

_____

_____

_____

b. Element Q is in group I of the Periodic Table. Predict the following (6)

i. The formula of the oxide of Q._____

ii. The solubility of the chloride of Q._____

iii. The effect of heating on the carbonate of Q. _____

iv. The effect of heating on the nitrate of Q. _____

v. A reaction equation for the formation of the hydride of Q.

_____

d. How does bond character in the hydrides change as you move from left to right across the Periodic Table ? (2)

_____

_____

e. What factor(s) accounts for the observed trend ? (3)

_____

3. a. Give the detailed electron configuration of Boron(1)_____

b. Predict the shape of a molecule of boron chloride. (1)

c. State, with reasoning, whether you would expect the molecule to be polar or not. (2)

b. Aluminium and Boron are both group III elements. Compounds of boron are covalent whereas compounds of aluminium have significant ionic characteristics. Account for this difference in the bonding characteristics of compounds of the two elements. (4)

c. Element X is below aluminium . Predict the chemical formula of the oxide of X.(1)

d.Predict the type of bonding that is likely to exist in the chloride of X. (1)

e. Aluminium was not produced, as the pure metal until the late 1800's. How do you account for its relatively late introduction as a pure metal ? (1)

f. An element M is below Aluminium in the Periodic Table. Predict, with reasoning, whether M would have a larger or smaller 1st ionisation energy than Aluminium. (2)

4.a. Define the term "crystal field splitting energy" (1)

b. Complete the table below. (4)

COMPLEX	GEOMETRY (name or diagram)	COORDINATION NUMBER OF THE METAL ION	OXIDATION STATE OF THE METAL ION	NAME OF THE COMPLEX
$TiCl_4$				
$[Ni(H_2O)_6]^{2+}$				

a. Some transition metal complexes exhibit cis - trans isomerism. Explain the term cis – trans isomerism.Illustrate your answer with relevant examples.(3)

b. In an analytical process, potassium dichromate was titrated against an iron (II) sulfate solution.

i. Write a balanced equation illustrating the reaction. (2)

ii. State whether the iron has been oxidized or reduced.(1) _____

iii. Identify the oxidizing and reducing agents in the process.(2)

Oxidizing agent :_____ Reducing agent : _____

5. The first part of this question is concerned with the following oxides. Use them to complete the following statements. Each formula may be used as often as needed.(6)

K_20 , CaO, CO, CO_2, NO_2, SO_2 ,

a. _____ & _____ are both acidic oxides.

b. _____ is a basic oxide.

c. _____ may be further oxidized to give another oxide.

d. _____ binds with the haemoglobin molecule leading to drowsiness and eventually death.

e. Write an equation showing what happens when ANY ONE of these oxides is mixed with distilled water. (2)

f. Group VIII is often referred to as the inert or noble elements.

i. What structural factors make these elements relatively unreactive ? (1)

ii. There are a few compounds of group VIII elements which can be formed. Predict, with reasoning, whether these elements are more likely to be Neon or Xenon compound.(4)

g. State one use for any one member of group VIII.(1)

SECTION II : Extended Answer Questions.

Choose any TWO of the following questions and answer them fully on the lined paper that has been provided. Credit will be given for clear logical work, with relevant reaction equations and examples.

4. Describe the industrial production of any ONE of the following economically important substances.

a. sodium , sodium hydroxide, iron, sulphuric acid, aluminium, bleach

Your account must include the starting materials, reaction conditions, reaction equations and 2 uses of the product. (10)

7. Discuss the relationship between chemical reactivity and atomic radius for group 1 elements and for group 7 elements. State trends and explain the trends.(10)

8. Many of man's modern day activities produce environmentally hazardous materials. Using EITHER carbon dioxide OR sulfur dioxide, discuss this statement. You answer should incude :

a. the name of the environmental problem that the gas causes (1)

b. two common sources of the specified pollutant gas.(2)

c. discussion of the mechanism and reactions that cause the problem names in part a.(4)

d. suitable means of decreasing the environmental impact of the specified gas. (3)

9. A lecturer prepared four bottles of white crystalline compounds and labelled the bottles. During the night the labels fell off and blew away. The lecturer was certain that the three compounds were aluminium chloride, ammonium chloride and zinc sulfate and sodium nitrate. Design a testing scheme that would allow the lecturer to determine the identities of the compounds A,B and C in a short time. The reagents that are available for use are sodium hydroxide, ammonia solution, barium nitrate solution, silver nitrate solution .Write equations for all reactions.(10)

THE END