



## CHEMISTRY 235 FINAL EXAMINATION SEMESTER 9804 CONTINUED .....

**SECTION A: MULTIPLE CHOICE QUESTIONS ( 30 MARKS)**

Answer ALL of the following questions on the answer sheet provided. For each question circle the letter which corresponds to the most appropriate answer.

- In sodium fluoride, both of the ions present have similar;
  - ionic radii
  - electron affinities
  - nuclear structures
  - electronegativities
  - polarising powers
- In which of the following compounds does nitrogen have the highest oxidation number?
  - $\text{Ca}_3\text{N}_2$
  - $\text{N}_2\text{O}_4$
  - $\text{HNO}_3$
  - $\text{NO}_2$
  - $\text{HNO}_2$
- Which of the following ions and molecules IS NOT trigonal planar in shape?
  - $\text{CO}_3^-$
  - $\text{PCl}_3$
  - $\text{NO}_3^-$
  - $\text{H}_2\text{CO}$
  - $\text{BF}_3$
- Which of the following can hydrogen bond?
  - $\text{H}_2$
  - $\text{SiH}_4$
  - $\text{CH}_3\text{OH}$
  - $\text{NaH}$
  - $\text{BeH}_2$
- Select the Lewis acid from the following:
  - $\text{CO}_2$
  - $\text{NH}_3$
  - $\text{BF}_3$
  - $\text{AlCl}_4^-$
  - $\text{BrF}_3$
- Which of the following ground-state electron configurations could be that of a transition metal?
  - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$
  - $1s^2 2s^2 2p^6 3s^2 2p^6 4s^1 3d^{10}$
  - $1s^2 2s^2 2p^6 3s^2 3p^6$
  - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10} 4p^6$
  - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^0 5p^6$
- Which of the following statements about group 7 elements is INCORRECT?
  - They have variable oxidation states in their compounds.
  - Electronegativity decreases with increasing atomic number.
  - They all form acidic hydrides.
  - In the gaseous state they all consist of diatomic molecules.
  - Reactivity increases descending the group.

8. The most stable oxidation state, at the bottom of group IV is
- +4
  - 4
  - +2
  - 2
  - +1
9. Most transition metals are paramagnetic because,
- they are not strongly attracted to a magnetic field
  - they have unpaired *d* electrons
  - they have more than one oxidation state
  - they are attracted to ions with large magnetic moments
  - they have low electronegativities
10. The elements in this pair have the least similarity in chemical properties.
- lithium and magnesium
  - oxygen and chlorine
  - beryllium and aluminum
  - nitrogen and silicon
  - boron and silicon

Questions 11 – 17 concern the following groups of the Periodic Table:

- group 1
- group 3
- group 4
- group 7
- group 8

Select from A to E the group into which you would place the elements described in question below.

- Elements of this group exhibit the most catenation.
  - These elements all form hydrides which react vigorously with water to produce hydrogen.
  - Elements of this group form halides, which act as Lewis acids.
  - These elements are very unreactive and thus form few compounds.
  - These elements exist as reactive diatomic molecules, with their reactivity decreasing with increasing atomic number.
  - Elements of this group form complex tetrahydrides, which are used as reducing agents in some organic reactions.
  - These elements form hydroxides which are alkalis.
18. Which of the following ions will oxidize iodide ions to iodine?
- $\text{SO}_3^{2-}$
  - $\text{S}_2\text{O}_3^{2-}$
  - $\text{HCO}_3^-$
  - $\text{C}_2\text{O}_4^{2-}$
  - $\text{S}_2\text{O}_8^{2-}$
19. Carbon tetrachloride can be produced by,
- reacting carbon disulphide and chlorine gas with iron as a catalyst.
  - reacting carbon with concentrated hydrochloric acid.
  - reacting ethane with chlorine gas.
  - reacting carbon dioxide and dilute hydrochloric acid.
  - reacting ethene with hydrogen chloride.
20. Some of the physical differences between ammonia,  $\text{NH}_3$ , and phosphine,  $\text{PH}_3$  could be attributed to which of the following?
- The N-H bond is less polar than the P-H bond.

- B. Phosphorus has a lower electronegativity than nitrogen.  
 C. Phosphine is a stronger reducing agent than ammonia.  
 D. Phosphine is a poor ionizing solvent.  
 E. Phosphine forms fewer  $\text{XH}_4^+$  salts.
21. Which of the following best describes the shape of a molecule of  $\text{IF}_5$ ?  
 A. octahedral  
 B. square planar  
 C. square pyramidal  
 D. trigonal bipyramidal  
 E. trigonal pyramidal
22. What is the bond order for  $\text{He}_2^+$ ?  
 A. 1  
 B.  $\frac{1}{2}$   
 C. 0  
 D.  $1\frac{1}{2}$   
 E. 2
23. What type of hybridization is exhibited by  $\text{SF}_6$ ?  
 A.  $\text{sp}^3\text{d}^2$   
 B.  $\text{sp}^3\text{d}$   
 C.  $\text{sp}^3$   
 D.  $\text{sp}^2\text{d}^2$   
 E.  $\text{sp}^2$
24. Copper exists as a face-centered cubic lattice. How many copper atoms are there in a unit cell?  
 A. 3  
 B. 1  
 C. 4  
 D.  $\frac{1}{2}$   
 E. 2
25. What is the ground state electron configuration of  $\text{F}_2^-$ ?  
 A.  $(1\sigma)^2(1\sigma^*)^2(2\sigma)^2(2\sigma^*)^2(1\pi)^4(3\sigma)^2(1\pi^*)^4$   
 B.  $(1\sigma)^2(1\sigma^*)^2(2\sigma)^2(2\sigma^*)^2(1\pi)^4(3\sigma)^2(1\pi^*)^4(3\sigma^*)^1$   
 C.  $(1\sigma)^2(1\sigma^*)^2(2\sigma)^2(2\sigma^*)^2(1\pi)^4(3\sigma)^2$   
 D.  $(1\sigma)^2(1\sigma^*)^2(2\sigma)^2(2\sigma^*)^2(1\pi)^4(3\sigma)^2(1\pi^*)^3$   
 E.  $(1\sigma)^2(1\sigma^*)^2(2\sigma)^2(2\sigma^*)^2(1\pi)^4(3\sigma)^2(1\pi^*)^3(3\sigma^*)^2$
26. Which of the following molecules or ions exhibits multicenter covalent bonding?  
 A.  $\text{AlF}_6^{3-}$   
 B.  $\text{SiO}_4^{4-}$   
 C.  $\text{N}_2\text{H}_4$   
 D.  $\text{B}_4\text{H}_{10}$   
 E.  $\text{C}_2\text{H}_6$

Questions 27 – 30 concern the following elements from the d block:

- A. Scandium  $3\text{d}^14\text{s}^2$   
 B. Chromium  $3\text{d}^54\text{s}^1$   
 C. Manganese  $3\text{d}^54\text{s}^2$   
 D. Iron  $3\text{d}^64\text{s}^2$   
 E. Copper  $3\text{d}^{10}4\text{s}^1$

27. Which element has the highest maximum oxidation state?  
 28. Which element forms colourless  $\text{X}^{3+}$  ions?  
 29. Which element forms an unstable  $\text{X}^+$  ion?

30. Which element would you expect to have the highest SECOND ionization energy?

**SECTION B: QUALITATIVE ANALYSIS (15 MARKS)**

Answer all the questions in the spaces provided.

The following tests were carried out with a certain solid substance X with the following observations.

TESTS	OBSERVATION(S)	DEDUCTION(S)
Add $\text{NaOH}_{(aq)}$ until in excess	White precipitate, insoluble in excess	
Add $\text{Na}_2\text{CO}_{3(aq)}$ and then dilute $\text{HCl}_{(aq)}$	White precipitate, soluble in dilute $\text{HCl}$ . Gas evolved which turned limewater milky.	
Add $\text{Na}_3\text{PO}_{4(aq)}$ then dilute $\text{HNO}_{3(aq)}$	White precipitate, soluble in dilute $\text{HNO}_3$ , no gas evolved.	
Add $\text{K}_2\text{CrO}_{4(aq)}$ and divide the result into two parts.	Yellow precipitate	
(i) To one part add dilute $\text{HCl}$ or dilute $\text{HNO}_3$	Precipitate dissolved in acid, solution turns from yellow to orange	
(ii) To the 2 <sup>nd</sup> part add ethanoic acid	Precipitate insoluble in acid	
Flame Test	Apple-green coloured flame	
Add $\text{AgNO}_{3(aq)}$ . Split the result into two parts.	White precipitate	
(i) Add $\text{NH}_{3(aq)}$ to one part	Precipitate dissolves	
(ii) Add dilute $\text{HNO}_3$ to the 2 <sup>nd</sup> part	Precipitate insoluble	

**SECTION B: CONTINUED**

Add $\text{Pb}(\text{NO}_3)_2(\text{aq})$ Heat and cool again ( give observations only)	White precipitate	
Mix some solid X with $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$ . Add few drops of conc. $\text{H}_2\text{SO}_4$ . Work in the fume cupboard.	Give observations	

Based on all the information given above, fill in observations where asked and write all your deductions and equations. Marks will be awarded for clear reasoning and logical deductions. Suggest an identity for X (give the chemical formula or chemical name).

X is \_\_\_\_\_

**SECTION C: STRUCTURED QUESTIONS (55 MARKS)**

Answer all of the following questions in the spaces provided below.

1. (a) What is a polydentate ligand? Give one example of a bidentate ligand and one example of a tridentate ligand.

(2)

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- (b) Name the following compounds: (2)
- (i)  $(\text{NH}_4)_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$       (ii)  $\text{Na}[\text{Co}(\text{C}_2\text{O}_4)_2\text{en}]$

- (c) Show two isomers of the complex with the formula  $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$  (2)

- (d) the d-block elements often give coloured solutions. Briefly explain why these solutions are coloured. (3)

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## CHEMISTRY 235 FINAL EXAM CONT'D.....

- (e) State two chemical properties that are typical of d-block elements. (2)

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2. Sodium chloride and caesium chloride have different crystal lattice structures although sodium and caesium are both in group I.

- (i) Using diagrams, describe the two structures. (4)

- (ii) What is the coordination number of the cation in (a) the NaCl structure and (b) the CsCl structure? What is the reason for the difference? (3)

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3. Give the Lewis structures for each of the following and predict the shape of the molecules. (2 marks each)

Molecule	Lewis Structure	Molecular Shape
$\text{IF}_4^+$		

$\text{SOF}_4$

$\text{ClO}_3^-$

4. (i) Write an equation for the preparation of (a) nitric acid from a nitrate and (b) phosphoric acid from an oxide of phosphorus. (2)

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- (ii) Draw the Lewis structures of these acids. (2)

## CHEMISTRY 235 FINAL EXAM CONT'D .....

- (iii) Give three ways in which the chemical properties of nitric acid differ from those of phosphoric acid. (3)

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**SECTION C CONTINUED: DESCRIPTIVE QUESTIONS**

There are three questions in this section. Each question is worth 12 marks. You are required to answer any two of these questions. Answer these questions on lined paper. Begin each question on a separate sheet. Credit will be given for appropriate examples, diagrams and reaction equations.

5. (i) Outline the process whereby pure aluminum oxide is obtained from bauxite, and the principles of the extraction of the metal by electrolysis. (6)
- (iii) Give chemical equations for the reaction of aluminum with:  
 a. oxygen and heat  
 b. water  
 c. chlorine (3)
- (iv) State two uses of aluminum. What properties make the metal well suited to uses. (3)
6. (i) Define the term *first ionization energy* of an element. (1)  
 (ii) State any two factors, which determine the first ionization energies of the elements in a given group of the Periodic Table. (2)  
 (iii) Three elements A, B, and C, have atomic numbers 8, 10 and 11 respectively.  
 (a) Write down the electronic configurations of the three elements. (3)  
 (b) What is the order of increasing first ionization energy of the three elements? (1)  
 (c) Explain your reasoning in (b) (2)  
 (d) Two elements have electronic configurations  $[\text{Xe}]6s^1$  and  $[\text{Xe}]6s^26p^5$ . What type of compound will they form when they react? Give the formula of the compound. Explain your reasoning for the answers given. (3)
7. (i) Which of the halogens has (a) the smallest electron affinity, (b) the greatest ability to form hydrogen bonds and (c) the greatest oxidizing power. (3)
- (ii) Compare the compounds HF, HCl, HBr and HI with respect to  
 (a) the strengths of the acids formed in aqueous solution  
 (b) thermal stability (2)
- (iii) Explain why the H-F bond has greater ionic character than the H-Cl bond. (2)



- (iv) What is the oxidation number of chlorine in (a)  $\text{ClO}^-$  (b)  $\text{ClO}_3^-$  (2)
- (v)  $\text{ClO}^-$  is formed when chlorine reacts with aqueous alkali. Write the ionic equation for this reaction. (1)
- (vi) Tetrachloromethane,  $\text{CCl}_4$ , does not react with water, but silicon(IV) chloride,  $\text{SiCl}_4$ , is rapidly hydrolysed. Explain the difference. (2)