

2018

## CHEMISTRY – HONOURS

Second Paper

Group - A

Full Marks : 50

*The figures in the margin indicate full marks.**Candidates are required to give their answers in their own words as far as practicable.*

CHT-11a

Unit-I

Answer *any three* questions.

1. (a) Compare the nuclear fission and fusion processes showing relevant nuclear reactions.  
 (b) What is the ground state term symbol of  $\text{Ti}^{2+}$  ion? 3+2
2. (a) According to Bohr's theory, the energy of  $n$ th orbit of a hydrogen atom is given by,

$$E_n = -\frac{21.76 \times 10^{-19}}{n^2} \text{ J.}$$

Calculate the longest wavelength of light that would be needed to remove an electron from the third Bohr orbit of the  $\text{He}^+$  ion.

(Given,  $h = 6.626 \times 10^{-34}$  J.sec,  $c = 3 \times 10^8$   $\text{ms}^{-1}$ )

- (b) Which one of the nuclides in each of the following pairs is radioactive and which is stable? Give reasons for your answer. 3+2
- (i)  ${}_{19}^{39}\text{K}$  and  ${}_{19}^{40}\text{K}$
- (ii)  ${}_{31}^{71}\text{Ga}$  and  ${}_{31}^{76}\text{Ga}$
3. (a) Consider the fission process—  ${}_{92}^{236}\text{U} \rightarrow {}_{54}^{140}\text{Xe} + {}_{38}^{93}\text{Sr} + 3n$

The binding energy per nucleon for the uranium nucleus is 7.6 MeV, while those for the  ${}^{140}\text{Xe}$  and  ${}^{93}\text{Sr}$  are 8.4 and 8.7 MeV respectively. Estimate the amount of energy released for each uranium fission.

Please Turn Over

- (b) For the 3p hydrogen-like atomic orbital, sketch and interpret the following plots : 3+2
- (i) The radial function
- (ii) The radial probability function
4. (a) Applying Hund's rules, arrange the following terms in order of increasing energy :  
 $1S, 1G, 3F, 1D, 3P$
- (b) What is the  $\alpha$ -activity in disintegrations per minute for 0.001 g sample of  $^{226}\text{Ra}$  ( $t_{1/2} = 1620$  years)? 3+2
5. (a) When do radionuclides attain their stability by positron emission and K-electron capture? Explain with suitable examples.
- (b) What is  $(n + 1)$  rule and show how the electronic configuration of La ( $z = 57$ ) violates the  $(n + 1)$  rule? 3+2

### Unit - II

Answer *any two* questions.

6. (a) The second ionization of carbon and the first ionization of boron, both correspond to the following :  
 $1s^2 2s^2 2p^1 \rightarrow 1s^2 2s^2 + \text{electron}$ . Compare the two ionization energy values, 24.3 eV and 8.3 eV, respectively.
- (b) Account for the fact that niobium and tantalum have almost same atomic radii. 3+2
7. (a) Using Slater's rules, determine  $Z^*$  for a 4s and a 3d electron of copper. Which type of electron is more likely to be lost when copper forms a positive ion?
- (b) Electron affinity of  $\text{SF}_5$  is greater than that of  $\text{SF}_4$  or  $\text{SF}_6$  — explain. 3+2
8. (a) State the factors on which electronegativity depends. Justify with suitable examples.
- (b) Predict the largest and smallest in each series suggesting explanation : 3+2
- (i)  $\text{Se}^{2-}, \text{Br}^-, \text{Rb}^+, \text{Sr}^{2+}$
- (ii)  $\text{Y}^{3+}, \text{Zr}^{4+}, \text{Nb}^{5+}$

### CHT-11b

#### Unit-I

Answer *any three* questions.

9. (a) Predict the structures of the following ions using VSEPR rules :
- (i)  $\text{SbF}_4^-$
- (ii)  $\text{SeF}_3^+$
- (iii)  $\text{IOF}_4^-$
- (b) Which member of the pair, NaF or  $\text{NaBF}_4$ , is likely to be more soluble in water? 3+2

10. (a) Rationalize the following bond angles in covalent molecules :
- (i)  $\text{NH}_3$  ( $\sim 107^\circ$ ) ;  $\text{NF}_3$  ( $\sim 102^\circ$ )
- (ii)  $\text{PH}_3$  ( $\sim 94^\circ$ ) ;  $\text{PF}_3$  ( $\sim 98^\circ$ )
- (b) KI is soluble in alcohol while KCl is insoluble. Explain. 3+2
11. (a) The formation of  $\text{CaF}$  is thermodynamically feasible. But  $\text{CaF}_2$  is more stable than  $\text{CaF}$ . Justify qualitatively with the help of Born Lande equation.
- (b) Calculate dipole moment of methanol from the given data :
- $\mu_{\text{O-H}} = 1.7 \text{ D}$
- $\mu_{\text{C-O}} = 0.7 \text{ D}$
- $\mu_{\text{CH}_3} = 0.4 \text{ D}$
- $\angle \text{COH} = 110^\circ$  3+2
12. (a) Draw the contributing resonance structures of cyanate ion,  $\text{OCN}^-$ , and identify the most stable structure with proper reasoning.
- (b) Justify the statement :  $\text{ICl}_2^-$  is linear, but  $\text{NH}_2^-$  is bent. 3+2
13. (a) State the nature of defect found in  $\text{FeO}$  and  $\text{NiO}$  compounds. Represent the type of possible stoichiometries. How does this defect affect electrical conductivity?
- (b) Which of the following pairs of isostructural compounds are likely to undergo thermal decomposition at lower temperature? Explain your answer.
- (i)  $\text{MgCO}_3$ ,  $\text{CaCO}_3$
- (ii)  $\text{CsI}_3$ ,  $(\text{CH}_3)_4\text{NI}_3$  3+2

### Unit - II

Answer *any two* questions.

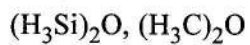
14. (a) Consider HSAB principle to answer the following :
- (i) Will  $\text{Cu}^{2+}$  react more favourably with  $\text{OH}^-$  or  $\text{NH}_3$ ?
- (ii) Will  $\text{Ag}^+$  react more favourably with  $\text{NH}_3$  or  $\text{PH}_3$ ?
- (b)  $\text{B}_2\text{O}_3$  is acidic,  $\text{Al}_2\text{O}_3$  is amphoteric and  $\text{Sc}_2\text{O}_3$  is basic. Justify. 3+2
15. (a) Calculate the  $\text{pK}_1$  of  $\text{H}_3\text{AsO}_3$  and  $\text{H}_3\text{PO}_3$  using Pauling's empirical rule.
- (b)  $\text{SbF}_5$  acts as an acid and  $\text{KF}$  acts as a base when dissolved in  $\text{BrF}_3$  solvent. Explain the observation giving proper chemical equations. 3+2

Please Turn Over

16. (a) 4g of NaOH was dissolved in 1 litre of a solution containing 1 mole of acetic acid and 1 mole of sodium acetate. Find the pH of the resulting solution.

( $K_a$  of acetic acid =  $1.8 \times 10^{-5}$ ).

- (b) Consider the following pair :



Explain why silyl ether is the weaker Lewis base.

3+2

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