REV-01
BSC/05/10

2025/11

SET A

B.SC. CHEMISTRY [HONOURS]
SEVENTH SEMESTER
INORGANIC CHEMISTRY V
BSC – 702

[USE OMR FOR OBJECTIVE PART]

Duration: 3 hrs. **Full Marks: 75**

Objective

Time: 30 min. **Marks: 25**

Choose the correct answer from the following: ***1×25=25***

1. If a molecule has an inversion center (i), what does the inversion operation do?
   a. Reflects all atoms through a plane
   b. Rotates the molecule by 180°
   c. Replaces every atom by an equivalent atom through the center of symmetry
   d. Combines rotation and reflection

2. Which of the following molecules possesses a C_3 axis of symmetry?
   a. H_2O
   b. NH_3
   c. CO_2
   d. XeF_4

3. Which of the following point groups is a *subgroup* of D_4h?
   a. C_4v
   b. Td
   c. D_3h
   d. Oh

4. For H_2O (C_2v), the irreducible representations correspond to:
   a. A_1, A_2, B_1, B_2
   b. C_3, C_4, C_2
   c. S_4, S_6, S_8
   d. D_4, D_6, D_8

5. The sum of squares of the dimensions of all irreducible representations in a point group equals to:
   a. Number of symmetry elements
   b. Number of atoms in the molecule
   c. Number of operations in a class
   d. Number of C_2 axes

6. The transport across membrane is achieved by proteins known as
   a. ion pumps and channels
   b. hemoglobin pump
   c. magnesium pump
   d. calcium pump

7. The active sites of most carbonic anhydrase contain
   a. Mg
   b. Zn
   c. Fe
   d. Ni

8. Calvin cycle is the process that plants and algae use to turn
   a. H_2 to H_2O
   b. CO to CO_2
   c. CO_2 from air to sugar
   d. SO_2 to sulphate

9. Action of cis-platin and related drugs is thought to be due to the formation of stable complex between
   a. Pt (II) and DNA
   b. Pt (II) and RNA
   c. Pt (III) and DNA
   d. Pt (III) and RNA

10. The intermediates such as peroxides are not released during conversion of
    a. H_2O_2 to H_2O
    b. molecular oxygen to H_2O
    c. H_2 to H_2O
    d. O_3 to H_2O

11. Electrons are filled up in molecular orbital according to
    a. Aufbau principle
    b. Hund's rule
    c. Pauli's principle
    d. All of the above

12. Which of the following statements about gerade (g) and ungerade (u) orbitals is true?
    a. Gerade orbitals change sign upon inversion
    b. Ungerade orbitals don't change sign upon inversion
    c. Gerade orbitals don't change sign upon inversion
    d. None of these

13. Bond order of CO molecule according to MOT is
    a. 1
    b. 2
    c. 3
    d. 4

14. Which of the following pairs consists of species that are both paramagnetic?
    a. N_2 and O_2
    b. N_2^+ and O_2^-
    c. O_2 and HF
    d. HF and CO

15. For the molecule BeH_2, molecular orbitals are formed according to the
    a. LCAO method
    b. SALC method
    c. Both a and b
    d. None of the above

16. Identify the pair of isobars from the following
    a. $^{228}Ra_{88}$, $^{228}Th_{90}$
    b. $^{58}Fe_{26}$, $^{58}Ni_{28}$
    c. $^{39}Ar_{19}$, $^{40}K_{19}$
    d. $^{1}H_1$, $^{2}H_1$

17. The nuclear reaction in which several nucleons or their combinations are ejected from their target nucleus is called ---------- reaction.
    a. Photochemical
    b. Spallation
    c. Evaporation
    d. Hydration

18. In scintillation counter phosphors are a combination of
    a. CuI, NaI
    b. NaI, TlI
    c. PtI, NaI
    d. NaI, CuI_2

19. Identify the set of familiar particles
    a. lepton, proton, neutron
    b. electron, positron, neutron
    c. neutron, proton, electron
    d. proton, electron, meson

20. ---------- emission takes place during transformation of $^{14}C_6$ to $^{14}N_7$
    a. α
    b. γ
    c. β
    d. δ

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Descriptive

Time : 2 hrs. 30 min. Marks : 50

[Answer question no.1 & any four (4) from the rest]

1. a. Define *symmetry element* and *symmetry operation*. Give two examples of each and explain how do they differ? 3+3+2+2 =10

   b. Give an account of the transport of Na^+ and K^+ ions actress the cell membrane.

   c. What are the three criteria atomic orbitals must have to overlap to form molecular orbitals.

   d. Explain spallation with an example.

2. a. Construct the *multiplication table* for the water molecule (C_2v point group). 7+3=10

   b. Find out the number of principal axis and subsidiary axis for $[PtCl_4]^{2-}$.

3. a. Discuss the function of Ca^{2+} as inter cellular messenger. 3+2+2+ 3=10

   b. "Cadmium, which is normally regarded as highly toxic, is now recognized as being essential nutrient of certain organisms."- Elucidate.

   c. Give an account on *Rubisco*, in terms of its role in Calvin Cycle.

   d. Why is a cobalt-based macrocyclic complex, rather than Iron-based complex like haem, is well suited for radical based rearrangement?

4. a. Draw MO diagram of O_2 and find out magnetic moment of O_2. 5+5=10

   b. Draw MO diagram of CO molecule and find out the bond order.

5. a. ^{210}Bi undergoes β decay to $1/8^{th}$ of its initial concentration in 15 days. Calculate the time required (in days) for its decay to $1/4^{th}$ of its initial concentration. 2+2+3+ 3=10

   b. What are the benefits of using ^{235}U instead of ^{238}U in fission reaction.

   c. Briefly explain Geigler-Muller counter used for calculating number of emitted radioactive particles.

d. Define a tracer. Write down the applications of tracer technique.

6. a. What is the character of a symmetry operation? How is it calculated from a matrix representation? Give an example using H_2O (C_{2v} point group). 5+3+2 =10

b. Discuss the action of *cis-platin* on cancer cells.

c. How bismuth can be used to treat gastric ulcers?

7. a. Arrange the following species in ascending order with regard to their (i) bond order, (ii) bond length, (iii) bond strength and (iv) magnetic moment value. 5+3+2 =10

N_2, N_2^+, O_2, O_2^- .

b. How would differentiate between isodiaphers and isobars? Explain.

c. Complete the following nuclear reactions:

(i) $^{235}U_{92} + {}^{1}n_0 \rightarrow {}^{96}Kr_{36}$ + -------- + 2n

(ii) $^{239}Np_{93} \rightarrow {}^{239}Pu_{94}$ + -----

(iii) $^{27}Al_{13} + \alpha \rightarrow {}^{30}P_{15}$ + ------

(iv) $^{30}P_{15} \rightarrow {}^{30}Si_{14}$ + --------

8. a. Find out the product of $[\sigma_{xy} \bullet S_4^z]$ (where S_4^z is the four fold improper axis of rotation around z-axis and "σ_{xy}" is the reflection of xy-plane. 2+2+3+ 3=10

b. Discuss the action of *carbonic anhydrase* in terms of zinc hydroxide mechanism.

c. Explain the non-existence of the Ne_2 molecule on the basis of Molecular Orbital Theory (MOT).

d. Define packing fraction. Calculate the packing fraction for ^{40}Ar with an isotopic mass of 39.96 g/mol.

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