FIRST SEMESTER (CUFYUGP) DEGREE EXAMINATION NOVEMBER 2024

CHEMISTRY

CHE1CJ101: INORGANIC CHEMISTRY-I

Question paper code : D112271

Section A

Each question carries 3 marks

1. **Write Born Lande equation and explain the terms used**

$$Lattice\ Energy, U = -\frac{N_A\, A\, Z^+ Z^- e^2}{4\pi\varepsilon_o r_o}\left(1 - \frac{1}{n}\right)$$

N_A ⟶ Avogadro Number

A ⟶ Madelung constant; depends on the geometry of the crystal. Included to account for the attractive interaction between the opposite ions in the crystal. Obtained from the crystal parameters

$Z^+ Z^-$ ⟶ Charges on the positive and negative ions

e ⟶ Charge of an electron

r_o ⟶ Interionic distance

ε_o ⟶ Permittivity of the free space

n ⟶ Born Exponent; Included to account for the repulsive interaction between interpenetrating electron clouds. Obtained from the compressibility mesurements

Correct equation 2 mark; Terms explained 1 mark

2. **Dipole moment of CCl_4 is zero. Why?**

   Structure of CCl_4-$CCl_4$is tetrahedral in shape- Dipole moment along each bond get can mutually cancelled

   (Drawing Structure 1 mark, shape 1 mark, mutual cancellation of dipole moment 1 mark)

3. **What are the factors affecting the formation of ionic compounds?**

   Inonisation energy- Electron affinity - lattice energy (1 mark each for each factor)

4. **Write some examples of nanomaterials in water purification with their mechanism of action**

   Use of Nanomaterials in water purification can be divided as (i) Nano Photocatalysis:- titanium dioxide (TiO_2) and zinc oxide (ZnO) (ii) Nano Adsorbents:- Graphene (iii) Nano Membranes:- Nanocellulose (iv)Nano metals or Metal oxides:- Titanium dioxide nanoparticles (At least 3 materials with mechanism of action: 3 mark)

5. **What are the different types of nanomaterials used in solar cells**

   Carbon nanotube, grapheme, quantum dots, Nanosilicon dioxide, nano titanium dioxide (At least 3 materials: 3 mark)

6. **How do surface area to volume ratio of nanomaterials influence their properties**

   (i) Reactivity: High surface area can speed up chemical reactions, making nanomaterials more reactive. (ii) **Catalytic properties**: Large surface area increases the amount of surface available for chemical reaction hence more catalytic activity **(iii) Melting point**: The surface atoms of nanomaterials are less stable than the interior atoms, which leads to a lower melting point for the surface layers. **(iv)Phase transition temperature and solubility**:These properties scale with the inverse size of the nanomaterial. (Explanation of at least three properties; 3 marks)

7. **What are the key steps in providing first aid for electric shock**

   Disconnect the power**,** Check the person's condition**,** Provide CPR **if required,** Treat burns **if any,** Take the person to the hospital in case of emergency (Three key steps; 3 marks)

8. **How would you use a fire extinguisher to put out fire in the laboratory**

   (i)Prepare: prepare the extinguisher according to the fire type(ii) Aim: Aim the nozzle at the base of the fire. **(iii)Squeeze**: Squeeze the lever to discharge the extinguishing agent. (iv) **Sweep**: Slowly sweep the nozzle from side to side while continuing to extinguish the fire. (v)**Exit**: Once the fire is extinguished, quickly exit the building. If it's safe, close the lab door. (vi)**Report**: Immediately report the incident to the lab PI and the Building Manager (3 marks for at least first three steps)

9. **What are the health effects of inhaling poisonous gases?**

   Toxic airborne substances can injure the respiratory tract (have local effects) and can also cause body-wide (systemic) injury. Most irritant gases are soluble in water and cause the abrupt onset of irritative symptoms at the mucosal surfaces they contact. **(for 2 health effects, 3 marks)**

10. **Distinguish between molarity and molality**

    Molarity: The number of moles of a substance per liter of solution. Molarity is temperature-dependent. The unit for molarity is mol/L or mol/dm3. **(1 ½ mark)**

    Molality:The number of moles of a substance per kilogram of solvent. Molality is independent of temperature. The unit for molality is mol/kg. **(1 ½ mark)**

    The key difference between molarity and molality is that molarity is based on the total volume of the solution, while molality is based on the mass of the solvent only.

Section B

11. Explain 3 fundamental points of Fajans rule with examples

Fajans rule – factors which effect polarisability of ions and give covalent character to ionic compounds

1. smaller the cation greater is the polarising power- increase in covalent character- example

2. Larger the anion greater is the polarisability –increase the covalent character – example

3Greater the charge on cation or anion greater is the polarisation - increase the covalent character – example

4. Cations with pseudo inert gas configuration -high polarising power. Cation with inert gas configuration -low polarising power example

Any 3 points with example 6marks

11. Oxygen molecule is paramagnetic but not Nitrogen molecule. Explain with MO diagram

O2 molecule: M.O Configration or MO energy level diagram 2marks

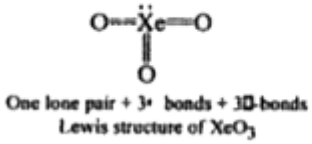
Two unpaired electrons, paramagnetic 1marks

N2 molecule: M.O Configration or MO energy level diagram 2marks

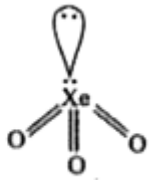
No unpaired electrons diamagnetic 1mark.

13 . **How many lonepairs and bond pairs are present in XeO3 ? Justify your answer with hybridisation**

XeO3: SP^3 hybridisation (1mark); Explanation with geometry (3marks); 3 bond pair and one lone pair (2marks)



One lone pair + 3σ bonds + 3Π-bonds
Lewis structure of XeO_3



Molecular shape of XeO_3 (Pyramidal)

Ground and excited electronic configuration of Xe.

Three electrons from 5p orbital of Xe is excited to vacant 5d orbitals and undergo SP3 hybridisation. One hybrid orbital contains lone pair, The other three hybrid orbitals overlap with oxygen to form σ bond . The 5d electrons form dπ-pπ bond with the same oxygen atoms .The geometry is pyramidal.

14. How can we minimize measurement errors?

Measurement errors can be minimised by

1.Periodic calibration of instruments

2. Analysis of standard samples

3. Independent analysis

4 Blank determination (1.5 marks for each point with explanation)

15. Explain different types of errors

Determinate and indeterminate errors

Determinate errors have a definite source which can be identified 3 types

Instumental errors, personal errors and method errors explain (3marks)

Indeterminate errors

Errors which arise due to uncertainity associated with every physical and chemical measurement

Classified into instrumental, personnal and conditional errors - explain (3marks)

16. What are the methods for representing precision

Precision expressed in terms of

1. Average deviation from mean

Average Deviation = $1/n \Sigma|xi - \bar{x}|$

where

- xi= Data values in the given set.
- $\bar{x}$ is the mean.
- n is the total number of data values.

2. Standard deviation S

The standard deviation is a measure of how spread out the data is from the mean. It's expressed in the same units as the data.

$$S = \sqrt{\sum_{i=1}^{i=n} \left(\frac{(x_i - \bar{x})^2}{N-1} \right)}$$

3.Relative standard deviation RSD

Standard deviation divided by mean of set of values $\frac{S}{\bar{x}}$

4. Variance

Measure of how far is each value from mean. It is the square of standard deviation.

1.5marks for each point

17. How are nanomaterials used in the removal of dyes from wastewater

(beyond the scope of syllabus; Syllabus demand basic idea only)

(i) Adsorption: Nanomaterials with a large surface area and high adsorption properties can remove pollutants from wastewater, even at low concentrations Examples include: **Silver nanoparticles**: These nanoparticles have superior physical, chemical, and biological properties, and can be embedded in nanocomposites with graphene oxide sheets, carbon nanotubes, cellulose etc. **Graphene oxide-based nanomaterials**: These nanomaterials have a large surface area, high adsorption capacity, and are recyclable. **Magnetic metal oxide nanocomposites**: These nanocomposites are robust and have a large surface area, making them effective adsorbents. They can also be separated from pollutants using an external magnetic field.

(ii) Photocatalysis: Some nanomaterials, like MoS_2 quantum dots, bismuth-based oxides, and graphite carbon nitride (g-C3N4), can be used as photocatalysts to remove dyes.

(For giving 3-4 materials , 6 marks may be given)

18. What are novel properties of nanomaterials that are not seen in the bulk materials

Surface area: Nanomaterials have a much larger surface area than bulk materials.

Quantum confinement effects: Quantum effects are more pronounced at the nanoscale, affecting a material's optical, electrical, and magnetic properties.

Thermal and electrical conductivity: Nanomaterials can exhibit extraordinary thermal and electrical conductivity.

Mechanical properties: Nanomaterials have excellent mechanical properties.

Catalytic support: Nanomaterials can support catalysts well, as 2D sheets of nanomaterials can disperse nanoparticles of active catalyst.

Antimicrobial activity: Some nanomaterials have antiviral, antibacterial, and antifungal properties.

Color: The color of nanomaterials can change depending on their size. For example, nano-sized gold appears red, while bulk gold appears yellow.

(for 4 properties 6 marks; 1 ½ mark each for each property with explanation)

Section C

19.You are working with a new chemical in the lab. How do you use MSDS to ensure Safe handling?

MSDS-Material safety data sheet gives all information regarding thre new chemical.

The information available are

1. Physical and chemical properties-like reactivity, flammable, explosive, corrosive, environment hazards etc
2. Health hazards on exposure and overexposure
3. Protective measures to be used whileusing thechemical
4. Safety procedure- storage, handling and disposal on spill
5. First aids to be given on exposure

5X2 =10marks

20. Discuss the hybridisation and shape of ClF3,BrF5 and SF4

Hybridisation 1mark

ClF_3: Sp3d hybridisation explanation 2marks

Shape -T shaped (draw the structure) 1 mark

BrF_5:Sp3d2 hybridisation explanation 2marks

Shape- square pyramidal(draw the structure) 1 mark

SF_4: Sp3d hybridisation explanation 2marks

Shape - See Saw (draw the structure) 1 mark