CHEMISTRY (CODE - 043)

CHAPTER TEST - QUESTION PAPER

Class XI (2026-27) | Chapter 4: Chemical Bonding and Molecular Structure

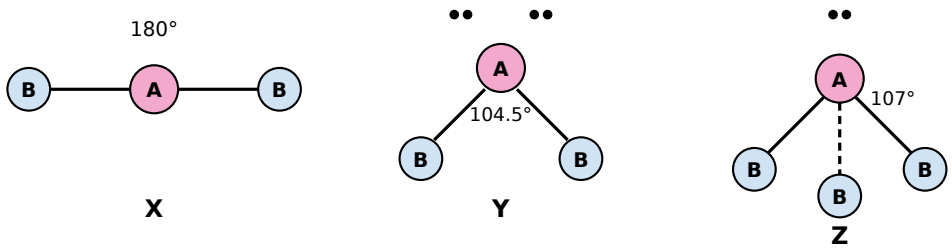
Time: 1 hour 30 minutes | Max. Marks: 35

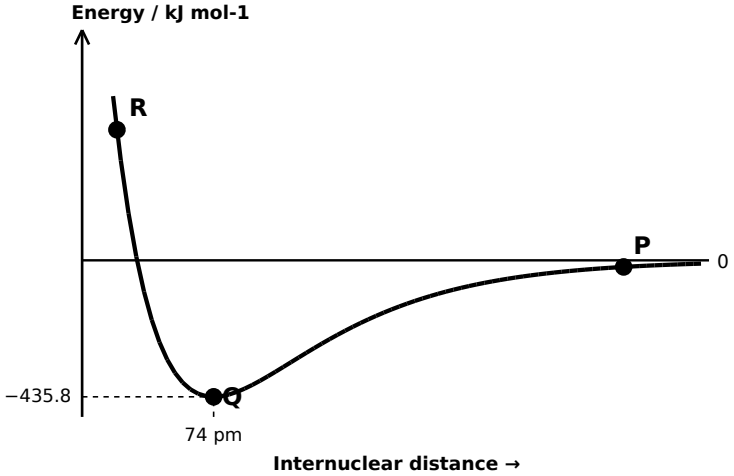
GENERAL INSTRUCTIONS:

1. Read the following instructions carefully.
2. There are 20 questions in this question paper with internal choice.
3. SECTION A consists of 12 questions carrying 1 mark each (Q. 1 to 9 are multiple-choice questions and Q. 10 to 12 are Assertion–Reason questions).
4. SECTION B consists of 4 very short answer questions carrying 2 marks each.
5. SECTION C consists of 2 short answer questions carrying 3 marks each.
6. SECTION D consists of 1 case-based question carrying 4 marks.
7. SECTION E consists of 1 long answer question carrying 5 marks.
8. All questions are compulsory. Internal choice is provided in Q. 16 (Section B) and Q. 20 (Section E).
9. Use of log tables and calculators is not allowed.

SECTION A

Questions 1 to 9 are multiple-choice questions. Only one of the choices is correct. Questions 10 to 12 are Assertion–Reason questions.

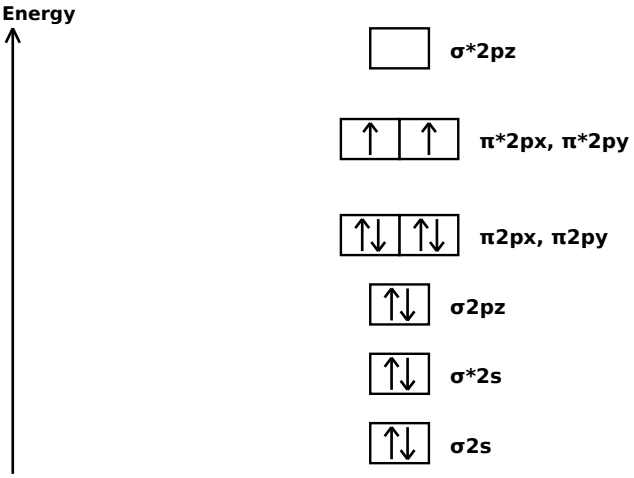
1	The total number of valence electrons that must be shown in the Lewis structure of the carbonate ion, CO_3^{2-}, is: A. 22 B. 24 C. 26 D. 18	1
2	The figure shows the shapes of three molecules X, Y and Z. A and B are not actual symbols. Lone pairs on A are shown as pairs of dots.  The molecules X, Y and Z could respectively be: A. $BeCl_2$, H_2O, NH_3 B. BF_3, H_2O, NH_3 C. $BeCl_2$, SO_2, CH_4 D. H_2O, $BeCl_2$, NH_3	1
3	The hybridisation of the phosphorus atom in PCl_5 is: A. sp^3 B. sp^3d C. sp^3d^2 D. dsp^2	1
4	Which one of the following molecules has a zero dipole moment? A. H_2O B. NH_3 C. BF_3 D. $CHCl_3$	1
5	The bond order of the superoxide ion, O_2^-, is: A. 1 B. 1.5 C. 2 D. 2.5	1

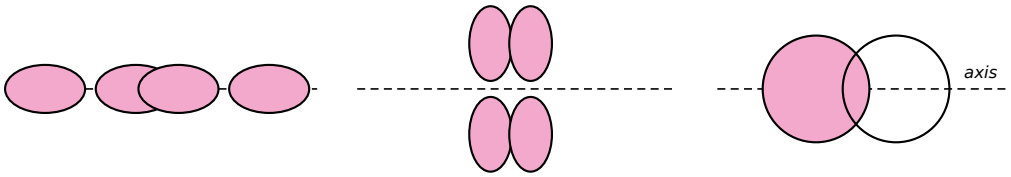
6	The number of bond pairs and lone pairs on the central atom of four species P, Q, R and S is given below. **Species** / **Bond pairs** / **Lone pairs** P / 4 / 0 Q / 3 / 1 R / 2 / 2 S / 4 / 1 Which option gives the correct shapes of P, Q, R and S? A. P – tetrahedral; Q – trigonal pyramidal; R – bent; S – see-saw B. P – square planar; Q – trigonal planar; R – linear; S – see-saw C. P – tetrahedral; Q – trigonal planar; R – bent; S – square planar D. P – trigonal bipyramidal; Q – pyramidal; R – linear; S – tetrahedral	1
7	The figure shows how the potential energy of two hydrogen atoms changes as the internuclear distance changes.  Which statement is correct? A. Q corresponds to the equilibrium bond length (74 pm) and the depth of the well is the bond enthalpy of H_2 B. P corresponds to the equilibrium bond length and the depth of the well is the lattice enthalpy C. R corresponds to the equilibrium bond length because the repulsion is greatest there D. Q corresponds to the atoms being infinitely far apart	1
8	Which of the following molecules is paramagnetic? A. N_2 B. O_2 C. F_2 D. H_2	1
9	The number of sigma (σ) and pi (π) bonds in ethyne, C_2H_2, is: A. 3 σ and 2 π B. 2 σ and 3 π C. 5 σ and 0 π D. 4 σ and 1 π	1

10	Questions 10 to 12 are Assertion (A) and Reason (R) type questions. Select the correct option. **Assertion (A):** BeF_2 has a zero dipole moment although the Be–F bonds are polar. **Reason (R):** The two equal bond dipoles point in opposite directions and cancel each other. A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1
11	**Assertion (A):** The H–N–H bond angle in NH_3 is 107°, less than the tetrahedral angle. **Reason (R):** The NH_3 molecule has a trigonal pyramidal shape. A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1
12	**Assertion (A):** The He_2 molecule is stable and exists. **Reason (R):** The bond order of He_2 is zero. A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1

SECTION B

Questions 13 to 16 are very short answer questions carrying 2 marks each.

13	The figure shows the filled valence molecular orbitals of a homonuclear diatomic molecule X_2 (12 valence electrons).  (i) Write the valence molecular orbital configuration and calculate the bond order of X_2. [1] (ii) Is X_2 paramagnetic or diamagnetic? Give a reason. [1]	2
14	The normal O–O single bond length is 148 pm and the O=O double bond length is 121 pm. Experimentally, both O–O bonds in ozone (O_3) are 128 pm long. (i) Define resonance. [1] (ii) Explain the observed bond length of ozone using the concept of resonance. [1]	2

15	The dipole moments of the hydrogen halides are given below. **Molecule** | **HF** | **HCl** | **HBr** | **HI** | **H_2** Dipole moment (D) | 1.78 | 1.07 | 0.79 | 0.38 | 0 (i) State the trend in the dipole moment from HF to HI and give a reason. [1] (ii) Why is the dipole moment of H_2 zero? [1]	2
16	The figure shows three types of overlap, P, Q and R, between atomic orbitals along the internuclear axis.  **P** **Q** **R** (i) Identify the type of overlap and the type of bond (σ or π) formed in P, Q and R. [1] (ii) Which of P and Q gives the stronger bond? Give a reason. [1] **OR** State the hybridisation of each carbon atom in propene, CH_3–CH=CH_2, and state the number of σ and π bonds in the molecule.	2

SECTION C

Questions 17 and 18 are short answer questions carrying 3 marks each.

17	In one Lewis structure of ozone (O_3) the central oxygen (O1) is joined to one end oxygen (O2) by a double bond and to the other end oxygen (O3) by a single bond. The electrons around each atom in the structure are given below. **Atom** | **Electrons in lone pairs** | **Electrons in bonds (shared)** O1 (central) | 2 | 6 O2 (end, double bond) | 4 | 4 O3 (end, single bond) | 6 | 2 (i) Write the expression for formal charge. [1] (ii) Calculate the formal charge on O1, O2 and O3 (an oxygen atom has 6 valence electrons). [1] (iii) Write the Lewis structure of ozone with the formal charges shown, and state what the formal charge is used for. [1]	3
18	Use the VSEPR theory to answer the following. (i) Predict the shapes and bond angles of $BeCl_2$ and BF_3. [1] (ii) Explain why NH_3 is trigonal pyramidal with a bond angle of 107° and not tetrahedral (109.5°). [1] (iii) Why is the bond angle in H_2O (104.5°) smaller than that in NH_3? [1]	3

SECTION D

Question 19 is a case-based question carrying 4 marks.

19	**Bond parameters** Bond length, bond order and bond enthalpy are important parameters of a covalent bond. Data for four molecules are given in the table.	4

Molecule	Bond order	Bond length (pm)	Bond enthalpy (kJ mol^{-1})
H_2	1	74	435.8
O_2	2	121	498
N_2	3	109	946
HCl	1	127	431

(i) Define bond enthalpy. Which molecule in the table has the strongest bond? [1]
(ii) How do bond length and bond enthalpy change with bond order? Support your answer with the data of O_2 and N_2. [1]
(iii) The bond enthalpies of the first and second O–H bonds in water are 502 and 427 kJ mol^{-1}. Calculate the average O–H bond enthalpy. [1]
(iv) Why are the two bond enthalpies in (iii) different? [1]

SECTION E

Question 20 is a long answer question carrying 5 marks.

20	(i) Write the molecular orbital configuration of the O_2 molecule (in KK notation). [1] (ii) Calculate the bond order of O_2, O_2^+ and O_2^-. [2] (iii) Arrange the three species in the decreasing order of stability and of bond length. [1] (iv) Is O_2^+ paramagnetic or diamagnetic? Give a reason. [1] **OR** (i) Describe the hybridisation in PCl_5: write the ground state and excited state outer electronic configurations of phosphorus (Z = 15) and the type of hybrid orbitals formed. [2] (ii) State the shape of PCl_5 and the bond angles. [1] (iii) Why are the axial bonds in PCl_5 longer than the equatorial bonds? [1] (iv) State the hybridisation of sulphur and the shape of SF_6. [1]	5

***** END OF QUESTION PAPER *****