Chapter Three : Periodic Properties and Chemical Bonding of Elements

Creative Essay Type

1. ▶ X, Y, Z are three consecutive non-metallic elements of second period, containing 3, 2, 1 unpaired electrons in their valence shell. *[Birshrestha Noor Mohammad Public College, Dhaka]*

a. What is isotope? 1

b. Explain H-bond. 2

c. Explain Pauli's exclusion principle by using unpaired electrons of element X. 3

d. Analyze the order of ionization energy of the mentioned elements. 4

Ans: See HSC EV Chemistry 1st Paper 3rd Chapter Note Ques. No. 38 of Answer Paper.

2. ▶ Answer the questions based on the following equations–

$AgNO_3 + NaCl \rightarrow A\downarrow + NaNO_3$

$A + BC_4DC(Excessive) \rightarrow E(Soluble)$

The atomic number of C is 1 and B and D are the first members of pnictogen and chalcogen respectively.

a. What is transition metal? 1

b. Explain the mechanism of conduction of electricity by ionic compound in aqueous solution. 2

c. The ionization potential of B and D is not same-explain. 3

d. E compound is white in solid state-explain with structure elaborately. 4

Ans: See HSC EV Chemistry 1st Paper 3rd Chapter Note Ques. No. 40 of Answer Paper.

3. ▶ Observe the following compounds

(i) C_2H_4 (ii) H_2O (iii) C_2H_2

[Willes Little Flower School & College, Dhaka]

a. What is the diagonal relationship of element? 1

b. Between Beryllium and Boron which one has more ionization potential and why? 2

c. Explain the hybridization process of the compound (ii) with diagram. 3

d. Is there any difference in hybridization process to formation of compound (i) and (iii). Analyze with logic. 4

Ans: See HSC EV Chemistry 1st Paper 3rd Chapter Note Ques. No. 43 of Answer Paper.

4. ▶ Look the table below.

Group → / Period ↓	1	15	17
1	X		
2		Y	
3			Z

[Rajshahi Cadet College, Rajshahi]

a. What is Hybridization? 1

b. How do preservatives save food? 2

c. Explain that 'Z' shows disproportion reaction. 3

d. Using YX_3 and YX_4^+ how could you prove that, the bond angle doesn't depend on hybridization? Analyze. 4

Ans: See HSC EV Chemistry 1st Paper 3rd Chapter Note Ques. No. 61 of Answer Paper.

5. ▶

Elements	Sc(21)	Ti(22)	V(23)	Cr(24)	Mn(25)	Fe(26)	Co(27)	Ni(28)	Cu(29)	Zn(30)
m.p(°C)	1541	1668	1910	1875	1245	1536	1495	1453	1083	420

[Rangpur Cadet College, Rangpur]

a. What are Chalcogens? 1

b. Why Nitrogen forms NCl_3 only, but Phosphorus forms PCl_3 and PCl_5 both? 2

c. Explain the reason of changing trends in m.p of elements present in the table. 3

d. Whether the elements in the table forms coloured compound or not? Describe. 4

Ans: See HSC EV Chemistry 1st Paper 3rd Chapter Note Ques. No. 67 of Answer Paper.

▸ Question No. a (Knowledge based)

Ques-1. What is polarity? *[D.B., Dj.B., S.B. J.B. 18]*

Ans: When to nonmetals are bonded covalently, the shared electrons are more attracted by the most elecronegive element thus creating partical positive and negative charge. It is called dipole and the property of creating dipole is called polarity.

Ques-2. What is periodic property? *[D.B.17]*

Ans: In periodic table, the repetition of elements with similar propeties in the order of increasing atomic number as in periodic table is called periodicity of properties.

Ques-3. What is Ligand? *[D.B.16]*

Ans: In the formation of complex compound, ligand is an ion or molecule that binds to central metal atom to form a co-ordination complex by donating one or more ligand's electron pairs.

Ques-4. What is electron affinity? *[C.B. 16]*

Ans: In gaseous state, the amount of energy emitted/released when one mole of electron is added to one mole neutral atom to form a negative ion, is called electron affinity.

Ques-5. What are lanthanides? *[Ctg.B. 17]*

Ans: From lanthanum (57) to Lutetium (71) of 6^{th} period, these 15 elements are called lanthanides.

Ques-6. Give the definition of modern periodic table. *[Ctg.B.17]*

Ans: The physical and chemical properties of elements in a periodic table changes according to the increase in atomic number. This is the modern periodic law.

Ques-7. What is electronegativity? *[Ctg.B.16]*

Ans: The ability of attracting the shared electron pair of covalent bond to the atom is called electronegativity of that atom.

Ques-8. What is ionization potential? *[R.B., C.B., Ctg.B., B.B. 2018]*

Ans: The energy required to take out one mole electrons from one mole gaseous isolated atoms of an element to transform it one mole unipositive ions, is known as ionization potential of the element.

▸ **Question No. b (Comprehension based)**

Ques-1. Why Fe is called transition metal?

[D.B., Dj.B., S.B. J.B. 18]

Ans: Those d-block elements which create at least one stable ion, where the d orbital is half filled ($d^1 - d^9$) are called transition element.

Fe(26) : $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$

∴ Fe is a d block element and it has two stable ion in which the d orbital is half filled–

$Fe^{2+}(26) = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ $\boxed{3d^6}$

$Fe^{3+}(26) = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ $\boxed{3d^5}$

∴ Fe is a transition element.

Ques-2. Between 'N' and 'O' which has smaller size? Explain. *[D.B.17]*

Ans: Nitrogen and Oxygen both are element of 2nd period of group 15 and group 16 respectively. According to periodic nature of periodic table; the radius of elements get reduced if we go from left to right order in same period, the number of orbital remains same but attraction between electrons and nucleus increases because of entering new electron. Nitrogen has five electrons in its second orbital and oxygen has six electron in its second orbital. So that the atomic radius of oxygen is less than nitrogen.

Ques-3. H_2O is a liquid but H_2S is gas — explain. *[D.B.17]*

Ans: Oxygen and sulphur are of same group and the hydrides of oxygen and sulphur are H_2O and H_2S and both have some similar properties. In room temperature H_2O is gas. The reason behind this is water is a polar molecule whereas; H_2S is a non polar compound. In polar compound due to hydrogen bonding the intermolecular distance reduces. It results in liquid nature of compound. But, H_2S is nonpolar and it has only Vanderwalls force so, it becomes gas in nature.

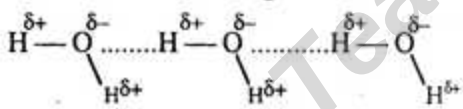


Figure: Hydrogen bond among the molecules of H_2O

Ques-4. In the process of crystallization of NaCl why HCl is added? *[D.B.16]*

Ans: In the process of crystallization- some drops of concentrated HCl be added in the coal solution. As a result the concentration of Cl^- increased. The ionic product increases and solubility decreases. As ionization product solubility product; the NaCl gets crystallized.

Ques-5. Between $CaCl_2$ and $AlCl_3$ salts, which one is more water-soluble? Why? *[Dj.B. 17]*

Ans: Between $CaCl_2$ and $AlCl_3$, the shape of Al^{3+} is less than the Ca^{2+}. Al^{3+} has more electron density. According to Fazan's law. The covalent properties of $AlCl_3$ is greater/more than the $CaCl_2$ and polarization occurs more incase by Al^{3+} to Cl^- ion. On the other hand in water , Ca^{2+} and $2Cl^-$ are attracted by opposite charge and surrounded by opposite charge- which results in higher solubility of $CaCl_2$ than that of $AlCl_3$.

Ques-6. Explain the variation of ionisation energy down a group of the periodic table. *[Ctg.B.17]*

Ans: The amount of energy required to release 1 mole of electrons from one mole of gaseous atoms to produce 1 mole of positively charged ions is called ionization potential.

In group from top to bottom, the number of shells increases. As a result, the attraction force of the electron in last shell towards the nucleus decreases, due to increase in size of atom, So, the amount of energy for the ionization also reduces. So, while going from to bottom in a group, the ionization potential deceases.

Ques-7. Sigma bond is mainly covalent bond– Explain. *[R.B. 16]*

Ans: When two orbital's of two atoms remaining in the same axis, overlap occured each other head to head or to the end face to form a molecule is called sigma bond.

Covalent bond is defined as a force holding atoms together through sharing of electrons having opposite spins and each atom can attain nearest inert gas configuration. Since in both the cases electrons share equally of atoms which formed molecules, so, sigma bond is mainly covalent bond.

Creative Multiple Choice

1. What are the numbers of d–block elements in the periodic table?

ⓐ 24 ⓑ 36
ⓒ 41 ⓓ 44 **c**

2. The electronegativities of C, H, O, H and S are 2.5, 2.1, 3.5, 3.0 and 2.5 respectively. Which of the bonds is polar?

ⓐ C – H ⓑ N – H
ⓒ S – H ⓓ O – H **d**

3. What type of hybridisation occurs in Xe of XeF_2? *[Dj.B.-17]*

ⓐ Sp ⓑ sp^2d
ⓒ Sp^3d^2 ⓓ Sp^3d **d**

4. Between two covalent bonds, which angle is bigger?

ⓐ H_2O ⓑ SO_2
ⓒ NH_3 ⓓ CH_4. **b**

5. Which of the following compounds has the highest bond angle?

ⓐ PCl_3 ⓑ H_2S
ⓒ PH_3 ⓓ H_2O **a**

6. Which of the following ion forms colored compound? *[All Board-18]*

ⓐ Cu^{4+} ⓑ Sc^{3+}
ⓒ Ni^{2+} ⓓ Zn^{2+} **c**

7. **Which of the following elements has the highest oxidation state?** *[S.B.-17]*
ⓐ Vanadium ⓑ Cobalt
ⓒ Chromium ⓓ Iron **a**

8. **Which one is liquid at room temperature?** *[Dj.B.-16]*
ⓐ P_4 ⓑ Na
ⓒ Br_2 ⓓ I_2 **c**

9. **What type of metal is Ca and Mg?**
ⓐ alkali ⓑ alkaline earth
ⓒ transition ⓓ coinage **b**

10. **Which element has the electronic configuration of ns^2?**
ⓐ coinage metals ⓑ alkaline earth
ⓒ alkali metals ⓓ inert gases **b**

11. **Which is the shape of p–orbital** *[Ctg.B.-16]*
ⓐ circular ⓑ sphere
ⓒ dumb-bell shape ⓓ double dumb-bell **c**

12. **Cl(17) belongs to which block?**
ⓐ s ⓑ p
ⓒ d ⓓ f **b**

13. **Number of unpaired electrons in Ni^{2+} ion —**
ⓐ 8 ⓑ 6
ⓒ 4 ⓓ 2 **d**

14. **If $M-2e^- \rightarrow M^{2+}$, which is the M metal?**
ⓐ alkali metal ⓑ alkaline earth
ⓒ transition metal ⓓ non-metal **b**

15. **Ore producing elements are called —**
ⓐ Coinage metal ⓑ Noble metals
ⓒ Chalcogen ⓓ Metalloid **c**

16. **Which is the released energy when electrons are accepted to become negative ions?**
ⓐ ionisation energy ⓑ electron affinity
ⓒ electronegativity ⓓ electropositivity **b**

17. **Correct order of electron affinity for halogens —**
ⓐ Cl > F > Br > I ⓑ F > Cl > Br > I
ⓒ Cl > Br > F > I ⓓ I > Br > Cl > F **a**

18. **What is the value of electron affinity for Na?**
ⓐ $-52.9\ kJ\ mol^{-1}$ ⓑ $-77\ kJ\ mol^{-1}$
ⓒ $-78\ kJmol^{-1}$ ⓓ $-79\ kJ\ Mol^{-1}$ **a**

19. **Which has the zero electron affinity?**
ⓐ Al ⓑ P
ⓒ Ar ⓓ S **c**

20. **How does electron affinity change down the group?**
ⓐ decreases ⓑ increases
ⓒ remains same ⓓ does not change **a**

21. **Which one forms acidic oxide and acidic hydride?** *[J.B.-17]*
ⓐ Sodium ⓑ Magnesium
ⓒ Nitrogen ⓓ Sulphur **d**

22. **Which has the least electronegativity?**
ⓐ He ⓑ C
ⓒ O ⓓ F **a**

23. **Which compound does not have π bond?**
ⓐ C_3H_6 ⓑ CO_2
ⓒ C_2H_4 ⓓ SiO_2 **d**

24. **Which is the covalent bond in a compond?**
ⓐ sigma bond ⓑ π–bond
ⓒ gama bond ⓓ α-bond **a**

25. **Which one is a covalent compound?**
ⓐ CsCl ⓑ FrCl
ⓒ $BeCl_2$ ⓓ HBr **d**

26. **The energy released during the dissolution of ionic compounds in water is called —**
ⓐ Solution energy ⓑ Hydration enthalpy
ⓒ Ionisation energy ⓓ Electron affinity **b**

27. **Covalent bond is absent in which of the compounds?**
ⓐ HCl ⓑ CCl_4
ⓒ H_2O ⓓ CsF **d**

28. **Which compound is ionic hydride?**
ⓐ PH_3 ⓑ H_2S
ⓒ HI ⓓ KH **d**

29. **Which of the following pairs will form ionic compound through mutual bonding?**
ⓐ Calcium and chlorine
ⓑ Silicon and nitrogen
ⓒ Two oxygen atoms
ⓓ Nitrogen and hydrogen **a**

30. **The strength of covalent bond depends on —**
ⓐ overlapping of s and p orbitals
ⓑ overlapping of p–p orbitals
ⓒ shape of new orbital formed due to over lapping
ⓓ extent of overlapping field **d**

31. **How many bonds are there in $[Cu(NH_3)_4]Cl_2$?** *[All Board-18]*
ⓐ 6 ⓑ 8
ⓒ 14 ⓓ 18 **d**

32. **Why is CCl_4 soluble in water?**
ⓐ Water and CCl_4 are both polar.
ⓑ Water and CCl_4 are both non-polar.
ⓒ Water is polar, but CCl_4 is non-polar.
ⓓ Water is non-polar, but CCl_4 is polar. **c**

33. **What type of hybridisation is present in PCl_5?** *[All Board-18]*
ⓐ sp ⓑ sp^2
ⓒ sp^3 ⓓ sp^3d **d**

34. Which of the following compounds has the highest melting and boiling point? *[Dj.B.-17]*

ⓐ $CaCl_2$ ⓑ $FeCl_2$
ⓒ $CuCl_2$. ⓓ $ZnCl_2$ **a**

35. $M + \Delta H \rightarrow M^+ + e^-$; which is ΔH?

ⓐ electron affinity ⓑ ionisation potential
ⓒ electronegative ⓓ electropositive **b**

36. Which of the following has a linear shape? *[C.B.-17]*

ⓐ carbon dioxide
ⓑ xenon tetrafluoride
ⓒ phosphorous pentachloride
ⓓ borontrifluoride **a**

37. What is the value of electron affinity for F?

ⓐ –333 kJ/mol ⓑ –348 kJ/mol
ⓒ –350 kJ/mol ⓓ –390 kJ/mol **a**

38. Cl has higher electron affinity than F. The reason is—

ⓐ electron density of F in 2nd energy level
ⓑ electron density of Cl in 2nd energy level
ⓒ size of F ⓓ size of Cl **c**

39. Which has the highest bond angle? *[Dj.B.-16]*

ⓐ PCl_3 ⓑ H_2S
ⓒ PH_3 ⓓ H_2O **a**

40. Which of the following has a linear geometric structure? *[All Board-18]*

ⓐ BCl_3 ⓑ H_2O
ⓒ $CH_3 - CH_3$ ⓓ CO_2 **d**

41. At which temperature does the hydrogen bond in H_2S break?

ⓐ 4°C ⓑ 10°C
ⓒ 50°C ⓓ 100°C **a**

42. What should be the electronegativity difference between the elements in a compound to have polarity in the compound?

ⓐ 0.5–1.7 ⓑ 1–2.1
ⓒ 2.5–3 ⓓ 3.1–3.5 **a**

43. What type of interaction is present in H_2O and I_2?

ⓐ dipole– induced dipole
ⓑ induced dipole – induced dipole
ⓒ polymer– polymer bond
ⓓ polymer – monomer bond **a**

44. Which one is insoluble in water?

ⓐ $C_6H_{12}O_6$ ⓑ $C_{12}H_{22}O_{11}$
ⓒ SiO_2 ⓓ NaCl **c**

45. Which is the symbol of ferric perchlorate?

ⓐ $Fe(ClO_4)_3$ ⓑ $Fe(ClO_3)_2$
ⓒ $Fe(ClO_3)_3$ ⓓ $Fe(Cl_2O_4)_2$ **a**

46. π-bond is formed in C_2H_4 from which orbital's overlapping? *[D.B.-17]*

ⓐ sp^2–Sp^2 ⓑ sp^2–s
ⓒ $2p_z$–$2p_z$ ⓓ $2p_y$–$2p_y$ **c**

47. The compound will be — when Sc^{3+} ion forms a compond —

i. Coloured
ii. Colourless
iii. Complex

Which is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **c**

48. The $_{11}X$ metal–

i. reacts with water
ii. stable and non-volatile
iii. more reactive than Fr

Which is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **a**

49. Due to the presence of hydrogen bond *[R.B.-17]*

i. HF is liquid
ii. ethanol is soluble in water
iii. ethanoic acid dimer

Which is correct?

ⓐ i & ii ⓑ ii & iii
ⓒ i & iii ⓓ i, ii & iii **d**

50. 8^O is – than 7^N —

i. smaller in size
ii. of lower ionization energy
iii. of higher atomic radius

Which is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **a**

51. BF_3 — *[D.B.-16]*

i. takes part in sp^3 hybridisation
ii. takes up tetrahedral structure
iii. forms co-ordination bond with NH_3

Which is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **c**

52. The $[Co(NH)_6]^{3+}$ ion — *[B.B.-15]*

i. is octahedral
ii. formed through sp^3d^2 hybridisation
iii. in paramagnetic

Which is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **d**

53. $P_2O_5 + H_2O \rightarrow X$; in the reaction X is —

i. an acid ii. a polyprotic acid
iii. a strong base

Which is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **a**

54. Atomic orbitals will enter into π–bond, when —

i. two molecules will be connected through double bond and triple bond
ii. two unhybridised orbitals overlap sideways
iii. two hybridised orbitals overlap sideways

Which is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **a**

55. The outermost electronic configuration of an element corresponds to (n–1) $d^{10}ns^2$, where, n has the lowest value. *[R.B.-16]*

i. the element is transitional
ii. a diamagnetic
iii. its compounds are colored

Which is correct?

ⓐ i & ii ⓑ ii & iii
ⓒ i & iii ⓓ i, ii & iii **c**

56. The octet incomplete compouds are — *[All Board-18]*

i. NH_3 ii. BF_3
iii. $AlCl_3$

Which is correct?

ⓐ i & ii ⓑ ii & iii
ⓒ i & iii ⓓ i, ii & iii **b**

57. Polarisation depends on — *[J.B.-16]*

i. size of cation ii. size of anion
iii. charge of cation

Which is correct?

ⓐ i & ii ⓑ ii & iii
ⓒ i & iii ⓓ i, ii & iii **d**

58. CH_4 molecule —

i. a non-polar compound
ii. formed through weak induced dipole
iii. is a hydrocarbon

Which is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **b**

Read the following stem and answer questions 59 and 60: *(D.B.-15)*

Element	Electronic Configuration	Electronegativity
L	ns^2	
M	$(n+1)s^2$	
X	ns^2np^4	2.5
Y	ns^2np^5	3.2

59. The nature of the compound XY_2—

ⓐ pure covalent ⓑ polar covalent
ⓒ nonpolar covalent ⓓ ionic **b**

60. MY_2 has — than LY_2

i. higher melting pont
ii. more solublity in water
iii. higher covalent character

Which is correct?

ⓐ i & ii ⓑ ii & iii
ⓒ i & iii ⓓ i, ii & iii **a**

Read the following stem and answer the questions 61 and 62.

Two elements, A and B are both highly electronegative. Both elements react with each other to form AB compound.

61. What is the nature of bonding in A – B?

ⓐ covalent ⓑ ionic
ⓒ co-ordination ⓓ hydrogen bond **a**

62. AB compound —

i. is soluble in organic solvent
ii. is a conductor of electricity in solution
iii. is of low boiling point

Which is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **d**

Observe the stem and answer the questions 63 and 64.

group / period	15	16	17	18
Second	L	E	R	Ne
Third	M	a	Q	Ar

63. How many electrons are there in G atom of the compound GQ_4?

ⓐ 1 ⓑ 2
ⓒ 4 ⓓ 6 **a**

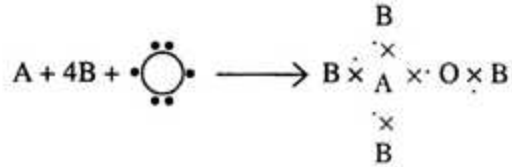
64. Observe the following information on the basis of stem:

i. Order of ionisation energy L > E
ii. Order of electron affinity Q > R
iii. MQ_3 forms dimer

Which is correct?

ⓐ i & ii ⓑ ii & iii
ⓒ i & iii ⓓ i, ii & iii **d**

Observe the following structure and answer the questions 65 & 66:

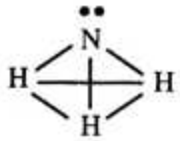


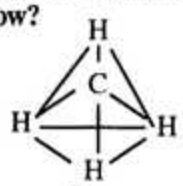
If A atom contains 4 more electrons, it would attain an inert gas configuration and one electron subracted from B, protein is made.

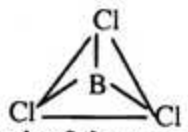
65. What is the symbol of the compound produced?

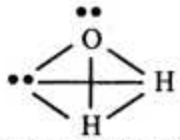
ⓐ CH_3OH ⓑ 
ⓒ $C_2H_5 - O - C_2H_5$ ⓓ CH_3COOH **a**

66. The atom 'A' will enter to sp^3 hybridisation in which of the molecule's shape shown below?

ⓐ 

ⓑ 

ⓒ 

ⓓ 

On the basis of the stem, answer the questions 67 and 68:

→Group / Period↓	VIA	VIIA
2nd	A	B
3rd	C	D

[Ctg.B.-15]

67. Which information is applicable to all elements of the stem?

ⓐ diatomic gas at room temperature
ⓑ highly electronegative element
ⓒ forms ionic compound with metal
ⓓ shows variable valency

c

68. According to stem —

i. electronegativity of B is higher than A
ii. electronaffinity of D is less than B
iii. CA_2 compound shows acidic properties.

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii

b

Read the following stem and answer questions 69 and 70.

'Y' is a non–metal and is found in sea-weeds. Deficiency of Y causes serious disease.

69. Y is a member of which block?

ⓐ s ⓑ p
ⓒ d ⓓ *f*

d

70. The member Y —

i. belongs to group VII A
ii. can form covalent and ionic compound.
iii. acts as oxidising agent.

Which of the following is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii

d

Observe the following figure and answer the questions 71 and 72.

L ⊕ ..... ⊖ Y
M ⊕ ..... ⊖ Y
N ⊕ ..... ⊖ Y

71. Which is the correct order of the polarising ability of cations?

ⓐ L > M > N ⓑ L < M < N
ⓒ K > N > M ⓓ K > M > N

a

72. NY compound is of high melting point, but LY becomes vapourised at low temperature. The reason is —

i. the charge density of L^+ is higher than Y^-
ii. L^+ is of smaller size and can easily polarise Y^-
iii. because of the distortion of Y^- extensively

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii

d