



IB Chemistry – SL

Topic 4 Questions

1. What is the formula for the compound formed by calcium and nitrogen?

- A. CaN
- B. Ca₂N
- C. Ca₂N₃
- D. Ca₃N₂

(Total 1 mark)

2. Element *X* is in group 2, and element *Y* in group 7, of the periodic table. Which ions will be present in the compound formed when *X* and *Y* react together?

- A. X^+ and Y^-
- B. X^{2+} and Y^-
- C. X^+ and Y^{2-}
- D. X^{2-} and Y^+

(Total 1 mark)

3. Based on electronegativity values, which bond is the most polar?

- A. B—C
- B. C—O
- C. N—O
- D. O—F

(Total 1 mark)

4. What is the Lewis (electron dot) structure for sulfur dioxide?

- A. $:\ddot{O}:S::\ddot{O}:$
- B. $:\ddot{O}:\ddot{S}:\ddot{O}:$
- C. $:\ddot{O}::S::\ddot{O}:$
- D. $:\ddot{O}::\ddot{S}:\ddot{O}:$

(Total 1 mark)



5. Which substance is most soluble in water (in mol dm⁻³) at 298 K?

- A. CH₃CH₃
- B. CH₃OCH₃
- C. CH₃CH₂OH
- D. CH₃CH₂CH₂CH₂OH

(Total 1 mark)

6. According to VSEPR theory, repulsion between electron pairs in a valence shell decreases in the order

- A. lone pair-lone pair > lone pair-bond pair > bond pair-bond pair.
- B. bond pair-bond pair > lone pair-bond pair > lone pair-lone pair.
- C. lone pair-lone pair > bond pair-bond pair > bond pair-lone pair.
- D. bond pair-bond pair > lone pair-lone pair > lone pair-bond pair.

(Total 1 mark)

7. Which molecule is linear?

- A. SO₂
- B. CO₂
- C. H₂S
- D. Cl₂O

(Total 1 mark)

8. Why is the boiling point of PH₃ lower than that of NH₃?

- A. PH₃ is non-polar whereas NH₃ is polar.
- B. PH₃ is not hydrogen bonded whereas NH₃ is hydrogen bonded.
- C. Van der Waals' forces are weaker in PH₃ than in NH₃.
- D. The molar mass of PH₃ is greater than that of NH₃.

(Total 1 mark)

9. Which molecule is non-polar?

- A. H₂CO
- B. SO₃
- C. NF₃



D. CHCl_3

(Total 1 mark)

10. What happens when sodium and oxygen combine together?

- A. Each sodium atom gains one electron.
- B. Each sodium atom loses one electron.
- C. Each oxygen atom gains one electron.
- D. Each oxygen atom loses one electron.

(Total 1 mark)

11. Which statement is correct about **two** elements whose atoms form a covalent bond with each other?

- A. The elements are metals.
- B. The elements are non-metals.
- C. The elements have very low electronegativity values.
- D. The elements have very different electronegativity values.

(Total 1 mark)

12. Which substance has the lowest electrical conductivity?

- A. Cu(s)
- B. Hg(l)
- C. $\text{H}_2(\text{g})$
- D. LiOH(aq)

(Total 1 mark)

13. When the following bond types are listed in decreasing order of strength (strongest first), what is the correct order?

- A. covalent > hydrogen > van der Waals'
- B. covalent > van der Waals' > hydrogen
- C. hydrogen > covalent > van der Waals'
- D. van der Waals' > hydrogen > covalent

(Total 1 mark)

14. Which statement is true for most ionic compounds?

- A. They contain elements of similar electronegativity.
- B. They conduct electricity in the solid state.



- C. They are coloured.
- D. They have high melting and boiling points.

(Total 1 mark)

15. What is the valence shell electron pair repulsion (VSEPR) theory used to predict?

- A. The energy levels in an atom
- B. The shapes of molecules and ions
- C. The electronegativities of elements
- D. The type of bonding in compounds

(Total 1 mark)

16. Which fluoride is the most ionic?

- A. NaF
- B. CsF
- C. MgF₂
- D. BaF₂

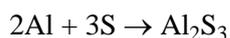
(Total 1 mark)

17. Which substance is most similar in shape to NH₃?

- A. GaI₃
- B. BF₃
- C. FeCl₃
- D. PBr₃

(Total 1 mark)

18. Which statement is a correct description of electron loss in this reaction?



- A. Each aluminium atom loses two electrons.
- B. Each aluminium atom loses three electrons.
- C. Each sulfur atom loses two electrons.
- D. Each sulfur atom loses three electrons.

(Total 1 mark)

19. Which molecule has the smallest bond angle?



- A. CO_2
- B. NH_3
- C. CH_4
- D. C_2H_4

(Total 1 mark)

20. In which substance is hydrogen bonding present?

- A. CH_4
- B. CH_2F_2
- C. CH_3CHO
- D. CH_3OH

(Total 1 mark)

21. Which is a correct description of metallic bonding?

- A. Positively charged metal ions are attracted to negatively charged ions.
- B. Negatively charged metal ions are attracted to positively charged metal ions.
- C. Positively charged metal ions are attracted to delocalized electrons.
- D. Negatively charged metal ions are attracted to delocalized electrons.

(Total 1 mark)

22. What intermolecular forces are present in gaseous hydrogen?

- A. Hydrogen bonds
- B. Covalent bonds
- C. Dipole-dipole attractions
- D. Van der Waals' forces

(Total 1 mark)

23. Which molecule is polar?

- A. CO_2
- B. PF_3
- C. CH_4
- D. BF_3

(Total 1 mark)



24. What are responsible for the high electrical conductivity of metals?

- A. Delocalized positive ions
- B. Delocalized valence electrons
- C. Delocalized atoms
- D. Delocalized negative ions

(Total 1 mark)

25. Which compound has the least covalent character?

- A. SiO_2
- B. Na_2O
- C. MgCl_2
- D. CsF

(Total 1 mark)

26. When C_2H_4 , C_2H_2 and C_2H_6 are arranged in order of **increasing** C–C bond length, what is the correct order?

- A. C_2H_6 , C_2H_2 , C_2H_4
- B. C_2H_4 , C_2H_2 , C_2H_6
- C. C_2H_2 , C_2H_4 , C_2H_6
- D. C_2H_4 , C_2H_6 , C_2H_2

(Total 1 mark)

27. Which compound contains **both** ionic and covalent bonds?

- A. MgCl_2
- B. HCl
- C. H_2CO
- D. NH_4Cl

(Total 1 mark)

28. When the species BF_2^+ , BF_3 and BF_4^- are arranged in order of **increasing** F–B–F bond angle, what is the correct order?

- A. BF_3 , BF_4^- , BF_2^+



- B. BF_4^- , BF_3 , BF_2^+
- C. BF_2^+ , BF_4^- , BF_3
- D. BF_2^+ , BF_3 , BF_4^-

(Total 1 mark)

29. Which species has a trigonal planar shape?

- A. CO_3^{2-}
- B. SO_3^{2-}
- C. NF_3
- D. PCl_3

30. When C_2H_4 , C_2H_2 and C_2H_6 are arranged in order of **increasing** C–C bond length, what is the correct order?

- A. C_2H_6 , C_2H_2 , C_2H_4
- B. C_2H_4 , C_2H_2 , C_2H_6
- C. C_2H_2 , C_2H_4 , C_2H_6
- D. C_2H_4 , C_2H_6 , C_2H_2

(Total 1 mark)

31. What is the formula for an ionic compound formed between an element, X, from group 2 and an element, Y, from group 6?

- A. XY
- B. X_2Y
- C. XY_2
- D. X_2Y_6

(Total 1 mark)

32. In the molecules N_2H_4 , N_2H_2 , and N_2 , the nitrogen atoms are linked by single, double and triple bonds, respectively. When these molecules are arranged in increasing order of the lengths of their nitrogen to nitrogen bonds (shortest bond first) which order is correct?

- A. N_2H_4 , N_2 , N_2H_2
- B. N_2H_4 , N_2H_2 , N_2
- C. N_2H_2 , N_2 , N_2H_4
- D. N_2 , N_2H_2 , N_2H_4



(Total 1 mark)

33. The compounds listed have very similar molar masses. Which has the strongest intermolecular forces?

- A. CH_3CHO
- B. $\text{CH}_3\text{CH}_2\text{OH}$
- C. $\text{CH}_3\text{CH}_2\text{F}$
- D. $\text{CH}_3\text{CH}_2\text{CH}_3$

(Total 1 mark)

34. What is the shape of the CO_3^{2-} ion and the approximate O–C–O bond angle?

- A. Linear, 180°
- B. Trigonal planar, 90°
- C. Trigonal planar, 120°
- D. Pyramidal, 109°

(Total 1 mark)

35. Which combination of $\Delta H_{\text{vaporization}}$ and boiling point is the result of strong intermolecular forces?

	$\Delta H_{\text{vaporization}}$	Boiling Point
A.	large	high
B.	large	low
C.	small	low
D.	small	high

(Total 1 mark)

36. What is the formula of the compound formed when aluminium reacts with oxygen?

- A. Al_3O_2
- B. Al_2O_3
- C. AlO_2



D. AlO_3

(Total 1 mark)

37. Which statement is true for compounds containing only covalent bonds?

- A. They are held together by electrostatic forces of attraction between oppositely charged ions.
- B. They are made up of metal elements only.
- C. They are made up of a metal from the far left of the periodic table and a non-metal from the far right of the periodic table.
- D. They are made up of non-metal elements only.

(Total 1 mark)

38. How many electrons are used in the carbon-carbon bond in C_2H_2 ?

- A. 4
- B. 6
- C. 10
- D. 12

(Total 1 mark)

39. Which compound has the highest boiling point?

- A. $\text{CH}_3\text{CH}_2\text{CH}_3$
- B. $\text{CH}_3\text{CH}_2\text{OH}$
- C. CH_3OCH_3
- D. CH_3CHO

(Total 1 mark)

40. What type of solid materials are typically hard, have high melting points and poor electrical conductivities?

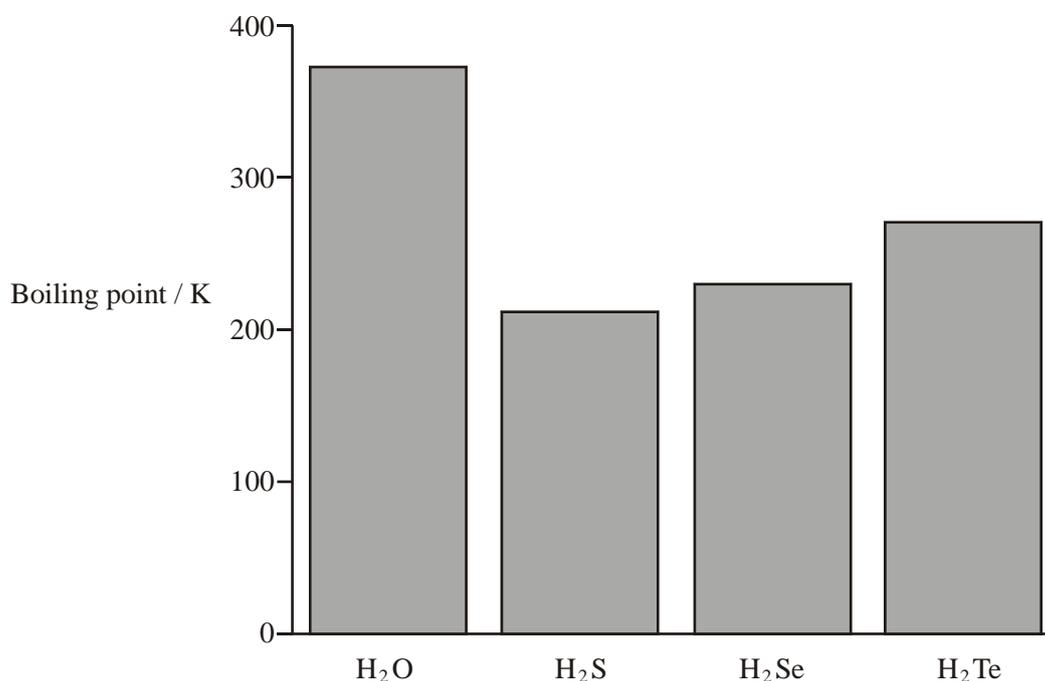
- I. Ionic
- II. Metallic
- III. Covalent-network

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

(Total 1 mark)



41. The boiling points of the hydrides of the group 6 elements are shown below.



(i) Explain the trend in boiling points from H₂S to H₂Te.

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(2)

(ii) Explain why the boiling point of water is higher than would be expected from the group trend.

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(2)

(Total 4 marks)

42. (i) State the shape of the electron distribution around the oxygen atom in the water molecule and state the shape of the molecule.

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(2)

(ii) State and explain the value of the HOH bond angle.



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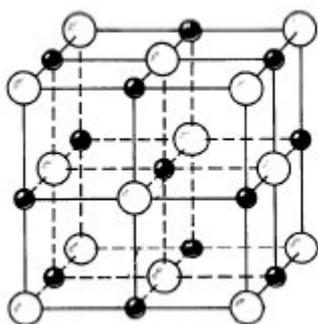
(2)
(Total 4 marks)

43. Explain why the bonds in silicon tetrachloride, SiCl_4 , are polar, but the molecule is not.

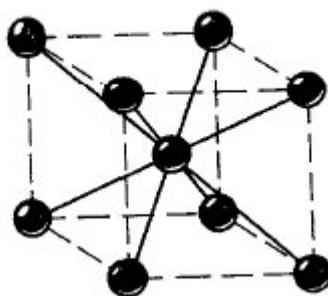
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(Total 2 marks)

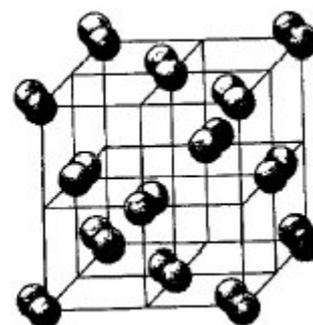
44. The diagrams below represent the structures of iodine, sodium and sodium iodide.



A



B



C

(a) (i) Identify which of the structures (A, B and C) correspond to iodine, sodium and sodium iodide.

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(1)

(ii) State the type of bonding in each structure.

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(3)



- (b) (i) Sodium and sodium iodide can both conduct electricity when molten, but only sodium can conduct electricity when solid. Explain this difference in conductivity in terms of the structures of sodium and sodium iodide.

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(4)

- (ii) Explain the high volatility of iodine compared to sodium and sodium iodide.

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(Total 10 marks)

45. (i) Draw Lewis (electron dot) structures for CO_2 and H_2S showing all valence electrons.

(2)

- (ii) State the shape of each molecule and explain your answer in terms of VSEPR theory.

CO_2

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H_2S

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(4)

- (iii) State and explain whether each molecule is polar or non-polar.

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(2)

(Total 8 marks)

46. Identify the strongest type of intermolecular force in each of the following compounds.

CH₃Cl

CH₄

CH₃OH

(Total 3 marks)

47. (a) An important compound of nitrogen is ammonia, NH₃. The chemistry of ammonia is influenced by its polarity and its ability to form hydrogen bonds. Polarity can be explained in terms of electronegativity.

(i) Explain the term *electronegativity*.

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(2)

(ii) Draw a diagram to show hydrogen bonding between two molecules of NH₃. The diagram should include any dipoles and/or lone pairs of electrons

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(3)

(iii) State the H–N–H bond angle in an ammonia molecule.

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(1)

(iv) Explain why the ammonia molecule is polar.

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(1)

(b) Ammonia reacts with hydrogen ions forming ammonium ions, NH₄⁺.

(i) State the H–N–H bond angle in an ammonium ion.



..... (1)

(ii) Explain why the H–N–H bond angle of NH_3 is different from the H–N–H bond angle of NH_4^+ ; referring to both species in your answer.

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(3)
(Total 11 marks)

48. State the type of bonding in the compound SiCl_4 . Draw the Lewis structure for this compound.

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(Total 3 marks)

49. Outline the principles of the valence shell electron pair repulsion (VSEPR) theory.

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(Total 3 marks)



50. (i) Use the VSEPR theory to predict and explain the shape and the bond angle of each of the molecules SCl_2 and C_2Cl_2

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(6)

- (ii) Deduce whether or not each molecule is polar, giving a reason for your answer.

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(3)

(Total 9 marks)

51. Draw a Lewis structure of a water molecule, name the shape of the molecule and state and explain why the bond angle is less than the bond angle in a tetrahedral molecule such as methane.

(Total 4 marks)

52. Predict and explain the order of the melting point for propanol, butane and propanone with reference to their intermolecular forces.

(Total 4 marks)

53. The elements sodium, aluminium, silicon, phosphorus and sulfur are in period 3 of the periodic table.

Describe the metallic bonding present in aluminium and explain why aluminium has a higher melting point than sodium.



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(Total 3 marks)

54. Draw the Lewis structure of NCl_3 . Predict, giving a reason, the $\text{Cl} - \text{N} - \text{Cl}$ bond angle in NCl_3 .

(Total 3 marks)

55. Arrange the following in **decreasing** order of bond angle (largest one first), and explain your reasoning.



(Total 5 marks)

56. (i) Outline the principles of the valence shell electron pair repulsion (VSEPR) theory.

(3)

(ii) Use the VSEPR theory to deduce the shape of H_3O^+ and C_2H_4 . For each species, draw the Lewis structure, name the shape, and state the value of the bond angle(s).

(6)

(iii) Predict and explain whether each species is polar.

(2)

(iv) Using Table 7 of the Data Booklet, predict and explain which of the bonds O-H, O-N or N-H would be most polar.

(2)

(Total 13 marks)

57. Predict and explain which of the following compounds consist of molecules:

NaCl , BF_3 , CaCl_2 , N_2O , P_4O_6 , FeS and CBr_4 .

(Total 2 marks)

58. Diamond, graphite and C_{60} fullerene are three allotropes of carbon.

(i) Describe the structure of each allotrope.

(3)

(ii) Compare the bonding in diamond and graphite.

(2)

(Total 5 marks)

59. State **two** physical properties associated with metals and explain them at the atomic level.

(Total 4 marks)



60. (a) Draw the Lewis structure of methanoic acid, HCOOH. (1)

(b) In methanoic acid, predict the bond angle around the (2)

(i) carbon atom.

(ii) oxygen atom bonded to the hydrogen atom.

(c) State and explain the relationship between the length and strength of the bonds between the carbon atom and the two oxygen atoms in methanoic acid.

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(3)
(Total 6 marks)