

Topic 4 Bonding - Sample Test Problems

1. What is the formula for the compound formed by calcium and nitrogen?
- A. CaN
B. Ca₂N
C. Ca₂N₃
D. Ca₃N₂
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^+
3. Which of the following increase(s) for the bonding between carbon atoms in the sequence of molecules C₂H₆, C₂H₄ and C₂H₂?
- I. Number of bonds
II. Length of bonds
III. Strength of bonding
- A. I only
B. I and III only
C. III only
D. I, II and III
4. What is the Lewis (electron dot) structure for sulfur dioxide?
- A. $\begin{array}{c} \ddot{\text{O}} \\ \vdots \\ \text{:}\ddot{\text{O}}\text{:S}::\ddot{\text{O}}\text{:} \\ \vdots \\ \ddot{\text{O}} \end{array}$
B. $\begin{array}{c} \ddot{\text{O}} \\ \vdots \\ \text{:}\ddot{\text{O}}\text{:}\ddot{\text{S}}\text{:}\ddot{\text{O}}\text{:} \\ \vdots \\ \ddot{\text{O}} \end{array}$
C. $\begin{array}{c} \ddot{\text{O}} \\ \vdots \\ \text{:}\ddot{\text{O}}\text{:}: \text{S}::\ddot{\text{O}}\text{:} \\ \vdots \\ \ddot{\text{O}} \end{array}$
D. $\begin{array}{c} \ddot{\text{O}} \\ \vdots \\ \text{:}\ddot{\text{O}}\text{:}: \ddot{\text{S}}\text{:}\ddot{\text{O}}\text{:} \\ \vdots \\ \ddot{\text{O}} \end{array}$

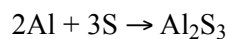
5. Which molecule is linear?
- A. SO_2
 - B. CO_2
 - C. H_2S
 - D. Cl_2O
6. Based on electronegativity values, which bond is the most polar?
- A. B—C
 - B. C—O
 - C. N—O
 - D. O—F
7. Which substance is most soluble in water (in mol dm^{-3}) at 298 K?
- A. CH_3CH_3
 - B. CH_3OCH_3
 - C. $\text{CH}_3\text{CH}_2\text{OH}$
 - D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
8. Which molecule is non-polar?
- A. H_2CO
 - B. SO_3
 - C. NF_3
 - D. CHCl_3
9. 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.

10. Which substance has the lowest electrical conductivity?
- A. Cu(s)
 - B. Hg(l)
 - C. H₂(g)
 - D. LiOH(aq)
11. Which statement best describes the attraction present in metallic bonding?
- A. the attraction between nuclei and electrons
 - B. the attraction between positive ions and electrons
 - C. the attraction between positive ions and negative ions
 - D. the attraction between protons and electrons
12. 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.
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
14. 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

15. Which fluoride is the most ionic?

- A. NaF
- B. CsF
- C. MgF₂
- D. BaF₂

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



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

17. 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.

18. 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.

19. Which molecule has the smallest bond angle?

- A. CO₂
- B. NH₃
- C. CH₄
- D. C₂H₄

20. What intermolecular forces are present in gaseous hydrogen?
- A. Hydrogen bonds
 - B. Covalent bonds
 - C. Dipole-dipole attractions
 - D. Van der Waals' forces
21. Which molecule is polar?
- A. CO_2
 - B. PF_3
 - C. CH_4
 - D. BF_3
22. 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
23. 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
24. Which compound contains **both** ionic and covalent bonds?
- A. MgCl_2
 - B. HCl
 - C. H_2CO
 - D. NH_4Cl

25. Which species has a trigonal planar shape?
- A. CO_3^{2-}
 - B. SO_3^{2-}
 - C. NF_3
 - D. PCl_3
26. 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
27. Which compound has the least covalent character?
- A. SiO_2
 - B. Na_2O
 - C. MgCl_2
 - D. CsF

28. The elements sodium and aluminum are both in period 3 of the periodic table.

Explain why aluminum has a higher melting point than sodium.

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29. (a) An important compound of nitrogen is ammonia, NH_3 . 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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(ii) Draw a diagram to show hydrogen bonding between two molecules of NH_3 . The diagram should include any dipoles and/or lone pairs of electrons

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

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(iv) Explain why the ammonia molecule is polar.

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(b) Ammonia reacts with hydrogen ions forming ammonium ions, NH_4^+ .

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

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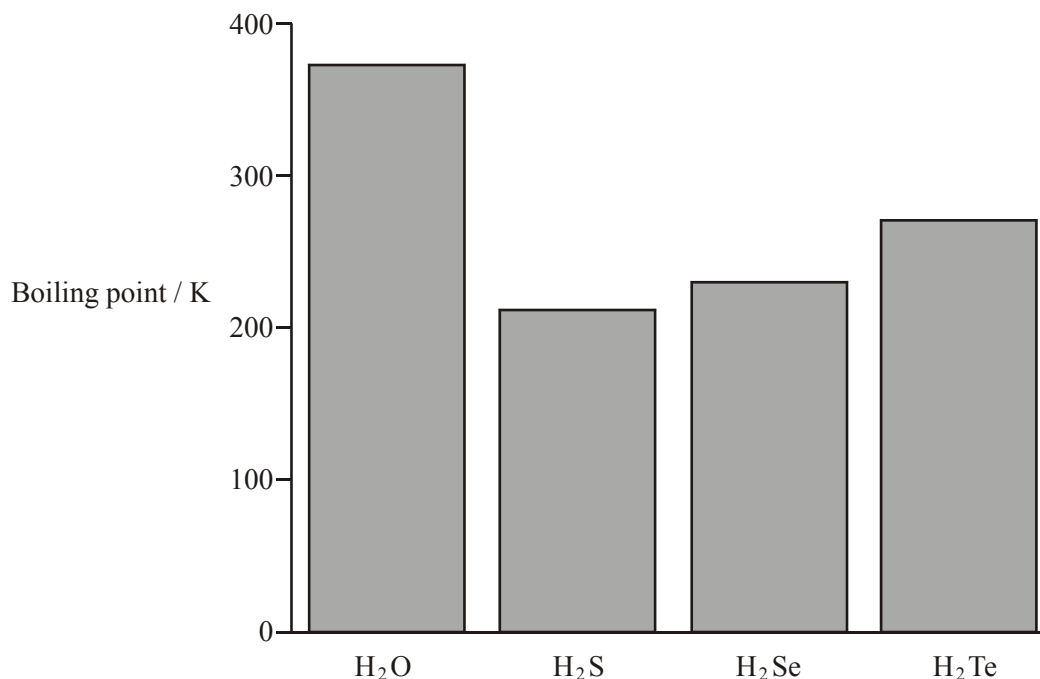
30. Identify the strongest type of intermolecular force in each of the following compounds.

CH₃Cl

CH₄

CH₃OH

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



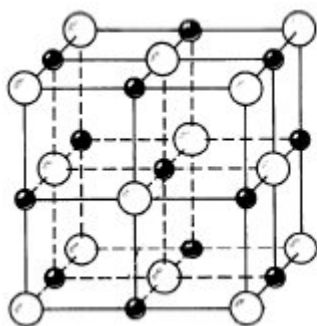
(i) Explain the trend in boiling points from H₂S to H₂Te.

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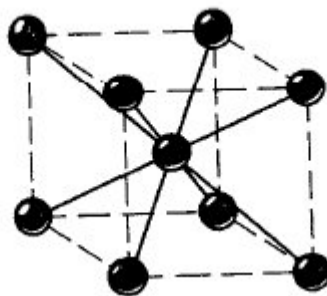
(ii) Explain why the boiling point of water is higher than would be expected from the group trend.

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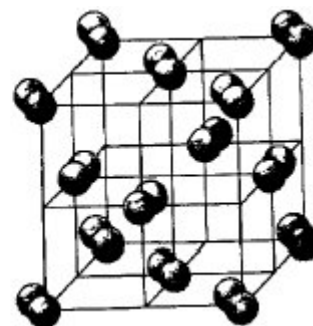
32. The diagrams below represent the structures of iodine, sodium and sodium iodide.



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

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

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

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

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

(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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