Bonding, Structure and Intermolecular Forces Questions

All answers and explanations will be provided on video

Section A – Multiple Choice

(Total 20 marks, allow 30 minutes)

1. Which of the following compounds does **not** contain ionic bonding?

   A. $NaNO_3$
   B. $(NH_4)_2CO_3$
   C. $CaCO_3$
   D. NH_3

2. Which of the following molecules or ions contains **at least one** lone pair of electrons?

   A. BH_3
   B. CH_4
   C. H_3O^+
   D. NH_4^+

3. Which one of the following species is polar?

   A. NH_3
   B. BF_3
   C. SO_3
   D. CO_2

4. What type of bonding is **not** present in the compound ammonium chloride, NH_4Cl?

   A. Ionic
   B. Covalent
   C. Dative Covalent
   D. Metallic

5. Which letter(A-D) describes an ionic bond?

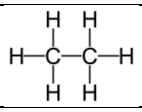
   A. The mutual attraction for shared electrons in molecules
   B. The attraction between positive ions and delocalised electrons
   C. The electrostatic attraction between oppositely charged ions
   D. The transfer of electrons from a metal to a non-metal

6. Which of the following molecules is linear?
   A. $BeCl_2$
   B. OF_2
   C. H_2O
   D. SO_2

7. Phosphorous pentafluoride, PCl_5, has a trigonal bipyramidal shape. Which of the following bond angles is not present in this molecule?

   A. 90°
   B. 109°
   C. 120°
   D. 180°

8. Some information about the bond lengths and bond angles in a molecule of ethane, C_2H_6, is shown below:

Structure	C-C bond length / nm	C-H bond angle
	0.154	109°

Which information is most likely to be true for a molecule of ethene, C_2H_4?

	C-C bond length / nm	C-H bond angle
A.	0.154	109°
B.	0.154	107.5°
C.	0.134	107.5°
D.	0.134	120°

9. The formula of potassium chromate (VI) is K_2CrO_4. What would be the most likely formula of aluminium chromate (VI)?

   A. $AlCrO_4$
   B. Al_2CrO_4
   C. $Al_2(CrO_4)_3$
   D. $Al_3(CrO_4)_2$

10. Which of the following halogen compounds has the largest dipole moment?

   A. Cl - Br
   B. F - I
   C. F - Br
   D. Cl - F

11. The following liquids have a similar number of electrons per molecule. Which is likely to have the highest boiling point?

A. $CH_3CH_2CH_2CH_2CH_3$
B. $(CH_3)_3COH$
C. $CH_3CH_2CH(OH)CH_3$
D. $CH_3CH_2CH_2CH_2OH$

12. Which of the following substances is likely to be insoluble in water?

A. methanol, CH_3OH
B. ethanol, CH_3CH_2OH
C. chloromethane, CH_3Cl
D. hydrogen fluoride, HF

13. A compound has a boiling point of -85°C. It dissolves in water to form a solution which conducts electricity. The compound is most likely to be:

A. Sodium chloride
B. Hydrogen chloride
C. Barium sulfate
D. Carbon dioxide

14. The following ions all have the electron configuration $1s^2 2s^2 2p^6$. Their ionic radii decrease in the order:

A. $O^{2-} > F^- > Na^+ > Mg^{2+}$
B. $Na^+ > Mg^{2+} > F^- > O^{2-}$
C. $F^- > O^{2-} > Na^+ > Mg^{2+}$
D. $F^- > Mg^{2+} > O^{2-} > Na^+$

15. Which species contain a dative covalent bond?

I. HCHO II. CO III. H_3O^+

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

16. Which pair of compounds is arranged in correct order of relative boiling points?

	Lower boiling point	Higher boiling point
A	CH_3OCH_3	CH_3CH_2OH
B	CH_3CHO	$CH_3CH_2CH_3$
C	CH_3CH_2OH	CH_3CHO
D	CH_3COOH	CH_3CH_2OH

17. A substance has a melting point above 3000°C and conducts electricity in the solid state. It does not dissolve in or react with water, but it reacts with oxygen when heated to form a compound which sublimes at -78°C. What is the substance?

    A. Sodium
    B. Iodine
    C. Graphite
    D. Diamond

18. Bromoethane has a boiling point of 38°C and chloroethane has a boiling point of 12°C. What is the most likely explanation for this difference?

    A. Bromoethane is able to form hydrogen bonds, chloroethane is not
    B. Chlorine is less electronegative than bromine
    C. Bromoethane has stronger London forces/Instantaneous-induced dipole attractions
    D. Bromoethane is more polar than chloroethane

19. Trifluoromethane, CHF_3, has a boiling point of -82°C and tetrafluoromethane, CF_4, has a boiling point of -128°C. What is the most likely explanation for this difference?

    A. Trifluoromethane has a lower M_r
    B. Trifluoromethane has a permanent dipole, tetrafluoromethane does not
    C. Trifluoromethane contains hydrogen bonding and tetrafluoromethane does not
    D. Trifluoromethane contains more polar bonds than tetrafluoromethane

20. Which of these substances will dissolve well in an organic non-polar solvent such as hexane?

    A. C_{60}
    B. H_2O
    C. $CaCl_2$
    D. CH_3OH

Section B – Longer Answer Questions

30 marks – allow 30 minutes

1. This question is about the compounds formed between aluminium and some group 7 elements.

a) Aluminium fluoride is an ionic compound formed when aluminium and fluorine react.

i) Predict the formula of aluminium fluoride (1)

ii) Draw a dot and cross diagram to show the bonding in aluminium fluoride. (3)

b) When aluminium reacts with chlorine, the compound formed is covalent.

i) Draw a dot and cross diagram to show the bonding in aluminium chloride (2)

When a sample of aluminium chloride is put through a mass spectrometer, there is a large peak with a mass of 267.

ii) What is the formula of the molecule with the mass of 267? (1)

iii) Explain how this molecule forms, with reference to the type of bonding (you may find it helps to use a diagram in your answer) (3)

(Total 10 marks)

2. CH_3^- and CH_3^+ are both intermediates that form during certain organic reactions. For **each** species:

- Draw an electron dot and cross diagram to represent the bonding
- Predict the H-C-H bond angle
- Predict the shape of the molecule
- Explain the difference in shapes and bond angles with reference to electron pair repulsion *(Total 10 marks)*

3. Discuss the differences in physical properties between the three compounds sodium oxide, carbon dioxide and silicon dioxide. Relate the difference in properties to the bonding and structure present in the three compounds.

(Total 10 marks)