1 Pentan-1-ol is less soluble than ethanol in water. The best explanation for this is that

☒ **A** pentan-1-ol molecules cannot form hydrogen bonds with water molecules, but ethanol molecules can.

☒ **B** London forces are stronger between pentan-1-ol molecules than between ethanol molecules.

☒ **C** carbon-carbon bonds are stronger in pentan-1-ol than in ethanol.

☒ **D** permanent dipole forces are stronger in pentan-1-ol than in ethanol.

(Total for Question = 1 mark)

2 Along the series of the Group 5 hydrides (NH_3, PH_3 and AsH_3), the boiling temperatures

☒ **A** decrease.

☒ **B** decrease then increase.

☒ **C** increase.

☒ **D** increase then decrease.

(Total for Question = 1 mark)

3 Graphite and buckminsterfullerene are forms of carbon. Buckminsterfullerene dissolves in octane but graphite does not. This is because

☒ **A** the bonds between carbon atoms in buckminsterfullerene are weaker than those in graphite.

☒ **B** buckminsterfullerene is molecular whereas graphite is a giant structure.

☒ **C** graphite has delocalised electrons but buckminsterfullerene does not.

☒ **D** graphite has covalent bonds and London forces but buckminsterfullerene has just London forces.

(Total for Question = 1 mark)

4 Hydrogen bromide has a lower boiling temperature than hydrogen iodide. This is because

☒ **A** hydrogen bromide has a smaller permanent dipole than hydrogen iodide.

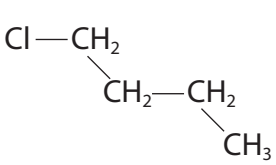
☒ **B** hydrogen bromide has weaker London forces than hydrogen iodide.

☒ **C** hydrogen iodide forms hydrogen bonds but hydrogen bromide does not.

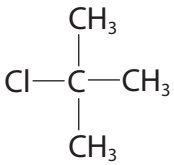
☒ **D** the H—I bond is stronger than the H—Br bond.

(Total for Question = 1 mark)

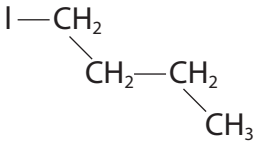
5 Consider the following compounds, **E**, **F**, **G** and **H**.



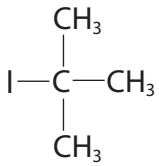
E



F



G



H

The boiling temperature of these compounds **increases** in the order

☒ **A** **H G F E**

☒ **B** **G H E F**

☒ **C** **E F G H**

☒ **D** **F E H G**

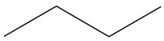
(Total for Question = 1 mark)

6 Which of the following substances does **not** have intermolecular hydrogen bonds?

- ☒ **A** Ethanoic acid, CH_3COOH
- ☒ **B** Propanone, CH_3COCH_3
- ☒ **C** Methanol, CH_3OH
- ☒ **D** Water, H_2O

(Total for Question = 1 mark)

7 Which of the following molecules has the lowest boiling temperature?



A

Pentane

C_3H_6

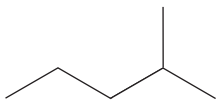
C

D

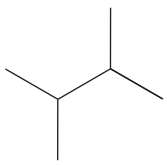
- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

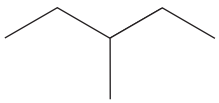
(Total for Question = 1 mark)

8 Which of the following molecules has the highest melting temperature?



A





C

D

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question = 1 mark)

9 Although they have the same relative molecular mass, the boiling temperatures of hexane (69 °C) and 2,2-dimethylbutane (49 °C) are significantly different. The reason for this is that

☒ **A** the intermolecular forces are stronger between hexane molecules because it has more electrons.

☒ **B** there are significantly stronger permanent dipole forces between hexane molecules.

☒ **C** the covalent bonds in hexane are stronger and so it requires more energy to break them.

☒ **D** the molecular shape of hexane molecules allows them to form stronger London forces.

(Total for Question = 1 mark)

10 Sodium chloride is more soluble in water than in hexane because

☒ **A** the intermolecular forces between water molecules are stronger than those between hexane molecules.

☒ **B** hexane molecules cannot fit between the ions in the sodium chloride lattice.

☒ **C** energy is released when the ions in sodium chloride are hydrated.

☒ **D** sodium ions and chloride ions form hydrogen bonds with water.

(Total for Question = 1 mark)

11 What are the strongest forces between molecules of hydrogen fluoride, HF?

☒ **A** Dipole-dipole forces.

☒ **B** Hydrogen bonds.

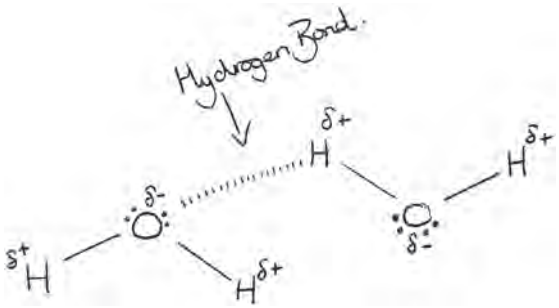
☒ **C** Ionic interactions.

☒ **D** London forces.

(Total for Question = 1 mark)

12 The diagram below is taken from a student's examination paper. It shows the hydrogen bonding between two water molecules.

Identify the error in the diagram.



☒ **A** The H—O—H bond angle within each water molecule should be 90°.

☒ **B** There should only be one lone pair of electrons on each oxygen atom.

☒ **C** The O—H—O bond angle between the water molecules should be 180°.

☒ **D** The hydrogen atoms should be ∂^- and the oxygen atoms should be ∂^+.

(Total for Question = 1 mark)

13 The boiling temperatures from methane to propane increase because

☒ **A** the number of ions increases, so there are stronger electrostatic attractions.

☒ **B** the covalent bonds are getting stronger, so require more energy to break.

☒ **C** there are more covalent bonds, so more energy is needed to break them.

☒ **D** the number of electrons increases, so there are stronger London forces.

(Total for Question = 1 mark)

14 The boiling temperature of ethanoic acid is very much higher than that of butane although these molecules have similar numbers of electrons. This is because ethanoic acid has

☒ **A** stronger covalent bonds.

☒ **B** stronger ionic bonds.

☒ **C** greater London forces.

☒ **D** hydrogen bonding.

(Total for Question = 1 mark)

15 Hydrogen iodide has a higher boiling temperature than hydrogen bromide. This is because

☒ **A** the H I bond is stronger than the H Br bond.

☒ **B** hydrogen iodide has stronger London forces than hydrogen bromide.

☒ **C** hydrogen iodide has a larger permanent dipole than hydrogen bromide.

☒ **D** hydrogen iodide forms hydrogen bonds but hydrogen bromide does not.

(Total for Question 1 mark)

16 Butane has a higher boiling temperature than 2-methylpropane. This is because butane has

☒ **A** stronger C H bonds.

☒ **B** more electrons.

☒ **C** a larger surface area.

☒ **D** hydrogen bonds.

(Total for Question 1 mark)

17 Methanol dissolves in water mainly due to the formation of new

☒ **A** hydrogen bonds.

☒ **B** dipole-dipole forces.

☒ **C** London forces.

☒ **D** covalent bonds.

(Total for Question 1 mark)

18 Which of the following compounds shows hydrogen bonding in the liquid state?

☒ **A** Hydrogen bromide, HBr

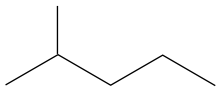
☒ **B** Hydrogen sulfide, H_2S

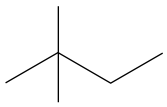
☒ **C** Silane, SiH_4

☒ **D** Ammonia, NH_3

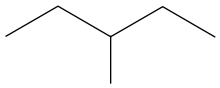
(Total for Question = 1 mark)

19 Which of these isomers has the highest boiling temperature?

☒ **A** 

☒ **B** 

☒ **C** 

☒ **D** 

(Total for Question = 1 mark)

20 Which of the following compounds has the highest boiling temperature?

☒ **A** CH_4

☒ **B** CH_3Cl

☒ **C** HCHO

☒ **D** CH_3OH

(Total for Question = 1 mark)

21 The difference in boiling temperature between methane (T_b 109 K) and ethane (T_b 185 K) is best explained by the different numbers of

☒ **A** protons.

☒ **B** electrons.

☒ **C** covalent bonds.

☒ **D** hydrogen bonds.

(Total for Question 1 mark)

22 Ethanol is soluble in water. The **best** explanation for this is

☒ **A** ethanol molecules form hydrogen bonds with water molecules.

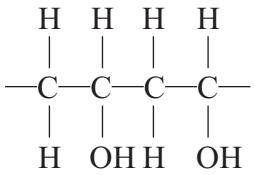
☒ **B** ethanol molecules form London (dispersion) forces with water molecules.

☒ **C** ethanol molecules form permanent dipole interactions with water molecules.

☒ **D** ethanol and water are miscible liquids.

(Total for Question 1 mark)

23 Poly(ethenol) is a water-soluble polymer. A section of the chain has the structure shown below.



The polymer is used for making hospital laundry bags so that laundry can be loaded directly into washing machines without it having to be handled.

Poly(ethenol) is water soluble because the polymer

☒ **A** is broken down by the water into monomers.

☒ **B** is broken down by the washing detergent.

☒ **C** breaks into monomers at the temperature of the wash.

☒ **D** forms many strong hydrogen bonds with the water.

(Total for Question 1 mark)

24 For parts (a) and (b), use your knowledge of intermolecular forces to predict the compound with the highest boiling temperature.

(a) ☒ **A** HF

☒ **B** H_2O

☒ **C** NH_3

☒ **D** CH_4

(1)

(b) ☒ **A** 1-iodobutane

☒ **B** 1-chlorobutane

☒ **C** 2-methyl-2-iodopropane

☒ **D** 2-methyl-2-chloropropane

(1)

(Total for Question 2 marks)

25 Which of the following has dipole-dipole interactions between its molecules, but no hydrogen bonding?

☒ **A** Methane, CH_4

☒ **B** Methanol, CH_3OH

☒ **C** Ammonia, NH_3

☒ **D** Hydrogen iodide, HI

(Total for Question = 1 mark)

26 Which list below shows the compounds in order of **increasing** boiling temperature?

☒ **A** CH_4, HCl, HF

☒ **B** HF, CH_4, HCl

☒ **C** HCl, HF, CH_4

☒ **D** HF, HCl, CH_4

(Total for Question = 1 mark)

27 Which of the following has the highest boiling temperature?

☒ **A** Pentane, $CH_3CH_2CH_2CH_2CH_3$

☒ **B** Hexane, $CH_3CH_2CH_2CH_2CH_2CH_3$

☒ **C** 2-methylbutane, $CH_3CH(CH_3)CH_2CH_3$

☒ **D** 2-methylpentane, $CH_3CH(CH_3)CH_2CH_2CH_3$

(Total for Question = 1 mark)