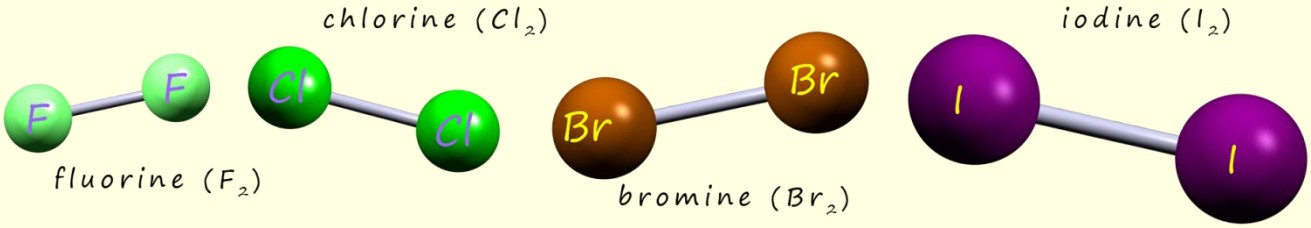
London dispersion or Van der waals forces

Answer the questions below then check your answers.

1. Explain how Van der Waals or London dispersion forces arise between atoms and molecules.
2. State the general relationship between the strength of London dispersion (Van der Waals) forces and the size of a molecule.
3. Why are London dispersion (Van der Waals) forces present between all molecules and atoms?
4. The noble gases are found in group 0 of the periodic table.
5. What forces exist between individual atoms in the noble gases?
6. Will helium at the top of group 0 or radon at the bottom have the most Van der Waals/ London dispersion forces between the atoms? Explain your answer.
7. The halogens are fluorine, chlorine, bromine and iodine. They consist of small diatomic molecules.



8. What intermolecular forces exist between halogen molecules?
9. Explain why iodine is a solid at room temperature but fluorine is a gas.
10. How is the shape of a molecule important when considering intermolecular forces such as London dispersion forces?
11. Van der Waals forces are often called induced dipole-dipole interactions. What does this phrase mean?
12. List two factors that can increase the strength of London dispersion (Van der Waals) forces between molecules.
13. Which alkane would have the highest boiling point, butane (C_4H_{10}) or Heptane (C_7H_{16})? Explain your answer.
14. Name the 2 types of intermolecular bonding that are stronger than London dispersion (Van der Waals) forces.

15. Diamond and graphite are both allotropes of carbon. Explain the significant difference in their hardness in terms of bonding and London dispersion (Van der Waals) forces.

16. Fats and many oils are derived from plants and animal products. Fats are solids and are generally saturated molecules, whereas oils are mostly polyunsaturated liquids. Explain this observation in terms of intermolecular forces between the molecules.

17. Carbon dioxide is a non-polar molecule. Dry ice is a common name for solid carbon dioxide. Carbon dioxide sublimes when heated (turns directly from a solid to a gas). Explain why carbon dioxide behaves this way in terms of its structure and the intermolecular bonding present.

18. Waxes are mixtures of long chain hydrocarbon molecules. The melting point of a wax depends on which particular long chain hydrocarbons it contains. Describe two factors that will influence the melting point of a wax in terms of intermolecular bonding.

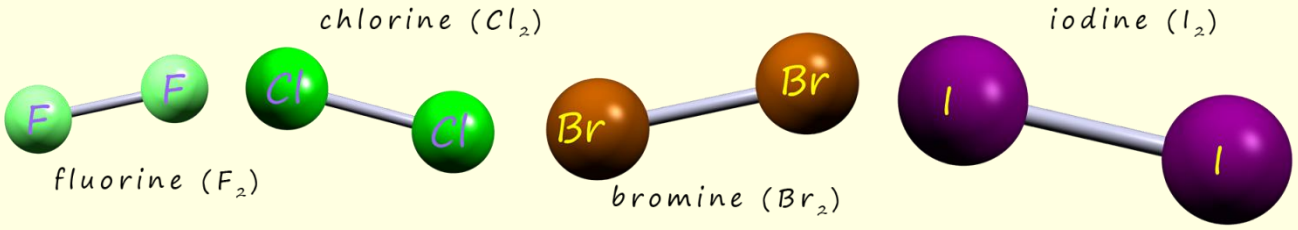
Answers

1. Explain how Van der Waals or London dispersion forces arise between atoms and molecules. Van der Waals forces arise due to random uneven movements of electrons within atoms and molecules. This creates areas of partial positive and partial negative charges within the atom/molecule. This is called an electric dipole or simply a dipole.

2. State the general relationship between the strength of London dispersion (Van der Waals) forces and the size of a molecule. Larger molecules = more electrons = greater chance of temporary dipoles = stronger London dispersion forces.
3. Why are London dispersion (Van der Waals) forces present between all molecules and atoms? All molecules and atoms have electrons that can be unevenly distributed.
4. The noble gases are found in group 0 of the periodic table. What forces exist between individual atoms in the noble gases? Van der Waals forces/ London dispersion forces exist between these atoms.
5. What forces exist between individual atoms in the noble gases? London dispersion forces/Van der Waals forces
6. Will helium at the top of group 0 or radon at the bottom have the most Van der Waals/ London dispersion forces between the atoms? Explain your answer. Van der Waals forces/London dispersion forces increase as the number of electrons increases, so there will be more Van der Waals/London dispersion forces in large atoms such as radon than in small atoms such as helium. Also the more electrons that are present the easier it is to Polarize the molecule or

atom which means more London dispersion/Van der Waals forces (Recall that polarization is the ease with which an electron cloud can be distorted).

7. The halogens are fluorine, chlorine, bromine and iodine. They consist of small diatomic molecules.



8. What intermolecular forces exist between halogen molecules? London dispersion or Van der Waals forces exist between these non-polar molecules
9. Explain why iodine is a solid at room temperature but fluorine is a gas. Iodine atoms are large atoms with lots more electrons than fluorine, so more Van der Waals bonding or London dispersion forces will occur. The larger the molecule the more electrons it has and the easier it is to polarize it.
10. How is the shape of a molecule important when considering intermolecular forces such as London dispersion forces? Van der Waals forces/London dispersion forces rely on the atoms/molecules being able to alter the electron distribution in neighbouring atoms/molecules. Molecules with large surface areas will allow this to happen more than molecules with smaller surface areas.
11. Van der Waals forces are often called induced dipole-dipole interactions. What does this phrase mean? Random movements of electrons in one atom/molecule can cause dipoles (regions of positive and negative charge) to form. These dipoles can then alter the electron distribution in neighbouring atoms/molecules that is they can cause them to form or be induced.

12. List two factors that can increase the strength of London dispersion (Van der Waals) forces between molecules. Larger molecular size/mass, more surface area for interaction. More electrons present

13. Which alkane would have the highest boiling point, butane (C_4H_{10}) or Heptane (C_7H_{16})? Explain your answer. Heptane – larger molecule, more electrons present, stronger London dispersion/Van der Waals forces present.

14. Name the 2 types of intermolecular bonding that are stronger than London dispersion (Van der Waals) forces. Dipole-dipole interactions, hydrogen bonding.

15. Diamond and graphite are both allotropes of carbon. Explain the significant difference in their hardness in terms of bonding and London dispersion (Van der Waals) forces. Diamond has a giant covalent network, very strong covalent bonds. Graphite: strong covalent bonds in flat layers of hexagons but layers held by weak London dispersion forces/Van der Waals, so layers can easily slide over each other.

16. Fats and many oils are derived from plants and animal products. Fats are solids and are generally saturated molecules, whereas oils are mostly polyunsaturated liquids. Explain this observation in terms of intermolecular forces between the molecules. **Plant oils** often have double bonds (unsaturated), leading to kinks in their hydrocarbon chains. This prevents close packing and weakens London dispersion/Van der Waals bonding, resulting in a lower melting point and so a liquid state.

17. Carbon dioxide is a non-polar molecule. Dry ice is a common name for solid carbon dioxide. Carbon dioxide sublimes when heated (turns directly from a

solid to a gas). Explain why carbon dioxide behaves this way in terms of its structure and the intermolecular bonding present. CO_2 is non-polar molecule which means it only has weak London dispersion/Van der Waals forces between molecules. These are easily overcome at room temperature, causing sublimation rather than melting.

18. Waxes are mixtures of long chain hydrocarbon molecules. The melting point of wax depends on which particular long chain hydrocarbons it contains. Describe two factors that will influence the melting point of a wax in terms of intermolecular bonding. Longer hydrocarbon chains means more electrons are present so stronger London dispersion forces/Van der Waals bonding which means a higher melting point.

Whereas branched chains reduce surface contact which means weaker London dispersion forces and so a lower melting point.