Medium Term Planning - Topic: STRUCTURE AND BONDING

Curriculum Intent	**In addition to working further on objectives from Year __, pupils will be taught, following National Curriculum guidelines, the following this topic:**
Skills/National Curriculum Links	Use the particle model to describe how energy, movement, and attraction between particles change as a substance is heated or cooled. Suggest why substances have different melting and boiling points from each other. **Evaluate a model, explaining its limitations.** Draw dot and cross diagrams of unfamiliar ionic compounds. Suggest and explain the charge of a monatomic ion based on its position in the periodic table. Suggest the charge on unfamiliar ions using the position of the element in the periodic table. Explain the ratio of metal and non-metal ions in compounds. Generate the formulae of a wide range of ionic compounds when the charges of the ions are given. Explain in detail why ionic compounds cannot conduct electricity when they are solid but can when molten or in solution. Justify in terms of properties that a compound has ionic bonding. Apply the ionic model to make predictions of the physical properties of ionic compounds. Draw dot and cross diagrams and ball and stick diagrams for unfamiliar small molecules. Suggest how double and triple covalent bonds can be formed. Suggest how the properties of a double covalent bond could be different to the properties of a single covalent bond.
Spiritual, moral, social, and cultural development	**SMSC:** group work from practical activities in this section. Also pupils can work in groups to produce a timeline for the development of the periodic table. **PSHE/British Values:** The history of the is important development of the atom when learning about british values and world values. Students will complete teamwork, leadership and put science into everyday situations. They will show mutual respect during classwork. **Skills Builder:** Listening (Receiving, retaining and processing info), Speaking (The oral transmission of info and ideas), Problem solving (Find a solution to a situation or challenge), Creativity (imagination and generation of new ideas), Staying positive (The ability to use tactics and strategies to overcome setbacks), aiming high (Set clear and tangible goals), Leadership and teamwork
Numeracy	
Literacy	**Vocabulary Tier 2:** solids liquids gases particles, constantly, random meting point vibrations, reversible, physical changes, temperature, forces, chemically, outermost shell, fixed positions, electode, molecule, graphite, conductor, transfer, lubricants, reinforce, sustainable. **Vocabulary Tier 3:** alloy, covalent bonding, covalent bonding, delocalized electron, dot and cross diagram, fullerene, gases, giant covalent structure, giant lattice, giant structure, intermolecular forces, ionic bond, liquids, nanoscience, particle theory, polymer, solids, states of matter. **Reading:** Following a written method and read risk assessments. Students may be directed to the textbook; this could be in lesson or at home on Kerboodle. **Writing:** Describing and explaining scientific phenomenon, free response writing for describing precautions taken, use of word mat to promote sentence formation. **Oracy:** inclusion of BEST resources which are research evidence on common misunderstandings in science, effective diagnostic questioning and formative assessment, constructivist approaches to building understanding, and effective sequencing of key concepts that promote metacognitive talk and dialogue.
Becoming future ready	**Careers/Employability:** Scientist Chemist Drug development Teacher Post-doctoral researcher
Adaptation	Throughout this topic, quality first teaching will provide differentiation:

QFT/SEND Provision	**By product:** Linear assessments and differentiated practical work. **By resource:** Lessons are differentiated per class and students, worksheets are available if support and assessments are linear. **By Intervention**: by providing different levels of supervision and support **By Progressive Questioning:** exploring pupils' understanding through interactive dialogue. **By Grouping:** according to prior attainment, gender, social preference, preferred learning style. **By Offering Optional Activities:** In class or as homework, to extend learning. This QFT/SEND provision will be explicit within the lesson-by-lesson schemes of work.
Implementation Curriculum Delivery Learning Outcomes **(Core Knowledge)**	To be able to: 2.2.1 **The three states of matter are solid, liquid, and gas**. Melting and freezing take place at the melting point, boiling and condensing take place at the boiling point. The three states of matter can be represented by a simple model. **In this model, particles are represented by small solid spheres. Particle theory can help to explain melting, boiling, freezing, and condensing.** The amount of energy needed to change state from solid to liquid and from liquid to gas depends on the strength of the forces between the particles of the substance. The nature of the particles involved depends on the type of bonding and the structure of the substance. **The stronger the forces between the particles the higher the melting point and boiling point of the substance.** **Limitations of the simple model above include that in the model there are no forces, that all particles are represented as spheres and that the spheres are solid.** Students should be able to: • predict the states of substances at different temperatures given appropriate data • explain the different temperatures at which changes of state occur in terms of energy transfers and types of bonding • recognise that atoms themselves do not have the bulk properties of materials **Explain the limitations of the particle theory in relation to changes of state when particles are represented by solid inelastic spheres which have no forces between them.** 2.2.2 In chemical equations, the three states of matter are shown as (s), (l), and (g).2.1.1 **There are three types of strong chemical** **bonds: ionic, covalent, and metallic. For ionic bonding the particles are oppositely charged ions. Ionic bonding occurs in compounds formed from metals combined with non-metals.** **For covalent bonding the particles are atoms which share pairs of electrons.** 2.1.2 When a metal atom reacts with a non-metal atom electrons in the outer shell of the metal atom are transferred. **Metal atoms lose electrons to become positively charged ions. Non-metal atoms gain electrons to become negatively charged ions. The ions produced by metals in Groups 1 and 2 and by** **non-metals in Groups 6 and 7 have the electronic structure of a noble gas (Group 0).** The electron transfer during the formation of an ionic compound can be represented by a dot and cross diagram.2.1.2 The charge on the ions produced by metals in Groups 1 and 2 and by non-metals in Groups 6 and 7 relates to the group number of the element in the periodic table. 2.1.3 **An ionic compound is a giant structure of ions. Ionic compounds are held together by strong electrostatic forces of attraction between oppositely charged ions.** These forces act in all directions in the lattice and this is called ionic bonding. 2.2.3 Ionic compounds have regular structures (giant ionic lattices) in which there are strong electrostatic forces of attraction in all directions between oppositely charged ions. **These compounds have high melting points and high boiling points because of the large amounts of energy needed to break the many strong bonds.** **When melted or dissolved in water, ionic compounds conduct electricity because the ions are free to move and so charge can flow.** 2.1.4 **When atoms share pairs of electrons,** **they form covalent bonds. These bonds between atoms are strong.** Covalently bonded substances may consist of small molecules, such as H_2, Cl_2, O_2, N_2, HCl, H_2O, NH_3, and CH_4. **Some covalently bonded substances have giant covalent structures, such as diamond.** Students should be able to: • **draw dot and cross diagrams for the molecules H_2, Cl_2, O_2, N_2, Cl, HCl, H_2O, NH_3, and CH_4** • **represent the covalent bonds in small molecules, using a line to represent a single bond.** 2.2.4 Substances that consist of small molecules are usually gases or liquids that have relatively low melting points and boiling points.

These substances have only weak forces between the molecules (intermolecular forces). It is these intermolecular forces that are overcome, not the covalent bonds, when the substance melts or boils.

The intermolecular forces increase with the size of the molecules, so larger molecules have higher melting and boiling points. These substances do not conduct electricity because the molecules do not have an overall electric charge.

2.2.5 Polymers have very large molecules. The atoms in the polymer molecules are linked to other atoms by strong covalent bonds. The intermolecular forces between polymer molecules are relatively strong and so these substances are solids at room temperature.

2.1.4 Some covalently bonded substances have very large molecules, such as polymers.
Students should be able to:

- describe the limitations of using dot and cross, ball and stick, two and three-dimensional diagrams to represent molecules or giant structures
- **deduce the molecular formula of a substance from a given model or diagram in these forms showing the atoms and bonds in the molecule.**

2.2.6 **Substances that consist of giant covalent structures are solids with very high melting points**. All of the atoms in these structures are linked to other atoms by strong covalent bonds. These bonds must be overcome to melt or boil these substances. Diamond and graphite (forms of carbon) and silicon dioxide (silica) are examples of giant covalent structures.

2.3.1 I**n diamond, each carbon atom forms four covalent bonds with other carbon atoms in a giant covalent structure, so diamond is very hard, has a very high melting point and does not conduct electricity.**

2.3.2 **In graphite, each carbon atom forms three covalent bonds with three other carbon atoms, forming layers of hexagonal rings and so graphite has a high melting point. The layers are free to slide over each other because there are no covalent bonds between the layers and so graphite is soft and slippery. In graphite, one electron from each carbon atom is delocalised.**
These delocalised electrons allow graphite to conduct thermal energy and electricity.
2.3.3 **Graphene is a single layer of graphite and has properties that make it useful in electronics and composites.**

Students should be able to explain the properties of graphene in terms of its structure and bonding.

Fullerenes are molecules of carbon atoms with hollow shapes. The structure of fullerenes is based on hexagonal rings of carbon atoms but they may also contain rings with five or seven carbon atoms. The first fullerene to be discovered was Buckminsterfullerene (C_{60}) which has a spherical shape.

Carbon nanotubes are cylindrical fullerenes with very high length to diameter ratios. Their properties make them useful for nanotechnology, electronics and materials.

Students should be able to:

- recognise graphene and fullerenes from diagrams and descriptions of their bonding and structure
- give examples of the uses of fullerenes, including carbon nanotubes.

2.1.5 **Metals consist of giant structures of atoms arranged in a regular pattern. The electrons in the outer shell of metal atoms are delocalised and so are free to move through the whole structure. The sharing of delocalised electrons gives rise to strong metallic bonds.**
2.2.7 **Metals have giant structures of atoms with strong metallic bonding. This means that most metals have high melting and boiling points.**

In pure metals, atoms are arranged in layers, which allows metals to be bent and shaped. **Pure metals are too soft for many uses and so are mixed with other metals to make alloys which are harder.**

Students should be able to explain why alloys are harder than pure metals in terms of distortion of the layers of atoms in the structure of a pure metal.

2.2.8 **Metals are good conductors of electricity because the delocalised electrons in the metal carry electrical charge through the metal. Metals are good conductors of thermal energy because energy is transferred by the delocalised electrons.**
2.4.1 Nanoscience refers to structures that are 1–100 nm in size, of the order of a few hundred atoms.
Nanoparticles, are smaller than fine particles (PM2.5), which have diameters between 100 and 2500 nm (1×10^{-7} m and 2.5×10^{-6} m).
Coarse particles (PM10) have diameters between 1×10^{-5} m and 2.5×10^{-6} m. Coarse particles are often referred to as dust.

	As the side of a cube decreases by a factor of 10 the surface area to volume ratio increases by a factor of ten. **Nanoparticles may have properties different from those for the same material in bulk because of their high surface area to volume ratio.** It may also mean that smaller quantities are needed to be effective than for materials with normal particle size. 2.4.2 **Nanoparticles have many applications in** **medicine for controlling drug delivery and in synthetic skin; in electronics; in cosmetics and sun creams; in the development of new catalysts for fuel cell materials; in deodorants and in** **fabrics to prevent the growth of bacteria.** New applications for nanoparticulate materials are an important area of research. Nanoparticles are being used in sun creams. Some of the benefits of nanoparticles in sun creams include better skin coverage and more effective protection from the Sun's ultraviolet rays. Disadvantages include potential cell damage in the body and harmful effects on the environment.
Current learning to be developed in the future within:	A level chemistry students will again cover structure and bonding ionic, covalent and metallic bonding. They also cover in detail electrochemistry – electrochemical cells.
Assessment	Refer to assessment maps for formative and summative assessment opportunities.
Impact	Attainment and Progress – Refer to assessment results / data review documentation.