P3 Particle Model of Matter

What's the science story?

The particle model is widely used to predict the behaviour of solids, liquids and gases and this has many applications in everyday life. It helps us to explain a wide range of observations and engineers use these principles when designing vessels to withstand high pressures and temperatures, such as submarines and spacecraft. It also explains why it is difficult to make a good cup of tea high up a mountain!

Previous knowledge:

KS3 – Particles, changes of state and pressure.
KS4 – P1 Energy – internal energy & specific heat capacity

Next steps…

P4 – Atomic structure

Keywords

Density
Mass
Volume

Internal energy
Thermal energy
Specific heat capacity

Latent heat
Kinetic energy

Working scientifically skills:

WS2 - Draw/Interpret diagrams
WS3 - Make predictions - Make prediction using a model
WS4 - Ethical arguments - Rights and wrongs of technology
WS5 - Risk perception - Hazards of new technology

Assessments:

End of unit test (summative)
Exit tickets x 1 (formative)
- Exit ticket – Density exam Q

AQA GCSE Combined Science Trilogy (8464)

Lesson No. and Title	Learning objectives	AQA Specification	Practical equipment
1. Density	4 – To define the term density. 6 – To calculate the density of a range of materials. 8 – To evaluate the density results obtained from a practical investigation.	**6.3.1.1 Density of materials** The density of a material is defined by the equation: density = mass/volume $\rho = m/V$ density ρ, in kilograms per metre cubed, kg/m^3 mass, m, in kilograms, kg volume, V, in metres cubed, m^3 The particle model can be used to explain • the different states of matter • differences in density. Students should be able to recognise/draw simple diagrams to model the difference between solids, liquids and gases. Students should be able to explain the differences in density between the different states of matter in terms of the arrangement of atoms or molecules.	REQ PRAC – Calculating density of regular and irregular objects Regular object and irregular objects, rulers, measuring cylinders, balances, eureka cans
2. Changes of state	4 – Describe the process of melting and boiling 6 – To explain the behaviour of a material in terms of particles. 8 – To describe the changes in the energy of individual particles during changes of state.	**6.3.1.2 Changes of state** Students should be able to describe how, when substances change state (melt, freeze, boil, evaporate, condense or sublimate), mass is conserved. Changes of state are physical changes which differ from chemical changes because the material recovers its original properties if the change is reversed.	DEMO – Modelling particles in different states Tray of balls for example. PRAC – Measuring the melting point Stearic acid, thermometer, test tubes, beakers, heating equipment

3. Internal energy & SHC	4 – To state the changes of state are linked to internal energy. 6 – To describe how the internal energy of a substance can be increased. 6 – Review how to calculate specific heat capacity	**6.3.2.1 Internal energy** Energy is stored inside a system by the particles (atoms and molecules) that make up the system. This is called internal energy. Internal energy is the total kinetic energy and potential energy of all the particles (atoms and molecules) that make up a system. Heating changes the energy stored within the system by increasing the energy of the particles that make up the system. This either raises the temperature of the system or produces a change of state. **6.3.2.2 Temperature changes in a system and specific heat capacity** If the temperature of the system increases: The increase in temperature depends on the mass of the substance heated, the type of material and the energy input to the system. The following equation applies: change in thermal energy = mass × specific heat capacity × temperature change $\Delta E = m\,c\,\Delta\theta$ change in thermal energy, ΔE, in joules, J mass, m, in kilograms, kg specific heat capacity, c, in joules per kilogram per degree Celsius, J/kg °C temperature change, $\Delta\theta$, in degrees Celsius, °C. The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.	DEMO – Changing state of water
4. Specific latent heat	4 – To describe the energy changes during melting and vaporisation. 6 – To calculate the latent heat of fusion and vaporisation for a substance. 8 – To apply the latent heat equation to a range of examples.	**6.3.2.3 Changes of state and specific latent heat** If a change of state happens: The energy needed for a substance to change state is called latent heat. When a change of state occurs, the energy supplied changes the energy stored (internal energy) but not the temperature. The specific latent heat of a substance is the amount of energy required to change the state of one kilogram of the substance with no change in temperature. energy f or a change of state = mass × specific latent heat $E = m\,L$ energy, E, in joules, J mass, m, in kilograms, kg specific latent heat, L, in joules per kilogram, J/kg Specific latent heat of fusion – change of state from solid to liquid Specific latent heat of vaporisation – change of state from liquid to vapour. Students should be able to interpret heating and cooling graphs that include changes of state. Students should be able to distinguish between specific heat capacity and specific latent heat.	

5. Gas pressure and temperature	4 – To describe the properties of a gas. 6 – To outline Brownian motion and how this provides evidence. 8 – To describe the linear relationship between temperature and pressure for a gas.	**6.3.3.1 Particle motion in gases** The molecules of a gas are in constant random motion. The temperature of the gas is related to the average kinetic energy of the molecules. Changing the temperature of a gas, held at constant volume, changes the pressure exerted by the gas. Students should be able to: • explain how the motion of the molecules in a gas is related to both its temperature and its pressure • explain qualitatively the relation between the temperature of a gas and its pressure at constant volume.	