# Scheme of work

## Physics – Particle model of matter

This resource provides guidance for teaching the Particle model of matter topic from our new GCSE Physics (8463). It has been updated from the draft version to reflect the changes made in the accredited specification. There are many changes throughout the document particularly in the opportunities to develop and apply practical and enquiry skills and communication skills.

The scheme of work is designed to be a flexible medium term plan for teaching content and development of the skills that will be assessed.

It is provided in Word format to help you create your own teaching plan – you can edit and customise it according to your needs. This scheme of work is not exhaustive; it only suggests activities and resources you could find useful in your teaching.

### 4.3 Particle model of matter

### 4.3.1 Changes of state and the particle model

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most candidates should be able to do* | **Suggested timing (hours)** | **Opportunities to develop Scientific Communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment opportunities and resources**  *Reference to past questions that indicate success* |
| --- | --- | --- | --- | --- | --- | --- |
| 4.3.1.1 | How to determine the density of a material.  Equation for density should be known. | The density of a material is defined by the equation:  density, *ρ*, in kilograms per metre cubed, kg/m3  mass, *m*, in kilograms, kg  volume, *V*, in metre cubed, m3 | 1 | Define density.  Describe how the density of regular and irregular shapes can be found by experiment.  Convert non-standard units into standard units for calculations.  Recall the equation for density and apply it.  Calculate the density, mass or volume of an object given any two other values. | Required practical  Use appropriate apparatus to make and record the measurements needed to determine the densities of regular and irregular solid objects and liquids. Volume should be determined from the dimensions of regularly shaped objects and by a displacement technique for irregularly shaped objects. Dimensions to be measured using appropriate apparatus such as a ruler, micrometer or Vernier callipers. (8.2.5)  Why do objects float? This topic can be linked to the above investigation as once you know the density of an object you can predict if it floats or sinks in water. | [BBC Bitesize – Density](http://www.bbc.co.uk/education/guides/zbg7hyc/revision)  [Cyberphysics – Density](http://www.cyberphysics.co.uk/topics/forces/density.htm) |
| 4.3.1.1 | The particle model of matter. | The particle model can be used to explain the different states of matter. | 1 | Draw diagrams to show the particle arrangements in solids, liquids and gases.  Describe and explain the different particle arrangements in solids, liquids and gases due to the bonds between the atoms.  Describe the motion of particles in solids, liquids and gases.  Describe and explain the limitations of the particle model of matter, in particular that the particles within the substance are not solid spheres and that the forces between the particles are not represented. | Why are models used in Physics?  Critically evaluate the models used to describe and explain the behaviour of solids, liquids and gases.  If you have a kinetic model, you can use it to demonstrate the motion of particles in a liquid/gas. If you don’t have a model, use a tray, filled with ping-pong balls (or marbles), and shake it. You can vary the number of ping-pong balls to demonstrate the three states. | [BBC Bitesize – Kinetic theory](http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/heatingandcooling/heatingrev2.shtml)  [Cyberphysics – The Particle Theory – states of matter](http://www.cyberphysics.co.uk/topics/kinetic_theory/statesOFmatter.html)  [Exampro user guide PowerPoint](http://filestore.aqa.org.uk/resources/science/AQA-GCSE-SCIENCE-EXAMPRO-UG.PPTX) |
| 4.3.1.1. | The particle model of matter to explain density of materials. | The differences in density between the different states of matter to be explained in terms of the arrangements of the particles (atoms or molecules). | 0.5 | Explain why the different states of matter have different densities in terms of mass and volume of the material..  Draw diagrams to show the particle arrangement of solids, liquids and gases. Use the diagrams to explain the differences in densities between solids, liquids and gases. | Make models of solids, liquids and gases using plasticine. Does the model produced show the 3D structure of these states? Use the model of the tray filled with ping-pong balls if you haven’t done it in The particle model of matter lesson.  Evaluate the models used to explain the properties of solids, liquids and gases. How well do these models cope with water which is less dense than ice (solid water)? | [Cyberphysics – The Particle Theory – states of matter](http://www.cyberphysics.co.uk/topics/kinetic_theory/statesOFmatter.html)  [Cyberphysics – Density](http://www.cyberphysics.co.uk/topics/forces/density.htm) |
| 4.3.1.2 | Changing the state of a substance. | When substances change state (melt, freeze, boil, evaporate, condense or sublimate), mass is conserved. | 0.5 | Why do substances change state?  Why does the temperature of a substance remain constant when the substance is changing state?  Explain how, when a substance changes state, the mass of the substance is unchanged as there is still the same number of atoms in the substance and it is just their arrangement that has altered.  Describe the changes of state in terms of solids, liquids and gases. | Find, by experiment, the melting point of salol. Compare value obtained with true value. Is there a discrepancy?  How do you account for the discrepancy? | [Cyberphysics – Changing State](http://www.cyberphysics.co.uk/topics/heat/latentheat/changingState.html)  [S-cool, the revision website | States of Matter](http://www.s-cool.co.uk/gcse/chemistry/atomic-structure/revise-it/states-of-matter) |
| 4.3.1.2 | Chemical and physical changes. | Changes of state are physical changes; the change does not produce a new substance. If the change is reversed the substance recovers its original properties. | 0.5 | What is the difference between a chemical and a physical change?  Describe the difference between a chemical and a physical change and provide examples for both types.  Describe how, if a physical change is reversed, the substance will recover its original properties. | Demonstrate physical and chemical changes and, where possible, the reversibility of a physical change, eg melting ice and then refreezing. | [PhysLink – What is the difference between a physical change and a chemical change?](http://www.physlink.com/Education/AskExperts/ae244.cfm) |

### 4.3.2 Internal energy and energy transfers

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| --- | --- | --- | --- | --- | --- | --- |
| 4.3.2.1 | Internal energy of a system.  Heating and temperature. | 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. And, either the temperature of the system increases, or changes of state happen. | 1 | What effect does increasing the temperature of an object have on the atoms that make up the object?  Describe temperature being a measure of the average kinetic energy of the particles in a substance.  Describe and explain how increasing the temperature of a substance affects the internal energy of a substance.  Define internal energy.  Explain how the strength of the bonds between the particles will affect how much energy is needed to change the state of the substance.  Evaluate data on the melting points and boiling points of different substances linked to the strength of the forces between the particles.  Explain what is happening at each stage of the heating curve produced. | Model the behaviour of atoms within a solid as it is heated past its melting point. You can use the tray of ping-pong balls or the kinetic theory apparatus if available. Critically analyse the model and suggest improvements to it.  Investigate the heating curve for water by heating some ice in a beaker until the water evaporates. Use temperature sensors/data loggers to record the temperature at fixed intervals, eg 30 seconds. A graph can be plotted of temperature against time. | [The Physics Classroom – What is Heat?](http://www.physicsclassroom.com/class/thermalP/Lesson-1/What-is-Heat)  [Antonine Education – Thermal Physics Tutorial 1 – Heat Flow](http://www.antonine-education.co.uk/Pages/Physics_5/Thermal_Physics/THE_01/Thermal_page_1.htm)  [Cyberphysics – Heating ice to observe changes in state](file:///C:\Users\Ed\Downloads\Heating%20ice%20to%20observe%20changes%20in%20state) |
| 4.3.2.2 | Specific heat capacity. | If the temperature of the system increases: the increase in temperature depends on the mass of the substance heated, what the substance is and the energy input to the system.  The following equation applies:  change in thermal energy, *∆E*, in joules, J  mass, *m*, in kilograms, kg  specific heat capacity, *c*, in joules per kilogram per degree Celsius, J/kg oC  temperature change, *∆θ*, in degrees Celsius, oC  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. | 1 | Describe and explain how the amount of water in a kettle affects how quickly it boils.  Explain why a pan of cooking oil heats up faster than a pan of water, with the same mass of each, in terms of specific heat capacity.  Why is water used in central heating systems?  Define specific heat capacity.  Describe the factors that affect how quickly the temperature of a substance increases, eg why does a half-full kettle heat up faster than a full kettle of water?  Calculate the change in thermal energy, mass, specific heat capacity or the temperature change of a substance that is heated or cooled. The equation will be provided on the equations sheet.  Students should be able to convert to SI units and use standard form in their answers.  Explain why special concrete blocks are used in storage heaters. | Plan a practical to investigate the rate of heating of various metals using a joulemeter to determine the energy input. If no joulemeter is available, use an ammeter, *I*, a voltmeter, *V*, and heat the material for a fixed amount of time, *t*. Calculate the energy transferred, *E,* using:  Determine the specific heat capacity of water by experiment. | [BBC Bitesize – Specific heat capacity](http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/heatingandcooling/buildingsrev3.shtml)  [Cyberphysics – Specific Heat Capacity](http://www.cyberphysics.co.uk/topics/heat/shc.htm) |
| 4.3.2.3 | 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, *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. | 1 | Define specific latent heat.  Draw heating and cooling graphs for a substance including a change of state.  Interpret a heating or cooling graph to explain what is happening at each stage of the graph.  Explain why a block of ice at 0 **°**Cthat is being heated does not increase in temperature initially.  Calculate the energy for a change of state, mass or specific latent heat of a substance given the other values.  Students will be expected to convert to SI units and use standard form where required.  Evaluate the use of different coolants used in fridges in terms of the specific latent heat of the coolant and the boiling point of the coolant.  Research the use of coolants in fridges.  Define specific latent heat of fusion and vaporisation.  Explain why the specific latent heat of vaporisation is greater than the specific latent heat of fusion for a given material in terms of the increase in separation of the particles.  Why is more energy required to vaporise 1 kg of water thanto melt 1 kg of ice? | Plan and carry out an investigation to find the specific latent heat of fusion of water.  Investigate the heating curve for water by heating some ice in a beaker until the water evaporates. Use temperature sensors/data loggers to record the temperature at fixed intervals, eg 30 seconds. A graph can be plotted of temperature against time.  Instead of the above carry out the Institute of Physics investigation from Episode 608-2: [The specific latent heat of fusion of ice](http://tap.iop.org/energy/thermal/608/page_47512.html) | [BBC Bitesize – Changing state](http://www.bbc.co.uk/schools/gcsebitesize/science/ocr_gateway/home_energy/heating_housesrev3.shtml)  [BBC Bitesize – Heating ice to observe changes in state](http://www.cyberphysics.co.uk/topics/heat/latentheat/latentheatexpt.htm) |

### 4.3.3 Particle model and pressure

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most candidates should be able to do* | **Suggested timing (hours)** | **Opportunities to develop Scientific Communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment opportunities and resources**  *Reference to past questions that indicate success* |
| --- | --- | --- | --- | --- | --- | --- |
| 4.3.3.1 | Using the particle model of matter explain motion of particles in a gas. | 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. The higher the temperature, the greater the average kinetic energy and so the faster the average speed of the molecules. | 1 | Describe the motion of molecules within a gas.  How does the temperature of a gas affect the movement of the particles within it?  Describe and explain how the motion of molecules in a gas changes as the gas is heated.  Why are gas cylinders likely to explode in a fire? | To investigate the motion of gas molecules you can conduct a Brownian motion experiment using smoke cells viewed under a microscope. To carry out the experiment use Institute of Physics’ Episode 601-1: [Brownian motion in a smoke cell](http://tap.iop.org/energy/kinetic/601/page_47422.html) | Video clip  [YouTube: States of Matter](https://www.youtube.com/watch?v=KCL8zqjXbME)  [Antonine Education – Thermal Physics Tutorial 3 – Molecular Kinetic Theory](http://www.antonine-education.co.uk/Pages/Physics_5/Thermal_Physics/THE_03/thermal_page_3.htm) |
| 4.3.3.1 | How gases exert forces on the walls of their containers. | When the molecules collide with the wall of their container they exert a force on the wall. The total force exerted by all of the molecules inside the container on a unit area of the walls is the gas pressure. | 0.5 | Describe why gases exert a force on a container.  Explain what is meant by gas pressure in terms of the forces exerted by the gas molecules on a given area.  Explain how blowing up a balloon too much can cause it to pop in terms of gas pressure. | Research how the gas pressure in a submarine stops it from crushing at depth.  Use PhET interactive simulations to model gas pressure: [Gas Properties – Gas, Pressure, Volume](https://phet.colorado.edu/en/simulation/gas-properties) | [BBC Bitesize – Temperature and gas calculations](http://www.bbc.co.uk/education/guides/zc4xsbk/revision/2) |
| 4.3.3.1 | How changing the temperature of a gas affects the pressure exerted. | Changing the temperature of a gas, held at constant volume, changes the pressure exerted by the gas (known as the Pressure law). | 1 | Describe and explain how changing the temperature of gas increases the gas pressure inside the container.  Explain why gas cylinders should not be placed near heat sources.  Evaluate newspaper articles of local fires that have involved gas canisters exploding and the reasons for the explosion in terms of gas pressure.  Why do aerosol deodorants say: keep away from fire?  Why do car tyre pressures have to be checked when cold, rather than after a long drive?  Find out why gas cylinders explode in fires (if not, look at questions above).  Write a newspaper article on an explosion caused by exploding gas canisters explaining the reasons for the explosion in terms of gas pressure.  Explain why a balloon dipped into liquid nitrogen becomes smaller. | Model what is happening inside a container of fixed volume when the temperature is changed.  Investigate the Pressure law:   1. Place a round-bottomed flask connected to a pressure gauge in a container of water. 2. Heat the water taking the temperature and pressure. 3. Plot a graph of pressure against temperature. | [BBC Bitesize – Temperature and gas calculations](http://www.bbc.co.uk/education/guides/zc4xsbk/revision/2)  [BBC Bitesize – The Gas Laws](http://www.bbc.co.uk/bitesize/higher/physics/mech_matt/gaslaws/revision/2/)  [Pass My Exams – Pressure and temperature relationship of a gas](http://www.passmyexams.co.uk/GCSE/physics/pressure-temperature-relationship-of-gas-pressure-law.html)  Video clip  YouTube: [Flat Tire Science – Liquid Nitrogen Experiment](https://www.youtube.com/watch?v=sEbxLrP_ZCU) |
| 4.3.3.2 | How changing the pressure of a gas affects the volume of the gas. (Physics only) | A gas can be compressed or expanded by pressure changes. The pressure produces a net force at right angles to the wall of the gas container (or any surface). | 1 | Explain why it is easy to compress a gas, but not solids or liquids.  Describe the effect of taking a balloon underwater: why does the balloon compress as it gets deeper? Why do scuba divers suffer from decompression sickness if they surface too quickly?  Why do balloons stay inflated even though the rubber is trying to go back to its original shape?  Investigate the use of recompression chambers to treat scuba divers that have suffered from decompression sickness. | What does a barometer measure and how does it work?  Have two sealed syringes: one filled with water, the other with air. Show you can compress the air one, but not the one filled with water. | [BBC Bitesize – Temperature and gas calculations](http://www.bbc.co.uk/education/guides/zc4xsbk/revision/3)  Video clip  YouTube: [BBC Short Circuit – Physics – 01 – Pressure (18'47'') 1 of 2 (Physics of Diving)](https://www.youtube.com/watch?v=6avnAt1fHKs) |
| 4.3.3.2 | How changing the volume of a gas affects the pressure. (Physics only) | Increasing the volume in which a gas is contained, at constant temperature, can lead to a decrease in pressure (known as Boyle’s law). | 1 | Describe and explain using the particle model how increasing the volume of a container will lead to a decrease in the pressure of the container due to the reduced number of collisions per unit area.  Candidates should also be able to explain why this is only the case at a constant temperature. | Model the effect of changing the volume of a fixed amount of gas. If the volume increases what happens to the number of collisions that the particles will have with the container wall in a given time?  Use Boyle’s law apparatus to investigate this, taking readings of pressure and volume and then plotting a graph of *p* against *V* and *p* against *1/V*. If the equipment isn’t available, use readings on this animation to plot a graph: [Pass My Exams – Pressure and volume relationship of a gas](http://www.passmyexams.co.uk/GCSE/physics/pressure-volume-relationship-of-gas-Boyles-law.html) | Pass My Exams – [Pressure and volume relationship of a gas](http://www.passmyexams.co.uk/GCSE/physics/pressure-volume-relationship-of-gas-Boyles-law.html)  [BBC Bitesize – The Gas Laws](http://www.bbc.co.uk/bitesize/higher/physics/mech_matt/gaslaws/revision/1/)  [Cyberphysics – Boyle's Law](http://www.cyberphysics.co.uk/topics/kinetic_theory/boyle.htm) |
| 4.3.3.2 | How pressure and volume of a gas are linked. HT only (Physics only) | For a fixed mass of gas held at a constant temperature:    pressure, *p*, in Pascals, Pa  volume, *V*, in metres cubed, m3 | 1 | Use the equation:    to describe how the pressure inside a container is dependent upon the volume of gas inside the container.  Explain using the equation how increasing the volume of a container will lead to a decrease in pressure quantitatively.  Find out why the CO2 cartridges used by cyclists to inflate their tyres have an insulating material placed around the cartridge. | Find out why the equation does not hold true in real situations, eg:   * a bike pump compressing air * a carbon dioxide cylinder being opened * a camping gas cylinder being used. | [Pass My Exams – Pressure and volume relationship of a gas](http://www.passmyexams.co.uk/GCSE/physics/pressure-volume-relationship-of-gas-Boyles-law.html)  [BBC Bitesize – The Gas Laws](http://www.bbc.co.uk/bitesize/higher/physics/mech_matt/gaslaws/revision/1/) |
| 4.3.3.3 | Work done on a gas and the change in internal energy caused. HT only. | Work is the transfer of energy by a force.  Doing work on a gas increases the internal energy of the gas and can cause an increase in the temperature of the gas. | 1 | Explain how doing work on an enclosed gas in a given situation, eg a bicycle pump, leads to an increase in temperature of the gas.  Find out why gas cylinders may freeze if they are opened and the gas inside is allowed to escape too quickly.  Examine the drawbacks of using a pump to compress a gas in terms of an increase in the kinetic energy of the particles and an increased gas pressure on the walls of the container. | Put a balloon over a drinks bottle and place the bottle in a beaker of hot water. The balloon should inflate. Carefully remove the bottle and place it in ice water, the balloon should deflate.  Place a bung containing a glass delivery tube in a round- bottomed flask, add a small amount of water and heat it. Once steam is coming out of the tube, quickly invert the flask and place the tube into a 100 ml beaker containing coloured water. | Video clip  YouTube: [Gas thermal expansion 1 – physics experiment](https://www.youtube.com/watch?v=yLCMKR4EKpw) |