Combined Science - Physics

CP12/13 Knowledge

CHURCH STRETTON SCHOOL

P12-13: Particle model, forces and matter

Lesson sequence

1. Particles and density
2. Core practical – investigating densities (CP16)
3. Energy and state changes
4. Energy calculations
5. Core practical – investigating water (CP17)
6. Gas temperature and pressure
7. Bending and stretching
8. Core practical – investigating springs (CP18)
9. Extension and energy transfers

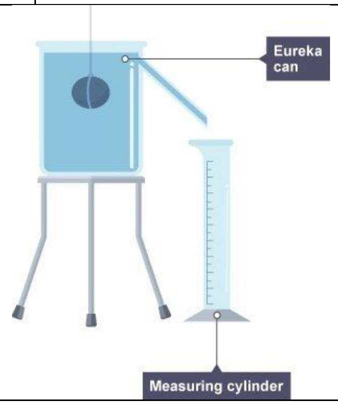
1. Particles and density

***State of matter**	Solid, liquid or gas.
***Changes of state**	Melting: solid → liquid Freezing: liquid → solid Evaporation: liquid → gas Condensation: gas → liquid Sublimation: solid → gas Deposition: gas → solid
***Solid**	Particles touching, neatly ordered, vibrating around a fixed point.
***Liquid**	Particles touching, random order, moving slowly.
***Gas**	Particles widely spaced, random order, moving fast.
****Forces of attraction**	Forces holding particles close to each other: strong in solids, weak in liquids, gone in gases.
****Changing state**	Increasing temperature gives particles more (kinetic) energy, allowing them to break the forces of attraction.
***Density**	The mass of 1 cm^3 of a substance. Units = kg / m^3

***Density and state**	Solid > liquid > gas, due to particles being closer together.
***Density calculations**	Density = mass / volume ρ = m / v Density = kilograms per cubic metre Mass = kilograms Volume = metres cubed

2. Core practical – investigating densities (CP16)

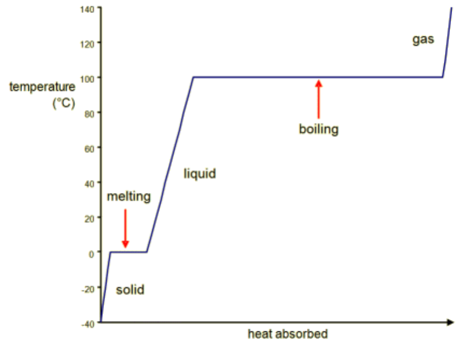
***CP16 - Aim**	To measure the density of some solids and liquids
***CP16 – Density of liquids**	Place a measuring cylinder on a balance and zero it. Add some liquid and record the mass and volume, Repeat with different liquids.
***CP16 – Density of solids**	Record the mass of a solid object. Fill a displacement can and place the object in it, catching the water in a measuring cylinder. Record the volume collected.
***CP16 – Density calculations**	Divide the mass by the volume.



3. Energy and changes of state

****Thermal energy and motion**	The hotter an object is, the faster its particles are moving.
****Temperature**	A measure of the average kinetic energy of the particles.

****Temperature vs thermal energy**	A very small hot object has less thermal energy than a very large cold object, because thermal energy is the energy of all the particles added up.
****Thermal energy depends on…**	Temperature, mass, material.
****Specific heat capacity, Q**	The amount of energy required to increase the temperature of 1 kg of a substance by 1 ^{O}C.
****Specific latent heat of evaporation**	The amount of energy required to change 1 kg of a substance (at its boiling point) from liquid to gas.
****Specific latent heat of melting**	The amount of energy required to change 1 kg of a substance (at its melting point) from solid to liquid.
****Heating curve**	As you heat a substance, the temperature rises steadily, with flat sections on the graph first as it melts, and later as it evaporates.



4. Energy calculations

****Temperature change calculations**	Thermal energy change = mass x specific heat capacity x temperature change ΔQ = m x c x ΔT Thermal energy change = J Mass = kg Specific heat capacity = J / kg Temp change = ^{O}C

****State change calculations**	Thermal energy = mass x specific latent heat Q = m x L Thermal energy = J Mass = kg Specific latent heat = J / kg

5. Core practical – investigating water (CP17)

***CP17 - Aim**	To investigate the temperature change as ice melts, and measure specific heat capacity of water.
***CP17 – Melting ice**	Place some ice in a boiling tube, measure the temperature then place the tube in a beaker of hot water from a kettle, kept warm by Bunsen, and measure temperature every 60s until fully melted.
***CP17 – Melting ice results**	Temperature rises steadily at first but levels out during melting.
***CP17 - SHC**	Place a polystyrene cup on a balance, zero it, mostly fill with water then measure the mass. Measure the temp. Use an immersion heater connected to a joulemeter to warm the water for 5 minutes and measure the temperature again.
***CP17 – SHC calculations**	SHC = energy used / (mass x temp change)

6. Gas temperature and pressure

****Temperature**	A measure of the average kinetic energy of the particles.
****Gas pressure**	Every time a gas particle hits a surface it pushes with a small force; gas pressure is the sum of these forces.
****Increasing gas pressure**	Gas pressure increases with temperature and number of particles.

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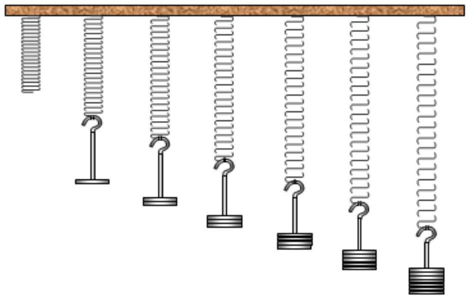
Pascals, Pa	The unit of pressure: 1 Pa = 1 N / m^2
Absolute zero, 0K	The coldest possible temperature when particles completely stop moving.
Kelvins	Measures temperatures relative to absolute zero: 0 K = absolute zero.
Kelvins and degrees Celsius	A kelvin is the same size as a degree Celsius, but 0 K = -273 ^oC, 273 K = 0 ^oC
Converting K to ^oC	Subtract 273
Converting ^oC to K	Add 273
Gas pressure and Kelvins	Gas pressure is directly proportional to temperature in K.
Absolute zero and gas pressure	Pressure is 0 Pa at 0 K because the particles are not moving.

7. Bending and stretching	
*Elastic	When something returns to its original shape after force is applied.
*Inelastic	When something doesn't return to its original shape after force is applied.
**Elasticity and force size	Some objects are elastic when a small force is applied, but inelastic when a large force is applied.
*Extension	The increase in length of a spring when a force is applied.
**Direct proportion	Doubling A doubles B, a graph of B vs A goes through the origin.
**Metal spring extension	The relationship between force and extension is linear and directly proportional, but becomes non-linear with large forces.
**Rubber band extension	The relationship between force and extension is non-linear.

8. Core practical – investigating springs (CP18)	
*CP18 - Aim	To explore how increasing the force affects the extension of a spring.
*CP18 - Setup	Suspend a spring or rubber band from a clamp stand and fix a metre ruler in place so the '0' is level with the bottom of the spring/band.
*CP18 – Measurements	Hang a 100 g (1 N) mass from the rubber band / spring, and measure the extensions. Repeat up to 1 kg.
*CP18 - Variations	Repeat with different springs.
*CP18 - Calculations	Calculate spring constant as: Spring constant = force / extension



9. Extensions and energy transfers	
*Spring constant	A measure of the strength of a spring: units = N/m
**Spring constant and graphs	The spring constant is the gradient of a graph of force vs extension.
*Force and extension calculations	Force = spring constant x extension F = k x X Force = N Spring constant = N/m Extension = m
*Extension is greater when...	Force is higher, spring constant is lower

*Work done	The energy transferred by a force.
**Spring energy calculations	Energy transferred in stretching = ½ x spring constant x $extension^2$ E = ½ x k x X^2 Energy = J Spring constant = N / m Extension = m