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OCR
Oxford Cambridge and RSA

GCSE (9–1)
Delivery Guide

GATEWAY SCIENCE PHYSICS A

J249
For first teaching in 2016

Matter

Version 1

Can also be used for teaching:
GCSE (9–1) GATEWAY SCIENCE COMBINED SCIENCE A

www.ocr.org.uk/physics

Introduction

GCSE (9–1)
GATEWAY SCIENCE PHYSICS A

Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- Content: A clear outline of the content covered by the delivery guide;
- Thinking Conceptually: Expert guidance on the key concepts involved, common difficulties students may have, approaches to teaching that can help students understand these concepts and how this topic links conceptually to other areas of the subject;
- Thinking Contextually: A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resources.feedback@ocr.org.uk

'These draft qualifications have not yet been accredited by Ofqual. They are published (along with specimen assessment materials, summary brochures and sample resources) to enable teachers to have early sight of our proposed approach.

Further changes may be required and no assurance can be given at this time that the proposed qualifications will be made available in their current form, or that they will be accredited in time for first teaching in 2016 and first award in 2018 (2017 for AS Level qualifications).'

Curriculum content Subtopic 1– The particle model

Mathematical learning outcome: **PM1.1i recall and apply: density (kg/m³)= mass (kg)/volume (m³)**
P1.1a describe how and why the atomic model has changed over time
P1.1b describe the atom as a positively charged nucleus surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with almost all of the mass in the nucleus
P1.1c recall the typical size (order of magnitude) of atoms and small molecules
P1.1d define density
P1.1e explain the differences in density between the different states of matter in terms of the arrangements of the atoms and molecules
P1.1f apply the relationship between density, mass and volume to changes where mass is conserved (M1a, M1b, M1c, M3c)

Approaches to teaching the content:

The process behind the development of the atomic model, such as the gold foil experiment by Geiger and Marsden can be difficult for learners to grasp, as radioactivity is not covered in this topic. Animations of the gold foil experiment can help learners appreciate how the observations were interpreted to create the model.

Learners should have a basic understanding of the ways in which particles behave. The chapters in this topic build strongly on these foundations so it is advisable to check prior understanding before exploring the areas on density. Modelling is a good tool when representing particles in different states of matter. This should not be new to GCSE learners, but they have possibly not made the link at Key Stage 3 between densities and the arrangements between atoms in solids, liquids and gases. The story of Archimedes and calculating the density of the gold crown can be a good starting point for density. This area is best delivered through a range of practical sessions, which can include floating and sinking predictions which are linked to subtopic P1.3.

Common misconceptions or difficulties learners may have:

Learners may have some misconceptions about particles in different states of matter that need addressing before approaching the density chapter. This can be done through assessing learners' starting points, modelling and scaffolding of responses.

Learners may also find the recall areas such as atom size difficult as a concept as they cannot be viewed. The suggested use of props and discussion of relative sizes may assist in this area.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

Statement P1.1d links with P1.3h as learners can relate density to floating and sinking in practical investigations.

Approaches to teaching the content:

A definition for density can be explored using population density on a world map. Learners can quickly work out that an area of land is more densely populated if there are more people per m^2 of land. This can then be broadened into a discussion about number of particles, their mass and volume using this analogy.

Applying the equation for density for conserved masses can be delivered practically such as with soil. The s mass of soil can be calculated however can be compressed to alter the volume, which will alter the density. Learners can make predictions based on their knowledge of this topic. These calculations can also be related to engineering e.g. foundation structures.

Activity 1

Thompson's plum pudding model of the atom

TES
https://www.tes.co.uk/teaching-resource/thomson-s-plum-pudding-model-of-the-atom-6328814

A clip just over 2 minutes in length summarising Thompson's plum pudding model. In the video in this model, the plums represent negatively charged electrons which can be 'plucked' out of the atom, leaving behind some positively charged pudding.

Activity 2

Resources to develop a learner timeline

GCSE Bitesize
http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_gateway/periodic_table/atomstrucrev5.shtml

A research link for learners to find information about the development of the atomic model. This can be used to make a timeline.

Activity 3

Resources to develop a learner timeline

ABTCE
http://www.abcte.org/files/previews/chemistry/s1_p3.html

A second research link for learners to find information about the development of the atomic model. This can be used to make a timeline or Facebook profiles to represent the information required.

Activity 4

Facebook activity

TES
https://www.tes.co.uk/teaching-resource/historical-figure-facebook-profile-6390662

General template that learners can use to represent any historical figure. This can be used for the scientists involved in the development of the atomic structure.

Activity 5

Discovering the nucleus

TES
https://www.tes.co.uk/teaching-resource/discovering-the-nucleus-6447071

Three levelled worksheets based on Geiger and Marsden's experiments. They take the learners through the practical and the results and ask a range of questions to follow. This is a good resource to use maybe as a consolidation of the topic once radiation has been looked at in more detail.

Activity 6

Geiger and Marsden's experiment

GCSE Bitesize
http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_gateway/periodic_table/atomstrucrev6.shtml

An animation to allow learners to be guided through the experiment and to check their understanding.

Activity 7

Visualising the size of an atom and small molecules

ehow
http://www.ehow.com/how_7378966_compare-size-atom.html

This short instruction sheet provides teachers with ideas to use in the classroom that will enable learners to better visualise the sizes of atoms.

Activity 8

Density: A story of Archimedes and the gold crown

YouTube
https://www.youtube.com/watch?v=KMNwXUCXLdk

A video summarising the story of Archimedes and the gold crown which is a good introduction to getting learners thinking about density and its relationship with mass and volume.

Activity 9

Population density graph

Geography online
http://www.geogonline.org.uk/images/popdens1.gif

A population density graph which will enable learners to discuss the definition of density based on people.

Activity 10

Density experiments

Steve Spangler science
http://www.stevespanglerscience.com/lab/experiments/category/density

Numerous free videos and experiment sheets for density experiments that can be printed straight from the website and used for whole class practical activities. Calculations can be completed based on many of the results.

Mathematical learning outcome: **PM1.2i apply: change in thermal energy = mass x specific heat capacity x change in temperature**
PM1.2ii apply: thermal energy for a change in state = m x specific latent heat
P1.2a describe how mass is conserved when substances melt, freeze, evaporate, condense or sublimate
P1.2b describe that these physical changes differ from chemical changes because the material recovers its original properties if the change is reversed
P1.2c describe how heating a system will change the energy stored within the system and raise its temperature or produce changes of state
P1.2 d define the term specific heat capacity and distinguish between it and the term specific latent heat
P1.2e apply the relationship between change in internal energy of a material and its mass, specific heat capacity and temperature change to calculate the energy change involved (M1a, M3c, M3d)
P1.2f apply the relationship between specific latent heat and mass to calculate the energy change involved in a change of state (M1a, M3c, M3d)

Approaches to teaching the content:

Learners have learnt about changes of state in Key Stages 2 and 3, some may still have misconceptions about what happens. This can then hinder learners progressing into understanding the more difficult topics of specific heat capacity and specific latent heat. A good way of overcoming these basic challenges is to allow learners to heat a certain mass of ice until it boils. They should observe all of the changes taking place and discuss what is happening at each point.

There are a lot of important key concepts in this subtopic surrounding heat, energy and changes of state. Learners should have an understanding from Key Stage 3 about the energy transfer between two adjacent objects. For clearer understanding learners need to know that the absorption of energy can change the state of matter, not just change the temperature.

Constructing a heating curve for water allows learners to become familiar with not only the states, but also that there is no significant temperature rise during melting, freezing and boiling. For the most able learners a full explanation is needed about why temperature does not increase when a change of state occurs. They should be able to explain that energy supplied during a change of state is used to break inter-molecular bonds and this explains why temperature does not change. This is a good time to introduce the concept of specific latent heat.

Specific heat capacity can be another challenging area for learners to grasp as the term sounds similar to specific latent heat and the equation can seem daunting. It would be advisable to deliver specific heat and specific latent heat separately and using different concepts, e.g. energy changes in different fuels are a common experiment when investigating specific heat capacity. Learners can then collect results and use the equation to calculate the thermal energy change.

Common misconceptions or difficulties learners may have:

To overcome some of the misconceptions learners may have about conservation of mass when changing states learners can complete simple experiments which can challenge their thinking, such as ice cubes in a bag, and discussing of what actually happens to the mass when it melts. Another is to consider a wet item of clothing on a washing line and thinking about where exactly the water goes when the item dries. Short observation based experiments followed by small group discussions can elicit deeper responses from learners. A link for these is provided in the resource section.

Wherever possible learners should develop the mathematical learning outcomes for this subtopic based on practical work. This can make it seem less complex for learners who may find applying formulae difficult.

Learners may confuse the definitions for specific heat capacity and specific latent heat. The following definitions should be known:

Specific heat capacity of a material is the energy needed to raise the temperature of 1 kg by 1K and that different materials have different specific heat capacities.

Specific latent heat of a material is the energy needed to melt or boil 1 kg of it and that different materials have different latent heats.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

The knowledge of heat, temperature, changes of state and energy changes gained in this subtopic is helpful when learners begin P1.3, exploring pressure and how molecules move with changing temperature.

Approaches to teaching the content:

The mathematical outcomes for this subtopic are best delivered practically and using an industrial context that is topical and relevant such as the best fuel for a car, or could be based on fuels for a new housing development and learners act as energy consultants.

When considering changes of state, contexts such as the atmosphere and the effect of global warming on sea levels, may make it more relevant to some learners.

Activities Subtopic 2 – The changes of state

Activity 1

Probing for learners understanding

Beyond penguins and polar bears
https://beyondpenguins.ehe.osu.edu/issue/water-ice-and-snow/common-misconceptions-about-states-and-changes-of-matter-and-the-water-cycle

This is a website to assist teachers new to delivering some of the concepts in this topic.

Activity 2

Sublime iodine

Royal Society of Chemistry
http://www.rsc.org/eic/2013/10/exchem0113-sublime-iodine

A short video clip showing the sublimation of iodine.

Activity 3

Specific heat capacity video

YouTube
https://www.youtube.com/watch?v=D3CwpfBzF94

A short video showing what specific heat capacity is and how it can be calculated.

Activity 4

Measuring heat energy of fuels

Nuffield Science
http://www.nuffieldfoundation.org/practical-chemistry/measuring-heat-energy-fuels

This link provides the information needed to complete a class practical. It provides guidance for measuring the heat energy of fuels. Contains apparatus list, technician notes, and procedure and teaching notes.

Activity 5

Latent heat of fusion of Ice

School Physics
http://www.schoolphysics.co.uk/age14-16/Heat%20energy/Heat%20energy/experiments/Latent_heat_of_fusion.doc

A downloadable document covering a practical that can be carried out with a class to determine the specific latent heat of ice.

Activity 6

Specific heat capacity puzzle

TES
https://www.tes.co.uk/teaching-resource/specific-heat-capacity-puzzle-cards-3013495

This link provides a printable set of 15 cards, some that contain questions and others that contain general information. Learners should work in small groups with one complete set of cards. The aim is to answer the questions using the information given. This is a good introduction to specific heat capacity, and can take learners approximately 30 minutes to gather the information they require.

Activity 7

Specific latent heat worksheet

TES
https://www.tes.co.uk/teaching-resource/specific-latent-heat-worksheet-6138471

Example questions for specific latent heat using calculations.

Mathematical learning outcome:
PM1.3i apply: for gases: pressure (Pa) x volume (m^3) = constant (for a given mass of gas and at a constant temperature)
PM1.3ii apply: pressure due to a column of liquid (Pa) = height of column (m) x density of liquid (kg/m^3) x g (N/kg) (HT)
P1.3a explain how the motion of the molecules in a gas is related both to its temperature and its pressure
P1.3b Explain the relationship between the temperature of a gas and its pressure at volume (qualitative only)
P1.3c recall that gases can be compressed or expanded by pressure changes and that the pressure produces a net force at right angles to any surface
P1.3d explain how increasing the volume in which a gas is contained, at constant temperature can lead to a decrease in pressure
P1.3e explain how doing work on a gas can increase its temperature (HT)
P1.3f describe a simple model of the Earth's atmosphere and of atmospheric pressure
P1.3g explain why atmospheric pressure varies with height above the surface
P1.3h describe the factors which influence floating and sinking (HT)
P1.3i explain why pressure in a liquid varies with depth and density and how this leads to an upwards force on a partially submerged object (HT)
P1.3j calculate the differences in pressure at different depths in a liquid

Approaches to teaching the content:

Several of the statements are new to the GCSE course but are generally covered at Key Stage 5. Boyle's law investigates the pressure and volume relationship. This can be demonstrated using animations, or by providing learners with a set of results and asking them to find the relationship in a data analysis exercise. Learners will find it easier to describe and explain this as a concept once they have found the relationship and calculated the constant.

The concept of pressure due to a column of liquid is also new to Key Stage 4. The best approach is to use a manometer and demonstrate that pressure can be calculated using height, density and gravity. If this equipment is not readily available there are some computer based simulations available for learners to access.

When 'work is done to a gas' its temperature increases. It is the additional energy that increases the internal energy of the molecules. Learner modelling with learners being the particles under pressure or using some of the simple suggestions in the resource section.

Common misconceptions or difficulties learners may have:

When exploring the compression of gases and increasing the temperature of the system it may be useful to adopt the term 'internal energy'. This enables learners to better explain that it is an increase in energy that is resulting in the temperature change.

It can be a difficult concept to explain that when a gas is compressed or expanded by pressure changes the pressure produces a net force at right angles to any surface. This can be easily demonstrated by allowing learners to half inflate a balloon and then press down on it from the top. The balloon will move outwards laterally which is demonstrating the force being at right angles to the force being exerted.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

Learners have explored density in Subtopic P1.1 and will have previously explored forces in Key Stage 3. This knowledge will act as a good foundation for forces and resultant force ideas that will result in the sinking or floating of objects.

Learners will already have a good understanding of particles and kinetic energy from subtopic P1.2. This will be required when considering how temperature has an effect on the molecules motion.

Approaches to teaching the content:

There are many contexts that can be used to help develop key ideas in this subtopic. Many of the contexts will have been experienced by learners using household items. Hand bicycle pumps could be used in class to demonstrate work done causing an increase in temperature.

When discussing the concepts of pressure increasing with depth under water scuba diving scenarios could be used.

Barometers can be a good example of how manometers work using the mathematical learning outcome PM1.3ii.

Activity 1

Boyle's law animation (Pressure x volume = a constant)

Pass my exams
http://www.passmyexams.co.uk/GCSE/physics/pressure-volume-relationship-of-gas-Boyles-law.html

This is a learner revision site; however the animation is really helpful to introduce the concept of Boyle's law.

Activity 2

Measuring gas pressure using a manometer

Institute of Physics, Nuffield foundation
http://www.nuffieldfoundation.org/practical-physics/measuring-gas-pressure-using-manometers

This experiment explores the use of a manometer to measure pressure in a column of liquid.

Activity 3

Physics fact sheet 99

Curriculum press
https://online.uwl.ac.uk/bbcswebdav/institution/TVU_Reading/14-19_Academy/Sixth_Form_Academy/Science/Physics/Physics%20Factsheets/Factsheets/99%20Gas%20Laws%20pract.pdf

Some gas law practicals. The majority of these are at AS level, however the Boyle's law experiment is helpful.

Activity 4

The physics hyper textbook

http://physics.info/gas-laws/

Useful mini practical's that can be completed very simply to demonstrate what happens during changes in volume creating a temperature change.

Activity 5

Gas laws learner activity

NClark
http://www.nclark.net/GasLaws

A website link which takes you to a virtual gas lab where temperature and pressure can be altered. There are questions that can then be answered based on the results of the gas lab.

Activity 6

Up thrust, floatation and liquid pressure

School Physics
https://www.tes.co.uk/teaching-resource/upthrust-flotation-and-liquid-pressure-6264338

Animation and a worksheet to follow based on what has been observed. Requires flash player.

Activity 7

Atmospheric pressure problems

School Physics
https://www.tes.co.uk/teaching-resource/atmospheric-pressure-problems-6263729

An independent research worksheet on atmospheric pressure and the problems it can cause.

Activity 8

The Goldilocks principle – a model of atmospheric gases

UCAR education
https://www.ucar.edu/learn/1_1_2_1t.htm

Learners use jelly beans and coloured cotton wool to produce a model of Earth's atmosphere. This can be completed as a comparison between Earth and the other 'sister' planets in a hands on way. There is background information for teachers before scrolling down the webpage and there is an equipment and a procedure section.

The small print

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