AQA Realising potential

Physics

Co-teaching Combined Science and Physics

April 2016

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Physics only content

4.2.5 Static electricity (physics only)

4.2.5.1 Static charge

Content	Key opportunities for skills development
When certain insulating materials are rubbed against each other they become electrically charged. Negatively charged electrons are rubbed off one material and on to the other. The material that gains electrons becomes negatively charged. The material that loses electrons is left with an equal positive charge. When two electrically charged objects are brought close together they exert a force on each other. Two objects that carry the same type of charge repel. Two objects that carry different types of charge attract. Attraction and repulsion between two charged objects are examples of non-contact force. Students should be able to: • describe the production of static electricity, and sparking, by rubbing surfaces • describe evidence that charged objects exert forces of attraction or repulsion on one another when not in contact • explain how the transfer of electrons between objects can explain the phenomena of static electricity.	

4.2.5.2 Electric fields

Content	Key opportunities for skills development
A charged object creates an electric field around itself. The electric field is strongest close to the charged object. The further away from the charged object, the weaker the field. A second charged object placed in the field experiences a force. The force gets stronger as the distance between the objects decreases. Students should be able to: • draw the electric field pattern for an isolated charged sphere • explain the concept of an electric field	
• explain how the concept of an electric field helps to explain the non-contact force between charged objects as well as other electrostatic phenomena such as sparking.	WS 1.2, 1.5

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4.3.3.2 Pressure in gases (physics only)

Content	Key opportunities for skills development
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).	WS 1.2
Students should be able to use the particle model to explain how increasing the volume in which a gas is contained, at constant temperature, can lead to a decrease in pressure. For a fixed mass of gas held at a constant temperature: pressure × volume = constant $p\,V = constant$ pressure, *p*, in pascals, Pa volume, *V*, in metres cubed, m^3 Students should be able to calculate the change in the pressure of a gas or the volume of a gas (a fixed mass held at constant temperature) when either the pressure or volume is increased or decreased.	MS 3b, c Students should be able to apply this equation which is given on the *Physics equation sheet*.

4.3.3.3 Increasing the pressure of a gas (physics only) (HT only)

Content	Key opportunities for skills development
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.	
Students should be able to explain how, in a given situation eg a bicycle pump, doing work on an enclosed gas leads to an increase in the temperature of the gas.	WS 1.2

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4.4.3 Hazards and uses of radioactive emissions and of background radiation (physics only)

4.4.3.1 Background radiation

Content	Key opportunities for skills development
Background radiation is around us all of the time. It comes from: • natural sources such as rocks and cosmic rays from space • man-made sources such as the fallout from nuclear weapons testing and nuclear accidents. The level of background radiation and radiation dose may be affected by occupation and/or location.	
Radiation dose is measured in sieverts (Sv) 1000 millisieverts (mSv) = 1 sievert (Sv) Students will not need to recall the unit of radiation dose.	WS 4.4

4.4.3.2 Different half-lives of radioactive isotopes

Content	Key opportunities for skills development
Radioactive isotopes have a very wide range of half-life values. Students should be able to explain why the hazards associated with radioactive material differ according to the half-life involved.	MS 1b Students should be able to use data presented in standard form.

4.4.3.3 Uses of nuclear radiation

Content	Key opportunities for skills development
Nuclear radiations are used in medicine for the: • exploration of internal organs • control or destruction of unwanted tissue. Students should be able to:	
• describe and evaluate the uses of nuclear radiations for exploration of internal organs, and for control or destruction of unwanted tissue	WS 1.4
• evaluate the perceived risks of using nuclear radiations in relation to given data and consequences.	WS 1.5

4.4.4 Nuclear fission and fusion (physics only)

4.4.4.1 Nuclear fission

Content	Key opportunities for skills development
Nuclear fission is the splitting of a large and unstable nucleus (eg uranium or plutonium). Spontaneous fission is rare. Usually, for fission to occur the unstable nucleus must first absorb a neutron. The nucleus undergoing fission splits into two smaller nuclei, roughly equal in size, and emits two or three neutrons plus gamma rays. Energy is released by the fission reaction. All of the fission products have kinetic energy. The neutrons may go on to start a chain reaction. The chain reaction is controlled in a nuclear reactor to control the energy released. The explosion caused by a nuclear weapon is caused by an uncontrolled chain reaction. Students should be able to draw/interpret diagrams representing nuclear fission and how a chain reaction may occur.	

4.4.4.2 Nuclear fusion

Content	Key opportunities for skills development
Nuclear fusion is the joining of two light nuclei to form a heavier nucleus. In this process some of the mass may be converted into the energy of radiation.	

4.5.4 Moments, levers and gears (physics only)

Content	Key opportunities for skills development
A force or a system of forces may cause an object to rotate. Students should be able to describe examples in which forces cause rotation. The turning effect of a force is called the moment of the force. The size of the moment is defined by the equation:	
moment of a force = force × distance $M = F d$ moment of a force, M, in newton-metres, Nm force, F, in newtons, N distance, d, is the perpendicular distance from the pivot to the line of action of the force, in metres, m. If an object is balanced, the total clockwise moment about a pivot equals the total anticlockwise moment about that pivot. Students should be able to calculate the size of a force, or its distance from a pivot, acting on an object that is balanced. A simple lever and a simple gear system can both be used to transmit the rotational effects of forces. Students should be able to explain how levers and gears transmit the rotational effects of forces.	MS 3c Students should be able to recall and apply this equation.

4.5.5 Pressure and pressure differences in fluids (physics only)

4.5.5.1 Pressure in a fluid

4.5.5.1.1 Pressure in a fluid 1

Content	Key opportunities for skills development
A fluid can be either a liquid or a gas. The pressure in fluids causes a force normal (at right angles) to any surface. The pressure at the surface of a fluid can be calculated using the equation:	
$\text{pressure} = \frac{\text{force normal to a surface}}{\text{area of that surface}}$ $\left[p = \frac{F}{A}\right]$	MS 3c Students should be able to recall and

Content	Key opportunities for skills development
pressure, p, in pascals, Pa force, F, in newtons, N area, A, in metres squared, m^2	apply this equation.

4.5.5.1.2 Pressure in a fluid 2 (HT only)

Content	Key opportunities for skills development
The pressure due to a column of liquid can be calculated using the equation:	
pressure = height of the column × density of the liquid × gravitational field strength [$p = h\,\rho\,g$] pressure, p, in pascals, Pa height of the column, h, in metres, m density, ρ, in kilograms per metre cubed, kg/m^3 gravitational field strength, g, in newtons per kilogram, N/kg (In any calculation the value of the gravitational field strength (g) will be given.)	MS 3b, 3c WS 4.3, 4.4, 4.5, 4.6 Students should be able to apply this equation which is given on the *Physics equation sheet*.
Students should be able to explain why, in a liquid, pressure at a point increases with the height of the column of liquid above that point and with the density of the liquid.	
Students should be able to calculate the differences in pressure at different depths in a liquid.	MS 1c, 3c
A partially (or totally) submerged object experiences a greater pressure on the bottom surface than on the top surface. This creates a resultant force upwards. This force is called the upthrust.	
Students should be able to describe the factors which influence floating and sinking.	

4.5.5.2 Atmospheric pressure

Content	Key opportunities for skills development
The atmosphere is a thin layer (relative to the size of the Earth) of air round the Earth. The atmosphere gets less dense with increasing altitude. Air molecules colliding with a surface create atmospheric pressure. The number of air molecules (and so the weight of air) above a surface decreases as the height of the surface above ground level increases. So as height increases there is always less air above a surface than there is at a lower height. So atmospheric pressure decreases with an increase in height.	

Students should be able to: • describe a simple model of the Earth's atmosphere and of atmospheric pressure • explain why atmospheric pressure varies with height above a surface.	WS 1.2

4.5.7.3 Changes in momentum (physics only)

Content	Key opportunities for skills development
When a force acts on an object that is moving, or able to move, a change in momentum occurs.	
The equations $F = m \times a$ and $a = \frac{v - u}{t}$ combine to give the equation $F = \frac{m \Delta v}{\Delta t}$ where $m\Delta v$ = change in momentum ie force equals the rate of change of momentum.	MS 3b, c Students should be able to apply this equation which is given on the *Physics Equation sheet.*
Students should be able to explain safety features such as: air bags, seat belts, gymnasium crash mats, cycle helmets and cushioned surfaces for playgrounds with reference to the concept of rate of change of momentum.	WS 1.2, 4
Students should be able to apply equations relating force, mass, velocity and acceleration to explain how the changes involved are inter-related.	MS 3b, 3c, 3d

4.6.1.3 Reflection of waves (physics only)

Content	Key opportunities for skills development
Waves can be reflected at the boundary between two different materials. Waves can be absorbed or transmitted at the boundary between two different materials.	
Students should be able to construct ray diagrams to illustrate the reflection of a wave at a surface. Students should be able to describe the effects of reflection, transmission and absorption of waves at material interfaces.	MS 5a, 5c WS 1.2

Required practical activity 9 (physics only): investigate the reflection of light by different types of surface and the refraction of light by different substances.

AT skills covered by this practical activity: AT 4 and 8.

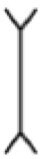
4.6.1.4 Sound waves (physics only) (HT only)

Content	Key opportunities for skills development
Sound waves can travel through solids causing vibrations in the solid. Within the ear, sound waves cause the ear drum and other parts to vibrate which causes the sensation of sound. The conversion of sound waves to vibrations of solids works over a limited frequency range. This restricts the limits of human hearing. Students should be able to: • describe, with examples, processes which convert wave disturbances between sound waves and vibrations in solids. Examples may include the effect of sound waves on the ear drum • explain why such processes only work over a limited frequency range and the relevance of this to human hearing. Students should know that the range of normal human hearing is from 20 Hz to 20 kHz.	

4.6.1.5 Waves for detection and exploration (physics only) (HT only)

Content	Key opportunities for skills development
Students should be able to explain in qualitative terms, how the differences in velocity, absorption and reflection between different types of wave in solids and liquids can be used both for detection and exploration of structures which are hidden from direct observation.	
Ultrasound waves have a frequency higher than the upper limit of hearing for humans. Ultrasound waves are partially reflected when they meet a boundary between two different media. The time taken for the reflections to reach a detector can be used to determine how far away such a boundary is. This allows ultrasound waves to be used for both medical and industrial imaging. Seismic waves are produced by earthquakes. P-waves are longitudinal, seismic waves. P-waves travel at different speeds through solids and liquids. S-waves are transverse, seismic waves. S-waves cannot travel through a liquid. P-waves and S-waves provide evidence for the structure and size of the Earth's core. Echo sounding, using high frequency sound waves is used to detect objects in deep water and measure water depth.	WS 1.4
Students should be aware that the study of seismic waves provided new evidence that led to discoveries about parts of the Earth which are not directly observable.	WS 1.1

4.6.2.5 Lenses (physics only)

Content	Key opportunities for skills development
A lens forms an image by refracting light. In a convex lens, parallel rays of light are brought to a focus at the principal focus. The distance from the lens to the principal focus is called the focal length. Ray diagrams are used to show the formation of images by convex and concave lenses.	
The image produced by a convex lens can be either real or virtual. The image produced by a concave lens is always virtual.	
Students should be able to construct ray diagrams to illustrate the similarities and differences between convex and concave lenses.	MS 5a, 5c WS 1.2
The magnification produced by a lens can be calculated using the equation:	
magnifcation $= \frac{\text{image height}}{\text{object height}}$ Magnification is a ratio and so has no units. Image height and object height should both be measured in either mm or cm.	MS 3b, c Students should be able to apply this equation which is given on the *Physics equation sheet*.
In ray diagrams a convex lens will be represented by:  A concave lens will be represented by: 	AT 4, 8 Investigate the magnification produced by a range of convex lenses.

4.6.2.6 Visible light (physics only)

Content	Key opportunities for skills development
Each colour within the visible light spectrum has its own narrow band of wavelength and frequency.	
Reflection from a smooth surface in a single direction is called specular reflection. Reflection from a rough surface causes scattering: this is called diffuse reflection.	
Colour filters work by absorbing certain wavelengths (and colour) and transmitting other wavelengths (and colour).	

The colour of an opaque object is determined by which wavelengths of light are more strongly reflected. Wavelengths that are not reflected are absorbed. If all wavelengths are reflected equally the object appears white. If all wavelengths are absorbed the objects appears black. Objects that transmit light are either transparent or translucent. Students should be able to explain: • how the colour of an object is related to the differential absorption, transmission and reflection of different wavelengths of light by the object • the effect of viewing objects through filters or the effect on light of passing through filters • why an opaque object has a particular colour.	

4.6.3 Black body radiation (physics only)

4.6.3.1 Emission and absorption of infrared radiation

Content	Key opportunities for skills development
All bodies (objects), no matter what temperature, emit and absorb infrared radiation. The hotter the body, the more infrared radiation it radiates in a given time. A perfect black body is an object that absorbs all of the radiation incident on it. A black body does not reflect or transmit any radiation. Since a good absorber is also a good emitter, a perfect black body would be the best possible emitter.	

4.6.3.2 Perfect black bodies and radiation

Content	Key opportunities for skills development
Students should be able to explain: • that all bodies (objects) emit radiation • that the intensity and wavelength distribution of any emission depends on the temperature of the body. (HT only) A body at constant temperature is absorbing radiation at the same rate as it is emitting radiation. The temperature of a body increases when the body absorbs radiation faster than it emits radiation. (HT only) The temperature of the Earth depends on many factors including: the rates of absorption and emission of radiation, reflection of radiation into space. (HT only) Students should be able to explain how the temperature	

of a body is related to the balance between incoming radiation absorbed and radiation emitted, using everyday examples to illustrate this balance, and the example of the factors which determine the temperature of the Earth.	
(HT only) Students should be able to use information, or draw/ interpret diagrams to show how radiation affects the temperature of the Earth's surface and atmosphere.	WS 1.2

4.7.2.4 Loudspeakers (physics only) (HT only)

Content	Key opportunities for skills development
Loudspeakers and headphones use the motor effect to convert variations in current in electrical circuits to the pressure variations in sound waves. Students should be able to explain how a moving-coil loudspeaker and headphones work.	

4.7.3 Induced potential, transformers and the National Grid (physics only) (HT only)

4.7.3.1 Induced potential (HT only)

Content	Key opportunities for skills development
If an electrical conductor moves relative to a magnetic field or if there is a change in the magnetic field around a conductor, a potential difference is induced across the ends of the conductor. If the conductor is part of a complete circuit, a current is induced in the conductor. This is called the generator effect. An induced current generates a magnetic field that opposes the original change, either the movement of the conductor or the change in magnetic field. Students should be able to recall the factors that affect the size of the induced potential difference/induced current. Students should be able to recall the factors that affect the direction of the induced potential difference/induced current. Students should be able to apply the principles of the generator effect in a given context.	

4.7.3.2 Uses of the generator effect (HT only)

Content	Key opportunities for skills development
The generator effect is used in an alternator to generate ac and in a dynamo to generate dc. Students should be able to: • explain how the generator effect is used in an alternator to generate ac and in a dynamo to generate dc • draw/interpret graphs of potential difference generated in the coil against time.	WS 1.4

4.7.3.3 Microphones (HT only)

Content	Key opportunities for skills development
Microphones use the generator effect to convert the pressure variations in sound waves into variations in current in electrical circuits. Students should be able to explain how a moving-coil microphone works.	

4.7.3.4 Transformers (HT only)

Content	Key opportunities for skills development
A basic transformer consists of a primary coil and a secondary coil wound on an iron core. Iron is used as it is easily magnetised. Knowledge of laminations and eddy currents in the core is not required. The ratio of the potential differences across the primary and secondary coils of a transformer V_p and V_s depends on the ratio of the number of turns on each coil, n_p and n_s.	
$\left[\frac{V_p}{V_s} = \frac{N_p}{N_s}\right]$ potential difference, V_p and V_s in volts, V In a step-up transformer $V_s > V_p$ In a step-down transformer $V_s < V_p$ If transformers were 100% efficient, the electrical power output would equal the electrical power input.	MS 3b, c Students should be able to apply this equation which is given on the *Physics equation sheet.*
$V_s \times I_s = V_p \times I_p$ Where $V_s \times I_s$ is the power output (secondary coil) and $V_p \times I_p$ is the power input (primary coil). power input and output, in watts, W Students should be able to: • explain how the effect of an alternating current in one coil in inducing a current in another is used in transformers • explain how the ratio of the potential differences across the two coils depends on the ratio of the number of turns on each	MS 3b, c Students should be able to apply this equation which is given on the *Physics equation sheet.*

• calculate the current drawn from the input supply to provide a particular power output • apply the equation linking the p.d.s and number of turns in the two coils of a transformer to the currents and the power transfer involved, and relate these to the advantages of power transmission at high potential differences.	MS 1c, 3b, c

4.8 Space physics (physics only)

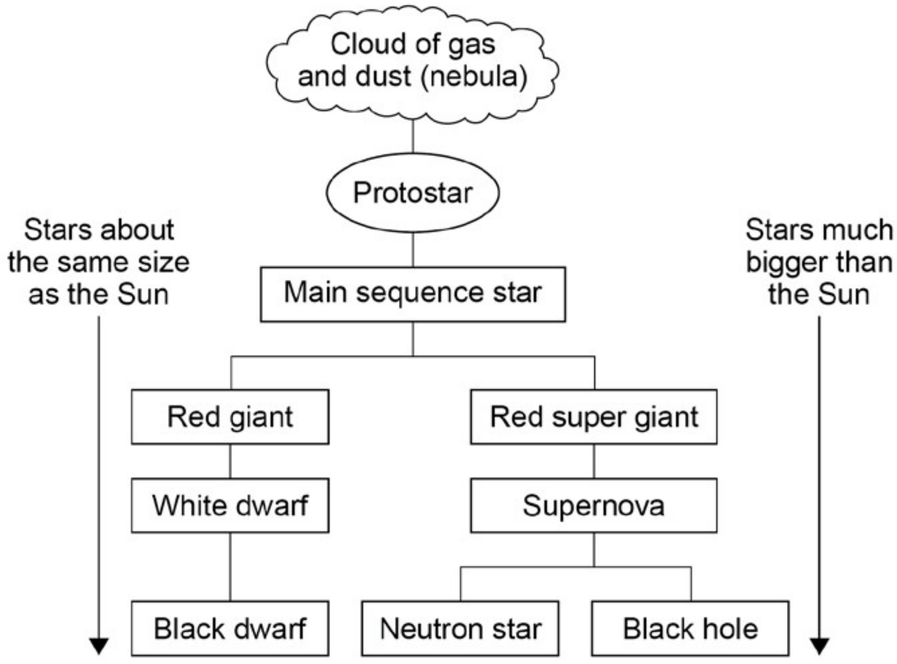
4.8.1 Solar system; stability of orbital motions; satellites (physics only)

4.8.1.1 Our solar system

Content	Key opportunities for skills development
Within our solar system there is one star, the Sun, plus the eight planets and the dwarf planets that orbit around the Sun. Natural satellites, the moons that orbit planets, are also part of the solar system. Our solar system is a small part of the Milky Way galaxy. The Sun was formed from a cloud of dust and gas (nebula) pulled together by gravitational attraction. Students should be able to explain: • how, at the start of a star's life cycle, the dust and gas drawn together by gravity causes fusion reactions • that fusion reactions lead to an equilibrium between the gravitational collapse of a star and the expansion of a star due to fusion energy.	

4.8.1.2 The life cycle of a star

Content	Key opportunities for skills development
A star goes through a life cycle. The life cycle is determined by the size of the star. Students should be able to describe the life cycle of a star: • the size of the Sun • much more massive than the Sun.	



Fusion processes in stars produce all of the naturally occurring elements. Elements heavier than iron are produced in a supernova.

The explosion of a massive star (supernova) distributes the elements throughout the universe.

Students should be able to explain how fusion processes lead to the formation of new elements.

4.8.1.3 Orbital motion, natural and artificial satellites

Content	Key opportunities for skills development
Gravity provides the force that allows planets and satellites (both natural and artificial) to maintain their circular orbits. Students should be able to describe the similarities and distinctions between the planets, their moons, and artificial satellites. (HT only) Students should be able to explain qualitatively how: • (HT only) for circular orbits, the force of gravity can lead to changing velocity but unchanged speed • (HT only) for a stable orbit, the radius must change if the speed changes.	

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4.8.2 Red-shift (physics only)

Content	Key opportunities for skills development
There is an observed increase in the wavelength of light from most distant galaxies. The further away the galaxies, the faster they are moving and the bigger the observed increase in wavelength. This effect is called red-shift.	
The observed red-shift provides evidence that space itself (the universe) is expanding and supports the Big Bang theory.	
The Big Bang theory suggests that the universe began from a very small region that was extremely hot and dense.	WS 1.2
Since 1998 onwards, observations of supernovae suggest that distant galaxies are receding ever faster.	
Students should be able to explain: • qualitatively the red-shift of light from galaxies that are receding • that the change of each galaxy's speed with distance is evidence of an expanding universe • how red-shift provides evidence for the Big Bang model • how scientists are able to use observations to arrive at theories such as the Big Bang theory	
• that there is still much about the universe that is not understood, for example dark mass and dark energy.	WS 1.1, 1.3