GCSE Science – Schemes of Work

Physics

Unit 3: Physics 3

Spec Reference	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 & resources *reference to past questions that indicate success*
P3.1 Medical applications of physics Physics has many applications in the field of medicine. These include the uses of X-rays and ultrasound for scanning, and of light for image formation with lenses and endoscopes.						
P3.1.3 Lenses						
a	Refraction is the change of direction of light as it passes from one medium to another. *Refractive index =* $\frac{\sin i}{\sin r}$	Describe how light is refracted when passing from one medium to another. Use the equation for refractive index	4	**Presenting and writing descriptions and explanations** Use ray and wave-front diagrams to describe and explain refraction. Calculations of refractive index using the results of practical experiments	**Obtaining and presenting primary evidence** *Does light always travel in straight lines?* Demonstration of refraction effects. Experiment to measure angles i and r for light passing through a rectangular glass block.	*P3.1.3 Lenses success criteria items PowerPoint* An interactive demonstration of refraction can be found at www.upscale.utoronto.ca/PVB/Harrison/Flash/Optics/Refraction/Refraction.html
b	A lens forms an image by refracting light.	Describe how a lens refracts light.				
c	In a convex or converging lens, parallel rays of light are brought to a focus at the principal	Define and use the terms associated with lenses, which includes 'convex', 'converging' and 'diverging', 'principal focus' and 'focal length'.		**Applications, implications and cultural understanding** Research uses of lenses.	Observing images of objects at different distances from converging and diverging lenses of different focal lengths. Experiment to find the focal	

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2 of 23

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	focus. The distance from the lens to the principal focus is called the focal length.			**Presenting and writing descriptions and explanations** Draw accurate and correctly labelled ray diagrams	length of different converging and diverging lenses by passing parallel rays of light through them. Measurement of the focal length of a converging lens by focusing a distant object on a screen.	
d	The nature of an image is defined by its size relative to the object, whether it is upright or inverted relative to the object and whether it is real or virtual.	Define and use the terms associated with images, which include 'upright' and 'inverted', 'real' and 'virtual', 'enlarged' and 'diminished'.		**Developing explanations using ideas and models** Use a ray diagram to explain the nature of a real and a virtual image		
e	The nature of the image produced by a converging lens for an object placed at different distances from the lens.	Describe the nature of the images formed by a converging lens when the object is at different distances from the lens, and the imaged formed by a diverging lens.		**Developing explanations using ideas and models** Draw ray diagrams to show image formation in converging and diverging lenses. Use the diagrams to work out magnification.	*Can an image just exist in your imagination?* Observation of various virtual images	

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Opportunities & resources

reference to past questions that indicate success |
|---|---|---|---|---|---|---|
| f | The use of a converging lens as a magnifying glass. | | | | | |
| g | The nature of the image produced by a diverging lens. | Draw diagrams to show the nature of the images formed by a converging lens when the object is at different distances from the lens, and the imaged formed by a diverging lens. | | | | |
| h | The construction of ray diagrams to show the formation of images by converging and diverging lenses. | | | | | |
| i | The magnification produced by a lens is calculated using the equation:

magnification = <u>image height</u>
                 object height | Use the magnification equation. | | | | |

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4 of 23

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P3.1.4 The eye						
a b c d	The structure of the eye. Correction of vision using convex and concave lenses to produce an image on the retina. Range of vision. The eye can focus on objects between the near point and the far point. Comparison between the structure of the eye and the camera.	Describe the function of parts of the eye: retina, lens, cornea, pupil/iris, ciliary muscle and suspensory ligaments. Explain how the action of the ciliary muscle causes changes in the shape of the lens, which allows the light to be focused at varying distances. Recall that the near point is approximately 25 cm and the far point is infinity. Be aware that the film in a camera or the charge-coupled devices (CCDs) in a digital camera is the equivalent of the retina in the eye.	3	**Presenting and writing descriptions and explanations** **Communication for audience and purpose** Design a poster showing how the eye works and how defects are corrected. Produce a chart showing the similarities and differences between a camera and the eye.	*Do we really see everything upside down?* **Working critically with primary evidence** Demonstration of model eye, eg biological model in sections. Demonstration of model eye with short and long sight and the use of lenses to correct these defects. **Obtaining and presenting primary evidence** Experiment to measure the near point. *Do cameras need glasses?* Build a pin-hole camera. Investigate the nature of the image and the effect of changes in the number and size of the pin-hole. Investigate the effect of using a lens in front of a large pinhole? Measurement of the focal	P3.1.4 The eye success criteria items powerpoint

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5 of 23

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e f g	The power of a lens is given by: $P = \dfrac{1}{f}$ The focal length of a lens is determined by: • the refractive index of the material from which the lens is made. • the curvature of the two surfaces of the lens. **HT only** **For a given focal length, the greater the refractive index, the flatter the lens. This means that the lens can be manufactured thinner.**	Use the equation for the power of a lens, where P is power in dioptres (D) and f is focal length in metres (m). Recall that the power of a converging lens is positive and the power of a diverging lens is negative.		Calculation of the power of a lens. **Applications, implications and cultural understanding** Research into why fewer people have very thick glasses nowadays compared with in previous years.	length of lenses and calculations of their power.	

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6 of 23

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P3.1.5 Other applications using light						
a	Total internal reflection and critical angle: **HT only** *Refractive index =* $\dfrac{1}{\sin c}$	Describe and explain the concept of total internal reflection and critical angle. **HT only** **Use the relationship between refractive index and critical angle.**	2	**Presenting and writing descriptions and explanations**	**Obtaining and presenting primary evidence** *How can light be bent around corners?* Experiment/ demonstration using semi-circular blocks to observe total internal reflection and to measure the critical angle.	[P3.1.5 Other applications using light success criteria items powerpoint](#) A computer simulation of total internal reflection can be found at [www.upscale.utoronto.ca/PVB/Harrison/Flash/Optics/Refraction/Refraction.html](#)
b	Visible light can be sent along optical fibres.	Describe the use of endoscopes for internal imaging.		Use ray diagrams to explain how light can pass along an optical fibre. **Applications, implications and cultural understanding** Produce a poster aimed at a patient to explain how an endoscope works.	Observation of light passing through optical fibres. Demonstration of total internal reflection by laser focused on jet of water coming from a pierced carbonated drinks bottle.	
c	The laser as an energy source for cutting, cauterising and burning.	Be aware of uses of lasers such as in eye surgery.		Research what a laser is and what its medical uses are.		

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P3.1.1 X-rays						
a b c	X-rays are part of the electromagnetic spectrum. They have a very short wavelength and cause ionisation. X-rays can be used to diagnose and treat some medical conditions. Precautions to be taken when X-ray machines and CT scanners are in use.	Describe how X-rays affect a photographic film in the same way as light, are absorbed by metal and bone but are transmitted by soft tissue. Explain how X-rays can be used for diagnosis of bone fractures and dental problems, in computerised tomography (CT) scans, and in treatment by killing cancer cells. Describe how the use of CCDs allows images to be formed electronically.	2	**Developing explanations using ideas and models** Research into discovery of X-rays. **Applications, implications** Research into uses and dangers of X-rays. Visit to X-ray department at a local hospital. **Presenting and writing arguments** Describe the health risks of X-rays and appropriate precautions that are used. Evaluate the benefits of having an X-ray against any health risks	*How can we see inside the body?* View a selection of X-ray photographs or CT scan images.	[P3.1.1 X-rays success criteria items powerpoint](#) An interesting article on X-ray images, 'Artist's X-ray images seek beauty underneath', can be found at [www.msnbc.msn.com/id/24792453](#) At the bottom of this article is a video about Nick Veasey's work. A video clip on the medical uses of X-rays can be found on the BBC website at [www.bbc.co.uk/learningzone/clips](#) by searching for clip '1455'.

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8 of 23

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P3.1.2 Ultrasound						
a b	Electronic systems can be used to produce ultrasound waves, which 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.	Recall that the range of human hearing is about 20 Hz to 20 000 Hz and that sound waves of higher frequencies are referred to as ultrasound. Explain the principle of ultrasound echoes.	2	**Presenting and writing descriptions and explanations** Use diagrams to explain what ultrasound is and how it can be used to calculate distance.	*Can we see using sound?* **Obtaining and presenting primary evidence** Demonstration of the limit of human hearing using signal generator and loudspeaker.	[P3.1.2 Ultrasound success criteria items powerpoint](#) A video clip and news article on 3D ultrasound's can be found on the Northwest Cable News website at www.nwcn.com/news/health/Ultrasound-shows-babies-in-3D-100278289.html

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9 of 23

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c	Calculation of the distance between interfaces in various media: *s = v × t*	Use the equation to calculate distances between interfaces and use data from diagrams of oscilloscope traces.		Calculations involving distance between interfaces.		
d	Ultrasound waves can be used in medicine, eg for pre-natal scanning and the removal of kidney stones.	Evaluate the medical use of ultrasound and X-rays, including an understanding that some of the differences in use are because ultrasound waves are non-ionising and X-rays are ionising. Compare the advantages and disadvantages of using ultrasound, X-rays or CT scans in terms of safety issues and the quality of image formed.		**Applications, implications** Research and present video clips or images of medical ultrasound scans and their uses. Talk and demonstration by medical professional. **Presenting and writing arguments** Evaluate the advantages and disadvantages of ultrasound versus other methods of imaging.		

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10 of 23

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P3.2 Using physics to make things work							
Many things, from simple toys to complex fairground rides, are constructed from basic machines such as the lever. A knowledge of the physics involved in balancing and turning can help us to make these appliances work.							
P3.2.1 Centre of mass							
a b c	The centre of mass of an object is that point at which the mass of the object may be thought to be concentrated. If freely suspended, an object will come to rest with its centre of mass directly below the point of suspension. The centre of mass of a symmetrical object is along the axis of symmetry.	Describe how to find the centre of mass of a thin, irregular sheet of a material. Analyse the stability of objects by evaluating their tendency to topple. Explain that objects with a wide base and low centre of mass are more stable than those with a narrow base and a high centre of mass.	2	**Applications and implications** Research the design of objects for stability, eg racing cars etc.	Demonstration of stable objects, eg Bunsen burner and unstable objects, eg tall thin vase etc. *Where is the centre of the UK?* **Obtaining and presenting primary evidence** Experiment to find the centre of mass of a UK shaped card.	

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11 of 23

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d e	For a simple pendulum: $T = \dfrac{1}{f}$ The time period depends on the length of a pendulum.	Use the equation $T = \dfrac{1}{f}$ Describe some applications of the pendulum, such as simple fairground and playground rides.		**Presenting and writing descriptions and explanations** Explanation of how the time period of a pendulum can be altered. Calculations using the equation. **Communication for audience and purpose** Presentation and explanation of images of pendulums in action.	*How can a pendulum be slowed down?* **Planning an approach** **Selecting and managing variables** Investigate the factors that affect the time period of a simple pendulum	An interactive activity about a pendulum can be found at http://phet.colorado.edu/en/simulation/pendulum-lab

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P3.2.2 Moments						
a	The turning effect of a force is called the moment.	Explain the concept of a turning moment and use the equation.	3	**Developing explanations using ideas and models** Use a diagram to model a real situation and to calculate the moment of a force.	*Can we make a force larger without any more effort?* **Obtaining and presenting primary evidence** Demonstrations/ of situations where force and distance combine to produce a moment, eg opening a door etc.	[P3.2.1 Centre of mass and P3.2.2 Moments success criteria items powerpoint](#) A video clip of levers can be found on www.youtube.com by searching for 'The Lever, a Simple Machine'.
b	The size of the moment is given by the equation: $M = F \times d$					
c	If an object is not turning, the total clockwise moment must be exactly balanced by the total anticlockwise moment about any pivot.				Experiment with balance beams and weights to verify the law of moments. Use the law of moments to predict the weight needed for balance in a given situation, and test it experimentally.	An interactive activity on balancing can be found at: http://phet.colorado.edu/en/simulation/balancing-act
d	**HT only** **The calculation of the**	**HT only** **Perform calculations involving**		**Presenting and writing descriptions and explanations**	Experiment to find the weight	

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13 of 23

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Opportunities & resources

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|---|---|---|---|---|---|---|
| f | size of a force, or its distance from pivot, acting on an object that is balanced.

HT only
If the line of action of the weight of an object lies outside the base of the object there will be a resultant moment and the body will tend to topple. | moments and balanced objects.

HT only
Use the idea of a resultant moment leading to toppling as applied to vehicles and simple balancing toys. | | Use the idea of moments to explain stability (HT) | of an object using the law of moments.

Investigate objects and slopes to find out the point at which the object topples. | |
| e | Ideas of simple levers. | Describe how a lever can be used as a force multiplier. | | Communication for audience and purpose
Design a poster showing how different levers work. | | |

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14 of 23

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P3.2.3 Hydraulics						
a	Liquids are virtually incompressible, and the pressure in a liquid is transmitted equally in all directions.	State that a force exerted at one point on a liquid will be transmitted to other points in the liquid.	2	**Presenting and writing descriptions and explanations** Describe and explain how hydraulics can be used to multiply forces Calculations using equation. **Applications and implications** Research where hydraulics are used in every-day life.	*Can a liquid lift a lorry?* **Obtaining and presenting primary evidence** Demonstration of water pressure, eg water coming out of holes at different depths in a tall container. Demonstration showing the basic idea of a hydraulic machine, eg two different diameter syringes containing water connected together by plastic tubing.	[P3.2.3 Hydraulics success criteria items powerpoint](#) Video clip showing how hydraulics helps fisherman load their catch http://science.howstuffworks.com/transport/engines-equipment/hydraulic.htm
b	The use of different cross-sectional areas on the effort and load side of a hydraulic system enables the system to be used as a force multiplier.	Explain the action of a hydraulic machine.				
c	The pressure in different parts of a hydraulic system is given by: $P = \dfrac{F}{A}$	Use the equation to calculate pressure.			Demonstration of a hydraulic machine in action e.g hydraulic jack.	

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P3.2.4 Circular motion						
a	When an object moves in a circle it continuously accelerates towards the centre of the circle. This acceleration changes the direction of motion of the body, not its speed.	Explain why an object in circular motion accelerates towards the centre of the circle, and what is meant by centripetal force. Explain that a centripetal force does not exist in its own right but is always provided by other forces such as gravitational force, friction or tension. Be able to identify which force(s) provide(s) the centripetal force in a given situation.	3	**Presenting and writing descriptions and explanations** Use diagrams to represent circular motion in a variety of situation and to identify the centripetal force. Explain how an object can move with a constant speed yet accelerate.	*How can objects keep moving in circles?* **Obtaining and presenting primary evidence** Demonstration of object in circular motion flying off tangentially when force is removed.	[P3.2.4 Circular motion success criteria items powerpoint](#) Video demonstrations of circular motion can be found at http://www.teachersdomain.org/resource/lsps07.sci.phys.maf.circmotion/
b	The resultant force causing this acceleration is called the centripetal force and is always directed towards the centre of the circle.					
c	The centripetal force needed to make an object perform circular motion increases as the mass of the object				Investigation measuring centripetal force on rubber bung tied to string moving in circular motion – effect of different speeds and different radii.	Other useful information and videos can be found at www.physics.org/explorelink.asp?id=50

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16 of 23

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	increases, the speed of the object increases and the radius of the circle decreases.					51

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17 of 23

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P3.3 Keeping things moving Electric currents produce magnetic fields. Forces produced in magnetic fields can be used to make things move. This is called the motor effect and is how appliances such as the electric motor create movement. Many appliances do not use 230 volts mains electricity. Transformers are used to provide the required potential difference.						
P3.3.1 The motor effect						
a	When a current flows through a wire a magnetic field is produced around the wire.

b   The motor effect and its use.

c   The size of the force can be increased by increasing the strength of the magnetic field or increasing the size of the current.

d   The conductor will not experience a force if it is parallel to the magnetic field. | Explain that a current in a conductor produces a magnetic field and that this is the basis for electromagnets, applications of which include their use on cranes for lifting iron or steel.

Explain the principle of the motor effect and know how to use Fleming's Left-hand Rule to identify the direction of the force produced. | 4 | **Presenting an explanation** Use of Flemings left hand rule to explain and predict direction of the force. Explain how the size of the force can be altered.

Applications and implications Presentation about life without electric motors. | *Can electricity be felt at a distance?* **Obtaining and presenting primary evidence** Demonstration of placing a foil strip with a current going through it in a strong magnetic field

Investigation of magnetic field around a wire carrying a current and inside a solenoid coil.

Demonstration of the motor effect. Making a working loud speaker.

Make simple motors from kits. | [P3.3.1 The motor effect success criteria items powerpoint](#) Useful information on an electric motor can be found at www.schoolscience.co.uk by searching for 'electric motors'.

An interactive motor demonstration can be found at www.walter-fendt.de/ph14e/electricmotor.htm |

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e	The direction of the force is reversed if either the direction of the current or the direction of the magnetic field is reversed.	Describe how the size and direction of the force produced can be altered.				S-cool revision topic 'Magnetism and Electromagnetism' can be found in the GCSE Physics section at www.s-cool.co.uk or by searching for 'electromagnetism'.

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19 of 23

Spec Reference	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 & resources reference to past questions that indicate success
P3.3.2 Transformers						
a	If an electrical conductor 'cuts' through a magnetic field a potential difference is induced across the ends of the conductor.	Describe the principle of electromagnetic induction.	3	**Presenting and writing descriptions and explanations** Describe electromagnetic induction. Make a poster highlighting the differences between the motor effect and electromagnetic induction.	*How can a low voltage motor work off the mains?* **Obtaining and presenting primary evidence** Experiment/ demonstration to observe electromagnetic induction.	[P3.3.2 Transformers success criteria items powerpoint](#) An experiment that shows the basic principle of any transformer can be found at [www.practicalphysics.org/go/Experiment_347.html](#)
b	If a magnet is moved into a coil of wire a potential difference is induced across the ends of the coil.					
c	The basic structure of the transformer.	Described the structure of the transformer. Explain how a transformer works. Explain the difference between a step-up transformer and a step-down transformer.		Describe and explain the structure and operation of a transformer Calculations using equations.	Experiments making a simple transformer using C-cores and insulated wire – observing the effect of d.c. and a.c. inputs, observing the effect of different coil ratios. Demonstration transformer – measuring voltages.	Computer simulations of transformer action can be found at [www.micro.magnet.fsu.edu/electromag/java/transformer/index.html](#)
d	An alternating current in the primary coil produces a changing magnetic field in the iron core and hence in the secondary coil. This induces an					

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	alternating potential difference across the ends of the secondary coil.					
e	In a step-up transformer the potential difference across the secondary coil is greater than the potential difference across the primary coil.					
f	In a step-down transformer the potential difference across the secondary coil is less than the potential difference across the primary coil.					
g	The potential	Use the transformer equation.				

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21 of 23

Spec Reference	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 & resources *reference to past questions that indicate success*
	difference across the primary and secondary coils of a transformer are related by the equation: $\dfrac{V_p}{V_s} = \dfrac{n_p}{n_s}$					
h	If transformers are assumed to be 100% efficient, the electrical power output would equal the electrical power input: $V_p \times I_p = V_s \times I_s$	Explain the difference between a switch mode transformer and a conventional transformer. State the advantages and uses of switch mode transformers.		**Applications and implications** **Presenting and writing arguments** Research the operation and evaluate the advantages of switch mode transformers over conventional transformers.		
i	Switch mode					

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22 of 23

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j	transformers operate at a high frequency, often between 50 and 200 kHz. Switch mode transformers are much lighter and smaller than traditional transformers working from a 50Hz mains supply.					
k	Switch mode transformers use very little power when they are switched on but no load is applied.					

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23 of 23