Education Scotland
Foghlam Alba

National 5 Physics

Resource Guide

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Physics National 5 Resource Guide

This resource guide has been produced in response to requests from staff who attended the NQ Sciences events at Hampden Stadium in December 2013. Those attending felt it would be useful to have a document which helped them navigate to the most relevant resources quickly.

The following pages show the mandatory course key areas table from the SQA Physics National 5 Course and Unit Support Notes. An additional fourth column has been included which contains hyperlinks to useful resources. **Please note: Staff are not required to use the resources listed – they are only included as helpful suggestions. Staff should also refer to the SQA website for the most up-to-date course and unit support notes.**

To further assist staff links to useful SQA documentation have been included at the beginning of each unit. The SQA documentation relating to the course is shown here.

Relevant SQA documentation	**Web link**
Course specification	http://bit.ly/1pdvy4a
Course assessment specification	http://bit.ly/1pCZshJ
Course and unit support notes (the original document which has been modified here)	http://bit.ly/1dadovx
General assessment information	http://bit.ly/PM2v8D
Specimen examination paper and marking scheme	http://bit.ly/1o2c2cn
Course Report 2015	http://bit.ly/20qzyMj

Education Scotland learning materials	
Links to educational websites, resources and guidance	http://bit.ly/1egJNP7
Past papers guidance	http://bit.ly/OywJLc

Electricity and Energy			**Unit specification: http://bit.ly/1nB4vzg**
Mandatory course key areas	**Suggested learning activities**	**Exemplification of key areas**	**Useful resources**
Conservation of energy Knowledge of the principle of 'conservation of energy' applied to examples where energy is transferred between stores. Identification and explanation of 'loss' of energy where energy is transferred. Use of an appropriate relationship to solve problems involving potential energy, mass, gravitational field strength and height. Use of an appropriate relationship to solve problems involving kinetic energy, mass and speed. Use of appropriate relationships to solve problems involving conservation of energy.	Investigate energy transfers and losses in the generation of electricity, motion down a hill, etc. using model car 'stunt sets'. Research other energy transfers in everyday objects such as solar panels. Discuss and explain why processes are not 100% efficient in terms of useful energy.	$E_p = mgh$ $E_k = ½mv^2$	Twig video clip – The energy of formula 1 Twig video clip – Energy transformation Twig video clip – Laws of thermodynamics PhET interactive simulation – Energy skate park BBC Learning Zone learner activity – Conversion of potential to kinetic energy and other forms of energy BBC Learning Zone video clip – Conversion between gravitational potential energy and kinetic energy BBC Knowledge and Learning learner notes – Conservation of energy BBC Knowledge and Learning quick test – Conservation of energy

Electrical charge carriers and electric fields Definition of electrical current as the electric charge transferred per unit time. Use of an appropriate relationship to solve problems involving charge, current and time. Knowledge of the difference between alternating and direct current.	Investigate the interaction of charged objects, for example, metallised polystyrene spheres attracted and repelled, Van de Graaff generator discharged through a micro ammeter. Discuss and research the uses of electrostatics, for example: laser printers, paint spraying, cling film, forensic science, removal of dust, electrostatic precipitators, electrostatic separators. Research the definition of current and its historical context. Use an oscilloscope/data logging software to compare alternating and direct sources.	$Q = It$	Twig video clip – What is electricity? PhET interactive activity – Balloons and static electricity BBC GCSE Bitesize animation – Electrostatics PhET interactive simulation – John Travoltage PhET interactive simulation – Charges and fields BBC Knowledge and Learning learner notes – Electric charge carriers and electric fields BBC Knowledge and Learning quick test – Electric charge carriers and electric fields Twig video clip – AC, DC and transformers Twig video clip – Static electricity

			BBC Knowledge and Learning learner activity – Mains supply and batteries
Potential difference (voltage) Awareness of the effect of an electric field on a charged particle. Knowledge that the potential difference (voltage) of the supply is a measure of the energy given to the charge carriers in a circuit.	Observe demonstrations of electric fields using Teltron tubes, olive oil and seeds with high tension supply, Van de Graaff generator, parallel plates and suspended pith ball. Use computer simulations to investigate the behaviour of charges in an electric field. Carry out practical investigations to measure potential differences across components in series circuits. Describe the energy transfers and show that although there is a transfer of energy in the circuit the law of conservation of energy still applies.		Twig video clip – FactPack: How to draw a circuit Colorado Physics learner resources – The electric force PhET interactive simulation – Electric field hockey

Ohm's law Use of a V-I graph to determine resistance. Use an appropriate relationship to solve problems involving potential difference (voltage), current and resistance. Knowledge of the qualitative relationship between the temperature and the resistance of a conductor.	Carry out a range of practical investigations to determine the relationship between potential difference, current and resistance using simple ohmic components. Carry out practical investigations with non-ohmic conductors, for example, a ray-box lamp.	$V = IR$	Twig video clip – Resistance PhET interactive simulation – Ohm's law SSERC staff resources – Resistance versus temperature BBC Knowledge and Learning learner activity – Ohm's law and resistance BBC Knowledge and Learning quick test – Ohm's law and resistance
Practical electrical and electronic circuits Measurement of current, voltage and resistance, using appropriate meters in complex circuits. Knowledge of the circuit symbol, function and application of standard electrical and electronic components including cell, battery, lamp, switch, resistor, variable resistor, voltmeter, ammeter, LED, motor, microphone, loudspeaker, photovoltaic cell, fuse, diode, capacitor, thermistor, LDR, relay,	Carry out experiments to confirm the relationships for current and voltage in series and parallel circuits. Construct and investigate a range of series, parallel and combination circuits using ammeters and voltmeters. Investigate the function of the named components in practical circuits, for example the function of a transistor as a switch.	$R_T = R_1 + R_2 + ...$ $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	BBC Knowledge and Learning learner activity – Resistors in series and parallel PhET interactive simulation – Circuit construction kit: d.c. BBC Bitesize learner activity – House wiring BBC Knowledge and Learning quick test – Behind the wall BBC Knowledge and Learning learner activity – Practical electrical and electronic circuits

transistor. For transistors, familiarity with the symbols for an npn transistor and an n-channel enhancement mode MOSFET. Explanation of their function as a switch in transistor switching circuits. Knowledge of current and voltage relationships in series and parallel circuits. Use of appropriate relationships to solve problems involving the total resistance of resistors in series and in parallel circuits, and circuits with a combination of series and parallel resistors.	Research and discuss the benefits of a ring circuit over a standard parallel circuit. Investigate the effect on the total resistance of a circuit of combining resistors in series and in parallel.		BBC Knowledge and Learning quick test – Practical electrical and electronic circuits Twig video clip – Circuits Twig video clip – Diodes and transistors Walter Fendt learner activity – Combinations of resistors
Electrical power Use an appropriate relationship to solve problems involving energy, power and time. Use appropriate relationships to solve problems involving power, potential difference (voltage), current and resistance in electrical circuits.	Measure and compare the power of various electrical devices. Investigate the relationship between power and fuses for household appliances. Investigate power loss using model power transmission	$P = \frac{E}{t}$ $P = IV$ $P = I^2R$ $P = \frac{V^2}{R}$	BBC Knowledge and Learning learner activity – Electrical power BBC Knowledge and Learning quick test – Electrical power

Selection of an appropriate fuse rating given the power rating of an electrical appliance. (3A fuse for most appliances rated up to 720W, 13A fuse for appliances rated over 720W.)	lines. Carry out a survey into household/educational establishment energy consumption.		

Specific heat capacity Knowledge that different materials require different quantities of heat to raise the temperature of unit mass by one degree Celsius. Knowledge that the temperature of a substance is a measure of the mean kinetic energy of its particles. Explanation of the connection between temperature and heat energy. Use an appropriate relationship to solve problems involving mass, heat energy, temperature change and specific heat capacity. Use of the principle of conservation of energy to determine heat transfer.	Heat different masses of water in similar kettles predicting which will reach boiling point first and explain the reasons for this prediction. Carry out experiments to compare the heat energy stored in different materials of the same mass when heated to the same temperature. Research clothing used for specialist jobs, for example fire fighter, astronaut and polar explorer. Explain why some foods seem much warmer on the tongue than others when cooked, eg tomatoes in a cheese and tomato toastie. Design a heating system for example heat pump, solar-heat traps, ground-storage systems, etc.	$E_h = cm\Delta T$	BBC Knowledge and Learning learner activity – Electrical power BBC Knowledge and Learning learner activity – Specific heat capacity BBC Knowledge and Learning quick test – Specific heat capacity BBC Knowledge and Learning video clip – Heat energy transfer experiment

	Design a central-heating boiler to be as 'efficient' as possible and to explain how they plan to reduce heat energy dissipation through the walls of the boiler.		
Gas laws and the kinetic model Knowledge that pressure is the force per unit area exerted on a surface. Description of how the kinetic model accounts for the pressure of a gas. Use of an appropriate relationship to solve problems involving pressure, force and area. Knowledge of the relationship between kelvins and degrees celsius and the absolute zero of temperature. Explanation of the pressure-volume, pressure-temperature and volume-temperature laws qualitatively in terms of a kinetic model.	Research the kinetic theory of gases. Investigate the relationship between pressure and force using gas syringe and masses. Observe Brownian motion in a smoke cell or an animation. Research the role of Lord Kelvin in the determination of the absolute scale of temperature. Investigate the relationships between the pressure, volume and temperature of a fixed mass of gas. Research and discuss the	$P = F/A$ $p_1V_1 = p_2V_2$ $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$ 0 K = –273°C	Twig video clip – Pressure and surface area Twig video clip – Gas laws PhET interactive simulation – Gas properties BBC Knowledge and Learning learner activity – Gas laws and the kinetic model BBC Knowledge and Learning quick test – Gas laws and the kinetic model

Use of appropriate relationships solve problems involving the volume, pressure and kelvin temperature of a fixed mass of gas.	limitations of the behaviour of real gases.		

Waves and Radiation			**Unit specification: http://bit.ly/1mfAQKu**
Mandatory course key areas	**Suggested learning activities**	**Exemplification of key areas**	**Useful resources**
Wave parameters and behaviours Knowledge that energy can be transferred as waves. Determination of frequency, period, wavelength, amplitude and wave speed for longitudinal and transverse waves. Use of appropriate relationships to solve problems involving wave speed, frequency, period, wavelength, distance, number of waves and time. Awareness of the practical limitations of demonstrating diffraction. Comparison of long wave and short wave diffraction.	Identify, measure and calculate frequency, wavelength and speed for sound waves or water waves, eg using data loggers, or echo methods. Use 'slinkies' to demonstrate transverse and longitudinal waves. Investigate the diffraction of waves around objects and through gaps.	$v = d/t$ $f=N/t$ $v = f\lambda$ $T = 1/f$	Education Scotland Glow NQ portal resources – staff and learner resources *(Glow login required)* Twig video clip – Echolocation dolphins BBC Knowledge and Learning learner activity – Wave YouTube video clip – Waves BBC Knowledge and Learning video clip – Calculating the speed of light University of Salford interactive simulation – Wave diffraction Virtual Physics interactive simulation – Diffraction of radio waves (courtesy of ©Flash Learning) Falstad learner simulation – Ripple tank

			BBC Knowledge and Learning learner activity – Wave parameters and behaviours BBC Knowledge and Learning quick test – Wave parameters and behaviours
Electromagnetic spectrum Knowledge of the relative frequency and wavelength of bands of the electromagnetic spectrum with reference to typical sources, detectors and applications. Knowledge of the qualitative relationship between the frequency and energy associated with a form of radiation. Knowledge that all radiations in the electromagnetic spectrum travel at the speed of light.	Explore, discuss and compare applications of e-m spectrum beyond the visible. Discuss and compare limitations for applications of e-m waves in relation to frequency.		Twig video clips – The electromagnetic spectrum Twig video clip – What is light? Twig video clip – Colour Twig video clip – Waves in medicine Twig video clip – How do mobile phones work? Twig video clip – What makes up the electromagnetic spectrum? SSERC practical activities – UV and IR experiments BBC Knowledge and Learning learner activity – Electromagnetic spectrum BBC Knowledge and Learning quick test – Electromagnetic spectrum

			BBC GCSE Bitesize learner activity – The electromagnetic spectrum WatchKnowLearn learner activity – Electromagnetic spectrum song BBC Learning Zone video clip – The effects of UV light on our skin BBC Learning Zone video clip – Infrared: the electromagnetic spectrum Twig video clip – Infrared snake hunt NASA learner activity – Cosmic colours BBC Knowledge and Learning video clip – Waves and communication Colorado University learner summary – Uses of electromagnetic waves BBC Knowledge and Learning video clips – Selection on uses of EM waves

Light In ray diagrams showing refraction, identification of the normal, angle of incidence and angle of refraction. Description of refraction in terms of change of wave speed, change of wavelength and change of direction (where the angle of incidence is greater than 0°).	Investigate the reason for the 'apparent depth' of water. Research practical applications of refraction in medicine and industry.		Twig video clip – The history of the microscope Twig video clip – Manipulating light PhET interactive simulation – Bending light Falstad learner activity – Refraction of water waves BBC Knowledge and Learning learner activity – Light BBC Knowledge and Learning quick test – Light

Nuclear radiation Knowledge of the nature of alpha, beta and gamma radiation, the relative effect of their ionisation, and their relative penetration. Use of an appropriate relationship to solve problems involving activity, number of nuclear disintegrations and time. Knowledge of background radiation sources. Use of appropriate relationships to solve problems involving absorbed dose, equivalent dose, energy, mass and radiation weighting factor. Comparison of equivalent dose due to a variety of natural and artificial sources. Awareness of equivalent dose rate and exposure safety limits for the public and for workers in radiation industries in terms of annual effective equivalent dose. Use of an appropriate relationship to solve problems involving	Research the extraction of naturally occurring radioactive materials. Measure background radiation in a number of locations. Research into society's reliance on radioactivity for a range of medical and industrial applications, including energy sources. Research annual background radiation in the UK and effective dose limits for a member of the public and for a radiation worker. Average annual background radiation in UK: 2.2 mSv Annual effective dose limit for member of the public: 1 mSv Annual effective dose limit for radiation worker: 20 mSv	$A=N/t$ D = E/m $H = Dw_r$ $\dot{H} = \frac{H}{t}$	Twig video clips – Nuclear power Twig video clips – Radioactive substances Twig video clip – Radioactive half-life Twig video clip – Nuclear fusion BBC Knowledge and Learning learner activity – Nuclear radiation BBC Knowledge and Learning quick test – Nuclear radiation SSERC practical activity – Radioactivity when you don't have a source PhET interactive simulation – Nuclear fission Arizona State University animation – Nuclear power station BBC Knowledge and Learning video clips – Nuclear radiation

equivalent dose rate, equivalent dose and time. Awareness of applications of nuclear radiation. Definition of *half-life* Use of graphical or numerical data to determine the half-life of a radioactive material. Qualitative description of fission and fusion, with emphasis on the importance of these processes in the generation of energy.	Discuss or debate the risks and benefits of radioactivity in society. Discuss or debate the biological effects of radiation. Research the significance of half-life in medical and industrial applications. Research current applications and developments of fission and fusion reactions to generate energy.		

Dynamics and Space			**Unit specification: http://bit.ly/1eOzrmf**
Mandatory course key areas	**Suggested learning activities**	**Exemplification of key areas**	**Useful resources**
Velocity and displacement – vectors and scalars Definition of vector and scalar quantities. Identification of force, speed, velocity, distance, displacement, acceleration, mass, time and energy as vector or scalar quantities. Calculation of the resultant of two vector quantities in one dimension or at right angles. Determination of displacement and/or distance using scale diagram or calculation. Use of appropriate relationships to solve problems involving velocity, displacement and time.	Set up an orienteering course in school grounds — calculate displacement and average velocity, distance and average speed. Discuss and compare the difference between vector and scalar quantities. Calculate average speed/velocity using distance/displacement data and time data from a number of contexts, for example athletics, cars, flight, space. Analyse motion vectors using scale diagrams and/or trigonometry.	$\bar{v} = \frac{s}{t}$ $v = \frac{s}{t}$	Education Scotland Glow NQ portal resources – staff and learner resources *(Glow login required)* Twig video clip – Speed, velocity and acceleration Twig video clip – Vectors: air traffic control BBC Knowledge and Learning learner activity – Forces, motion and energy Michigan State University interactive simulation – Vector addition University of Arkansas interactive simulation – Vector calculator YouTube video clip – Introduction to vectors and scalars BBC Knowledge and Learning learner activity and quick test– Vectors and scalars

Velocity–time graphs Sketch of velocity–time graphs for objects from recorded or experimental data. Interpretation of velocity–time graph to describe the motion of an object. Determination of displacement from a velocity–time graph.	Plot graphs from data sets — manually or use of software. Capture and analyse data using appropriate software, eg trolleys running down slopes. Observe the *v*-*t* graph of bouncing ball using a motion sensor.	*s* = area under *v*–*t* graph.	Walter Fendt interactive simulation – Motion with constant acceleration BBC Knowledge and Learning learner activity – Speed–time graphs BBC Knowledge and Learning quick test – Speed–time graphs
Acceleration Use of an appropriate relationship to solve problems involving acceleration, initial velocity (or speed), final velocity (or speed) and time. Determination of acceleration from a velocity–time graph.	Determine the acceleration of a vehicle using two light gates and timer recording times for instantaneous speeds and time between. Determine acceleration from a velocity-time graph by finding the gradient using data software.	$a = \frac{v - u}{t}$	BBC Knowledge and Learning learner activity – Velocity and acceleration BBC Knowledge and Learning quick test – Velocity and acceleration SSERC practical activity – Wiimote® physics SSERC practical activity – Loop the loop experiments

Newton's laws Application of Newton's laws and balanced forces to explain constant velocity (or speed), making reference to frictional forces. Use of an appropriate relationship to solve problems involving unbalanced force, mass and acceleration for situations where more than one force is acting. Use of an appropriate relationship to solve problems involving work done, unbalanced force and distance/displacement. Use of an appropriate relationship to solve problems involving weight, mass and gravitational field strength, including on different planets. Knowledge of Newton's second law including its application to space travel, rocket launch and landing. Knowledge of Newton's third law	Identify forces in vehicles travelling with constant velocity, for example car, helicopter or boat. Investigate 'frictionless movement' using an air hockey puck, linear air-track or model hovercraft. Discuss practical examples of balanced forces, for example gliding, floating in water or tug of war. Investigate Newton's second law using a linear air track or other suitable means. Experiment with water rockets. Observe lunar landing simulations. Investigate parachutes, for example by dropping flat and crushed sheet of paper.	$F = ma$ $W = Fd$ *or* $E_w = Fd$ $W = mg$	YouTube video clip – Newton's first law of motion PhET interactive simulation – Forces and motion: basics Twig video clip – Terminal velocity BBC Knowledge and Learning video clip – A demonstration of friction BBC Knowledge and Learning video clip – Aerodynamics – reducing air friction BBC Knowledge and Learning video clip – Mass and weight PhET interactive simulation – Lunar lander BBC Knowledge and Learning learner activity – Forces and Newton's laws BBC Knowledge and Learning quick test – Forces and Newton's laws YouTube video clip – Crash test with and without safety belt

and its application to explain motion resulting from a 'reaction' force. Use of Newton's laws to explain free-fall and terminal velocity.	Demonstrate balanced forces and terminal velocity by dropping ball bearings into glycerine filled measuring cylinders. Relate Newton's laws to car safety measures, for example seatbelts, air bags or crumple zones.		SSERC practical activities – Road safety context for teaching forces BBC Knowledge and Learning video clip – Falling bodies BBC Knowledge and Learning video clips – Forces, motions and energy
Projectile motion Explanation of projectile motion. Use of appropriate relationships to solve problems involving projectile motion from a horizontal launch, including the use of motiongraphs. Explanation of satellite orbits in terms of projectile motion.	Observe the 'String of pearls' experiment (using a strobe light to see the separation of projectile motion). Observe the 'Monkey and hunter' experiment. Use tracking software to analyse a video recording of projectile motion. Investigate and calculate 'drop time' and 'time of flight'. Discuss Newton's 'thought' experiment.	Area under v_h – t graphs for horizontal range and area under v_V-t graphs for vertical height. $v_h = s/t$ (constant horizontal velocity) $v_V = u + at$ (constant vertical acceleration)	Waowen interactive simulation – Newton's cannon NASA interactive simulation – Newton's cannon Physics Classroom learner resources – Monkey and zookeeper National STEM Centre staff notes – Pearls of water Walter Fendt interactive simulation – Projectile motion BBC Knowledge and Learning video clip – Projectile motion

			Ion – capa interactive simulation – Orbit BBC Knowledge and Learning learner activity – Projectile motion BBC Knowledge and Learning quick test – Projectile motion
Space exploration Awareness of evidence supporting current understanding of the universe from telescopes and space exploration. Awareness of the benefits of satellites, for example GPS, weather forecasting, communications and space exploration (Hubble telescope, ISS) Qualitative awareness of the relationship between the altitude of a satellite and its period. Awareness of the potential benefits of space exploration. Awareness of the challenges of space travel, including, for example: Travelling large distances with the	Discuss space exploration (emphasising the idea that this is a continually developing area) using suitable simulations and/or DVDs. View videos of re-entry, for example of Joe Kittinger or Felix Baumgartner. Discuss the need for thermal protection systems to protect spacecraft on re-entry, including qualitative and quantitative specific heat capacity. Design and make a model heat shield for re-entry.	$E_h = cm\Delta T$ $E_h = ml$ $Ep = mgh$ $Ek = ½mv^2$ $W = Fd$ *or* $E_w = Fd$	Twig video clip – Mars: dead planet Twig video clip – Mars: the search for water Twig video clips – Big bang Twig video clip – Planet Kevin Twig video clip – Kittenger: First man in space? Twig video clip – Man on the moon BBC Knowledge and Learning learner activity – Earth and space NASA learner resources – Orbits r us BBC Knowledge and Learning video clip – Gravitational pull and space travel

possible solution of attaining high velocity by using ion drive (producing a small unbalanced force over an extended period of time) or using a 'catapult' from a fast moving asteroid, moon or planet. Maneuvering a spacecraft in a zero friction environment, possibly to dock with the ISS. Maintaining sufficient energy to operate life support systems in a spacecraft with the possible solution of using solar cells with area that varies with distance from the Sun. Awareness of the risks associated with manned space exploration, for example fuel load on takeoff, potential exposure to radiation, pressure differential and challenges of re-entry to a planet's atmosphere. Use of an appropriate relationship to solve problems involving heat energy, mass and specific latent heat.			NASA interactive simulation – Celestia How stuff works learner resource – Apollo's re-entry Flight global image – Apollo's blackened heat-shield YouTube video clip – Meteor hits Russia Educypedia animation – How GPS works YouTube video clip – Columbia space shuttle break up

Cosmology Use of the term 'light year' and conversion between light years and metres. Description of the observable universe — origin and age of universe. Awareness of the use of different parts of the electromagnetic spectrum in obtaining information about astronomical objects. Identification of continuous and line spectra. Use of spectral data for known elements, to identify the elements present in stars.	Construct a simple spectroscope from a CD disk and examine common light sources. Use a spectroscope to look at a range of light sources, eg sodium lamp and other gas discharge lamps. Research recent advances in astronomy and in our knowledge of the universe. View the night sky with a telescope. Discuss how radio telescopes, the COBE satellite and the SETI institute have advanced our knowledge of the universe.		Twig video clip – Planet hunters Twig video clip – What is a light year? Twig video clips – Earth Twig video clip – The goldilocks zone Astronomy and Law learner resource – Astronomical units YouTube video clip – Big Bang introduction (staff resource) NASA image – Line spectra of elements and absorption spectra of sun BBC Knowledge and Learning video clip – Spectroscopy and the composition of stars BBC Learning Zone video clip – Dark matter and gravity Sloan Digital Sky Server staff resources – Background on developments of knowledge of universe Hubble site images – From the Hubble space telescope

			BBC Knowledge and Learning learner activity – Space exploration and cosmology BBC Knowledge and Learning quick test – Space exploration and cosmology