Scheme of Learning: Advancing Physics

Unit : Physics in action

Topic	Learning: Objectives/outcomes	Teaching/learning: Activities	Assessment for Learning	PLTS/SfS Other opportunities
Teaching Time: 3 hours 1.1 Seeing the Invisible The variety of kinds of imaging in physics. Examples: ultrasound scanning; astronomical images at different wavelengths; satellite images; images of atoms; images of theoretical models. Revision of wavelength, frequency and wave speed, and electromagnetic spectrum. Idea of pixel; numerical storage of information and resolution.	• Images can be formed with many kinds of signals, including ultrasound and all regions of the electromagnetic spectrum. These images can be recorded electronically by microsensors; an example is the charge-coupled device (ccd). Images are composed of discrete picture elements – pixels. Images on the atomic scale can be recorded by scanning methods; an example is the scanning tunneling microscope. The resolution of an image is the smallest distance over which a change can be seen	• Activity 10S Software based 'Looking at images' • Activity 20D Demonstration 'Electronic image capture' • Activity 30D Demonstration 'Distance measurement with ultrasound'	• Question 10S Short answer 'Speed, wavelength and frequency' • Question 20E Estimate 'Large and small distances and times' • Question 30E Estimate 'Making estimates about images' • Question 30X Explanation-Exposition 'Different kinds and uses of images' • Question 160S Short Answer 'Ultrasound tape measure problems' • Question 170S	• This section gives students a real chance to investigate what interests them. There is a huge choice of images available from books/magazines/internet Adaptable Able to learn new things quickly Literate in word number and informatics.

Topic	Learning: Objectives/outcomes	Teaching/learning: Activities	Assessment for Learning	PLTS/SfS Other opportunities
Teaching Time: 3 hours 1.2 Information in images (3h) Introduction to logarithms via the bit or byte as unit of amount of information ($N = 2^I$). Logarithmic ('times') ladders of quantities over a wide range of values. Processing images: averages or medians to smooth or reduce noise; ways of sharpening or finding edges. Noise as an example of uncertainty in information	• Images are composed of discrete pixels, each specified in brightness (and perhaps colour) by numbers. Image enhancement, for instance removing noise, enhancing contrast, locating edges, using false colour, can help to extract the maximum information from an image. Averaging can smooth or remove noise from images. Medians of sets of pixels can often nearly completely eliminate random noise. Logarithmic measures can help deal with very large or small quantities. 'Times' scales are logarithmic representations	• Activity 50S Software based 'Image processing: The surface of Mercury' • Plus at least one of: • Activity 60S Software based 'Image enhancing: Volcanoes on Io' • Activity 70S Software based 'Medical uses of x-ray images' • Activity 80S Software based 'Medical uses of ultrasound images' • Activity 120S Software Based 'How big are your computer files?'	• Question 60S Short Answer 'A scanning electron microscope image of Velcro' • Question 70S Short Answer 'Image processing by brightness and contrast control' • Question 110S Short Answer 'Bits and bytes in images' • Question 120S Short Answer 'Logarithms and powers' • Question 130C Comprehension 'X-ray image of the Kepler supernova remnant'	Able to learn new things quickly Literate in word number and informatics.

Topic	Learning: Objectives/outcomes	Teaching/learning: Activities	Assessment for Learning	PLTS/SfS Other opportunities
Teaching Time: 4 hours 1.3 With your own eyes Eye and vision.	This section discusses the structure and action of the eye, including the fact that the retina does some signal processing. It continues with the formation of a real image by a converging lens, including the relation 1 / *v* = 1 / *u* + 1 / *f* and calculations of the magnification. It also gives the opportunity to show how the measurement of lens power and magnification as an example of careful measurement, taking account of uncertainties Visual processing and some illusions. Formation of real image by converging lens. Focal length and power. Power 1/*f* as curvature added to wavefront by lens. 1 / *v* = 1 / *u* + 1 / *f* (Cartesian convention) Measurement and uncertainty in simple optical experiments.	• Activity 130D Demonstration 'Grey step: Edge enhancement in the retina' • Activity 140E Experiment 'The intelligent eye' • Activity 150D Demonstration 'Models of the eye' • Activity 60D Demonstration 'Image in mid-air' • Activity 170E Experiment 'Converging lenses: power and focal length' • Activity 180D Demonstration 'Where are the parts of an object in its image?' • Activity 190D Demonstration 'Disappearing glass' • Activity 190E Experiment 'A converging lens adds constant curvature 1 / f ' (without uncertainties) • Activity 195E Experiment 'A converging lens adds constant curvature 1/f, with estimates of uncertainty' (With uncertainties) • Activity 200E Experiment 'Magnification and the power of a lens'	• Question 140S Short Answer 'Response of the human eye to differences in brightness' • Question 150S Short Answer 'Cameras and eyes' • Question 160C Comprehension 'Satellite imaging' • Question 50D Data Handling 'Representing experimental uncertainties graphically 1 • Question 60D Data Handling 'Representing experimental uncertainties graphically 2	Creative innovators Able to use new technologies Great team workers

Topic	Learning: Objectives/outcomes	Teaching/learning: Activities	Assessment for Learning	PLTS/SfS Other opportunities
2.1 Making very small things Introduction: what sensors can do.	Moving charged particles, current and potential difference.	• Activity 20D Demonstration 'Current and charge in electron beams' • Activity 30D Demonstration 'Spooning charge' • Activity 40D Demonstration 'Shuttling ball and ions in a flame' • Activity 50D Demonstration 'Conduction by 'coloured' ions' • Activity 60E Experiment 'Conduction by students'	• Question 20S Short Answer 'Revision questions' • Question 30S Short Answer 'Kinds of light bulb' • Question 70C Comprehension 'Electron beams' • Question 40S Short Answer 'Ions in chemical cells: Large and small numbers 1' • Question 50S Short Answer 'Ions in X-ray machines: Large and small numbers 2' • Question 60S Short Answer	
		• Activity 100E Experiment 'Using a wide range of kinds of sensor' • Activity 110E Experiment 'Using the digital multimeter to measure resistance' • Activity 120E Experiment 'Resistors in series and parallel' • Activity 130D Demonstration 'Lamp lighting' • Activity 140E Experiment 'The filament lamp: The relationship between power and applied potential difference'		

Scheme of Learning: Advancing Physics

Unit : Physics in Action

2.2 Miniature circuits	Using a range of sensors; detecting signals from them, sensitivity, resistance of detector Conductance and resistance, ohmic and non-ohmic conductors, parallel and series circuits	• Activity 100E Experiment 'Using a wide range of kinds of sensor' • Activity 110E Experiment 'Using the digital multimeter to measure resistance' • Activity 120E Experiment 'Resistors in series and parallel' • Activity 130D Demonstration 'Lamp lighting' • Activity 140E Experiment 'The filament lamp: The relationship between	• Question 90C Comprehension 'Sensors and Formula 1 racing' • Question 100S Short Answer 'Some circuit problems' • Question 110S Short Answer 'Power of appliances' • Question 120S Short Answer 'Effect of an ammeter in a circuit' • Question 125S Short Answer 'Combining conductances' • Question 130S Short Answer 'Circuit resistance'	Creative innovators Able to use new technologies Great team workers
2.3 Controlling and measuring potential differences	Potentiometer as a sensor, linearity Potential divider	• Activity 200E Experiment 'Potential dividers' • Display Material 145O OHT 'Sources and internal resistance' • Reading 70T Text to Read 'When is a potential divider linear?' ICT Activities • Activity 210S Software Based 'Effect of load on a potential divider' • Activity 220S Software Based 'A simple temperature probe' • Activity 230S Software Based 'A better temperature probe'	• Question 170S Short Answer 'Tapping off potential difference' • Question 180S Short Answer 'Loading the potential divider' • Question 190D Data Handling 'Lamp and resistor in series' • Question 200S Short Answer 'Controlling a robot arm'	

2.4 Sensors and our senses Sensors that change resistance.	Design of potential divider circuits. Emf and internal resistance, potential divider with one resistor varying	• Activity 240E Experiment 'Internal resistance of a source of emf' • Activity 150D Demonstration 'Response time of thermistors' • Question 250S Short Answer 'Resistance and conductance of thermistors' • Question 260S Short Answer 'Response time of thermistors' • Question 270S Short Answer 'Response time of light sensors'	• Question 210S Short Answer 'Using a measurement amplifier as a comparator' • Question 220S Short Answer 'Internal resistance of power supplies' • Question 230X Explanation-Exposition 'Heating coils' • Question 240X Explanation-Exposition 'Brightness of bulbs'	Able to learn new things quickly Literate in word number and informatics.
2.5 Making good measurements with sensors	Team tasks: using sensors to accomplish a task. Resolution, sensitivity, response time, calibration, uncertainty, systematic error Preparation for later assessed Quality of Measurement task	• Activity 180D Demonstration 'Limitations of sensors' • Introduce team tasks with • Activity 400E Experiment 'Team sensor tasks briefing' • Activity 260E Experiment 'Monitoring rapid changes in light intensity' • Activity 270E Experiment 'Calibrating a position sensor' • Activity 280E Experiment 'Measuring rainfall' • Activity 290E Experiment 'Comparing a photodiode and a photoresistor' • Activity 300E Experiment 'Using temperature sensors' • Activity 310E Experiment 'Monitoring vibration' • Activity 320E Experiment 'The oscillations of a hacksaw blade'	• Question 260X Explanation-Exposition 'Using a sensor in a potential divider' • Question 270D Data Handling 'Using non-ohmic behaviour' • Question 280X Explanation-Exposition 'Filament lamp and thermistor in series'	Able to use new technologies Able to learn new things quickly Literate in word number and informatics.

Topic	Learning: Objectives/outcomes	Teaching/learning: Activities	Assessment for Learning	PLTS/SfS Other opportunities
3.1: Digital revolution and the death of distance	information coded in binary form; bits as a measure of amount of information; sampling of waveforms; digitising of samples; rates of transmission of information in bits per second.	• Activity 20D Demonstration 'What do digital signals look like?' • Activity 30D Demonstration 'Data transfer on an optical fibre' • Activity 40D Demonstration 'Sampling vibrations on a string' • Activity 50E Experiment 'Guess a waveform from a sample' • Activity 70S Software based 'Looking less often' • Activity 60D Demonstration 'Mains interference as noise' • Activity 70D Demonstration 'Electrical noise pick-up' • Activity 80E Experiment 'Looking at signal conversion'	• Question 10C Comprehension 'Teleworking: Working from home using telecommunications' • Question 20C Comprehension 'History of telegraphy' • Question 30C Comprehension 'History of telephony' • Question 40C Comprehension 'Computing and communications come together' • Question 50S Short Answer 'Simple sampling' • Question 60S Short Answer 'Sampling repetitive motion'	Creative innovators Able to use new technologies Great team workers
3.2: Signalling with electromagnetic waves	Radio spectrum, polarisation, spectrum of a signal and bandwidth	• Activity 110H Home Experiments 'Home experiments with radio and television signals' • Activity 110H Home Experiment 'Home experiments with radio and television signals' • Activity 120D Demonstration 'Polarisation of waves' • Activity 130E Experiment 'Polarisation by scattering' • Activity 140D Demonstration 'Polarisation of reflected light' • Activity 150H Home Experiment 'Telling frequencies apart' • Activity 170E Experiment 'Spectrum analysis: Simple signals'	• Question 80X Explanation-Exposition 'Charting the electromagnetic spectrum' • Question 90S Short Answer 'Using the wave equation' • Question 100S Short Answer 'Hearing better, phoning sooner' • Question 110C Comprehension 'Maritime communications'	Able and confident communicators Able to use new technologies Possessors of a wide range of interests.

Topic	Learning: Objectives/outcomes	Teaching/learning: Activities	Assessment for Learning	PLTS/SfS Other opportunities
4.1 Making the best choice	Range and variety of materials	• Activity 10E Experiment 'Tensile testing: Getting a feel for materials 1' • Activity 20E Experiment 'Compressive testing: Getting a feel for materials 2' • Activity 30E Experiment 'Hardness testing: Getting a feel for materials 3' • Activity 40E Experiment 'Tear testing: Getting a feel for materials 4' • Activity 50E Experiment 'Measuring density: Getting a feel for materials 5' • Activity 60E Experiment 'Comparing thermal conductivities: Getting a feel for materials 6' • Activity 70E Experiment 'Electrical conduction: Getting a feel for materials 7' • Activity 90H Home Experiment 'Anisotropy in an apple' • Activity 100H Home Experiment 'Creep in an everyday material' • Activity 110H Home Experiment	• Question 10S Short Answer 'Exploring the range of materials' • Question 20C Comprehension: The Bronze Age • Question 30C Comprehension: Portraits in plastic • Reading 10T Text to read: Steel – the most important material? • Reading 20T Text to read: Materials from nature • Reading 100T Text to read: 'Introduction to materials selection charts'	Able to learn new things quickly Literate in word, number and informatics
4.2 Better buildings	Tensile testing, stress, strain, the Young modulus	• Activity 100E Experiment 'Plot and look: Measuring breaking stress of materials' • Activity 150E Experiment 'Good measurement of Young modulus' • Activity 140E Experiment 'How strong is a paper structure?'	• Question 10E Estimate 'Making estimates about mechanical behaviour of materials' • Question 45S Short Answer 'Calculations on stress, strain and the Young modulus' • Question 50S Short Answer 'Measuring the Young modulus' • Question 50D Data Handling 'Stress, strain and the Young modulus'	Able and confident communicators Able to use new technologies Possessors of a wide range of interests.

Topic	Learning: Objectives/outcomes	Teaching/learning: Activities	Assessment for Learning	PLTS/SfS Other opportunities
4.3 Conducting very well; conducting very badly	Resistance and conductance; resistivity and conductivity	• Activity 310E Experiment 'Measuring resistance of good conductors' • Activity 330E Experiment 'Measuring the resistance of two insulators' • Use the above if the class lacks the necessary experience • Activity 340E Experiment 'How the dimensions of a conductor affect resistance' • Activity 345E Experiment 'Introduction to resistivity using conducting paper' • Activity 350E Experiment 'Good measurements of electrical resistivity'	• Question 20E Estimates 'Making estimates about electrical behaviour of materials' • Question 70S Short Answer 'Electrical properties' • Question 80S Short Answer 'Resistivity and conductivity calculations' • Question 100S Short Answer 'Conductance and conductivity' • Question 90X Explanation-Exposition 'Review questions'	Able to learn new things quickly Literate in word, number and informatics
4.4 Problems of measuring mechanical and electrical properties	This section focuses on how to make good measurements. It draws on the experiments done in the previous sections and draws out the ideas of how to do experiments carefully and to improve them.	This section is an opportunity to review measurement issues from previous activities.		

Topic	Learning: Objectives/outcomes	Teaching/learning: Activities	Assessment for Learning	PLTS/SfS Other opportunities
5.1 Materials under the microscope	Scaling and modelling Looking at images Electron and atomic microscopy	• Activity 10E Experiment 'Looking at bone' • Activity 30E Experiment 'Looking at wood and wood products' • Activity 40E Experiment 'Looking at textiles' • Activity 50H Home experiment 'Sweets and biscuits' • Activity 20S Software based 'Wood and wood products' • Activity 60H Home Experiment 'Model of a crystal' • Activity 70H Home Experiment 'Packing rice grains' • Activity 100H Home experiment 'Spaghetti model of a polymer'	• Question 10C Comprehension 'Visible structures' • Question 50S Short Answer 'Ants, atoms and chips' • Question 30D Data Handling 'The size of an atom'	Able and confident communicators Able to use new technologies Possessors of a wide range of interests.
5.2 Stiff stuff, strong stuff	Introducing fracture behaviour Importance of crack propagation Composite materials	• Activity 130D Demonstration 'Photoelastic stress' • Activity 290H Home Experiment 'Ice and paper composite' • Activity 300H Home Experiment 'A jelly composite' • Activity 310H Home Experiment 'Making and testing composite biscuit' • Activity 140E Experiment 'More than one spring'	• Question 40C Comprehension 'Photoelastic stress images' • Question 110S Short Answer 'Bone' • Question 120C Comprehension 'Concrete: A material for all seasons' • Question 130C Comprehension 'Wire rope and suspension bridges' • Question 50C Comprehension 'Tendon elasticity'	Creative innovators Able to use new technologies Great team workers

5.3 Making more of materials	Slip and dislocations in metals Comparing structures of ceramics, ionic crystals, metals, and polymers	• Activity 60H Home Experiment 'Model of a crystal' • Activity 150E Experiment 'Growth of grains' • Activity 160H Home Experiment 'Making ice crystals' • Activity 170E Experiment 'Growing grains in a zinc ingot' • This can be time consuming but worthwhile. However a software alternative is provided: • Activity 180S Software Based 'Studying grains in zinc' • Activity 190E Experiment 'A bubble-raft model of dislocations' • Activity 200E Experiment 'Heat treatment of steel' • Activity 210E Experiment 'Work hardening of copper'	• Question 70X Explanation-Exposition 'Questions on metals' • Question 80S Short Answer 'Further questions on metals' • 100S Short Answer 'Questions on polymers'	Able to learn new things quickly Literate in word, number and informatics
5.4 Controlling conductivity	Explaining the differences in conductivity between metals, semiconductors and insulators	• Activity 320E Experiment 'Calibration of a thermistor'	• Question 140D Data Handling 'How resistivity changes with temperature' • Question 160C Comprehension 'High-temperature superconductivity' • Question 170X Explanation-Exposition 'Conductivity' • Question 180E Estimates 'Estimating with materials'	Able to learn new things quickly Literate in word, number and informatics