DIGGING UP THE PAST

Overview of chapter

Table 5.1 summarises the content and skills covered in this chapter, and Table 5.2 lists the learning outcomes required by the exam specification. The latter are also listed as 'Achievements' in the final section of the chapter in the Student Book.

Table 5.1 Summary of the chapter *Digging Up the Past*

Outline and reference to student materials			Key points	Skills	Notes
Section 1.1 Resistive surveying	Using video and Internet to show geophysical surveying	Activity 1	Material properties can be measured remotely and non-destructively	Use of ICT	
	Exploring resistance of various conductors	Activity 2	$R = V/I$	Practical work	Link with SPC
	Exploring 1D and 2D models of resistive survey	Activity 3	Obtaining and displaying data	Practical work Use of ICT	
Section 1.2 Resistivity	Investigating factors affecting resistance	Activity 4	Measuring resistance Finding patterns in data	Practical work Use of ICT Application of number	Revision of R in series and parallel
	Measuring and calculating resistivities	Activity 5	$R = \frac{\rho l}{A}$	Practical work Application of number	Core practical
	Plotting resistivities on a log scale	Activity 6	Advantage of log scale	Application of number	Optional extension work
	Discussing models of electrical conduction		Explaining electrical properties of materials		Link with SPC
Section 1.3 Potential difference and potential dividing	Interpreting survey data	Additional Sheet 1	Random variations in data: 'noise'	Application of number	
	Discussing energy and pds in a series circuit	Activity 7	Conservation of energy pd = energy per unit charge		Link with SPC
	Exploring a potential divider circuit	Activity 8	Ratio of pds = ratio of resistances	Practical work Application of number	
	Discussing variations of potential in series circuit	Activity 9	Potential at a point		
	Exploring 2D variations in potential	Activity 10	Equipotentials	Practical work Application of number	Optional extension work
	Calculating potential gradients	Additional Sheet 2	Potential gradient and electric field	Application of number	Optional extension work
Section 1.4 Summing up Part 1	Summarising and explaining resistive surveying	Activity 11	Application of knowledge and skills from Part 1	Study skills Communication	

Outline and reference to student materials			Key points	Skills	Notes
Section 2.1 X-rays	Plotting wavelengths of electromagnetic radiation on log scale	Activity 12 Additional Sheet 3	Log scale Typical X-ray wavelengths Properties of X-rays	Application of number	
Section 2.2 X-ray diffraction	Using laser to simulate X-ray diffraction	Activity 13	Effect of spacing on size of diffraction pattern Symmetry	Practical work	
	Completing and discussing diagrams of diffraction and superposition	Additional Sheets 4 and 5	Diffraction Superposition	Communication	Link with MUS
	Observing diffraction by obstacles and by single and double slits	Activity 14	Objects smaller than wavelength produce no 'shadow' Diffraction and superposition produce interference patterns	Practical work Communication	
Section 2.3 Diffraction grating	Using Huygens' principle to construct the shape of a wavefront		Secondary wavelets		
	Deriving the diffraction grating equation		$d \sin \theta_n = n\lambda$ Order of diffraction		Link to MUS
	Using a grating to determine wavelength of light	Activity 15		Practical work Application of number	Core practical
	Deriving equations for diffraction by a double slit	Additional Sheet 6	$x = n\lambda D/s$		Optional extension work
	Simulating diffraction and Bragg reflection by crystal	Activity 16	Size of diffraction pattern depends on spacing of atoms	Practical work	
	Using X-ray powder photographs	Activity 17	Minerals can be identified using X-ray diffraction		
Section 2.4 Summing up Part 2	Summarising and explaining X-radiography and X-ray diffraction	Activity 18	Application of knowledge and skills from Part 2	Communication Study skills	
Section 3.1 Seeing the detail	Exploring resolution of own eyes Studying artefacts using an optical microscope	Activity 19 Activity 20	Wavelength and resolution Objects smaller than wavelength cannot be imaged	Practical work	
Section 3.2 Electron waves	Observing and discussing electron diffraction patterns	Activity 21	Diffraction patterns Wave nature of electrons	Application of number	
	Using the de Broglie equation		$\lambda = h/mv = h/p$		Link to HFS
Section 3.3 Electron microscopes	Using web-based simulations to explore the operation of scanning and transmission electron microscopes	Activity 22 Activity 23 Additional Sheet 7		Use of ICT	

Outline and reference to student materials			Key points	Skills	Notes
Section 3.4 Summing up Part 3	Summarising wave nature of electrons, and influence of wavelength on quality of image	Activity 24 Activity 25	Application of knowledge and skills from Part 3	Communication Study skills	
Section 4.1 The dating game	Researching and discussing techniques for dating	Activity 26	Techniques for different materials and timescales Calibration	Communication	
Section 4.2 Is it genuine?	Researching the Piltdown Man hoax	Activity 27	Use of data to resolve uncertainty	Use of ICT Communication	
Section 4.3 Peer review	Discussing and using peer review for publications and grant applications	Activity 28	Role of scientific community	Study skills Communication	
Section 5.1 Putting the pieces together	Reviewing uses of electromagnetic radiation	Activity 29		Study skills	Links with SPC and MUS
	Reviewing work on DC circuits, conduction in solids, waves, log graphs, ethical issues	Activity 30		Study skills	
Section 5.2 Questions on the whole chapter	Questions and calculations	Additional Sheet 8		Communication Application of number	Consolidation and revision
Section 5.3 Achievements	Chapter test	Additional Sheets 9 and 10		Communication Application of number	Questions illustrate style of external test

Table 5.2 Learning outcomes specified for *Digging Up the Past*

Statement from Examination Specification		Section(s) in this chapter
1	know and understand the distinction between base and derived quantities and their SI units	1.2
2	demonstrate their knowledge of practical skills and techniques for both familiar and unfamiliar experiments	1.2, 1.3, 2.3
4	understand the limitations of physical measurement and apply these limitations to practical situations	1.2, 2.3
5	be able to communicate information and ideas in appropriate ways using appropriate terminology	1.4, 2.1, 2.3
7	understand the role of the scientific community in validating new knowledge and ensuring integrity	4.2, 4.3
39	be able to use the equation $R = \frac{\rho l}{A}$	1.2
40	CORE PRACTICAL 2: Determine the electrical resistivity of a material	1.2
41	be able to use $I = nqvA$ to explain the large range of resistivities of different materials	1.2
42	understand how the potential along a uniform current-carrying wire varies with the distance along it	1.3
43	understand the principles of a potential divider circuit and understand how to calculate potential differences and resistances in such a circuit	1.3
44	be able to analyse potenial divider circuits where one resistance is variable including thermistors and Light Dependent Resistors (LDRs)	1.3
83	understand what is meant by *diffraction* and use Huygens' construction to explain what happens to a wave when it meets a slit or an obstacle	2.2, 2.3
84	be able to use $n\lambda = d \sin\theta$ for a diffraction grating	2.3
85	CORE PRACTICAL 8: Determine the wavelength of light from a laser or other light source using a diffraction grating	2.3
86	understand how diffraction experiments provide evidence for the wave nature of electrons	3.2
87	use the de Broglie equation $\lambda = \frac{h}{p}$	3.2

This chapter uses archaeological contexts to develop some ideas about DC electricity, waves and the wave behaviour of electrons. *Digging Up the Past* is intended to be taught after both *The Sound of Music* and *Technology in Space*, as it builds on concepts that they introduce.

The chapter has three main parts, each of which builds on some ideas from *The Sound of Music* and/or *Technology in Space*. Part 1 uses resistive surveying to reinforce students' knowledge of DC electricity and to introduce resistivity and logarithmic graphs. In Part 2, in the context of X-ray diffraction studies of artefacts, students review and extend their knowledge of waves and the electromagnetic spectrum. Part 3 explores the use of optical and electron microscopy in archaeology, illustrating the relationship between wavelength and image quality and introducing electron waves. Part 3 builds on Part 2, so they should be taught in sequence. Part 4 shows how various techniques, including dating, can be used to expose archaeological fakes and highlights the role of peer review. Part 5 looks back over the whole chapter and draws together the main ideas.

If the teaching of this chapter is to be shared, then Parts 1 and 4 can be taught in parallel with Parts 2 and 3.