SPARE PART SURGERY

Overview of chapter

Table 6.1 summarises the content and skills covered in this chapter, and Table 6.2 lists the learning outcomes required by the exam specification. The latter are also listed as 'Achievements' in the final section of the unit in the Student Book.

Table 6.1 Summary of the chapter *Spare Part Surgery*

Outline and reference to student materials			Key points	Skills	Notes
Section 1.1 Smart limbs	Reading article about prosthetic limb user and developer				
Section 1.2 Informed consent	Interviewing someone who has had spare part surgery Discussing aspects of spare parts: cost, physics	Activity 1 Activity 2	Benefits and drawbacks of spare part surgery Role of physics in developing spare parts	Communication	Preparation for Activity 10
	Discussing priorities in selecting patients for surgery	Activity 3	Ethics and decision making	Communication	
Section 2.1 Bone and joint replacement	Reading and answering questions about skeletons and joints	Activity 4	Importance of forces exerted in bones	Communication	
Section 2.2 The right stuff	Describing and defining mechanical properties		Meaning of elastic, plastic, hard, stiff, tough, brittle, ductile, smooth, durable	Communication	Terms also used in EAT
	Obtaining force–extension graph for material that does not obey Hooke's law	Activity 5	Hooke's law	Practical work	Review of work from HFS and EAT
	Measuring ultimate compressive stress for 'bone substitute'	Activity 6	Stress Ultimate compressive and tensile stress	Practical work Application of number	
	Relating elastic modulus to atomic-scale properties	Additional Sheet 1	Review of earlier work		Optional extension work
Section 2.3 By design	Reading about prosthetics			Communication ICT	
	Discussing and using stress–strain graphs Determining the Young modulus of a material	Activity 7 Additional Sheet 1	Strain Young modulus	Practical work Application of number	Core practical
Section 2.4 Take the strain	Finding energy stored in deformed sample		Area under force–extension graph and under stress–strain graph	Application of number	Links with HFS and EAT
	Relate elastic modulus to atomic-scale properties	Additional Sheet 1	Review of earlier work		Optional extension work
Section 2.5 The inside story	Relating properties of polymers to their atomic-scale structure	Additional Sheet 2	Idea of 'random walk'		Optional extension work
Section 2.6 Summing up Part 2	Summarising ideas about structure and properties of materials	Activity 8	Application of knowledge and skills from Part 2	Communication Study skills Use of IT	

Outline and reference to student materials			Key points	Skills	Notes
Section 3.1 One in the eye	Introduction discussing lens implants and contact lenses	Activity 9			
Section 3.2 Seeing eye to eye	Introduction to lenses Behaviour of converging lenses Formation, size and position of real images	Activity 10 Activity 11 Additional Sheet 3	Converging and diverging lenses, effect of curvature Power and focal length Lens formula Ray diagrams for real images Magnification		
Section 3.3 Seeing near and far	Accommodation in the human eye Behaviour of diverging lenses Formation, size and position of virtual images Lenses for correcting vision	Activity 12 Activity 13 Activity 14 Activity 15 Activity 16	The eye, and near and distance vision Effect of converging and diverging lenses Ray diagrams for virtual images Combining powers		
Section 3.4 Lenses for all occasions	Transmission and reflection at a boundary Refractive index, anti-reflection coatings (thin films)				
Section 3.5 Eyes right – summing up Part 3	Summarising ideas about eyes and lenses	Activity 17 Activity 18	Application of knowledge and skills from Part 3	Communication Study skills Application of number	
Section 4.1 Ultrasound imaging of the heart	Reading about the heart and ultrasound imaging		Action of the heart Role of ultrasound in medical physics	Communication	
Section 4.2 Ultrasound echoes	Measuring speed of sound in air Measuring dimensions of laboratory with 'laser' tape measure Demonstrating pulse–echo technique Demonstrating simple acoustic lens Demonstrating and explaining flicker fusion	Activity 19 Activity 20 Activity 21 Activity 22	Meaning of ultrasound Wave equation Measuring with pulse–echo technique Different sound speed in different materials	Practical work Application of number Communication	Students might have already done Activity 19 (determining speed of sound) as it is specified as core practical in MUS
Section 4.3 Doppler ultrasound	Observing and explaining Doppler effect	Activity 23	Doppler shift due to approaching/receding source and/or observer	Communication	Qualitative only – links with STA
Section 4.4 Summing up Part 4	Summarising ideas about waves at boundaries and Doppler effect	Activity 24	Application of knowledge and skills from Part 4	Study skills	
Section 5.1 Getting better	Reviewing work on materials	Activity 25 Activity 26	Benefits and risks	Study skills Communication	Link to Activity 1
Section 5.2 Questions on the whole chapter	Questions and calculations	Additional Sheet 4		Communication Application of number	Consolidation and revision
Section 5.3 Achievements	Chapter test	Additional Sheets 5, 6, 7 and 8		Communication Application of number	Questions illustrate style of external test

Table 6.2 Learning outcomes specified for *Spare Part Surgery*

Statement from Examination Specification		Section(s) in this chapter
1	know and understand the distinction between base and derived quantities and their SI units	2.2, 2.4
2	demonstrate their knowledge of practical skills and techniques for both familiar and unfamiliar experiments	2.2, 2.3, 3.2, 3.3
3	be able to estimate values for physical quantities and use their estimate to solve problems	2.2, 2.4, 4.2
4	understand the limitations of physical measurement and apply these limitations to practical situations	2.3
5	be able to communicate information and ideas in appropriate ways using appropriate terminology	2.2, 3.4, 5.1
6	understand applications and implications of science and evaluate their associated benefits and risks	1.2, 2.1, 3.4
8	understand the ways in which society uses science to inform decision making.	1.2, 3.4
54	understand how to use the relationships ● (*tensile*/*compressive*) *stress* = force/cross-sectional area ● (*tensile*/*compressive*) *strain* = change in length/original length ● *Young modulus* = stress/strain	2.2
55	be able to draw and interpret tensile/compressive stress–strain graphs, and understand the term *breaking stress*	2.2
57	CORE PRACTICAL 5: Determine the Young modulus of a material	2.3
58	be able to calculate the elastic strain energy E_{el} in a deformed material sample, using the equation $\Delta E_{el} = \frac{1}{2}F\Delta x$, and from the area under the force/extension graph. The estimation of area and hence energy change for both linear and non-linear force/extension graphs is expected	2.4
75	understand the term *focal length* of converging and diverging lenses	3.2, 3.3
76	be able to use ray diagrams to trace the path of light through a lens and locate the position of an image	3.2, 3.3
77	be able to use the equation power of a lens $P = 1/f$	3.2
78	understand that for thin lenses in combination $P = P_1 + P_2 + P_3 + \ldots$	3.3
79	know and understand the terms *real image* and *virtual image*	3.2
80	be able to use the equation $1/u + 1/v = 1/f$ for a thin converging or diverging lens with the real-is-positive convention	3.2, 3.3
81	know and understand that magnification = image height/object height and $m = v/u$	3.2
88	understand that waves can be transmitted and reflected at an interface between media	3.4, 4.2
89	understand how a pulse–echo technique can provide information about the position of an object and how the amount of information obtained may be limited by the wavelength of the radiation or by the duration of pulses	4.2

In this chapter, a medical context is used to introduce and reinforce some work on materials.

This chapter is intended to be taught towards the end of the first year of the A level course. It provides opportunities to revisit and review earlier work as well as introducing new material. It should be taught after *Higher, Faster, Stronger* (which covers forces and motion and the use of graphs) and *Good Enough to Eat* (which introduces some basic ideas about solid materials).

After Part 1, which sets the scene for the whole chapter, Part 2 is a study of large- and small-scale properties of materials in the context of replacement joints.

Part 3 is a study of lenses in the context of the eye and correction of defects.

Part 4 covers ultrasound scans to explain pulse–echo techniques.

If the chapter is to be divided between two teachers, one could take Parts 2 and 4 while the other took Part 3.