

Chapter 10 Creating Models

Outline July 01

Lesson length = 65 mins

Lessons available: 12 Summer Term, 10 Autumn Term

Section	Lessons	Main concepts and key words	In class	Private study
10.1	2 3	Models as simplified description of reality, obeying definite rules, Exponential changes: rate proportional to quantity, decay curves, $dN/dt = -kN$ Radioactive decay: activity, background, randomness, decay constant, half-life,	WorldMaker models of forest fire, percolation, rabbits A10S, A20S – look at one, modify and/or construct another Model bacteria population (by hand and/or Excel) Q10C Disposal of radioactive waste Expt – decay of thoron (NB follow local rules) Simulation using dice (A50E), WorldMaker (A40S, 60S) and/or Excel models Q20S Randomness and half-life	Q30S Decay in theory and practice Qs from SG p.8 Perhaps Q40S ‘Model growth and sample decay’
10.2	2 4 1	Capacitance, $C = Q/V$, farad, Decay through resistor, time constant RC , half-life, $dQ/dt = -Q/RC$, $Q/Q_0 = e^{-t/RC}$ Radioactivity by analogy: $N/N_0 = e^{-\lambda t}$, $t_{1/2} = \ln 2 / \lambda$ Other egs of exponential change, $dQ/dt = kQ$ in general, growth and decay, testing for exponential: constant ratio, log graphs Energy stored in capacitor $E = \frac{1}{2}QV$, area under Q, V	Demo A90D ‘Super-capacitor’, Expt – investigate capacitor behaviour (A100E, 120D or w/s) Demo – overloaded capacitor, NB safety screen, eye protection Q50S ‘Short Qs on charging capacitors’ (good warm-up on Q, I) Expt and/or datalogging demo (A130E) – measure capacitor discharge; D300 ‘Analogies between charge and water’ Model discharge – Modelling A140S, A150S, A180S and/or Excel; extension for mathematically able A160S ‘Approximations to e ’ Q90S ‘Radioactive decay with exponentials’, D400 ‘Half-life and time constant’ Demo – capacitor lighting bulbs and running motor Q120S ‘Energy to and from capacitors’	Q60S ‘Charging capacitors’ Q70S ‘Discharge and time constants’ Perhaps A170S ‘Exponentials and powers’ SG p.19 Could use Q80S Q110S ‘Energy stored in capacitors’

		graph,		
10.3	2	Introduction to oscillator vocab: amplitude, period, harmonic, isochronous; $f=1/T$	Build a time-measuring device, given string, springs, masses, bottles etc Expt circus or do-and-present A200P, 210P, 220P. 230P Perhaps D60O 'A language to describe oscillations' Practical investigation of factors affecting period of pendulum	Q150S 'Revisiting motion graphs'
	2	Investigation skills: controlling variables, reducing and estimating errors, getting a straight line graph		
	4	SHM, $x=A\sin(2\pi ft+\phi)$, restoring force proportional to displacement, $d^2s/dt^2=a=-(2\pi f)^2x$, $(2\pi f)^2x=k/m$ for mass on spring, v -t and a-t graphs, phase relationships	Demo A240P 'Looking at an oscillator – carefully', D700 'Snapshots of the motion of a simple harmonic oscillator' Modelling oscillations: A250S, 270S, D1000 'Graphs of SHM', perhaps D80O, 90O, 110O Test predictions from models by experiment A260E 'Loaded spring oscillator' Perhaps A300S 'Making links with mathematics' (phase relationships)	Perhaps A290S 'Slopes and Models' Q160S 'Oscillators' Q170S 'Energy and pendulums' Extension for more able Q190S 'Harmonic oscillators'
10.4	2	Energy stored in stretched spring Energy of oscillator = $PE+KE = \frac{1}{2}mv^2 + \frac{1}{2}kx^2$, energy at $x=0$, max Resonance, natural frequency, width of response curve increases as damping increases	Model A370S 'Energy in oscillators', D130O 'Energy flow in an oscillator' Perhaps Q220S 'Bungee jumping' Demos or do-and-present A320E, A330E, A340E, A350E D140O 'Resonance' Perhaps A360S 'Modelling resonance', Q240S 'Oscillator energy and resonance'	Q210D 'Energy in a simple oscillator Optional (for mathematically inclined) Q230X 'Energy in a oscillator: with calculus' SG Qs p.28 Q250S 'Resonance in car suspension systems' Reading 30T 'The Tacoma Narrows bridge collapse' and optional 40T 'Tacoma Narrows: re-evaluating the evidence'