Tutorial 10

Problem 1. K. & K. 11.12
A small cuckoo clock has a pendulum 25 cm long with a mass of 10 g and a period of 1 s. The clock is powered by a 200-gram weight which falls 2 m between the daily windings. The amplitude of the swing is 0.2 rad. What is the Q of the clock? How long would the clock run if it were powered by a battery with 1 J capacity?

Problem 2. K. & K. 11.14
Stationary motion of a damped oscillator driven by an applied force $F_0 \cos \omega t$ is given by $x_a(t) = X_0 \cos(\omega t + \phi)$. Consider an oscillator that is released from rest at $t = 0$, with initial conditions $x(0) = 0$ and $v(0) = 0$. For $t \to \infty$ the motion will settle at $x(t) = x_a(t)$, but for finite t $x(t)$ is a superposition of $x_a(t)$ and the solution of the free damped harmonic oscillator $x_b(t)$,

$$x(t) = x_a(t) + x_b(t).$$

1. Show that if $x_a(t)$ satisfies the equation of motion for the driven, damped harmonic oscillator, so does $x(t) = x_a(t) + x_b(t)$.

2. Determine the arbitrary constants in $x_b(t)$ such that $x(t)$ satisfies the initial conditions.

3. Sketch the resulting motion for the case where the oscillator is driven at resonance.