Vibrations & Waves Classwork 1
(Monday 17 January 2005)

Twenty students are packed into a small minibus driving down a road. They drive over a speed bump. The minibus takes off, and upon landing oscillates violently up and down. The oscillations decay away with time.
(mass of each student: 70kg; mass of minibus: 1000kg)

i) What type of oscillation is occurring?
ii) What general equation does this follow?
iii) The minibus oscillates with a period of 1 second. By assuming $\omega' \approx \omega_0$ find an *approximate* value of spring constant s.
iv) For simplicity assume that the initial amplitude A(t = 0) = 0.05 m and the phase $\phi = 0$. After 10 seconds the oscillation has decayed to 10^{-3} m. Calculate the mechanical resistance r.
v) Recalculate s given this value of r. How much would the period vary from the observed period if r = 0?
vi) What is the total energy TE stored in the oscillations initially (t = 0) and after 10 seconds?
vii) What is the quality factor Q?

The students return to Imperial and get a new minibus with different suspension (different r & s) but the same mass. They drive over the original speed bump again. The minibus oscillates violently again with a period of 1 second. However, after 1 second the oscillation has decayed to 10^{-4} m.
viii) Taking A as before, recalculate r.
ix) Recalculate s.
x) Recalculate Q.

The students then notice that they are driving towards another much larger bump in the road. Some of the students begin to jump out the back of the minibus.
xi) About how many students need to jump out before the remainder in the minibus will have the most comfortable landing?