1. Consider a pendulum of length l with a mass m. We will need this going forward with our investigation of oscillatory motion under different regimes (damping, driven, etc.)
   (a) Derive the equation of motion for this system when the amplitude is small.
   (b) How does frequency depend on amplitude?
   (c) How does frequency depend on mass?
   (d) How does frequency depend on length?
   (e) Generate a phase-space diagram for θ and $\dot{\theta}$. Label all important points. Show that there is a clockwise rotation in phase space.
   (f) Generate a phase-space diagram with an initial amplitude larger than part (**??**)
   (g) What is $\theta(t)$?
   (h) What is $\dot{\theta(t)}$?
   (i) What is $x(t)$?
   (j) What is $y(t)$?
   (k) Show that the total energy of this system is conserved with respect to time.
   (l) *Build* a real pendulum and collect some data on its behaviour for small amplitude oscillations. How does your model compare to a real system?