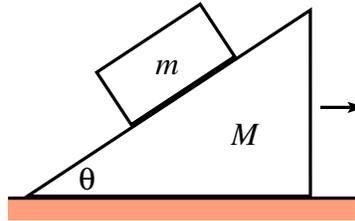


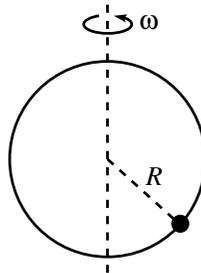
# 1 Newtonian or Lagrangian

A block of mass  $m$  is held at rest on a frictionless plane of mass  $M$ , angle of incline  $\theta$ . The plane rests on a frictionless horizontal surface. Find the acceleration of  $m$  and  $M$  after the block is released.



# 2 Small oscillations

A bead is free to move without friction along a circular wire hoop of radius  $R$ , which rotates with constant angular speed  $\omega$  about a vertical diameter. What is the minimum value of  $\omega$  for which the bead will remain at a fixed  $\theta_0$ ? For a sufficiently large  $\omega$ , what is  $\theta_0$  (as a function of  $\omega$ )? What is the frequency of small oscillations about  $\theta_0$ ?



# 3 Coupled oscillations

Two masses are connected to each other by a massless spring of spring constant  $\kappa_{12}$  and to fixed walls by springs of spring constant  $\kappa$ . Find the characteristic frequencies of longitudinal modes.

