Lecture 1.2
Simple Harmonic Motion with an Additional Force

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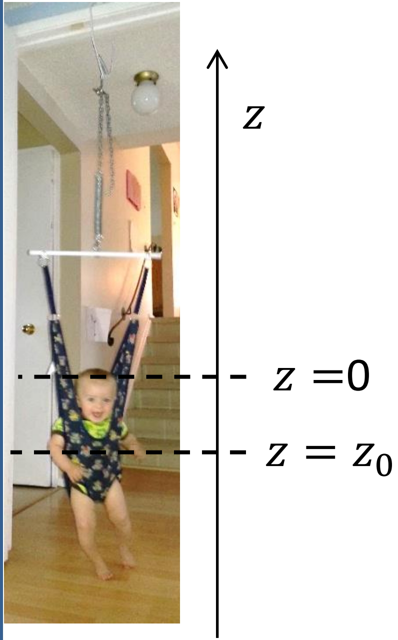
What if there is an additional constant force?

The baby in the jolly jumper is subject to gravity as well as the spring force.

Adding an extra force

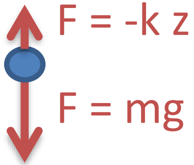


From the free-body diagram:

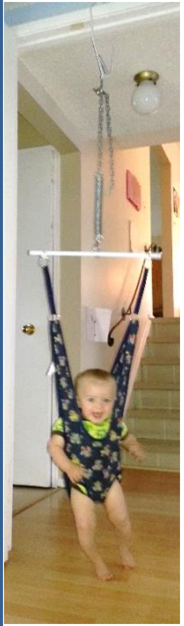
$$F_z = -kz - mg$$

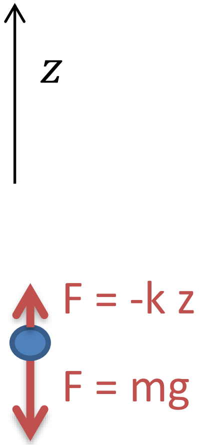
Equilibrium is when $F = 0$.

The extra force will change the equilibrium point $z = 0$.



Adding an extra force



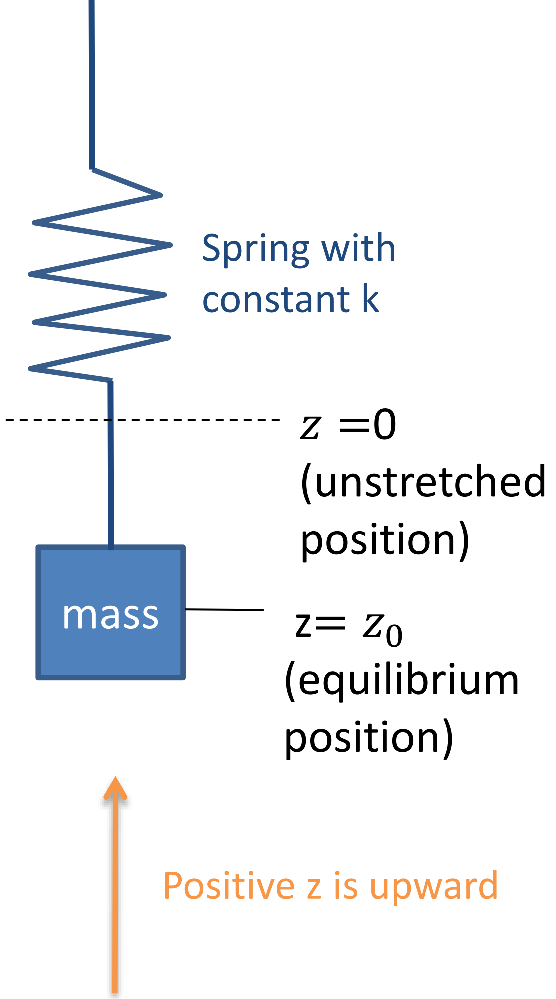


From the free-body diagram:

$$F = -kz - mg$$

Equilibrium is when $F = 0$. Let z_0 be the distance between the unstretched and equilibrium positions:

$$0 = -kz_0 - mg$$
$$kz_0 = -mg$$
$$z_0 = -mg/k$$



Then: $F = -kz - mg$

becomes $F = -k(z - z_0)$

If we now let $z' = z - z_0$

then we have the SHM force law:

$$F = -kz'$$

Motion is SHM:

$$z'(t) = A\cos(\omega t + \phi_0)$$

Or

$$z(t) = A\cos(\omega t + \phi_0) + z_0$$