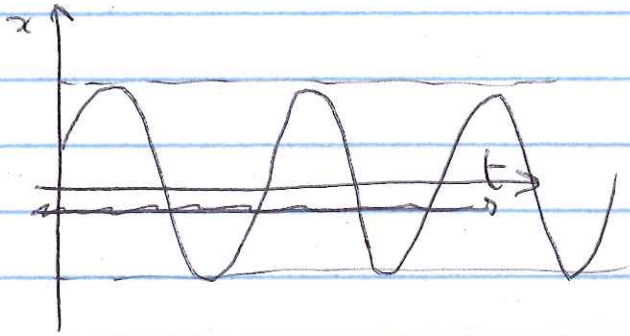
* Damped harmonic motion

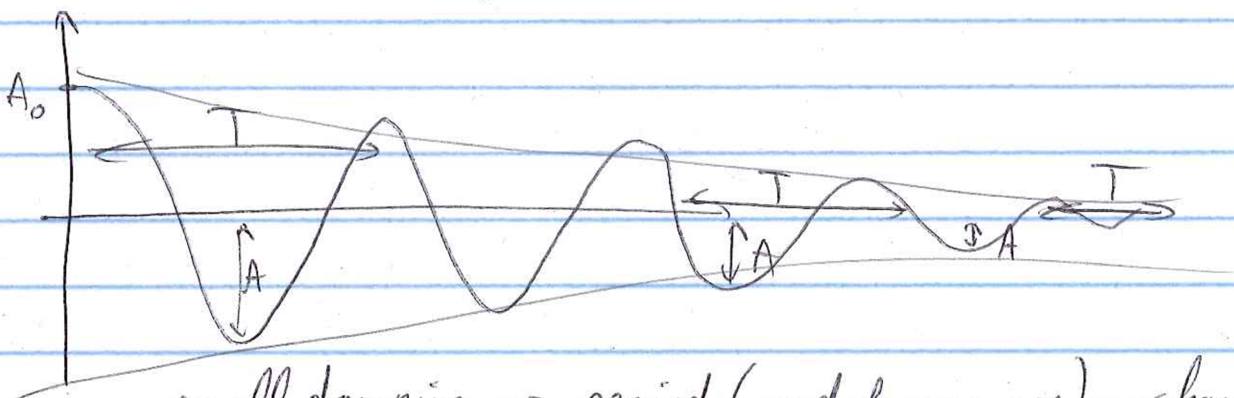


$\underline{x} = A \cos \omega t$

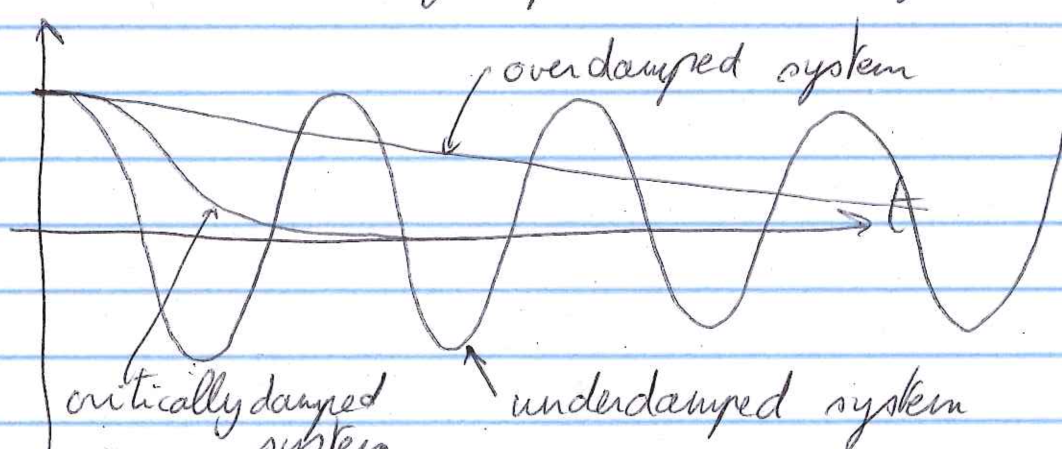
A is constant

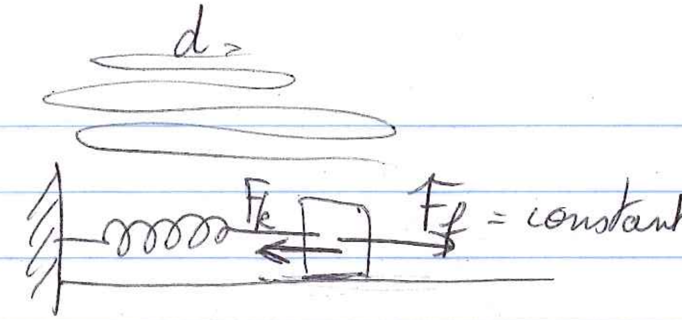
non-conservative forces : $W_{nc} \rightarrow$ change of total energy

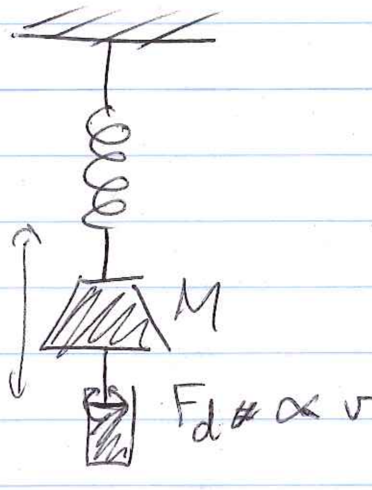
$$\Delta(\underbrace{KE + PE}_{E_{total}}) = \Delta\left(\frac{1}{2} k A^2\right) \longrightarrow \Delta A$$



small damping → period (and frequency) unchanged
large damping → period does change







$\hookrightarrow F_f = \mu_k N = \mu_k mg$

$W_{NC} = F_f d = \mu_k mgd$

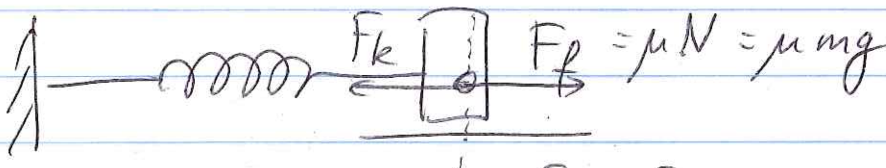
$\underline{E_{total,\,initial}} = \frac{1}{2}kA^2 = \underline{W_{NC}}$

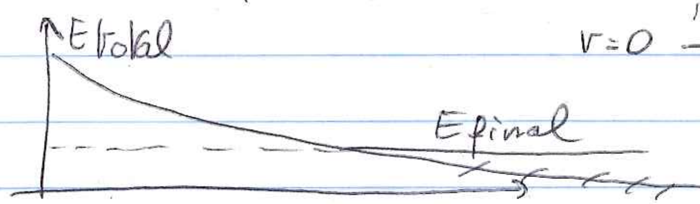
$\frac{1}{2}kA^2 = \mu_k mgd$

$\hookrightarrow d = \frac{kA^2}{2\mu_k mg}$

Is there energy left at the end?

$E_{total,\,final} = 0$ if we end at equilibrium





$v = 0 \rightarrow F_k = F_f$

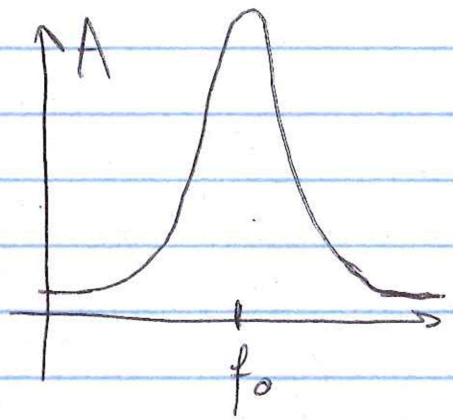
$kx = \mu mg$

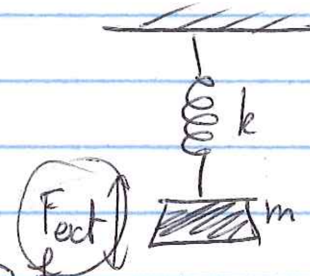
$\hookrightarrow x = \frac{\mu mg}{k}$

$PE_{final} = \frac{1}{2}k\left(\frac{\mu mg}{k}\right)^2$

* Forced oscillations : energy added to the system

- soldiers on bridge
- musical instrument





$f_0 = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ = natural frequency

f = frequency of external

$f = f_0 \Rightarrow$ resonance

Bay of Fundy

time for waves to travel to the end and back = 12.4 hrs

time between the tides = 12.42 hrs

* Waves : traveling disturbances