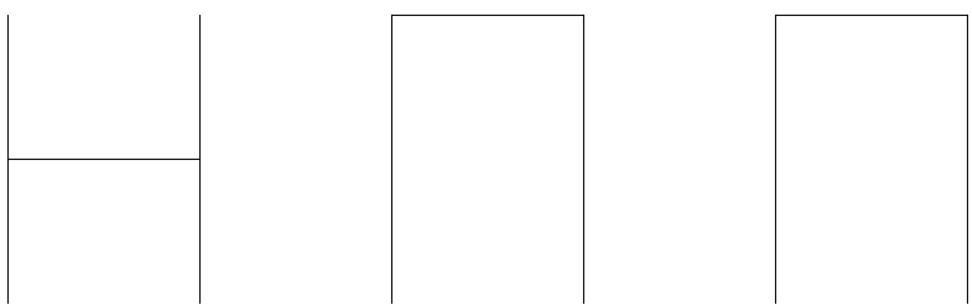
6. (30 pts.) Daredevil Dave is at it again. This time, the 80 kg stuntman wants to launch himself vertically with a vertical spring launcher, as shown in the diagram. There is 1000 N/m spring attached to a platform that can move up and down inside a cylinder. When the spring is in its relaxed position, the platform is at the top of the cylinder. Take that position to be the origin. Daredevil Dave will then compress the spring to a height y_i (less than zero) and launch himself vertically. He leaves the platform at the top of the cylinder, and eventually reaches a maximum height y_f. As long as the platform is inside the cylinder (that is, as long as $y < 0$) the cylinder exterts a constant frictional force of 300 N on the platform. Your eventual goal will be to find y_f. Treat Dave as a particle throughout.

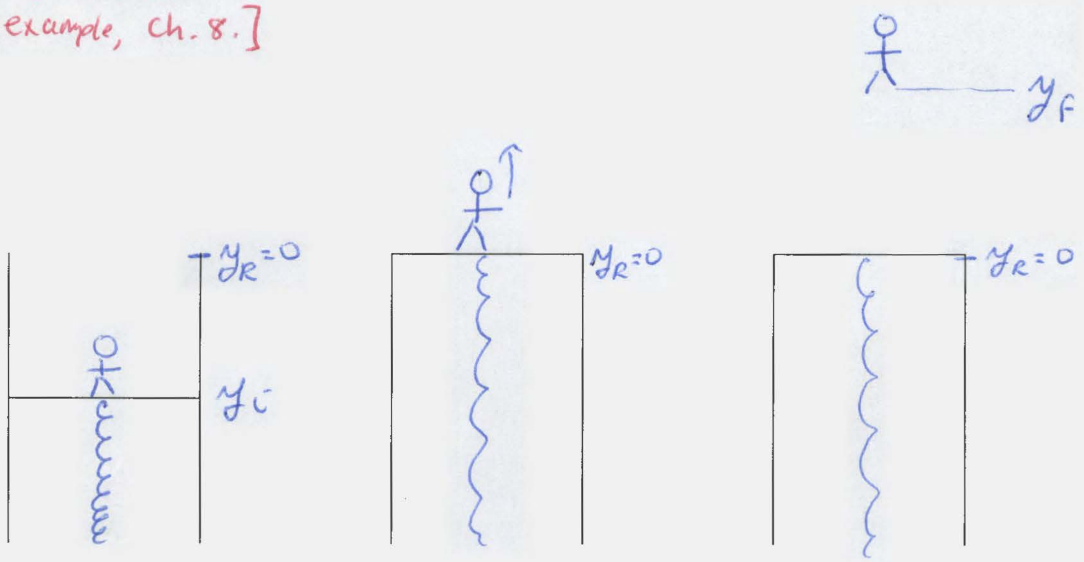


a. (10 pts.) What value for y_i should Dave pick so that the maximum magnitude of his acceleration will be $5g$?

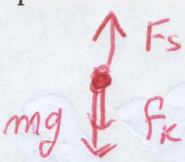
b. (15 pts.) Find the maximum height y_f. (If you are unsure of your answer to part (a), you may use $y_i = 7$ m, even though that is not the correct value.)

6. (30 pts.) Daredevil Dave is at it again. This time, the 80 kg stuntman wants to launch himself vertically with a vertical spring launcher, as shown in the diagram. There is 1000 N/m spring attached to a platform that can move up and down inside a cylinder. When the spring is in its relaxed position, the platform is at the top of the cylinder. Take that position to be the origin. Daredevil Dave will then compress the spring to a height y_i (less than zero) and launch himself vertically. He leaves the platform at the top of the cylinder, and eventually reaches a maximum height y_f. As long as the platform is inside the cylinder (that is, as long as $y < 0$) the cylinder exterts a constant frictional force of 300 N on the platform. Your eventual goal will be to find y_f. Treat Dave as a particle throughout.

[See elevator example, Ch. 8.]



a. (10 pts.) What value for y_i should Dave pick so that the maximum magnitude of his acceleration will be $5g$?



Use $\sum F = ma$

$$-f_K - k(y_i - \overset{0}{\cancel{y_R}}) - mg = m(5g)$$

$$-ky_i = 6mg + f_K$$

$$y_i = -\frac{6mg}{k} + f_K = \frac{-6(80)(9.8)}{1000} + 300$$

$$\boxed{y_i = -5.004\ m}$$

b. (2.0 pts.) Find the maximum height y_f. (If you are unsure of your answer to part (a), you may use $y_i = -7$ m, even though that is not the correct value.)

$$E_i + W_{other} = E_f$$

$$E_i - \underbrace{f_K (\cancel{y_R} - y_i)}_{} = E_f$$

friction opposes motion only while $y < y_R$

$$K_i + U_i + f_K y_i = K_f + U_f$$

$$0 + mgy_i + \frac{1}{2}k(y_i - y_R)^2 + f_K y_i = 0 + mgy_f$$

Using correct $y_i = -5.004$:

$$y_i + \frac{1}{2}\frac{k}{mg}(y_i - y_R)^2 + \frac{f_K y_i}{mg} = y_f$$

$$-5.004 + \frac{1{,}000\,(-5.004)^2}{2(80)9.8} + \frac{(300)(-5.004)}{(80)(9.8)} = y_f$$

$$\boxed{9.05\text{ m} = y_f}$$

If you use $y_i = -7$,

$$-7 + \frac{1}{2}\frac{(1000)(-7)^2}{(80)(9.8)} + \frac{300(-7)}{(80)(9.8)} = y_f$$

$$\boxed{21.6\text{ m} = y_f}$$