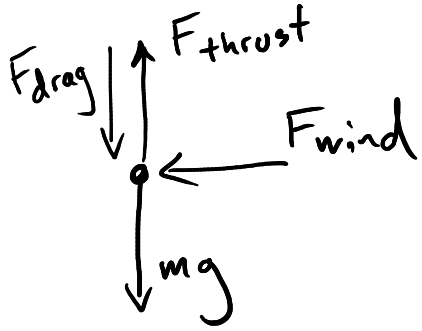
Draw FBD

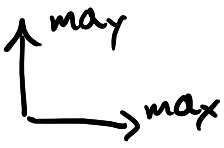
Why like that?

include drag, wind, thrust, gravity

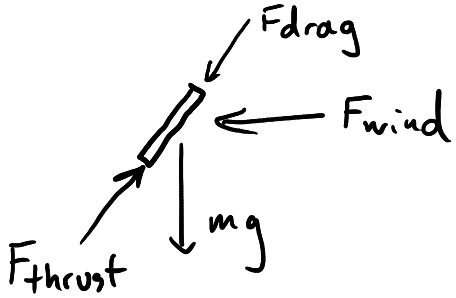
(1)



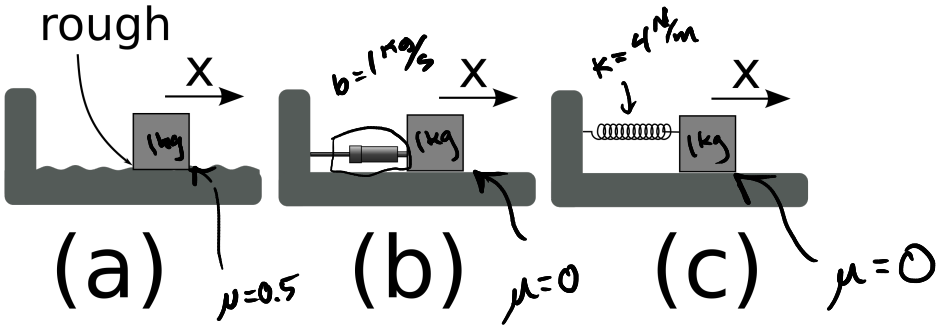
=

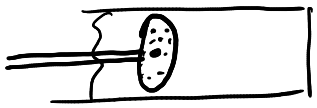


(2)



=

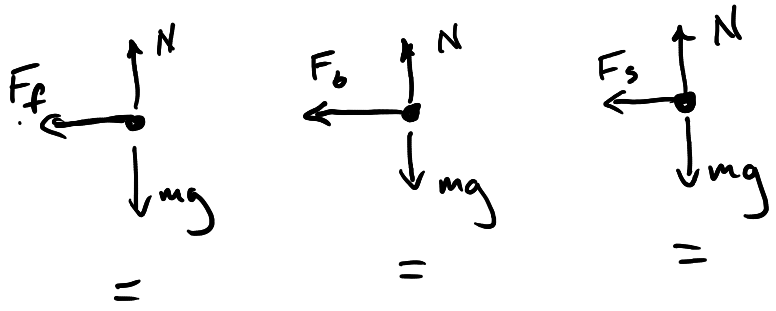




$F_f = \mu mg$

$F_b = b\dot{x}$

$F_s = kx$



RD

note:

lazy Cooper shortcut

$\frac{dx}{dt} = \dot{x}$

$\frac{d^2x}{dt^2} = \ddot{x}$

(a) $-\mu mg = ma = m\ddot{x}$

(b) $-b\dot{x} = ma = m\ddot{x}$

(c) $-kx = ma = m\ddot{x}$

(a) $\rightarrow$ $\ddot{x} = -\mu g = -\frac{g}{2}$

$x(t) = x_0 + v_0 t - \frac{1}{2}\cdot(0.5)(g)\cdot t^2$ (kinematic eqn)

(b) $\ddot{x} = -b\dot{x}$ or $\dot{v} = -bv$

$$\frac{1}{v}\frac{dv}{dt} = -bv \cdot \frac{1}{v}$$

$$\int_{v_0}^{v(t)} \frac{dv}{v} = \int_0^t -b \cdot dt$$

$$\ln(v) - \ln(v_0) = -b \cdot t$$

$$e^{\ln\left(\frac{v}{v_0}\right)} = e^{-bt}$$

$$v(t) = v_0 e^{-bt}$$

$$\frac{dx}{dt} = v_0 e^{-bt}$$

$$\int_{x_0}^{x(t)} dx = \int_0^t v_0 e^{-bt} \cdot dt$$

$$x(t) - x_0 = \frac{-v_0}{b}\left(e^{-bt} - e^0\right)$$

$$x(t) = \frac{v_0}{b}\left(1 - e^{-bt}\right)$$

$$\frac{d}{dt}\left(e^{-bt}\right) = -be^{-bt}$$

$$\int e^{-bt}dt = \frac{-1}{b}e^{-bt}$$