

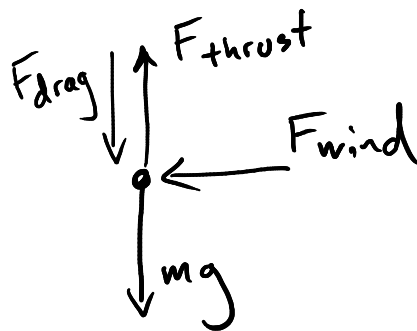
Draw FBD

why like that?

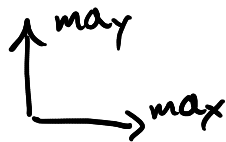
include drag, wind,
thrust,
gravity



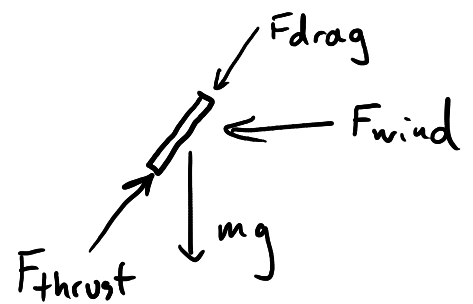
①



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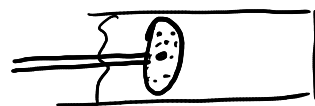
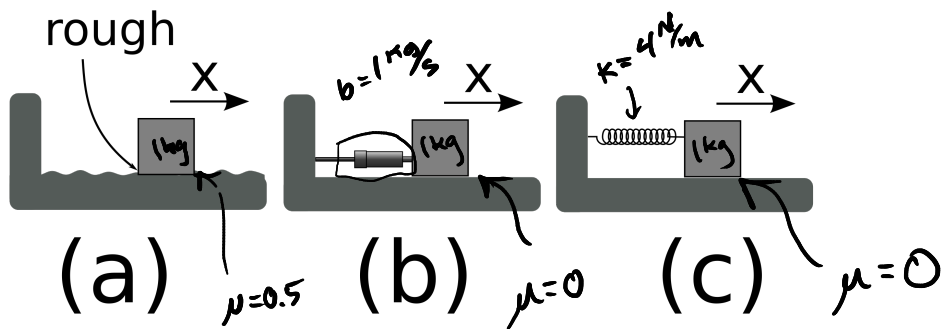


②



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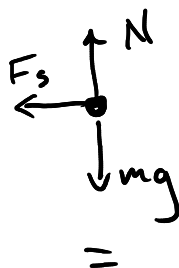
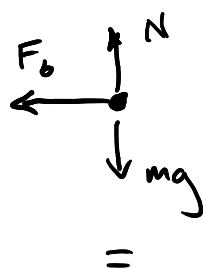
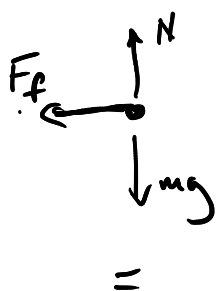




$$F_f = \mu mg$$

$$F_b = b \dot{x}$$

$$F_s = kx$$



$$ma \rightarrow$$

$$ma \rightarrow$$

$$ma \rightarrow$$

RD

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

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

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

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

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

(kinematic equ)

note:

lazy Cooper shortcut

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

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

(b)

$$\ddot{x} = -b \dot{x} \quad \text{or} \quad \dot{v} = -bv$$

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

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

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

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

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

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

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

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

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

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

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