Tutorial, Oct. 16

(3.75)

$$V_{term} = \sqrt{\frac{2mg}{\rho A}}$$

(a) Bowling ball (d) Watermelon

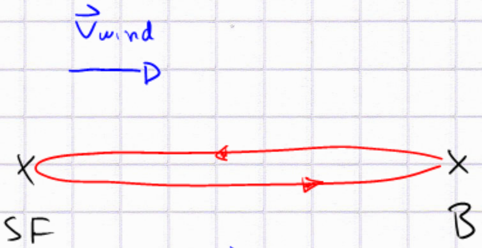
(b) Beach ball (e) Cantaloupe

(c) Spear / javelin (f) Apple

$$\frac{m}{A} = \frac{\rho_b V}{A} \overset{\text{sphere}}{=} \rho_b \frac{4\pi R^3}{3\pi R^2} = \frac{4}{3}\rho_b R$$

(b) < (f) < (e) < (d) < (a) < (c)

(4.40)



$V_{wind} = 50$ m/s

$V_{plane-air} = 250$ m/s

$d_{SF-B} = 5000$ km

$$\vec{V}_{plane-ground} = \vec{V}_{plane-air} + \vec{V}_{wind}$$

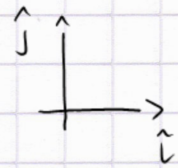
$$\vec{V}_1 = \vec{V}_2 + \vec{V}_{rel}$$

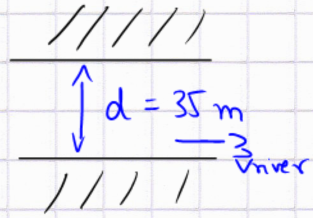
(a) $V^{B \to SF}_{plane-ground} = 250 - 50 = 200$ m/s

(b) $V^{SF \to B}_{plane-ground} = 250 + 50 = 300$ m/s

(c) $$V_{ave} = \frac{2d}{\Delta t} = \frac{2d}{\Delta t_1 + \Delta t_2} = \frac{2d}{\frac{d}{V^{(a)}_{plane-gr.}} + \frac{d}{V^{(b)}_{plane-gr}}} = 240 \text{ m/s}$$

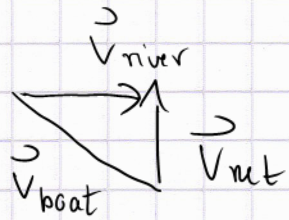
4.42





$V_{river} = 0.25$ m/s

$\Delta t = 4$ min $= 240$ s

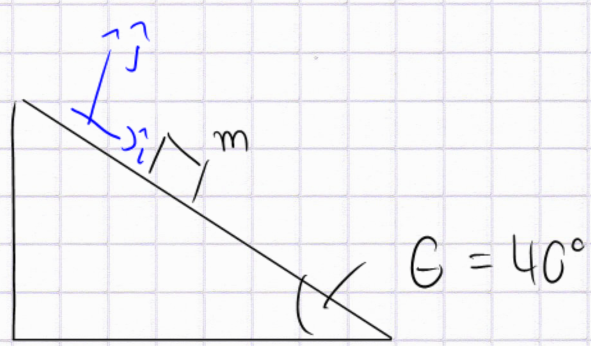


$$\vec{V}_{boat} = \vec{V}_{net} - \vec{V}_{river}$$
$$= V_{net}\,\hat{j} - V_{river}\,\hat{i}$$

class: $\Delta t = \dfrac{d}{V_{net}} \iff V_{net} = \dfrac{d}{\Delta t} = 0.146$ m/s

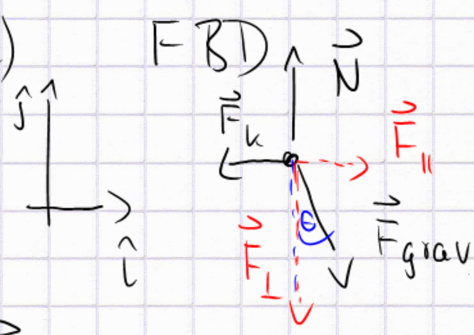
$$V_{boat} = \sqrt{V_{net}^2 + V_{river}^2} = 0.29 \text{ m/s}$$

4.46



$\theta = 40°$

(a) FBD



(b) $\vec{F}_{\parallel} = mg \sin\theta\,\hat{i}$ $\qquad$ $\vec{N} = N\hat{j} = mg\cos\theta\,\hat{i}$

$\vec{F}_{\perp} = -\,mg\cos\theta\,\hat{j}$ $\qquad$ $\vec{F}_k = -\mu_k N\,\hat{i} = -\mu_k mg\cos\theta\,\hat{i}$

(c) Newton-2

$\hat{i}$ $\quad ma_x = mg\sin\theta - \mu_k mg\cos\theta$ ←

$\hat{j}$ $\quad ma_y = N - F_\perp = 0$

(d) $a_x = 2.4\ m/s^2$

$$a_x = g\sin\theta - \mu_k g\cos\theta$$

$$\Leftrightarrow \frac{a_x}{g} = \sin\theta - \mu_k\cos\theta$$

$$\Leftrightarrow \mu_k = \tan\theta - \frac{a_x}{g\cos\theta} = 0.52$$

(4.52) same geometry as in (4.46)

$\theta = 20°$

$\mu_k = 0.45$

(a) $a_x = g\sin\theta - \mu_k g\cos\theta$

$$= -0.79\ m/s^2$$

(b) $\Delta V_x = V_f - V_0 = a_x\Delta t$ coming to stop: $V_f = 0$

$$\Leftrightarrow \Delta t = -\frac{V_0}{a_x} = 17.7\ s$$

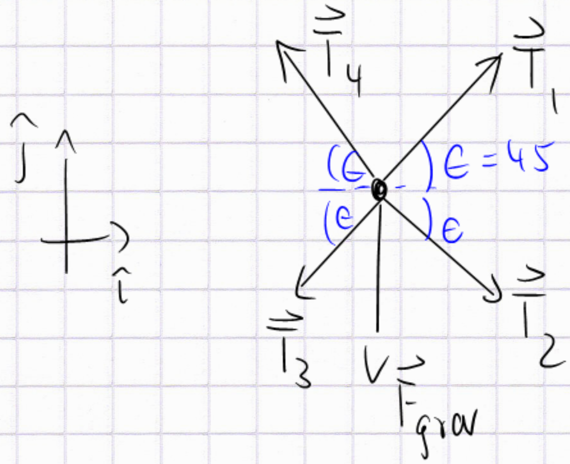
car doesn't stop if $a_x \geq 0$

$$\Leftrightarrow g(\sin\theta - \mu_k\cos\theta) \geq 0$$

$$\Leftrightarrow \mu_k \leq \tan\theta = 0.36$$

(4.66)

FBD



static equilibrium

$$\vec{F}_{grav} + \vec{T}_1 + \vec{T}_2 + \vec{T}_3 + \vec{T}_4 = 0$$

($\hat{j}$)

$$ma_y = 0$$

$$= -mg + T_{1,y} + T_{2,y} + T_{3,y} + T_{4,y}$$

$$= -mg + 2T_{top}\sin\theta - 2T_{bot}\sin\theta$$

$$\Rightarrow 2T_{top}\sin\theta = mg + 2T_{bot}\sin\theta$$

$$\Rightarrow T_{top} = \frac{mg}{2\sin\theta} + T_{bot} = 80.5\text{ N}$$