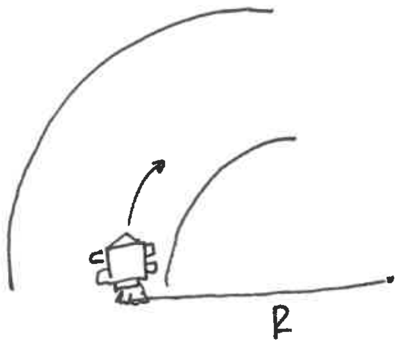
1

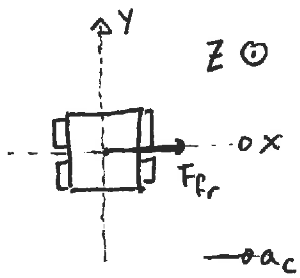


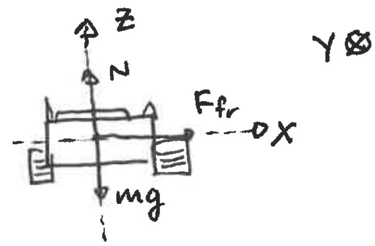
$R = 100\,m$

$m = 2000\,kg$

$\mu_s = 0.9$

Free body diagrams





X	Y	Z
$F_{fr} = m a_c$ — ①	N/A	$N - mg = 0$ — ②

$a_c = \frac{V^2}{R}$ — ③ $\qquad F_{fr} = \mu_s N$ — ④

②, solve for N.

$N = mg$ — ②'

① ← (②', ④, ③), solve for V.

$$\mu_s N = m\frac{V^2}{R}$$

$$\mu_s mg = m\frac{V^2}{R}$$

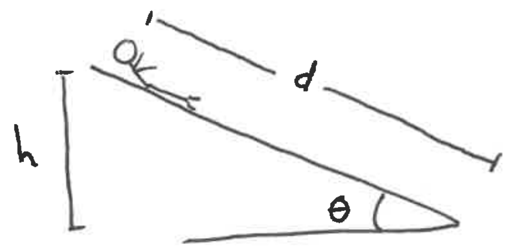
$$V^2 = R\mu_s g$$

$$V = \sqrt{\mu_s R g}$$

$$V = \sqrt{(0.9)(100)(10)}$$

$$\boxed{V = 30\,m/s}$$

2



$V_0 = 0\ m/s$

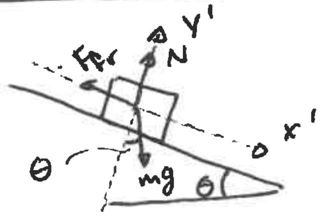
$m = 60\,kg$

$\mu_k = 0.25$

$d = 10\,m$

$h = ?$

Free body diagram



$\underline{x'}$

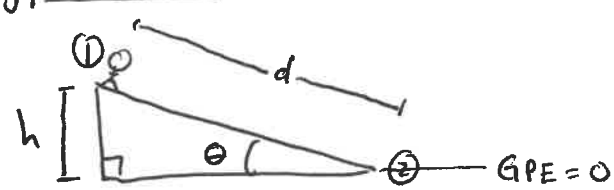
$mg\sin\theta - F_{fr} = ma_x$ — ①

$\underline{y'}$

$N - mg\cos\theta = 0$ — ②

$F_{fr} = \mu_k N$ — ③

Energy Diagram



$\frac{h}{d} = \sin\theta$

$h = d\sin\theta$ — ⑤

$\underline{E①}$

$GPE + \cancel{SPE}^{0} + \cancel{FE}^{0} + \cancel{KE}^{0} = \underset{0}{\cancel{GPE}} + \underset{0}{\cancel{SPE}} + FE + KE$ (E②)

$mgh = \frac{1}{2}mv^2 + \mu_k N \cdot d$ — ④

②, solve for N.

$N = mg\cos\theta$ — ②'

④ ← (②', ⑤), solve for V.

$mgd\sin\theta = \frac{1}{2}mv^2 + \mu_k mg\cos\theta \cdot d$

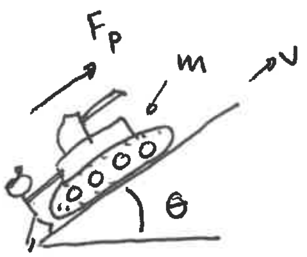
$\frac{1}{2}v^2 = gd(\sin\theta - \mu_k\cos\theta)$

$V = \sqrt{2gd(\sin\theta - \mu_k\cos\theta)}$

$V = \sqrt{2(10)(10)(\sin 30° - 0.25\cos 30°)}$

$\boxed{V = 7.53\,m/s}$

3

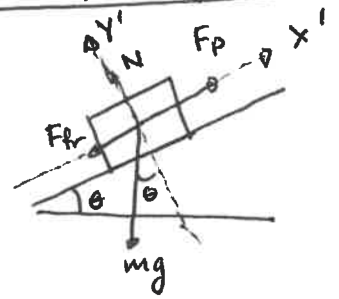


$F_p = 60{,}000\ N$ $\quad v = 1\ m/s$

$m = 5000\ kg$

$\theta = 30°$

Free Body Diagram



Constant velocity means $a = 0$.

X'

$F_p - mg\sin\theta - F_{fr} = 0$ — ①

Y'

$N - mg\cos\theta = 0$ — ②

$F_{fr} = \mu_k N$ — ③

②, solve for N.

$N = mg\cos\theta$ — ②'

① ← (②', ③), solve for μ_k.

$F_p - mg\sin\theta - \mu_k mg\cos\theta = 0$

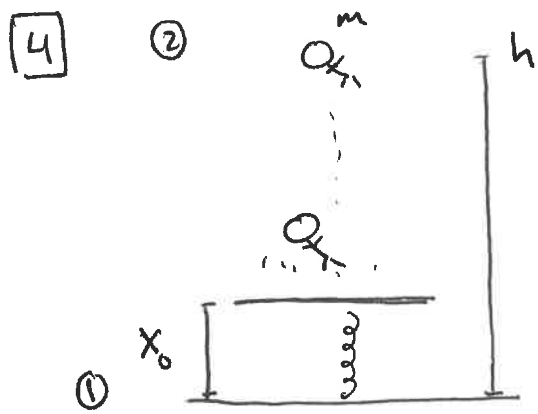
$F_p - mg\sin\theta = \mu_k mg\cos\theta$

$$\mu_k = \frac{F_p - mg\sin\theta}{mg\cos\theta}$$

$$\mu_k = \frac{60{,}000 - (5000)(10)\sin 30°}{(5000)(10)\cos 30°}$$

$\boxed{\mu_k = 0.81}$ ← note: this is <u>unitless</u>.

4



$m = 50\,kg$

$x_0 = 0.50\,m$

$k = 40{,}000\ N/m$

- - - GPE = 0 (I set this)

$$\overbrace{\cancel{GPE}^{0} + SPE + \cancel{KE}^{0} + \cancel{FE}^{0}}^{E_①} = \overbrace{GPE + \cancel{SPE}^{0} + \cancel{KE}^{0} + \cancel{FE}^{0}}^{E_②}$$

$$\frac{1}{2} k x_0^2 = mgh \quad — ①$$

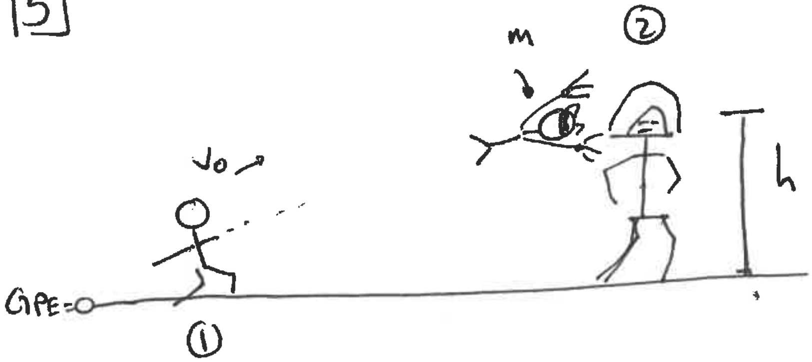
①, solve for h.

$$h = \frac{\frac{1}{2} k x_0^2}{mg} = \frac{k x_0^2}{2mg}$$

$$h = \frac{(40{,}000)(0.5)^2}{2(50)(10)}$$

$$\boxed{h = 10\,m}$$

5



m = 80 kg
h = 5 m
V_o = 30 m/s

$$\underline{E_{①}} \qquad\qquad \underline{E_{②}}$$

$$\cancel{GPE}^{0} + \cancel{SPE}^{0} + KE_1 + \cancel{FE}^{0} = GPE + \cancel{SPE}^{0} + KE_2 + \cancel{FE}^{0}$$

$$\frac{1}{2} m v_0^2 = mgh + \frac{1}{2} m v_f^2 \quad — ①$$

①, solve for v_f.

$$\frac{1}{2} v_0^2 = gh + \frac{1}{2} v_f^2$$

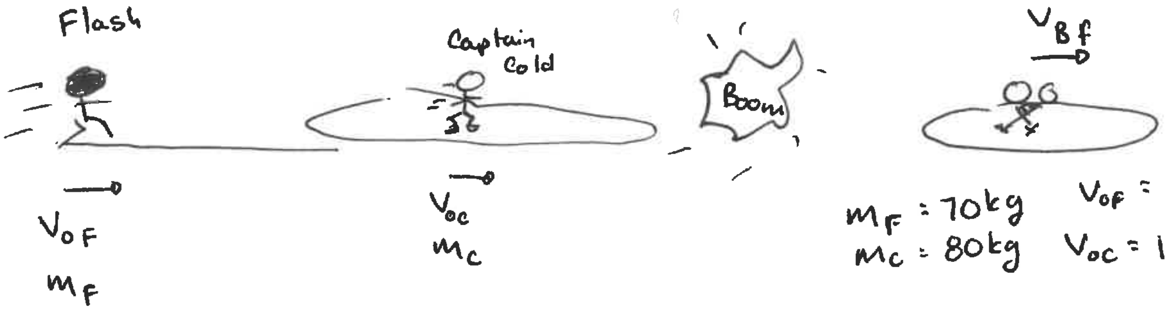
$$V_0^2 - 2gh = v_f^2$$

$$V_f = \sqrt{V_0^2 - 2gh}$$

$$V_f = \sqrt{(30)^2 - 2(10)(5)}$$

$$\boxed{V_f = 28.3 \text{ m/s}}$$

6



$m_F : 70\text{kg}$ $V_{oF} = 50\text{m/s}$
$m_c : 80\text{kg}$ $V_{oc} = 10\text{m/s}$

Cannot use conservation of energy.

Use conservation of momentum (collision)

X

$$P_{ix} = P_{fx}$$

Y

$$\cancel{P_{iy}}^{0} = \cancel{P_{fy}}^{0}$$

$$m_F V_{oF} + m_c V_{oc} = (m_F + m_c) V_{Bf} \quad — ①$$

①, solve for V_f.

$$V_{Bf} = \frac{m_F V_{oF} + m_c V_{oc}}{m_F + m_c}$$

$$V_{Bf} = \frac{(70)(50) + (80)(10)}{70 + 80}$$

$$\boxed{V_{Bf} = 28.7\text{m/s}}$$