60

Physics 122

Midterm – November 2017 #1

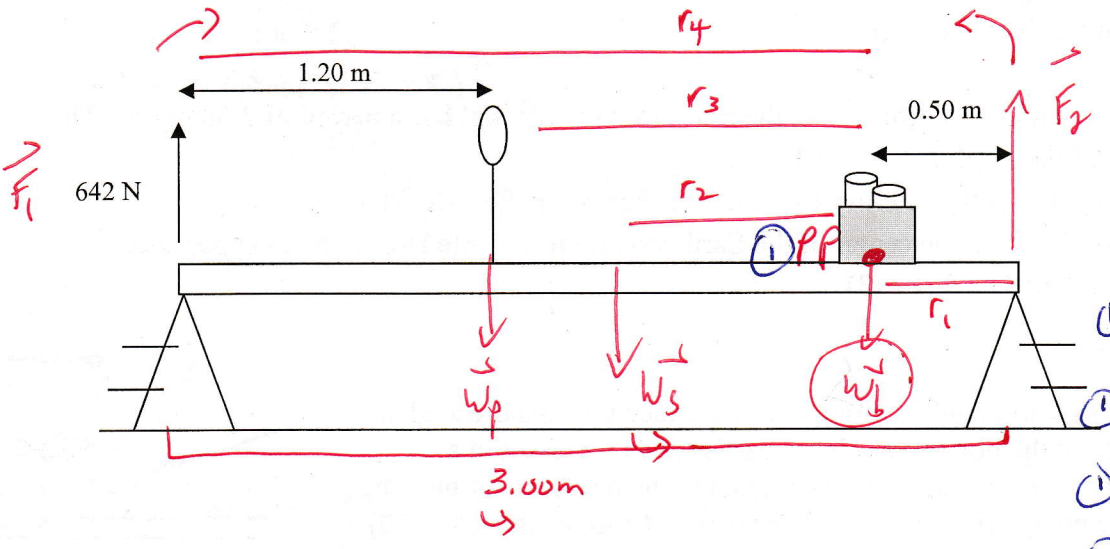
Name - Key

Date - Tues, Nov. 21/17

Do problems #1 ~~and #2~~ in the space provided. Do #2-6 on your own loose leaf.
Show your work.

---

1. An 850.0 N painter stands 1.20 m from one end of a 3.00 m long scaffold supported at each end by a stepladder. The scaffold has a mass of 26 kg and the upward force applied to the left end of the scaffold is as indicated in the diagram. If the box of paint cans is located 0.50 m from the right end of the scaffold, what is the magnitude of the force acting on the right end of the scaffold? Assume a state of static equilibrium. (10)



$W_p = 850.0\ N$
$m_s = 26\ kg$
$F_1 = 642\ N$
$F_2 = ?$
(1) $r_1 = 0.50m$
(1) $r_3 = 1.3^0m$
(1) $r_2 = 1.0^0m$
(1) $r_4 = 2.50m.$

$-\tau_{F_1} + \tau_{W_p} + \tau_{W_s} + \tau_{F_2} = 0$ (2)

$-r_4F_1 + r_3W_p + r_2W_s + r_1F_2 = 0$

$-r_4F_1 + r_3W_p + r_2 m_s g + r_1F_2 = 0$ (1)

$$F_2 = \frac{r_4F_1 - r_3W_p - r_2m_sg}{r_1}$$ (1)

$$F_2 = \frac{2.50(642) - (1.30)(850.0) - (1.00)(26)(9.80)}{0.50}$$

$F_2 = 4.9\times10^2\ N.$ (1)

The magnitude of the force is 4.9×10^2 N.

10

3.

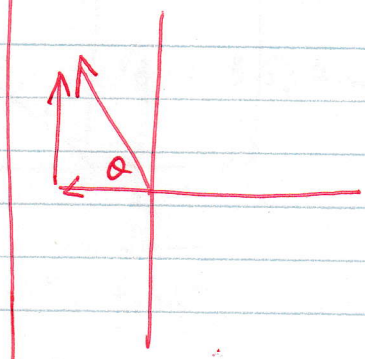
① $m_h = 4.8\,kg$

$\vec{v}_h = 0$

$\vec{v}_{hx} = 0$

$\vec{v}_{hy} = 0$

$m_1 = 1.4\,kg$



$\vec{v}_1' = 12.0\,m/s,\ 15°\ NofW$

$\vec{v}_{1x}' = -12.0\cos 15°$

$\vec{v}_{1y}' = +12.0\sin 15°$ ②

$m_2 = 2.3\,kg$

$\vec{v}_2' = 8.0\,m/s,\ S$

$\vec{v}_{2x}' = 0$

$\vec{v}_{2y}' = -8.0\,m/s$ ①

$\vec{v}_3' = ?$

$m_3 = 1.1\,kg$ ①

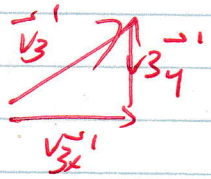
x: ~~$m_h \vec{v}_{hx}$~~ $= m_1 \vec{v}_{1x}' + ~~m_2 \vec{v}_{2x}'~~ + m_3 \vec{v}_{3x}'$

10

$\vec{v}_{3x}' = \dfrac{-m_1 \vec{v}_{1x}'}{m_3}$ ①

$\vec{v}_{3x}' = \dfrac{-(1.4)(-12.0\cos 15°)}{1.1}$

$\vec{v}_{3x}' = 14.8\,m/s$ ①



y: ~~$m_h \vec{v}_{hy}$~~ $= m_1 \vec{v}_{1y}' + m_2 \vec{v}_{2y}' + m_3 \vec{v}_{3y}'$

$\vec{v}_{3y}' = \dfrac{-m_1 \vec{v}_{1y}' - m_2 \vec{v}_{2y}'}{m_3}$ ①

$\vec{v}_{3y}' = \dfrac{-(1.4)(12.0\sin 15°) - (2.3)(-8.0)}{1.1}$

$\vec{v}_{3y}' = 12.8\,m/s$ ①

$v_3' = \sqrt{(14.8)^2 + (12.8)^2}$

$v_3' = 20\,m/s,$

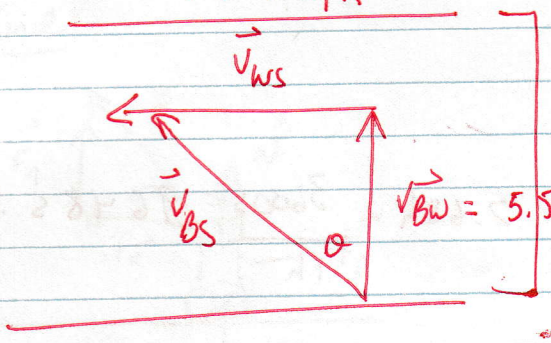
$\tan\theta = \dfrac{12.8}{14.8}$

$\theta = 41°$

$\vec{v}_3' = 20\,m/s,\ 41°\ NofE$ ②

100 m = 0.100 km

4. 4.12 km/h



sketch. (1)

(4)

a) $V_{bs} = \sqrt{(5.53)^2 + (4.12)^2}$ (1)

$V_{bs} = 6.90$ km/h

$\tan\theta = \frac{4.12}{5.53}$ (1)

$\theta = 36.7°$

$\vec{V_b} = 6.90$ km/h, 36.7° W of N (1)

53.3° N of W

b) $v = \frac{d}{t}$

$t = \frac{d}{V_{WS}}$ (1)

$t = \frac{0.100}{4.12} = 0.0243\,h \times \frac{60\,min}{1\,h} = 1.46\,min$ (1) (1)

(4)

c) $v = \frac{x}{t}$

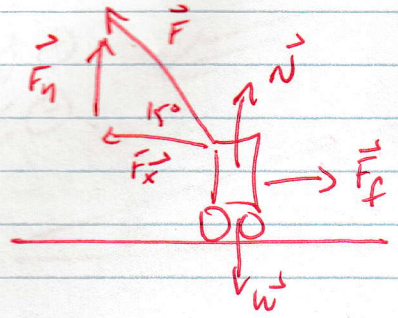
$x = V_{BW} t$ (1)

$x = (5.53)(0.0243)$

$x = 0.134$ km. (1)

(2)

6. Fuel



$m = 204\ kg$

$a = 1.6\ m/s^2$

$\vec{F}_A = ?$

$\mu = 0.18$

$\vec{F}_{net} = m\vec{a}$

$+F_f - F_x = m(-a)$ ③

① $\mu N - F\cos\theta = -ma$

$\mu(mg - F\sin\theta) - F\cos\theta = -ma$

② ①

$\mu mg - \mu F\sin\theta - F\cos\theta = -ma$ ①

$\mu mg + ma = \mu F\sin\theta + F\cos\theta$

$F = \dfrac{\mu mg + ma}{\mu\sin\theta + \cos\theta}$ ①

$N + F_y - W = 0$

$N = W - F_y$

$N = mg - F\sin\theta$

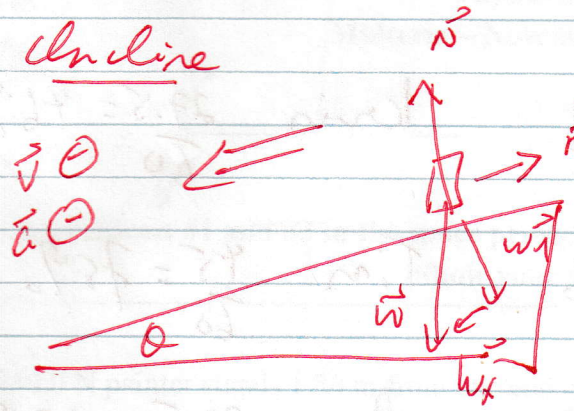
10

$F = \dfrac{(0.18)(204)(9.8) + (204)(1.6)}{(0.18)\sin 15^\circ + \cos 15^\circ}$

$F = 6.8 \times 10^2\ N$. ①

The force applied is $6.8 \times 10^2\ N$, 15° above h.

6. Incline



$a = 2.13\ m/s^2$

$\theta = 25.0°$

$\mu = ?$

10

$\vec{F_{net}} = m\vec{a}$

$-w_x + F_f = m(-a)$ (3)

$-W\sin\theta + \mu N = -ma$ (i) (ii)

$-mg\sin\theta + \mu w_y = -ma$ (i)

$-mg\sin\theta + \mu mg\cos\theta = -ma$ (i) (m's)

$\mu g\cos\theta = g\sin\theta - a$

$\mu = \dfrac{g\sin\theta - a}{g\cos\theta}$ (i)

$\mu = \dfrac{(9.80)\sin 25.0° - 2.13}{(9.80)\cos 25.0°}$

$\mu = 0.226$ (i)

The coeff. of fric. is 0.226.