Name: Solutions

Homework Week # 7

Energy & Power
Due Thurs 10/10/19

Reading

C&J Physics:	**Tues – Ch. 7: 1-3**	**Thurs – Ch. 7: 3-5**
OS Coll Phys:	**Tues – Ch. 8: 1-4**	**Thurs – Ch. 8: 4-7**

Problems

Problem 1. **6.6**

Problem 2. **6.9**

Problem 3. **6.14**

Problem 4. **6.18**

Problem 5. **6.31**

Problem 6. **6.38**

Problem 7. **6.43**

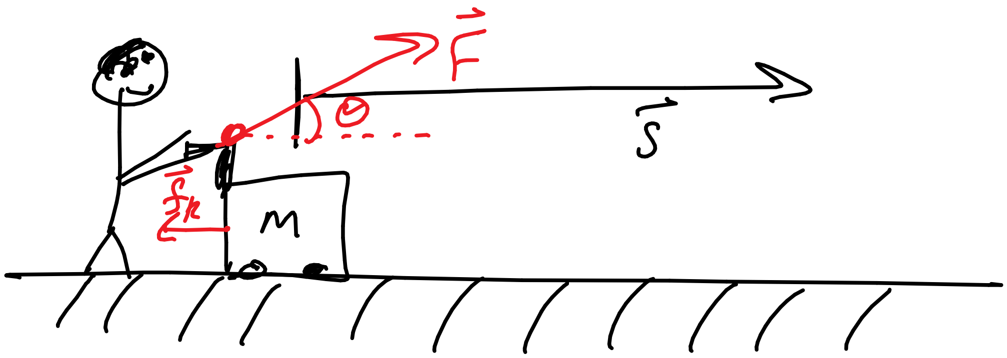
Problem 8. **6.48**

Problem 9. **6.62**

Problem 10. **6.75**

Prob. 1 $\frac{1}{3}$ 6.6

$m = 10.0$ kg pushed $s = 22.0$ m @ const. speed in dir. $\theta = 29°$ from $+x$. $f_k = 48.0$ N during the push.

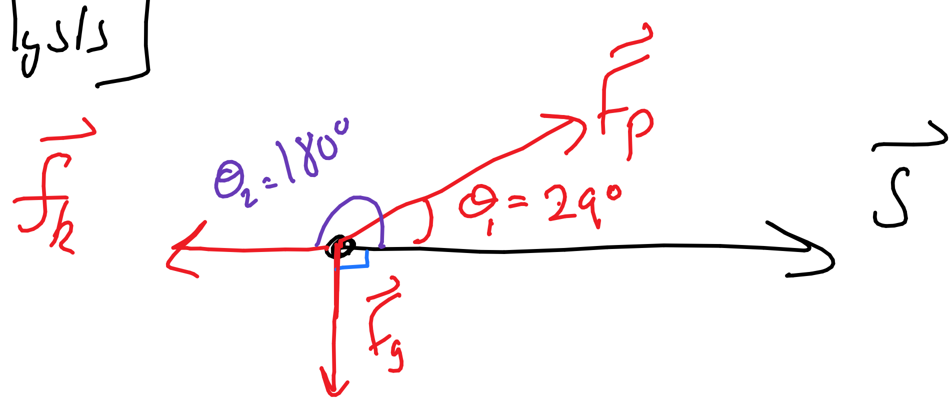


=

- $PE_0 = PE_f$ no change in height
- $KE_0 = KE_f$ @ const. speed

$\}$ • W_{nc} from $\vec{F}_{push}$ & $\vec{f_k}$ & $W_{nc} = 0$

[vector analysis]



$$W_{nc} = F_p s \cos\theta_1 + f_k s \cos\theta_2$$

$$E_0 + W_{nc} = E_f$$

$$\cancel{KE_0} + \cancel{PE_0} + W_{nc} = \cancel{PE_f} + \cancel{KE_f}$$

$$W_{nc} = W_{F_p} + W_{f_k} = 0$$

$$W_{F_p} = -W_{f_k}$$

$$F_p \cancel{s} \cos\theta_1 = -f_k \cancel{s} \cos\theta_2$$

$$F_p \cos\theta_1 = -f_k \cos\theta_2$$

$$F_p = \frac{-f_k \cos\theta_2}{\cos\theta_1}$$

$f_k = 48.0 N$
$\theta_2 = 180°$
$\theta_1 = 29.0°$

$$F_p = \frac{-(48.0\ N)(-1)}{0.875}$$

(a) $$\boxed{F_p = 54.9\ N}$$

3/14

Prob. 1 → 3/3

$W_{f_k} = f_k \, s \cos\theta_2 = -(48.0 N)(22.0 m)$

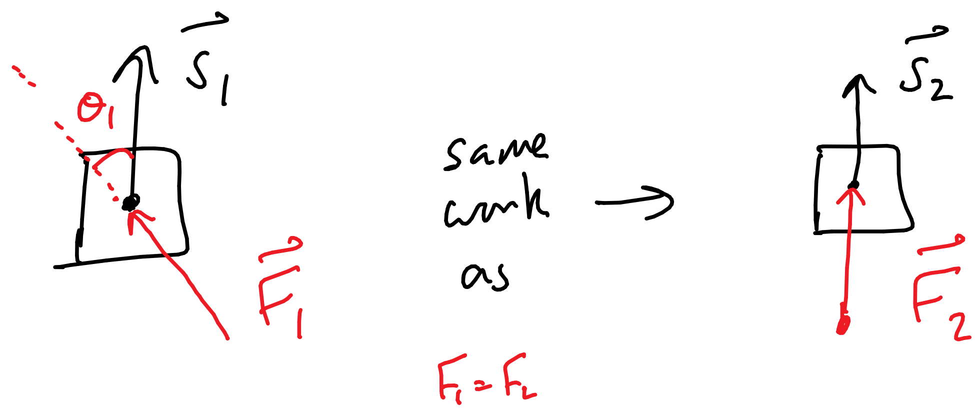
(b) $\boxed{W_{f_k} = -1056 \text{ J}}$

(c) $\boxed{W_{F_p} = +1056 \text{ J}}$

(d) $W_{F_g} = F_g \, s \cos 90° = \boxed{0 \text{ J}}$

Prob. 2 6.9 4/14

$\vec{s} = 52\,m$ North, $\vec{F}_1$ const. and directed θ_1 West of North. What is this angle θ_1 if we know work is equivalent to applying equal force $\vec{F}_2$ straight north for $s_2 = 47\,m$.



$$W_1 = W_2$$

$$\cancel{F_1}\, s_1 \cos\theta_1 = \cancel{F_2}\, s_2 \,\cancelto{1}{\cos\theta_2}$$

$$\cos\theta_1 = \frac{s_2}{s_1} = \frac{47\,m}{52\,m}$$

$$\theta_1 = \cos^{-1}\left(\frac{47}{52}\right)$$

$$\boxed{\theta_1 = 25.3^\circ}$$

Prob. 3 6.14 5/14

$m = 0.045\ kg$; $\vec{F}$ s.t. that

$|\vec{F}|_{ave} = 6800\ N$, $\theta = 0°$ for $|\vec{s}| = 0.010\ m$

Find v_f when $v_0 = 0$

$$W_{net} = \Delta KE$$

$$W_{net} = Fs\cos\theta = \frac{1}{2}m\left(v_f^2 - v_0^2\right)$$

$$\frac{1}{2}mv_f^2 = Fs\cancel{\cos\theta}^{\,1}$$

$$v_f^2 = \frac{2Fs}{m}$$

$$v_f = \sqrt{\frac{2Fs}{m}}$$

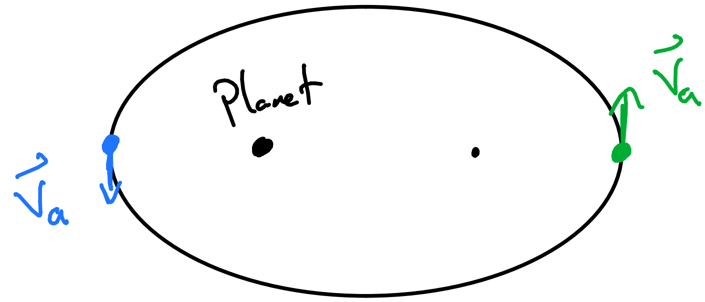
$$v_f = \sqrt{2\frac{(6800\,N)(0.010\,m)}{(0.045\,kg)}}$$

$$\boxed{v_f = 55.0\,\frac{m}{s}}$$

Prob. 4   6.18   6/14

$m = 7420 \text{ kg}$; $V_a = 2820 \frac{m}{s}$

$V_p = 8450 \frac{m}{s}$. Find W_G



Gravity produces a conservative force which means we can simplify to $E_0 = E_f$. We need to remember that $W = \Delta KE$.

$$KE_0 + PE_0 = KE_f + PE_G$$

$$\Longleftrightarrow \quad PE_0 - PE_f = KE_f - KE_0$$

$$W_G = \Delta KE = -\Delta PE_G$$

(a) $V_0 = V_a$, $V_f = V_p$

$$W_a = \frac{1}{2} m (v_f^2 - V_0)^2$$

$$\boxed{W_a = 2.4 \times 10^{11} \text{ J}}$$

(b) $V_0 = V_p$, $V_f = V_a$

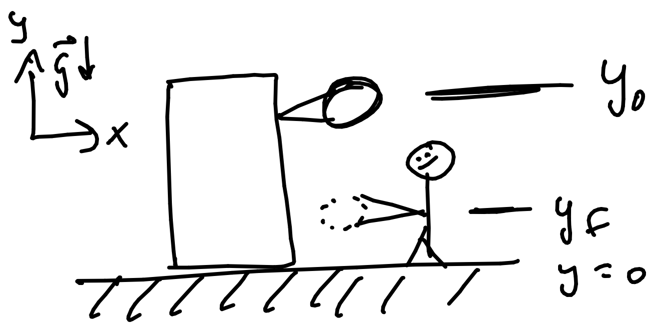
$$W_b = -W_a$$

$$\boxed{W_b = -2.4 \times 10^{11} \text{ J}}$$

Prob. 5 // 6.31 — 7/14

$m = 0.60\,kg$, $v_0 = v_f = 0$, $y_0 = +6.1\,m$

$y_f = 1.5\,m$



FBD when falling

$W = Fs\cos\theta$, $PE = mgy$

$W_g = -\Delta PE_g$

(a) $W = mgh = (0.60\,kg)(10.0\,\frac{m}{s^2})(6.1-1.5)\,m$

$$\boxed{W_g = 27.6\,J}$$

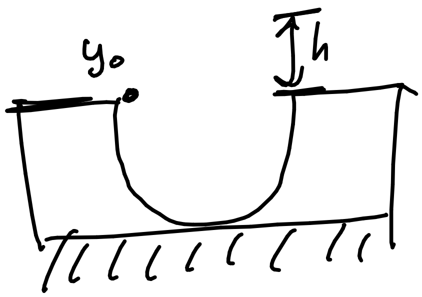
(b) $PE_0 = 36.6\,J$

(c) $PE_f = 9.0\,J$

(d) $\Delta PE = -27.6\,J = -W_g$

Prob. 6 6.38 8/14

If $y_0 = 0, v_0 = 5.4 \frac{m}{s}$, find y_f for $v_f = 0 \frac{m}{s}$ if nonconservative forces negligible



$$KE_0 + PE_0 + W_{nc} = KE_f + PE_f$$

$$W_{nc} = 0, \quad PE_0 = 0, \quad KE_f = 0$$

$$PE_f = KE_0$$

$$mgh = \frac{1}{2} m v_0^2$$

$$h = \frac{v_0^2}{2g}$$

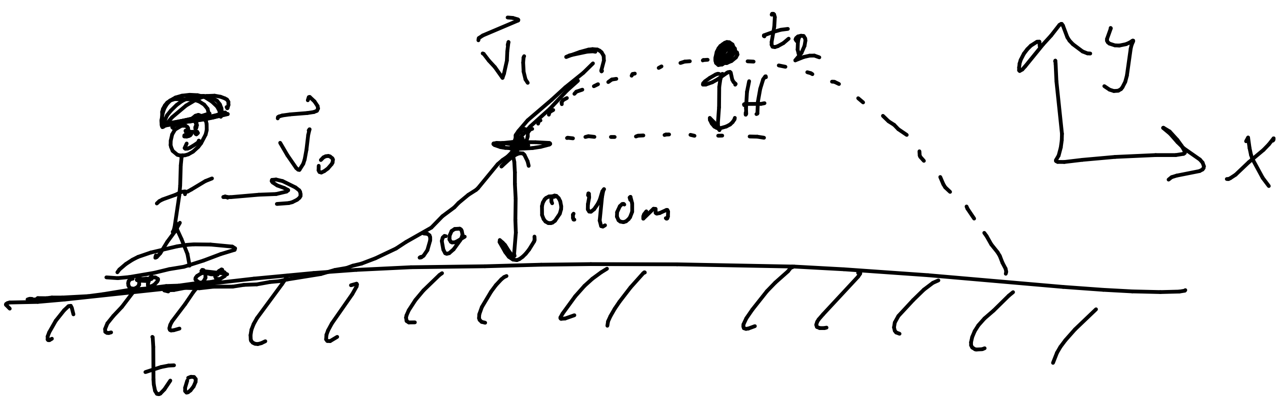
$$h = \frac{(5.4 \frac{m}{s})^2}{2(10.0 \frac{m}{s^2})}$$

* don't forget to square v_0!

$$\boxed{h = 1.46 m}$$

Prob. 7 6.43 1/2 9/14

For $v_0 = 5.4\ \frac{m}{s}$, $y_0 = 0$, find max height of projectile. List height H above ramp. $\theta = 48°$, $y_1 = 0.40m$



<u>Note:</u> $y_2 - y_1 = H$ &

$V_2 \neq 0$ b/c $V_{2x} \neq 0$!

$V_2 = V_{1x} = V_1 \cos\theta$

$$E_0 = E_1 = E_2$$

From $E_0 = E_1 \rightarrow \frac{1}{2} m v_0^2 = mgy_1 + \frac{1}{2} m v_1^2$

$$v_1^2 = v_0^2 - 2gy_1 = 21.16\ \frac{m^2}{s^2}$$

$$v_1 = 4.6\ \frac{m}{s} \neq v_0$$

Prob. 7 2/2

$$E_1 = E_2 \rightarrow \frac{1}{2}mv_1^2 + mgy_1 = \frac{1}{2}mv_2^2 + mgy_2$$

$y_2 - y_1 = H$ so let's use $g(y_2 - y_1)$

$$g(y_2 - y_1) = \frac{1}{2}(v_1^2 - v_2^2)$$

$$H = \frac{1}{2g}(v_1^2 - v_{1x}^2)$$

$$H = \frac{v_{1y}^2}{2g}$$

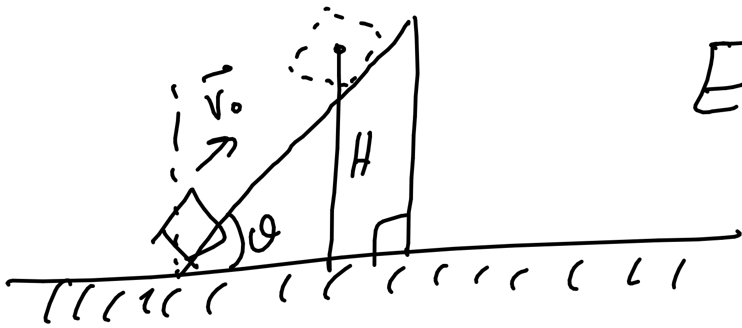
$$H = \frac{(v_1 \sin\theta)^2}{2g} = \frac{v_1^2 \sin^2\theta}{2g}$$

$$\boxed{H \cong 0.58\,m = 0.60\,m}$$

Prob. 8 1/2 6.48 11/14

Two cases of $v_0 = 7.00\,\frac{m}{s}$, $\theta_0 = 50°$.
Find total height for both.
Ignore W_{nc}

(a)



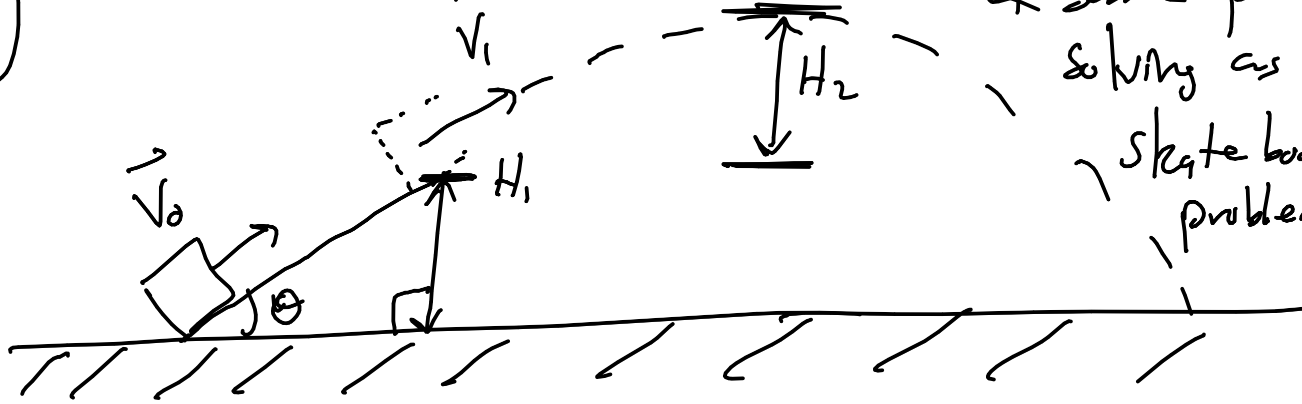
$E_0 = E_f$

$PE_0 = 0$
$KE_f = 0$

$$KE_0 = PE_f \rightarrow \frac{1}{2}mv_0^2 = mgH$$

$$\boxed{H = \frac{v_0^2}{2g} \cong 2.45\,m}$$

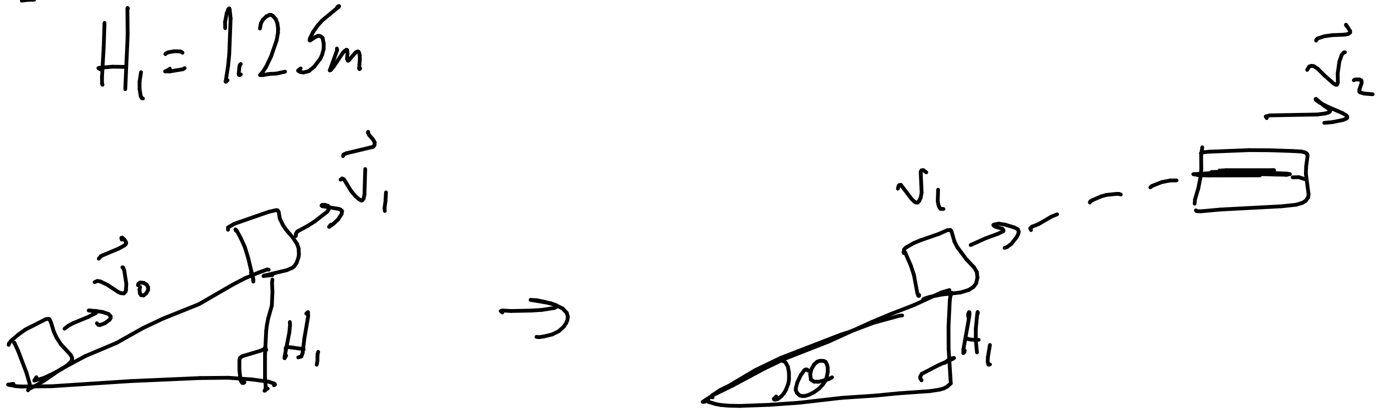
(b)



* same problem*
solving as
skateboarder
problem!

Prob. 8 2/2

$H_1 = 1.25 m$



$E_0 = E_1 \rightarrow \quad v_1^2 = v_0^2 - 2gH_1 = 24.0 \frac{m^2}{s^2}$

$$v_1 = 4.90 \frac{m}{s}$$

$v_2 = v_{1x} = v_1 \cos\theta$

$E_1 = E_2 \rightarrow \quad \frac{1}{2}v_1^2 + gy_1 = \frac{1}{2}v_2^2 + gy_2$

$y_2 - y_1 = H_2 \quad\quad g(y_2 - y_1) = \frac{1}{2}(v_1^2 - v_2^2)$

$$H_2 = \frac{1}{2g}(v_1^2 - v_{1x}^2)$$

$$H_2 = \frac{(v_1 \sin\theta)^2}{2g}$$

$H_2 = 0.70 m \rightarrow \boxed{H_1 + H_2 = 1.95 m}$

Prob. 9 6.62

$F = 22N$ completely aligned with turning path $s = 2\pi r$, $r = 0.28m$. If $t = 1.3s$ for each revolution, calc. average power

---

$$P_{ave} = \frac{\Delta E}{\Delta t} = \frac{\text{Work}}{\Delta t}$$

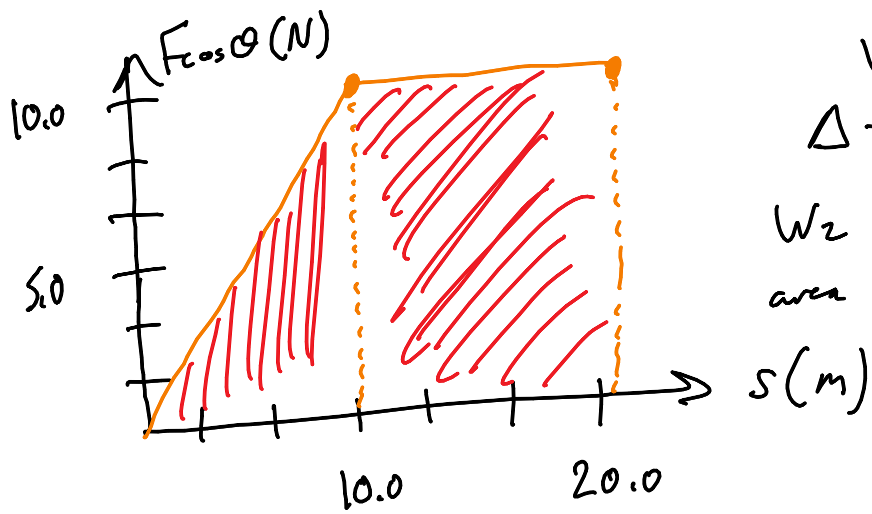
$$P_{ave} = \frac{(22N)(2\pi)(0.28m)}{(1.3s)}$$

$$P_{ave} = \frac{38.704}{1.3} \frac{J}{s}$$

$$\boxed{P_{ave} = 29.8 \text{ W}}$$

Prob. 10 6.75

Find final speed of a 6.00 kg object for the given force application when it is initially @ rest ($V_0 = 0$) and the ground is level ($PE_0 = PE_f$).



W_1 for Δ-area calc.

W_2 for ⏢ area calc.

$$W = \Delta KE = \frac{1}{2} m v_f^2$$

$$V_f = \sqrt{\frac{2W}{m}} \quad ; \quad W = W_1 + W_2$$

$$V_f = \sqrt{\frac{2(50 + 100)\,J}{6.00\,kg}} = \boxed{7.07 \frac{m}{s}}$$