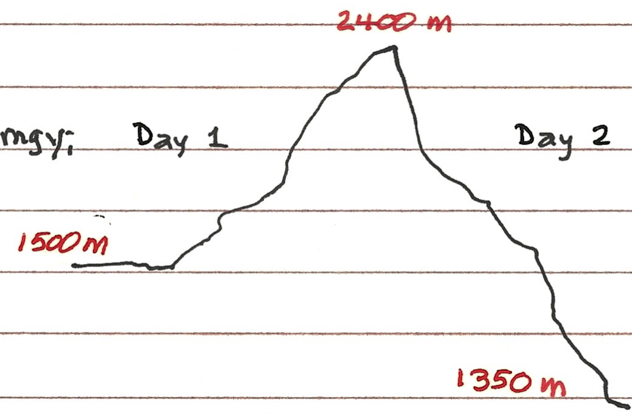
DATE

TOPIC ①

Chapter 7

Ex. 1

In one day, a 75-kg climber ascends from the 1500-m level...



a.) ΔPE_{gr} on Day 1

$\Delta PE_{gr} = PE_f - PE_i = mgy_f - mgy_i$

$\Delta PE_{gr} = mg(y_f - y_i)$

$= 75(9.8)(2400-1500)$

$$\boxed{\Delta PE_{gr} = 6.62 \times 10^5 \text{ J}}$$

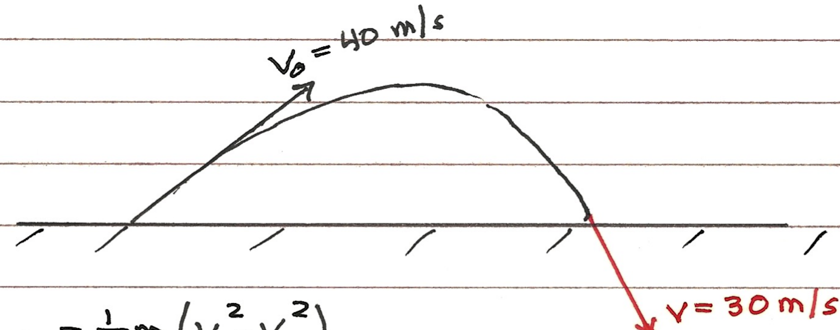
b.) ΔPE_{gr} on Day 2

$\Delta PE_{gr} = mg(y_f - y_i) = 75(9.8)(1350-2400) = -7.72 \times 10^5 \text{ J}$

$$\boxed{\Delta PE_{gr} = -7.72 \times 10^5 \text{ J}}$$

Example Suppose a 2.0-kg projectile is launched over level ground...

$W_{Drag} = ?$



$W_{TOT} = K_f - K_i$

$W_{gr} + W_{Drag} = K_f - K_i$

$-mg\underbrace{(y_f - y_i)}_{=0} + W_{Drag} = \frac{1}{2}m(V^2 - V_0^2)$

$W_{Drag} = \frac{1}{2}m(V^2 - V_0^2) = \frac{1}{2}(2.0\text{ kg})(30^2 - 40^2)\text{m}^2/\text{s}^2$

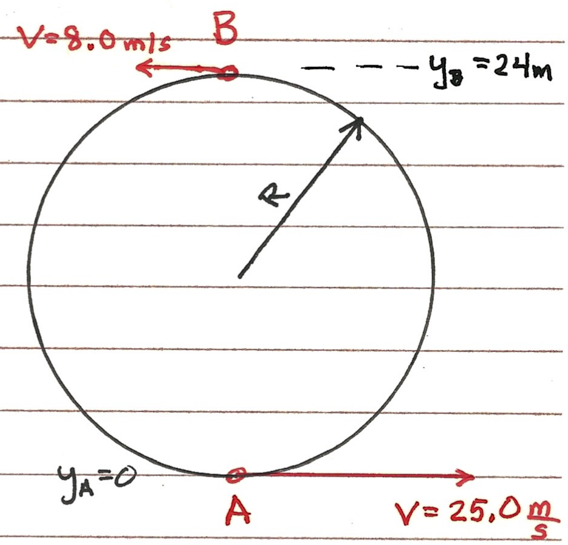
$$\boxed{W_{Drag} = -700 \text{ J}}$$

Chapter 7

Ex. 11 You are testing a new amusement park roller coaster ....

$R = 12.0\ m$

$m = 120\ kg$



$$W_{TOT} = W_{gr} + W_{fr} = K_f - K_i$$

$$W_{fr} = \frac{1}{2}m(v_f^2 - v_i^2) - W_{gr}$$

$$W_{fr} = \frac{1}{2}m\left(8^2 - 25^2\right) - \left(-mg\left(y_B - y_A\right)\right)$$

$$W_{fr} = \underset{120\ kg}{m}\left[\frac{1}{2}\left(8^2 - 25^2\right) + 9.8\left(24 - 0\right)\right]$$

$$\boxed{W_{fr} = -5436\ J}$$

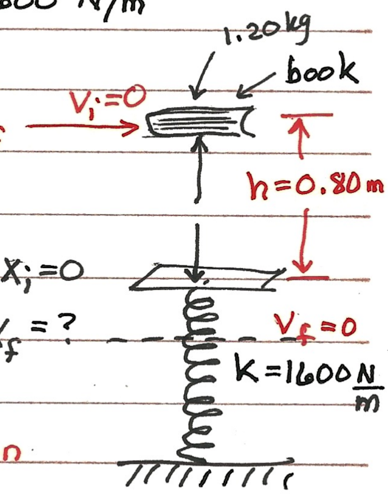
Ex. 21 A spring of negligible mass has force constant $k = 1600\ N/m$.

a.) $W = 3.20\ J$ How far was the spring compressed?

$$U = 3.20\ J = \frac{1}{2}kx^2 \qquad x = \sqrt{\frac{2U}{k}} = \sqrt{\frac{2(3.20\ J)}{1600\ N/m}} = 0.0632\ m$$

$x = 6.32\ cm$

b.) You place the spring vertically with one end on the floor. Find $x_f = ?$



Work-Energy theorem

$$W_{TOT} = \Delta K \Rightarrow W_{gr} + W_{el} = \underset{=0}{K_f} - \underset{=0}{K_i}$$

$$-mg\left(0 - (h + x_f)\right) - \frac{1}{2}k\left(x_f^2 - \underset{=0}{x_i^2}\right) = 0$$

Multiply by a (-) sign

$$\frac{1}{2}kx_f^2 - mgx_f - mgh = 0$$

Quadratic Equation

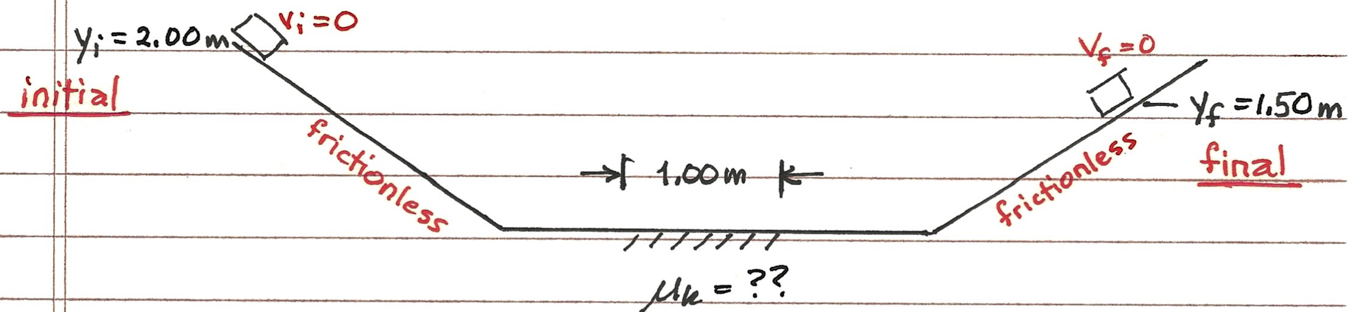
$$x_f = \frac{mg \pm \sqrt{(mg)^2 + 2kmgh}}{k} = 0.1158\ m \quad \text{or} \quad -0.1011\ m$$

DATE

TOPIC ③

Chapter 7

Example A 1.00 kg box is released from rest on a frictionless inclined plane ...

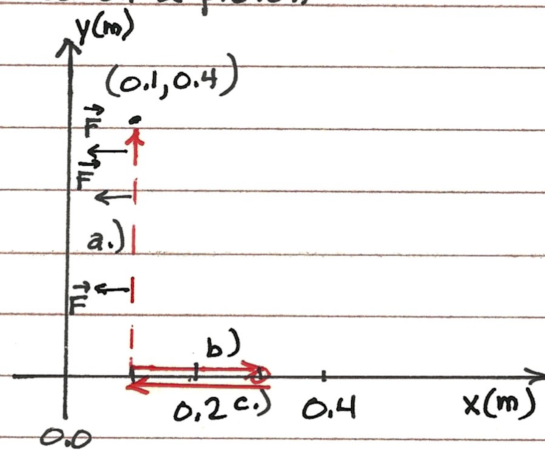


$$W_{TOT} = \Delta K = K_f - K_i \Rightarrow W_{gr} + W_{fr} = 0 - 0$$

$$-mg(y_f - y_i) - \mu_k \overbrace{mg}^{N}(1.00\,m) = 0 \qquad \mu_k \cancel{mg}(1.00\,m) = \cancel{mg}(y_i - y_f)$$

$$\mu_k = \frac{(y_i - y_f)}{1.00\,m} = \frac{(2.00 - 1.50)\,m}{1.00\,m} = 0.50 \qquad \boxed{\mu_k = 0.50}$$

Ex. 28 In an experiment, one of the forces exerted on a proton is $\vec{F} = -\alpha x^2 \hat{i}$ where $\alpha = 12\,N/m^2$



a.) Work done by the force $\vec{F}$.

$\vec{F} \cdot \vec{s} = 0 \qquad \boxed{W_F = 0}$

b.) Work done by the force $\vec{F}$.

$$W = -\int_{0.1}^{0.3} \alpha x^2\,dx = -\frac{\alpha x^3}{3}\Bigg|_{0.1\,m}^{0.3\,m}$$

$$W = -\frac{12\,N/m^2}{3}\left(0.027\,m^3 - 0.001\,m^3\right) = \boxed{-0.104\,J}$$

c.) Work done by the force $\vec{F}$.

$$W = -\int_{0.3}^{0.1} \alpha x^2\,dx = +\int_{0.1}^{0.3} \alpha x^2\,dx = \boxed{+0.104\,J}$$

Chapter 7

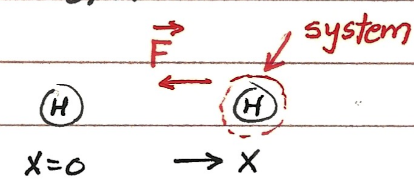
Ex. 28 cont'd $\vec{F}$ is a conservative force. $\int_A^A \vec{F}\cdot d\vec{s}$

$$F = -\frac{d}{dx}U(x)$$

$$dU = -F\,dx \qquad \int_{U_0}^{U(x)} dU = -\int_0^x F(x)\,dx = +\alpha\int_0^x x^2\,dx = +\alpha\frac{x^3}{3}$$

$$U(x) - \underbrace{U(0)}_{=0} = +\alpha\frac{x^3}{3} \qquad \boxed{U(x) = +\alpha\frac{x^3}{3}}$$

Ex. 32 The potential energy of a pair of hydrogen atoms separated by a large distance x is given by $U(x) = -C_6/x^6$



$$F_x = -\frac{d}{dx}U(x)$$

$$= -\frac{d}{dx}\left(\frac{-C_6}{x^6}\right) = \frac{d}{dx}\left(C_6 x^{-6}\right) = -6C_6x^{-7}$$

$$\boxed{F_x = -\frac{6C_6}{x^7}}$$

This is attractive.

Prob. 57 In a truck-loading station at a post office, a small 0.200-kg package...

a.) What is μ_k?

$V_B = 4.80$ m/s

$V_C = 0.00$ m/s

$$W_{TOT} = \Delta K \qquad \underbrace{W_{gr}}_{=0} + W_{fr} = K_f - K_i$$

$$W_{fr} = \Delta K = \underbrace{K_f}_{=0} - K_i = -\frac{1}{2}mV_B^2$$

$$-\mu_k \cancel{m}gs = -\frac{1}{2}\cancel{m}V_B^2 \qquad \mu_k = \frac{V_B^2}{2gs}$$

$$\mu_k = \frac{(4.80\text{ m/s})^2}{2(9.8\text{ m/s}^2)(3.00\text{ m})} = \boxed{0.392}$$

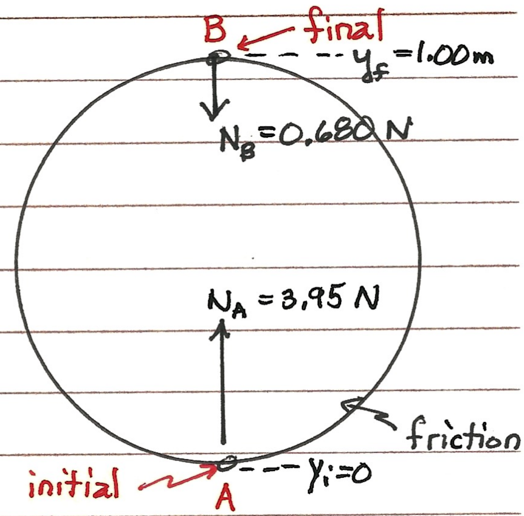
b.) $W_{A\to B} = K_f - K_i \qquad W_{fr} + W_{gr} = \frac{1}{2}m(V_B^2 - \underbrace{V_A^2}_{=0})$

$$W_{fr} = \frac{1}{2}mV_B^2 - W_{gr} = \frac{1}{2}mV_B^2 - (-mg\underbrace{(0-R)}_{Y_f - Y_i})$$

$$W_{fr} = m\left[\frac{1}{2}V_B^2 - gR\right] = 0.200\text{ kg}\left[\frac{1}{2}(4.80)^2 - (9.8)(1.60)\right] = \boxed{-0.832\text{ J}}$$

Chapter 7

Prob. 70 A small block with mass 0.0400 kg slides in a vertical circle of radius $R = 0.500$ m.....



$$W_{TOT} = \Delta K = K_f - K_i$$

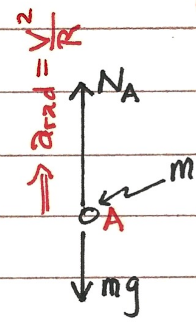
$$W_{fr} + W_{gr} = \tfrac{1}{2}m(V_B^2 - V_A^2)$$

$$W_{fr} = \tfrac{1}{2}m(V_B^2 - V_A^2) - W_{gr}$$
$$= \tfrac{1}{2}m(V_B^2 - V_A^2) - (-mg(y_f - y_i))$$

$$W_{fr} = \tfrac{1}{2}m(V_B^2 - V_A^2) + mgy_f$$

$$W_{fr} = \tfrac{1}{2}\left[mV_B^2 - mV_A^2\right] + mgy_f$$

Free-Body Diagram at Point A:

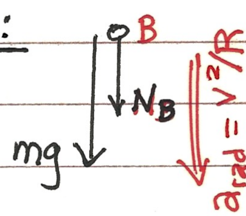


$$\Sigma F_y = \frac{mV_A^2}{R}$$

$$N_A - mg = \frac{mV_A^2}{R}$$

$$mV_A^2 = R(N_A - mg)$$

Free-Body Diagram at Point B:



$$\Sigma F_y = \frac{mV_B^2}{R}$$

$$mg + N_B = mV_B^2/R \qquad mV_B^2 = R(N_B + mg)$$

$$W_{fr} = \tfrac{1}{2}\left[R(N_B + mg) - R(N_A - mg)\right] + mgy_f$$

$$W_{fr} = \tfrac{1}{2}\left[R(N_B - N_A) + 2mgR\right] + mgy_f$$
$$= \tfrac{1}{2}\left[\tfrac{1}{2}(0.68 - 3.95) + 2(0.040)(9.8)(\tfrac{1}{2})\right] + (0.040)(9.8)(1.0)$$

$$\boxed{W_{fr} = -0.229 \text{ J}}$$