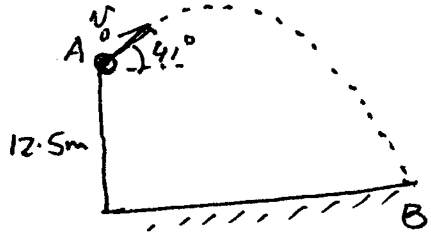
Solutions H. W. CH. #8, Fall (011); PHYS101

1: $v_0 = 14$ m/s at an angle of $41°$ above the horizontal



a) Work done by the Gravitational force when the ball goes from A to B:

We see that the displacement $\vec{d} = -12.5\hat{j}$ (vertical drop of 12.5m from its starting position) & $\vec{F} = mg(-\hat{j})$

$$\therefore W_{mg} = m\vec{g}\cdot\vec{d} = mgd = (1.5\,kg)(9.8\,\tfrac{m}{s^2})(12.5m)$$

$$= 184\,J$$

b) We know that $\Delta U = -W_{mg} = -184\,J$

c) If the gravitational potential energy is taken to be zero at the top of the cliff (starting position), then the potential energy of the system on reaching the ground will be 184 J less than at the top of the cliff. Hence $U(\text{at } B) = -184\,J$

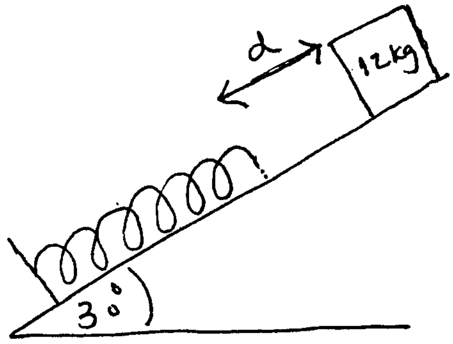
You can look at it as follows:

$\Delta U \equiv$ change in potential energy $= U_f - U_i$

ΔU is negative when the final position is lower than the initial position and vice versa

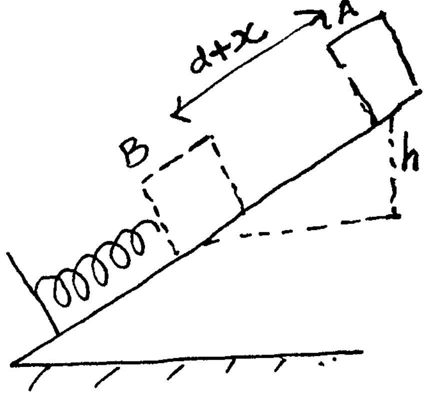
$$\therefore \Delta U = U_B - U_A = -W_{mg} = -184\,J$$

$$U_B = U_A - 184\,J = 0 - 184\,J = -184\,J$$



Initialy position

(a)



Final Look

(b)

21:

i) $m = 12$ kg

ii) The spring can be compressed by 2.0 cm by a force of 270 N. This Statement gives you the value of the spring constant indirectly. i.e.

$$K = \left|\frac{F}{\Delta x}\right| = \frac{270N}{0.02m} = 1.35\times 10^{4}\ \frac{N}{m}$$

a)

iii) Using $\Delta K + \Delta U_g + \Delta U_s = 0$

$\Delta K = K_B - K_A = 0$ (The block is at rest at A and stops at B)

$\Delta U_g = U_B - U_A = -mgh = -mg(d+x)\sin 30^\circ$

$\left[\frac{h}{d+x} = \sin 30^\circ \Rightarrow h = (d+x)\sin 30^\circ \right]$

$\Delta U_s = (U_s)_B - (U_s)_A = \frac{1}{2}Kx^2 - 0$ {block at A the spring is in its normal State}

$= \frac{1}{2}kx^2$ (x = compression of the spring $= 0.055$m)

$\therefore\ 0 - mg(d+x)\sin 30^\circ + \frac{1}{2}kx^2 = 0 \Rightarrow -mg(d+x)\sin 30^\circ = -\frac{1}{2}kx^2$

$mgd * 0.5 + mgx * 0.5 = \frac{1}{2}(1.35\times 10^{4})(0.055)^2$

$58.8\,d + 3.23 = 20.419 \Rightarrow d = 0.292\,m$

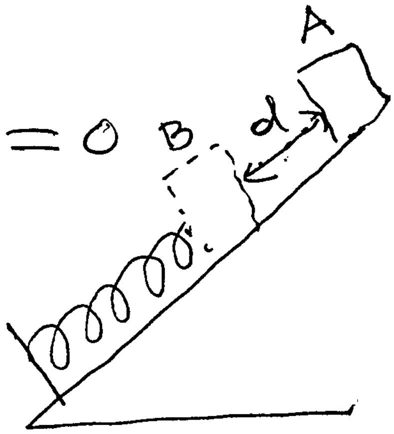
Total distance covered down the incline $= 0.35m$

b) To find the speed of the block just before it hits the spring, we again use

(NEXT SHEET)

21: Continued

$$\Delta K + \Delta U_g + \Delta U_s = 0$$



In this case

$$\Delta K = K_B - K_A = \frac{1}{2}mv^2 - 0$$

$$\Delta U_g = -mgd\sin 30^\circ$$

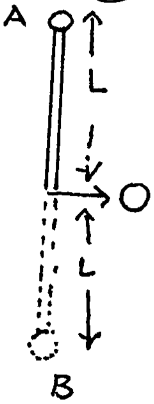
$$\Delta U_s = 0 \quad \left(\text{the spring is still in its normal State}\right)$$

$$\therefore \quad \frac{1}{2}\cancel{m}v^2 - \cancel{m}gd\sin 30^\circ = 0$$

$$v^2 = 2gd\sin 30^\circ = 2 * 9.8 * 0.293 * 0.5$$

$$v = 1.69 \text{ m/s} = 1.7 \text{ m/s}$$

31: The rod of length L is fixed at point O to form a pendulum.



a) The ball is initially at point A, finally at point B: Using for the ball:

$$\Delta K + \Delta U_g + \cancel{\Delta U_s}^{\,0} = \cancel{W_{nc}}^{\,0}$$

$$\Delta K = \frac{1}{2}mv_B^2 - \cancel{\frac{1}{2}mv_A^2}^{\,0}$$

$$\Delta K + \Delta U_g = 0$$

$$\Delta U_g = -mg(2L).$$

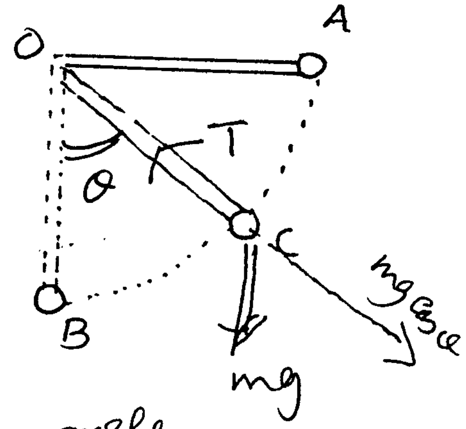
$$\therefore \quad \frac{1}{2}\cancel{m}v_B^2 = \cancel{m}g(2L)$$

$$v_B = 2\sqrt{gL}$$

b) At the bottom of the swing the free-body diagram looks like this:

$$\therefore \quad T - mg = \frac{mv_B^2}{L} \Rightarrow T = mg + mv_B^2/L$$

$$\therefore \quad T = mg + \frac{m4g\cancel{L}}{\cancel{L}} = 5mg$$



31: (Continued):

c) The ball is released from horizontal position as shown.

Initial position is A, final position is C } θ is the angle with the vertical

$$\therefore \quad T - mg\cos\theta = \frac{m v_c^2}{L}$$

$$T = mg\cos\theta + \frac{m v_c^2}{L}$$

Now we should find v_c ???

$A \to C: \quad \Delta K + \Delta U_g = 0$

$\Delta K = \frac{1}{2} m v_c^2 - \cancel{\frac{1}{2} m v_A^2}^{\,0}$

$\Delta U_g = -mgh$
$= -mgL\cos\theta$

$$\therefore \quad \frac{1}{2}\cancel{m} v_c^2 = \cancel{m} gL\cos\theta$$

$$v_c^2 = 2gL\cos\theta$$

Then $\quad T = mg\cos\theta + 2mg\cos\theta = 3mg\cos\theta$

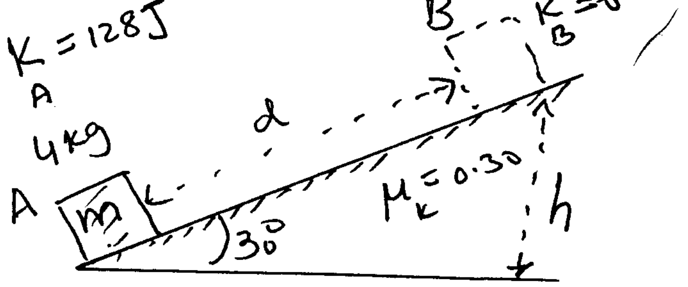
According to the information given $T = mg$

$$\therefore \quad \cancel{mg} = 3\cancel{mg}\cos\theta$$

$$\cos\theta = 1/3 \implies \theta = \cos^{-1}(1/3)$$

$$\theta = 70.5^\circ \approx 71^\circ$$

54:



$$\Delta K + \Delta U_g + \cancel{\Delta U_s}^{0} = W_{nc}$$

$$\therefore \Delta K + \Delta U_g = W_{nc}$$

$$\Delta K = \underbrace{\cancel{\tfrac{1}{2} m v_B^2}^{0}}_{K_B} - \underbrace{\tfrac{1}{2} m v_A^2}_{K_A} = -128J$$

$$\Delta U_g = +mgh = mgd \sin 30°$$

$$W_{nc} = -f_k d = -\mu_k mg \cos 30° * d$$

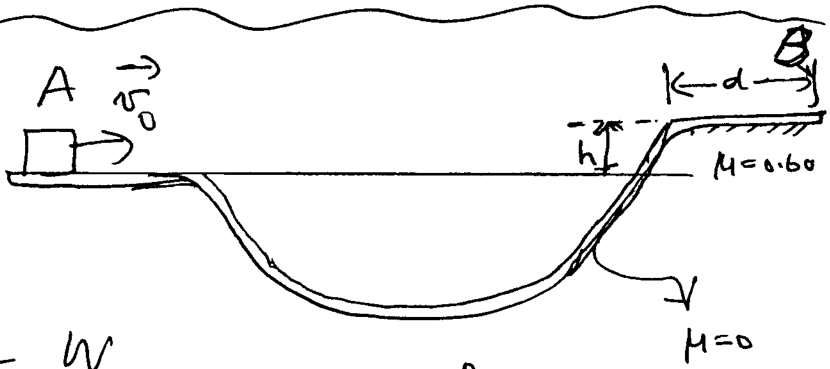
$$\therefore -128 + mgd \sin 30° = -\mu_k mg \cos 30° d$$

$$\therefore d \left[mg \sin 30° + \mu_k mg \cos 30° \right] = 128$$

$$d \left[19.6 + 10.18 \right] = 128 \Rightarrow d = 4.3 m$$

59: $v_0 = 6.0 m/s$

$h = 1.1 m$



Going from $A \to B$

$$\Delta K + \Delta U_g + \cancel{\Delta U_s}^{0} = W_{nc}$$

$$\Delta K = \cancel{K_B}^{0} - K_A = -\tfrac{1}{2} m v_0^2$$

$$\Delta U_g = +mgh$$

$$W_{nc} = -f_k d = -\mu_k mgd$$

$$-\tfrac{1}{2} \cancel{m} v_0^2 + \cancel{m} g h = -\mu_k \cancel{m} g d$$

$$d = \frac{+\tfrac{1}{2} v_0^2 - \cancel{m} g h}{\mu_k g}$$

$$d = \frac{\tfrac{1}{2}(6.0)^2 - 9.8 * 1.1}{0.6 * 9.8} = \frac{18 - 10.78}{5.88} = 1.22 m$$

$$d = 1.2 m$$