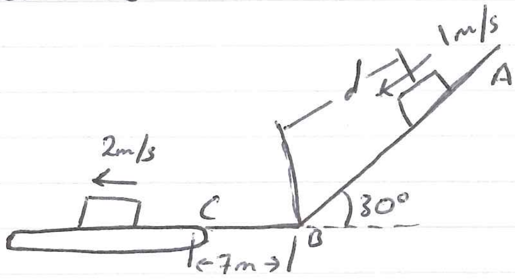
Week 11

Statics + Dynamics

Problem 13.12



$d = 7.5$ $\mu_k = 0.25$

$v_A = 1\,m/s$ $v_c = 2\,m/s$

a) Speed of package at c

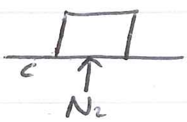
$F = \mu N$

$N_1 = mg \cos 30$

$F_1 = 0.25\, mg \cos 30$

$U_{A \to B} = mgd \sin 30 - F_1 d$

$= mgd(\sin 30 - 0.25 \cos 30)$



$N_2 = mg$

$F_2 = 0.25\, mg$

$x = 7 \rightarrow$ From $B \to C$

$U_{B \to C} = -0.25\, mg\, x$

$T_A = \frac{1}{2} m v_A^2$

$T_c = \frac{1}{2} m v_c^2$

$T_A + U_{A \to B} + U_{B \to C} = T_c$

$\frac{1}{2} \cancel{m} v_A^2 + \cancel{m} g d(\sin 30 - 0.25 \cos 30) - 0.25 \cancel{m} g\, 7 = \frac{1}{2} \cancel{m} v^2$

$\frac{1}{2}(1)^2 + 9.81(7.5)(\sin 30 - 0.25 \cos 30) - 0.25(9.81)(7) = \frac{1}{2} v^2$

$\frac{1}{2} + 20.858 - 17.1675 = \frac{1}{2} v^2$

$\sqrt{4.1905 \times 2} = v$

$v = 2.89\, m/s$

b) Distance package will travel until rest (relative to belt).

$\underrightarrow{F_x} = \mu_k mg.$ $V_{Belt} = 2m/s$

$F \times d = W$

$\frac{1}{2} m v_c^2 - u_k mgd - \frac{1}{2} m v_{belt}^2 = 0$

$\frac{1}{2} v_c^2 - u_k g d - \frac{1}{2} v_{belt}^2 = 0$

$\frac{1}{2} \cdot (2.89)^2 - 0.25(9.81) d - \frac{1}{2}(2^2) = 0$

$4.18 - 2.453 d - 2 = 0$

$\frac{2.18}{2.453} = d$

$\underline{\underline{d = 0.89m}}$

Problem 13.75

a) $V_B^2 = gr = 9.81 \times 0.5 = 4.905 \; m^2/s^2$

$V_B = \sqrt{4.905} = 2.215 \; m/s$

$T_B = \frac{1}{2} m V_B^2 = 0.5 \times 0.2 \times 4.905^2 = 2.406$

$V_B = mg(2.5 + 0.5) = 3 \times 0.2 \times 9.81 = 5.886$

$T_C = \frac{1}{2} m V_C^2 = 0.5 \times 0.2 \times V_C^2 = 0.1 V_C^2$

$V_C = 2.5 \times 0.5 = 1.25$

$T_B + V_B = T_C + V_C$

$\rightarrow (2.406 + 5.886) = 0.1 V_C^2 + 1.25$

$8.292 = 0.1 V_C^2 + 1.25$

$70.42 = V_C^2$

$V_C = 8.392 \; m/s$

$8.392 \; m/s > 3.5 \; m/s$

↳ Therefore cannot use loop.

b) $T_A = \frac{1}{2} m V_0^2 = 0.5 \times 0.2 \times V_0^2 = 0.1 V_0^2$

$V_A = 0$

At C:

↳ $V_C = 3.5 \; m/s$

$T_C = \frac{1}{2} m V_C^2 = 0.5 \times 0.2 \times (3.5)^2 = 1.225$

$V_C = 2.5 \times 0.5 = 1.25$

$T_A + V_A = T_C + V_C$

$0.1 V_0^2 + 0 = 1.225 + 1.25$

$V_0^2 = 24.75$

$V_0 = 4.975 \; m/s$

Jonathan Spencer Balakumar
B326019

Problem 13.167

$\Sigma m V_1 + \Sigma \text{ Impulse} = \Sigma m V_2$

t for A

$m V_A \sin 20 + 0 = m(V'_A)$

$(V'_B) = V_B \cos 20 = -3 \cos 20 = -2.8191 \text{ m/s}$

n direction for both

$m V_A \cos 20 - m V_B \sin 20 = m(V'_A)_n + m(V'_B)_n$

$(V_A')_n + (V'_B)_n = V_A \cos 20 - V_A \sin 20$

$= 3 \cos 20 - 3 \sin 20$

when $e = 0.9$

$(V'_B)_n - (V'_A)_n = e\left[(V_A)_n - (V_B)_n\right]$

$0.9\left[3 \cos 20 - -3 \sin 20\right]$

$(V'_B)_n + (V'_A)_n = 3 \cos 20 - 3 \sin 20$

$(V'_B)_n - (V'_A)_n = 0.9\left[3 \cos 20 - 3 \sin 20\right]$

$(V'_A)_n = -0.8338 \text{ m/s}$

$(V'_B)_n = 2.6268 \text{ m/s}$

$(V'_A)_n = 0.8338 \text{ m/s} \quad \swarrow 20$
$(V'_A)_t = 1.0261 \text{ m/s} \quad \nwarrow 70°$
$(V'_B)_n = 2.6268 \text{ m/s} \quad \nearrow 20$
$(V'_B)_t = 2.8191 \text{ m/s} \quad \searrow 70$

$V_A = \sqrt{0.8338^2 + 1.0261^2} = 1.322 \text{ m/s}$

$\tan a = \dfrac{1.0261}{0.8338} \qquad a = 50.9°$

$a + 20 = 70.9°$

$V'_A = 1.322 \text{ m/s} \quad \swarrow 70.9°$

$$V'_B = \sqrt{2.6268^2 + 2.8191^2}$$

$$= 3.85 \, m/s$$

$$\tan \beta = \frac{2.8191}{2.6268} \qquad \beta = 47^\circ$$

$$\cancel{\beta + 20 = 67}$$

$$\beta - 20 = 27^\circ$$

$$V'_B = 3.85 \, m/s \; \measuredangle 27^\circ$$