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Initial Max. deformation

The maximum force $F = kx$ occurs when x is a maximum with $\dot{x} = 0$.

$U_1 = \Delta T: m g x - \frac{1}{2} k x^2 = 0, x = \frac{2 m g}{k}$
 So $F = kx = 2 m g$

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$T_A + V_{A-0} = T_B: 0 + 2 m g R = \frac{1}{2} m v_B^2, v_B = 4 g R$

(a) $\sum F_n = m a_n: N_B = m \frac{4 g R}{R} = 4 m g$

(b) $T_A + V_{A-C} = T_C: 0 + 3 m g R = \frac{1}{2} m v_C^2, v_C = 6 g R$

$\sum F_n = m a_n: N_C - m g = m \frac{6 g R}{R}$
 $N_C = 7 m g$

(c) Coll stopping point E:

$T_A + V_{A-E} = T_E$
 $0 + 2 m g R - m g (\frac{1}{2} s) - \mu_k \frac{1}{2} m g s = 0$
 $s = \frac{4 R}{1 + \mu_k}$

(Note: Normal force on incline is $N = m g \cos 30^\circ = \frac{\sqrt{3}}{2} m g$)

3/130 Let $s =$ distance down incline before reversal of direction.

$U_1 = 110(2)(10 + s - 5) - 300(10 + s - 5) \frac{5}{13} = 1046 ft \cdot lb$
 $\Delta T = \frac{1}{2} \frac{320}{32.2} [v^2 - (21)^2] = 4.66 v^2 - 377 ft \cdot lb$
 $U_2 = \Delta T: 1046 = 4.66 v^2 - 377$
 $v = 17.45 ft/sec$

The initial kinetic energy is positive regardless of the velocity direction.

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$U_1 = \Delta T$
 $150 (\frac{1}{2} \sin 60^\circ) - 30 \frac{1}{2} (1 - \cos 60^\circ) = \frac{1}{2} \frac{30}{32.2} (v^2 - 0)$
 $v^2 = 160.8, v = 12.68 ft/sec$

3/132 $U_1 = \Delta T; m g (0.8 - 1.2 \cos 60^\circ) = \frac{1}{2} m (v^2 - 9)$
 $9.81(0.20) = \frac{1}{2} (v^2 - 9), v^2 = 12.92, v = 3.59 m/s$

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$\sum F = 0: 1810 - 4T = 0, T = 2450 N$

Length of cable $L = 4v_A + \text{constants}$
 $\dot{L} = 4v_A = 4(3) = 12 m/s$
 $P_{out} = -T \dot{L} = -2450(12) = 29.4 \text{ kW}$
 or $P_{out} = 21.4 \text{ kW}$
 $c = \frac{P_{out}}{P_{in}}, P_{in} = \frac{P_{out}}{c} = \frac{21.4}{0.8}$
 $P_{in} = 36.8 \text{ kW}$

3/134 Active-force diagrams

$F_{20} = 0.9(20)(9.81) \cos 30^\circ = 122.4 N$

$U = \Delta T$ (system)
 First interval: $20(9.81)(1.2) - [20(9.81)(0.5 + 122.4) \frac{1}{2}] = \frac{1}{2} 30 v^2 + \frac{1}{2} 50 (v_B^2)$
 $v^2 = 6.096 \text{ m/s}^2, v = 2.449 \text{ m/s}$

Second interval: $15(9.81)(y) - [20(9.81)(0.5 + 122.4) \frac{1}{2} + 0 - \frac{1}{2} 15(6.096)] = \frac{1}{2} 50 (\frac{5.097}{0.8})^2$
 $y = 2.14 \text{ m}, s = \frac{1}{2} (1.8 + 2.14) = 1.97 \text{ m}$

3/135 $U = \Delta T, -\int_0^s (3x^2 + 60x) dx = \frac{1}{2} \frac{48}{32.2} (0 - v^2) 12$
 $2^3 + 30x^2 = \frac{36}{32.2} v^2, v \text{ in ft/sec.}$
 $v^2 = \frac{32.2}{36} (64 + 480) = 62.82 \text{ (ft/sec)}^2, v = 25.0 ft/sec$

3/136 $\theta = \tan^{-1} \frac{6}{108} = 3.43^\circ$

$U_1 = \Delta T: V_E + mgh = \frac{1}{2} m (v_E^2 + v^2)$
 $U_E = -1400(9.81)(200 \sin 3.43^\circ) + \frac{1}{2} 1400 \left[\left(\frac{20}{3.6}\right)^2 - \left(\frac{18}{3.6}\right)^2 \right]$
 $= -683000 J \text{ or } -683 kJ$

Energy lost $Q = 683 kJ$

3/137 The power output of the drivetrain is $P_{out} = Fv = 560 \left(\frac{30}{3.6}\right) = 14550 W$

The power input to the drivetrain:
 $P_{in} = \frac{P_{out}}{c} = \frac{14550}{0.70} = 20800 W$

So the motor output $P = 20 kW$

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