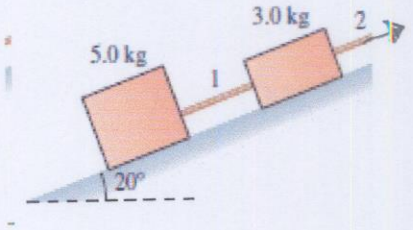
Group Problems: Work-Energy Theorem, connected objects, and power

1. A penguin slides 4.0 m down a snowy incline at a constant speed of 1.4 m/s. The incline is angled 5.0° above the horizontal. At the bottom of the hill, the penguin slides onto a horizontal patch of snow. The coefficient of kinetic friction is the same on both slope and horizontal.
   a. use work/energy ideas to find the coefficient of kinetic friction.
   b. how far does the penguin slide on the horizontal patch before coming to a stop?

2. Boxes A (5.0 kg) and B (3.0 kg) are connected by rope 1 and are being pulled up a ramp at a constant speed by rope 2. The boxes are pulled a distance of 3.5 m along the ramp. Find the tension in rope 2.



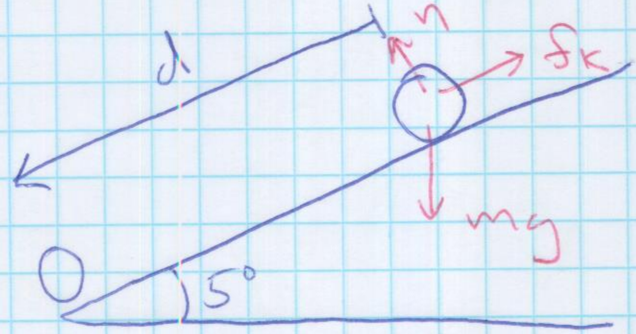
3. The mass of an elevator and its occupants is 1200 kg. The electric motor that lifts the elevator can provide a maximum power of 15,000 W. What is the maximum constant speed at which this motor can lift the elevator?

4. Bob can throw a 500 g rock with a speed of 30 m/s. During the time that the rock is in his hand, his hand moves forward by 1.0 m.
   a. How much force, assumed to be constant, does Bob apply to the rock?
   b. How much work does Bob do on the rock?

Slope:

Practice

1. $W = \Delta K$

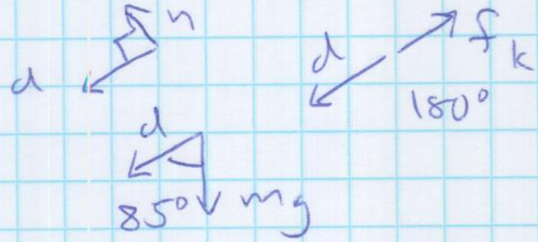


System: Just penguin.

$W_n = 0 \; : \; \theta = 90°$

$W_f = f\, d \cos 180°$

$W_{mg} = (mg)\, d \cos 85$

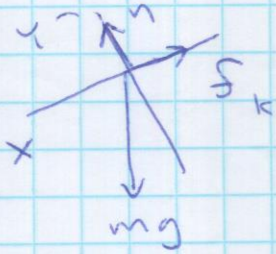


and v = constant, so $\Delta K = 0$.

$0 + f d(-1) + mg d \cos 85 = 0$

$\mu n d = mg d \cos 85°$

need n:



$\Sigma F_y = m a_y$

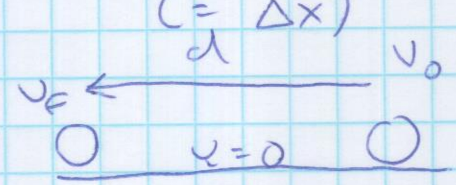
$n - mg \cos 5° = 0$

$n = mg \cos 5°$

$\mu mg \cos 5° = mg \cos 85°$

$\mu = \frac{\cos 85°}{\cos 5°} = 0.087$

Flat:

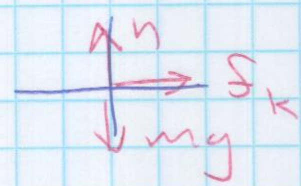


$K_f + U_{gf} + \Delta E_{TH} = K_0 + U_{g0} + W$

$0 + 0 + f \Delta x = \frac{1}{2} m v_0^2 + 0 + 0$

System: Everythi

$\mu n \Delta x = \frac{1}{2} m v_0^2$

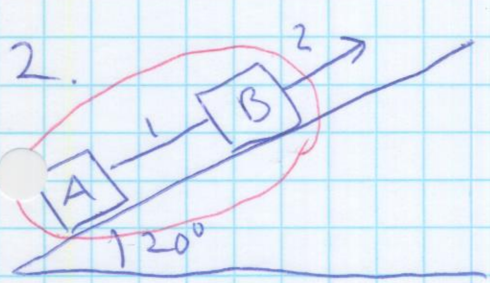


$\mu mg \Delta x = \frac{1}{2} m v_0^2$

$\Delta x = \frac{v_0^2}{2 \mu g} = \frac{(1.4 \text{ m/s})^2}{2(0.087)(9.8 \text{ m/s}^2)}$

$\Delta x = 1.15 \text{ m}$

2.



Moves up ramp at constant vel. for 3.5 m.

System: A, rope 1, B, Earth.

Work: Done by T_2.

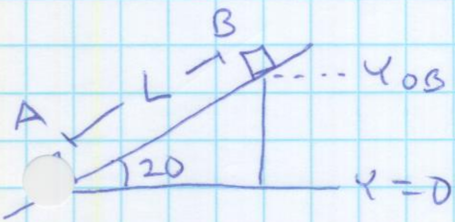
$f = 0$.

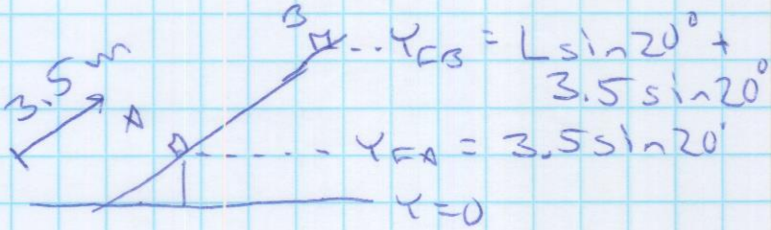
$$K_{FA} + K_{FB} + U_{gFA} + U_{gFB} + \Delta E_{TH} = K_{0A} + K_{0B} + U_{g0A} + U_{g0B} + W$$

vel const, so $K_{FA} = K_{0A}$, $K_{FB} = K_{0B}$. Cancel.

$f = 0$ so $\Delta E_{TH} = 0$

$$U_{gFA} + U_{gFB} + 0 = U_{g0A} + U_{g0B} + W_{T2}$$





$$(U_{gFA} - U_{g0A}) + (U_{gFB} - U_{g0B}) = T_2 d \cos 0°$$

$$m_A g(3.5 \sin 20 - 0) + m_B g(L\sin 20 + 3.5\sin 20 - L\sin 20) = T_2 d (1)$$

$$(m_A + m_B) g (3.5 \sin 20°) = T_2 (3.5)$$

$$(8\ kg)(9.8\ m/s^2)(3.5 \sin 20° = T_2 (3.5\ m)$$

$$T_2 = 26.8\ N$$