Tutorial #2: Newton's laws and friction (Problems)

Please complete the first 4 problems before attending the online lecture.

Problem #1 (Newton's Laws)

Estimate the average force exerted by a shot putter on a 7.0 kg shot if the shot is moved through a distance of 2.8 m and is released with a speed of 13 m/s.

(Ans: Newtons' laws, 211.25 N)

Problem #2 (Newton's Laws)

A 75 kg petty thief wants to escape from a third-story jail window. Unfortunately, a make shift rope made of sheets tied together can support a mass of only 58 kg. How might the thief use this rope to escape?

(Ans: Give a quantitative answer, -2.2 m/s^2).

Problem #3 (Using Newton's Laws)

One 3.2 kg paint bucket is hanging by a massless cord from another 3.2 kg paint bucket also hanging by a massless cord as shown in the figure below.

a. If the buckets are at rest, what is the tension in each cord? (Ans: 31 N, 63 N)

b. If the two buckets are pulled upward with an acceleration of 1.25 m/s^2 by the upper cord, calculate the tension in each cord. (Ans: 35.36 N, 70.72 N)

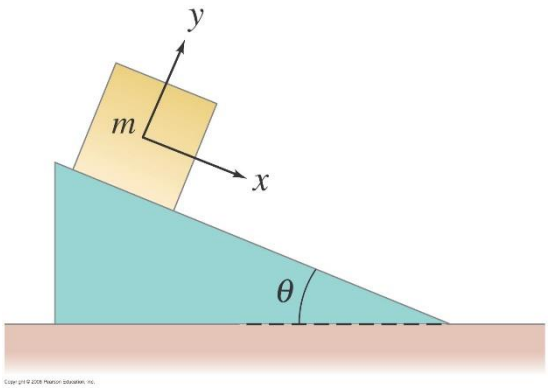
Problem #4 (Using Newton's Laws)

The block shown in the figure below has a mass of m = 7.0 kg and lies on a fixed smooth frictionless plane tilted at an angle $\theta = 22.0^0$ to the horizontal.

a. Determine the acceleration of the block as it slides down the plane.

(Ans: 3.67 m/s^2)

b. If the block starts from rest 12.0 m up the plane from the base, what will be the block's speed when it reaches the bottom of the incline? (Ans: 9.3 m/s)



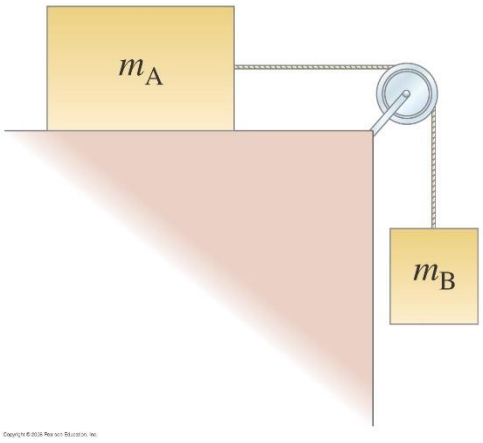
Problem #5

A block of mass m_A is resting on a smooth horizontal surface as shown in the figure below. It is connected by a thin cord that passes over a pulley to a second block of mass m_B, which hangs vertically.

a. Draw a free body diagram for each block showing the force of gravity on each, the force (tension) exerted by the cord, and any normal force.

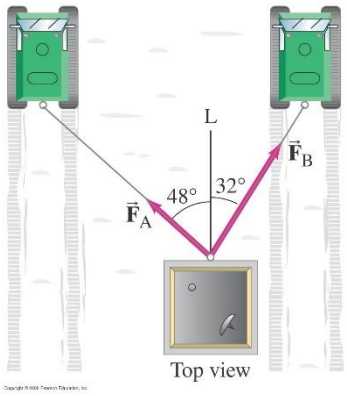
b. Apply Newton's second law to find formulas for the acceleration of the system and for the tension in the masses of the pulley and cord.

(Ans: $F_T = g\dfrac{m_A m_B}{m_A + m_B}$)



Problem #6

Two snow cats in Antartica are towing a house to a new location as shown in the figure below. The sum of the forces F_A and F_B exerted on the house by the horizontal cables is parallel to to the line L and F_A is 4,500 N. Determine F_B and the magnitude of F_{Ay} and F_{By}. (Ans : 6,311 N, 8,363 N)

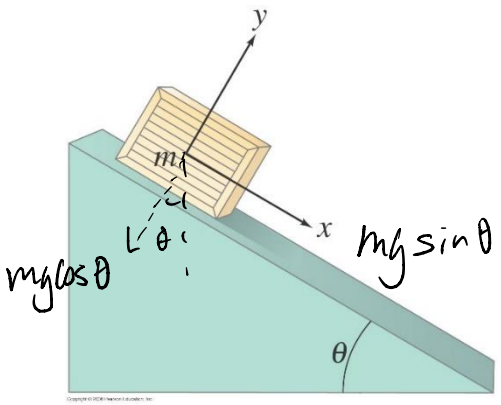


Problem #7

If the coefficient of kinetic friction between a 22 kg crate and the floor is 0.30, what horizontal force is required to move the crate at a steady speed across the floor? What horizontal force is required if μ_k is 0? (Static, dynamic friction and Newton's laws) (Ans: 65 N)

Problem #8

The crate shown in the following figure lies on a plane tilted at an angle $\theta = 25.0^0$ to the horizontal with $\mu_k = 0.19$.



a. Determine the acceleration of the crate as it slides down the plane

b. If the crate starts from rest 8.15 m up the plane from the base, what will be the crate's speed when it reaches the bottom of the incline?

(2.454 m/s^2, 6.3 m/s)

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