Slide 1

Multi-object Force Problems

What happens when one object causes another to start to move?

Slide 2

An object on a table…

- Ever had your pet pull something off the table by grabbing a part of the table cloth?
- How would you figure out how long you have to get to the table to catch the stuff?
- This is the question that we will be answering in this lecture…

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Steps to Solve this type of Problem

1. Determine what information you are given.
2. Solve any linear motion equations required to find the acceleration.
3. Draw a free body diagram of each object drawing and labeling all the forces on that object.
4. Write a net force equation for each object based on your free body diagram.
5. Solve the equations either one at a time or as a system of equations depending on the information given.

Now let's start the examples…

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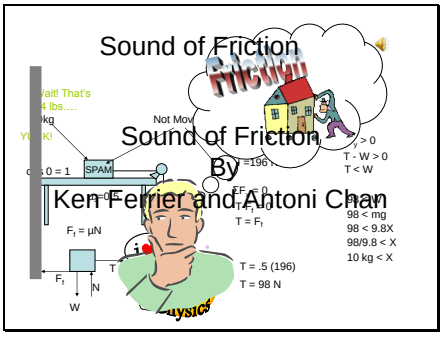
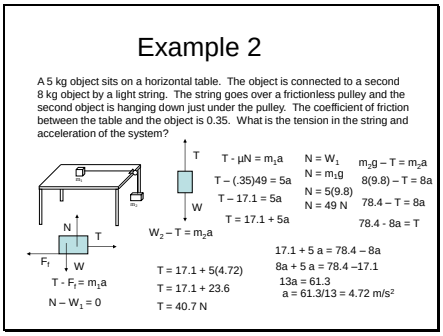
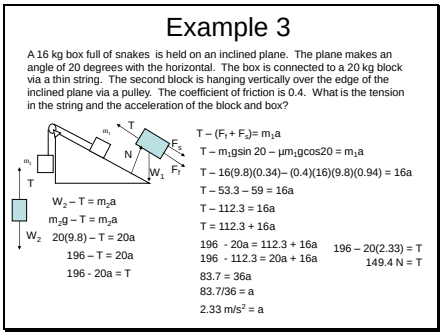


Slide 5



Slide 6



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Your turn

Horizontal

A 10 kg box is at rest on a horizontal table. It slides across the 1.5 m long table in 0.85 seconds. The box is attached to a string that passes over a pulley at the edge of the table. The other end of the string is connected to a 8 kg block. What is the acceleration of the objects? What is the tension in the string? What is the coefficient of friction between the box and the table?

a) a = 4.155 m/s²
b) T = 45.2 N
c) μ = 0.37

Inclined Plane

A 10 kg box starts from rest. It slides down the 1.5 m long ramp in 0.85 seconds. The box is attached to a string that passes over a frictionless pulley and then is attached to a second 2 kg block and hangs down vertically. The ramp makes an angle of 30 degrees with the horizontal. What is the acceleration of the objects? What is the tension in the string? What is the coefficient of friction between the box and the ramp?

a) a = 0.583 m/s²
b) T = 230.4 N
c) μ = 0.257

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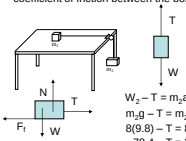
Your Turn - Horizontal

A 10 kg box is at rest on a horizontal table. It slides across the 1.5 m long table in 0.85 seconds. The box is attached to a string that passes over a pulley at the edge of the table. The other end of the string is connected to a 8 kg block. What is the acceleration of the objects? What is the tension in the string? What is the coefficient of friction between the box and the table?



$T - F_f = m_1a$

$N - W_1 = 0$

$N = W_1$
$N = m_1g$
$N = 10(9.8)$
$N = 98\ N$

$W_2 - T = m_2a$
$m_2g - T = m_2a$
$8(9.8) - T = 8(4.155)$
$78.4 - T = 33.24$
$78.4 - 33.24 = T$
$45.2\ N = T$

$T - \mu N = m_1a$
$45.2 - \mu 98 = 10(4.155)$
$45.2 - 41.55 = \mu 98$
$3.6 = \mu 98$
$3.6/9.8 = \mu$
$0.37 = \mu$

$x = v_{x0}t + \frac{1}{2}at^2$
$1.5 = \frac{1}{2}a(0.85)^2$
$1.5 = \frac{1}{2}a(0.722)$
$1.5 = a(0.361)$
$1.5/0.361 = a$
$4.155\ m/s^2 = a$

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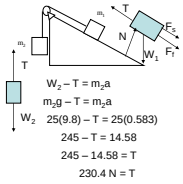
Your Turn – Inclined Plane

A 30 kg box starts from rest. It slides up the 1.5 m long ramp in 1.85 seconds. The box is attached to a string that passes over a frictionless pulley and then is attached to a second 25 kg block and hangs down vertically. The ramp makes an angle of 30 degrees with the horizontal. What is the acceleration of the objects? What is the tension in the string? What is the coefficient of friction between the box and the ramp?



$W_2 - T = m_2a$
$m_2g - T = m_2a$
$25(9.8) - T = 25(0.583)$
$245 - T = 14.58$
$245 - 14.58 = T$
$230.4\ N = T$

$T - (F_f + F_s) = m_1a$
$T - m_1g\sin 30 - \mu m_1g\cos 30 = m_1a$
$230.4 - 30(9.8)(0.5) - \mu(30)(9.8)(0.87) = 30(.583)$
$230.4 - 147 - 255\mu = 17.5$
$83 - 255\mu = 17.5$
$83 - 17.5 = 254\mu$
$65.5 = 254\mu$
$65.5/254 = \mu$
$0.257 = \mu$

$x = v_{x0}t + \frac{1}{2}at^2$
$1.5 = \frac{1}{2}a(1.85)^2$
$1.5 = \frac{1}{2}a(3.43)$
$1.5 = a(1.714)$
$1.5/1.714 = a$
$0.583\ m/s^2 = a$