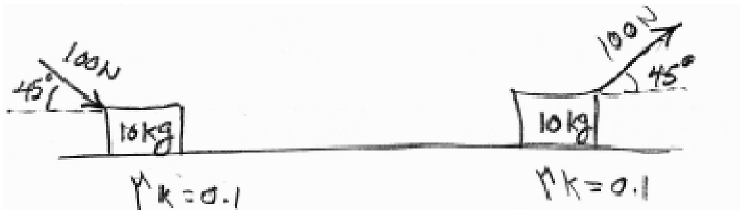
Physics

Quiz 2

(November 2007)

Name:____________________

1) Suppose two students decide to move two identical boxes on the floor. The coefficient of kinetic friction between the boxes and the floor is 0.1. Both students apply identical forces with magnitude equal to 100N. Each box's mass is 5Kg. Both students apply the force with an angle of 45 degrees with the horizontal; however, one student tries to push the box and the other student tries to pull the box on the floor (5 pts.)



A) Find the force of friction in each case:

$$\textit{Case 1: } F_f = F_N.\mu_k = (10 \times 9.8 + 10\,0 \sin 45).(0.1) = 16.9N$$

$$\textit{Case 2: } F_f = F_N.\mu_k = (10 \times 9.8 - 10\,0 \sin 45).(0.1) = 2.72N$$

B) Find the acceleration of the box in each case:

$$\text{Case 1: } F_{net} = F - F_f = 100 \cos 45 - 16.9 = 53.8N$$
$$a = \frac{F}{m} = \frac{53.8}{10} = 5.38\,{}^{m}/_{s^2}$$

$$\text{Case 2: } F_{net} = F - F_f = 100 \cos 45 - 1.29 = 67.9N$$
$$a = \frac{F}{m} = \frac{67.9}{10} = 6.79\,{}^{m}/_{s^2}$$

C) Calculate the final velocity of each box after 1 second (assuming V_i=0)

$$\textit{Case 1: } v_f = v_i + a\Delta t = 0 + 3.42(1) => v_f = 5.38\,{}^{m}/_{s}$$

$$\textit{Case 2: } v_f = v_i + a\Delta t = 0 + 5.12(1) => v_f = 6.79\,{}^{m}/_{s}$$

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D) Why are the accelerations different?

The force of friction that opposes the motion is of the box is les in the second case; thus the acceleration would be greater.

2) A 90.0 kg skier glides down a slope with an incline of 17.0°.What frictional force is needed for the skier to move at a constant velocity? (2.5 pts)

Since there is no acceleration (constant velocity):

$$F - F_f = 0$$

$$mg\sin\theta - (mg\cos\theta)\mu_k = 0$$

$$mg\sin\theta = mg\cos\theta\,\mu_k = 90.0 \times 9.8 \times \sin 17 = 257.8N$$

3) A force of 1760 N is required to start moving a bundle of wooden planks up a ramp. If the ramp's incline is 17° and the mass of the planks is 266 kg, what is the coefficient of static friction between the planks and the ramp? (3.5 pts)

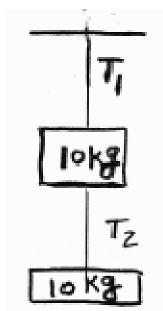
$$1760N = mg\sin\theta + mg\cos\theta\,\mu_k$$

$$1760N = 266 \times 9{,}8 \times \sin 17 + 266 \times 9.8 \times \cos 17 \times \mu_k$$

$$\frac{1760 - 266 \times 9.8 \times \sin 17}{266 \times 9.8 \times \cos 17} = \mu_k$$

$$=> \mu_k = 0.40$$

4) Consider the system depicted below: (4 pts)



A) If the rope is pulled up at constant speed, find T_1 and T_2:

$$T_1 = 10 \times 9.8 = 98N$$

$$T_2 = (10 + 10) \times 9.8 = 196N$$

B) If the rope is pulled up with an acceleration of 2 m/s^2, find T_1 and T_2:

$$T_1 = 98 + 10 \times 2 = 118N$$

$$T_2 = 196 + 20 \times 2 = 236N$$

Type equation here.

6) A lunch pail is accidentally kicked off a steel beam on a building under construction. Suppose the initial horizontal speed is 1.50 m/s. (5 pts)

A) How far does the lunch pail fall after it travels 3.50 m horizontally?

$$v = \frac{\Delta x_x}{\Delta t} = \Delta t = \frac{\Delta x_x}{v} = \frac{3.50}{1.5} = 2.3\ s$$

$$\Delta x_y = \frac{1}{2}at^2 + v_i t => \Delta x_y = \frac{1}{2} \times 9.8 \times (2.3)^2 + 0 = 25.9m$$

B) If the building is 250 m tall, and the lunch pail is knocked off the top floor, what will be the horizontal displacement of the lunch pail when it reaches the ground?

$$\Delta x_y = \frac{1}{2}at^2 + v_i t => 250 = \frac{1}{2} \times 9.8 \times t^2 + 0 => t = 7.14\ s$$

$$v = \frac{\Delta x_x}{\Delta t} => \Delta x_x = v\Delta t = 1.50 \times 7.14\ s = 10.71m$$

C) What is the total velocity of the lunch pail when it reaches the ground (magnitude and direction)?

$$(10.71)^2 + (1.50)^2 = x^2$$

$$=> x = 10.81\ {}^{m}/_{s}$$

$$\theta = \tan^{-1}(\frac{-10.71}{1.50}) = 82\ degrees\ above\ the\ horizontal.$$

EC-1) In 1994, a commercial automobile accelerated from rest to 88.0 km/h in 3.07 s. Cars accelerate because of traction, which in turn depends on the force of static friction between the rubber of their tires and the road. If the force of acceleration is entirely provided by static friction between the tires and pavement (an overly simplified assumption), calculate the coefficient of static friction between the tires and the road.

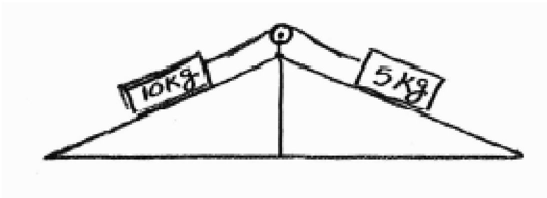
$$88.0\frac{km}{hr} \div 3.6 = 24.4\frac{m}{s}$$

$$v_f = v_i + a(\Delta t) => 24.4 = 0 + a(3.7) => a = 6.6\ m/s^2$$

$$F = ma = mg\mu_k$$

$$a = g\mu_k => \mu_k = 0.67$$

EC-2) Suppose a physics student decides to test the Atwood machine principle on inclined planes. The figure below shows the type of machine student is building (You must consider $a = -g = -10.0m/s^2$ and both angles to be 30 degrees)



A) Calculate the acceleration of the system if there is no friction?

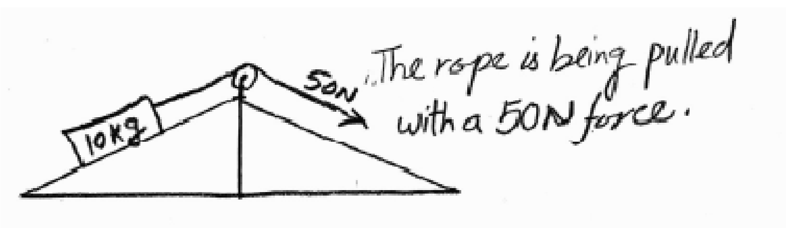
$$\begin{cases} m_1 g \sin\theta - T = m_1 a \\ T - m_2 g \sin\theta = m_2 a \end{cases} => \begin{cases} 10 \times 10 \times 0.5 - T = 10a \\ T - 5 \times 10 \times 0.5 = 5a \end{cases}$$

$$=> a = \frac{g \sin\theta (m_1 - m_2)}{(m_1 + m_2)} = 1.67\ m/s^2$$

B) Calculate the acceleration of the system when the coefficient of kinetic friction for both ramps is 0.1?

Remains as Extra Credit!

C) Suppose the student then tries to test the machine depicted below (no friction) and compare the acceleration to the original machine (with no friction). How is the acceleration of this second machine compared to the first one?



Remains as Extra Credit!