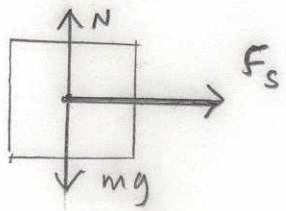
Key

PHYSICS 161, Spring 2003

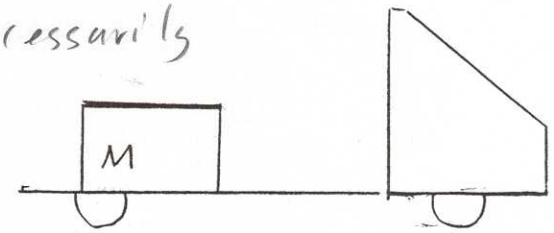
Discussion Quiz , Tuesday, March 18

Q1). A box of mass M lies on the floor of a truck as shown in Fig 1. The coefficients of static and kinetic friction between the box and the truck's floor are $\mu_s = 0.3$ and $\mu_k = 0.2$ respectively. **A person standing on the sidewalk observes the box to stay put relative to the truck bed at all times.**

a). At $t = 0$, the truck starts from rest and accelerates with an acceleration of magnitude a_0. Draw a free body diagram of the box.



f_s is not necessarily equal to its maximum value.



b). Write down the $\Sigma F_x = ma_x$ equation for the box. If $M = 10kg$ and $a_0 = 1m/s^2$, what is the magnitude of the frictional force on the box? Do we know if it is necessarily equal to the maximum value of static friction force?

$\Sigma F_x = m a_x$

$f_s = m a_0$

$= (10kg)(1m/s^2)$

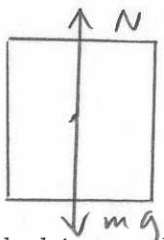
$\Rightarrow$ $f_s = 10\,kg\,m/s^2 = 10$ Newtons

$f_{s,max} = \mu_s N = \mu_s mg$

$= (0.3)(10kg)(9.8 m/s^2)$

$= 29.4N.$

c). At $t = t_1$, the truck attains a speed of $65mi/hr$. If the truck now starts coasting with constant velocity , what then is the magnitude of the force of friction on the box? Draw a free body diagram of the box as it coasts along with the truck at constant velocity.



d). At some time $t = t_2 > t_1$,the truck driver suddenly brakes to a halt. Suppose that the box does not slide relative to the truck bed. Draw a free body diagram of the box as it comes to rest along with the truck. What is the maximum acceleration the truck could've had with the box staying put rlative to the truckbed?

To find the maximum acceleration such that the box stays put, we want to maximize the force of static friction. so $f_s = f_{s,max} = \mu_s N$.

$\Sigma F_x = m a_x$

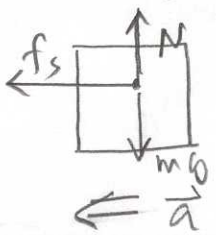
$-f_{s,max} = -m a_x$

$+\mu_s N = +m a_x$

$\Rightarrow +\mu_s mg = m a_x$

$\Rightarrow$ $a_x = +\mu_s g$

$a_x = 2.94\,m/s^2$



PHYSICS 161, Spring 2003

Discussion Quiz, Thursday, March 20

Q1). Fig 1 shows a cart A being pushed to the right along the horizontal floor. A small block B is in contact with the vertical right side of the cart. The floor is frictionless. However, the coefficient of static friction between the block and the side of the cart is $\mu_s = 0.30$. **Suppose that the cart has the minimum acceleration needed such that the block remains at rest relative to the cart at all times in this problem.**

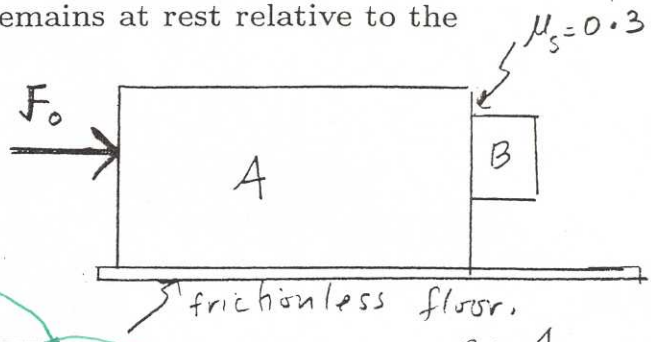
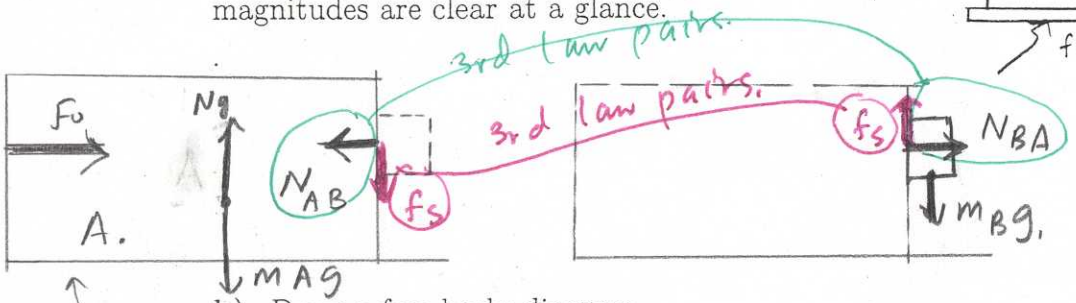


fig 1.

a). Draw a free body diagram of the block B. Label forces appropriately and draw the force vectors such that the relative magnitudes are clear at a glance.



$\vec{N}_{AB} = -\vec{N}_{BA}$

b). Draw a free body diagram of the cart. Follow same instructions as above.

c). Write down the $\Sigma F_y = m_B a_y$ equation for the block B.

$\Sigma F_y = m_B a_y^0$ Must use $f_{s,max}$ for minimum a.

$f_s - m_B g = 0 \Rightarrow \mu_s N_{BA} = m_B g \Rightarrow N_{BA} = \frac{m_B g}{\mu_s}$

d). Write down the $\Sigma F_x = m_B a_x$ equation for the block B. Using your answer from part (c) above, find the magnitude of the acceleration of the cart.

$\Sigma F_x = m_B a_x \Rightarrow \frac{m_B g}{\mu_s} = m_B a \Rightarrow \boxed{a = \frac{g}{\mu_s}}$

$N_{BA} = m_B a$

e).. If $m_B = 2kg$, find the magnitude of the normal force applied on the block.

$$N_{BA} = \frac{m_B g}{\mu_s} = \frac{(2kg)(9.8 m/s^2)}{(0.3)} = 65.3 N$$

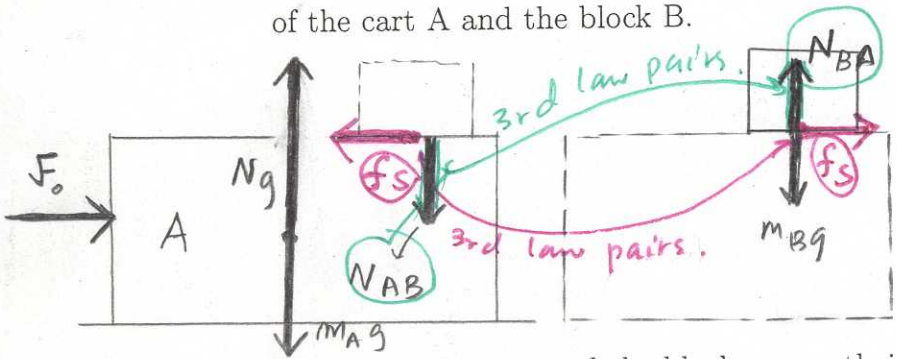
$\boxed{N_{BA} = N_{AB} = 65.3 N}$

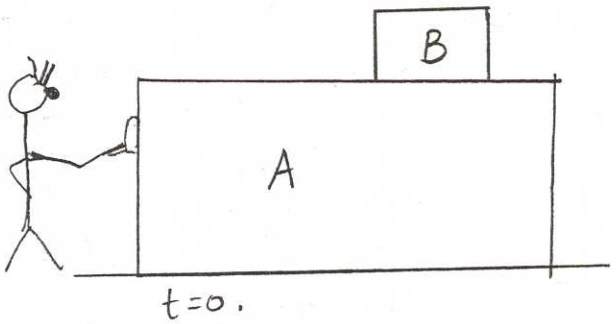
PHYSICS 161, Spring 2003

Discussion Quiz, Friday, March 21

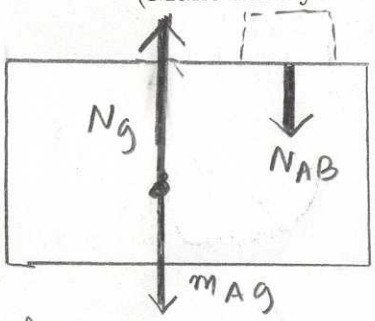
Q1). Fig 1 shows a cart A being pushed to the right along the horizontal floor. A small block B is sitting on top of the cart. The floor is frictionless. However, the coefficient of static friction between the block and the top surface of the cart is $\mu_s = 0.30$. **The block is observed to stay put relative to the cart at all times.**

a). The cart and the box are initially at rest. Suppose that at $t = 0$, you give the cart a big push towards a friend with force F_0. Draw a complete free body diagram of the cart A and the block B.





b). When the cart and the block are on their way over to your friend on the other side of the room, draw a separate free body diagram of the cart and the block. (Make sure you don't violate N1 and N2).

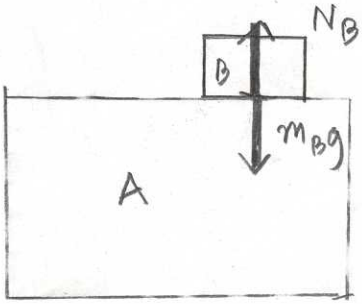


Note that:

$N_g - m_A g - N_{AB} = 0$

$\Rightarrow N_g = m_A g + N_{AB}$

So $N_g > m_A g$.



$N_{BA} = m_B g$

&

$\vec{N}_{BA} = -\vec{N}_{AB}$

c). When the cart and the block reach your friend, she stops the cart with her foot. Draw a free body diagram of the cart and the block. If the mass of the block is $1kg$, and the mass of the cart is $10kg$, what is the maximum force your friend can apply such that the block does not slide relative to the cart?

(c). Need f_s to be maximum possible to provide the acceleration for block B.

$\Sigma F_x = m_B a_x$

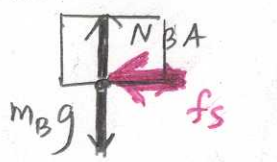
$f_{s,max} = m_B a$

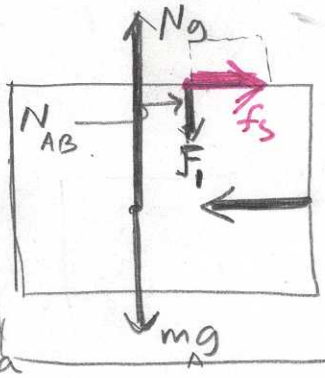
$\mu_s N_{AB} = m_B a$

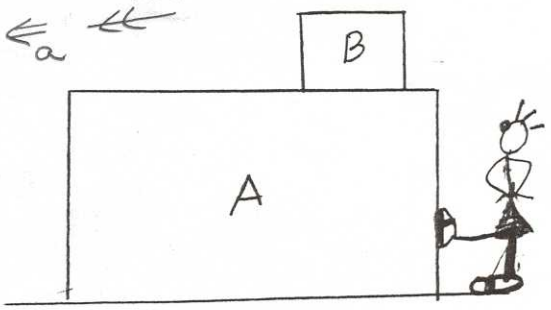
$\mu_s m_B g = m_B a$

$\Rightarrow \boxed{a = \mu_s g}$

$\boxed{a = 2.94\, m/s^2}$







$\Sigma F_x = m_A a$

$F_1 - f_s = m_A a$

$F_1 = f_s + m_A a$

$= m_B a + m_A a \Rightarrow \boxed{F_1 = (m_A + m_B) a} = 32.34 N.$