Friction Practice Name:_____

1. What is the force of friction if $F_N = 67\ N$ and $\mu = 0.44$?

$F_{fric} = \mu F_N$

$= 0.44 \times 67N$

$= 29N$

2. What is the coefficient of friction if an object experiences 75 N of friction and $F_N = 96$ N

$F_{fric} = \mu F_N$

$\frac{F_{fric}}{F_N} = \mu \rightarrow \frac{75N}{96N} = 0.78$

3. An 25 kg object is pushed across a floor with $\mu = 0.23$

a. What is the force of gravity acting on the object? $F_g = mg = 25kg \times 9.8 m/s^2$

$= 245N \approx 250N$

b. What is the normal force acting on the object?

Same as F_g since it isn't accelerating up or down 250N

c. What is the force of friction acting on the object?

$F_{fric} = \mu F_N = 0.23 \times 245N = 56N$

d. What force must the object be pushed with to have it move with constant velocity?

If it has constant velocity $F_{net} = 0$ so forces are balanced $F_{app} = 56N$

e. What will happen if the object is pushed with more force than that in d?

It will accelerate in the direction it is being pushed.

f. What will happen if the object is pushed with less force than in d?

It will slow.

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4. A 45 kg block has a coefficient of static friction with of the floor of 0.56 and a coefficient of kinetic friction of 0.35.
   a. What force must be applied to start the block moving?

$F_N = F_g = mg = 45kg \times 9.8\frac{m}{s^2}$
$= 441N$

Force applied must equal force of static friction to start it moving

$F_{fric} = \mu_s F_N = 0.56 \times 441 = 246.96N$

$F_{app} = 250N$

   b. What force must be applied once it is moving to keep it moving at a constant velocity?

Force applied must equal force of kinetic friction

$F_{fric} = \mu_K F_N = 0.35 \times 441N$
$= 150N$

5. A 2.5 kg block is traveling at 12 m/s over a surface with coefficient of kinetic friction of 0.23.
   a. What is the magnitude of the force acting to slow the motion? ($F_{fric} = \mu F_N$)

$F_N = F_g = mg$
$= 24.5N$

$F_{Fric} = 0.23 \times 24.5N$
$= 5.635N \approx 5.6N$

   b. What is the acceleration of the block? ($F_{net} = ma$)

$\frac{F_{net}}{m} = a \rightarrow \frac{5.635N}{2.5kg} = 2.254\frac{m}{s^2}$ since it is slowing the block $-2.3m/s^2$

   c. How long will it take until the block comes to a stop? ($v_f = v_0 + at$)

Use formula sheet with $v_f = 0$, $v_0 = 12m/s$ $a = -2.254\frac{m}{s^2}$

$t = 5.324sec \approx 5.3sec$

   d. How far will the block travel before it stops? ($v_f^2 = v_0^2 + 2ad$)

0 $12m/s$ $-2.254m/s^2$

$d = 31.94m$
$\approx 32m$

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6. What is the coefficient of static friction between a 54 kg desk and the floor if it takes 225 N of force to start moving the desk?

$F_{fric} = \mu F_N$

$F_N = F_g = mg = 54kg \times 9.8 m/s^2 = 529.2N$

$\mu = \frac{F_{fric}}{F_N} = \frac{225N}{529.2N} = 0.4252 \simeq (0.43)$

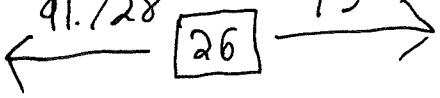
7. A 26 kg block has coefficient of kinetic friction of 0.36 with the floor. It is being pushed with a force of 95 N.

   a. What is the force of friction slowing the motion?

$F_{fric} = \mu F_N = 0.36 \times 254.8N = 91.728N \simeq (92N)$

$F_N = F_g = mg = 26kg \times 9.8 \frac{m}{s^2} = 254.8N$

   b. What is the net force acting on the block?



$F_{net} = 95N - 91.728N = 3.272N \simeq (3.3N)$ in direction it is being pushed

   c. What is the acceleration of the block?

$F_{net} = ma \rightarrow \frac{F_{net}}{m} = a$

$\frac{3.272N}{26kg} = 0.1258 m/s^2 \simeq (0.13 m/s^2)$ in direction it is being pushed

   d. If it started at rest, how long will it take to push it 15m?

Use $d = v_0 t + \frac{1}{2} a t^2$

15m, $v_0 = 0$, $a = 0.1258 m/s^2$

$t = 15.44 \simeq (15 sec)$

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8. A 2.0 kg block is pushed so it has a starting velocity of 14 m/s. It travels 12.3 m before coming to a stop.

   a. Determine the acceleration of the block.

$V_0 = 14 m/s$

$V_f = 0 m/s$

$d = 12.3 m$

Use $V_f^2 = V_0^2 + 2ad$

$a = -7.9675 m/s^2 \approx (-8.0 m/s^2)$

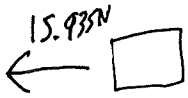
   b. Determine the net force acting on the block (since friction is the only unbalanced force acting on the block this will also be the force of friction)

$F_{net} = ma = 2.0 kg \times -7.9675 \frac{m}{s^2}$

$= -15.9350 N$ or $15.9350 N$ in direction opposite motion

   c. Determine the coefficient of friction between the block and the floor.

(16 N)



$F_{fric} = F_{net} = 15.9350 N$

$F_N = F_g = mg = 2.0 kg \times 9.8 \frac{m}{s^2}$

$= 19.6 N$

$F_{fric} = \mu F_N$

$\frac{F_{fric}}{F_N} = \mu \rightarrow \frac{15.9350 N}{19.6 N} = (0.81)$

9. A block is pulled at a constant velocity along a floor, the coefficient of friction between the block and the floor is 0.34. If it is pulled with a force of 56 N what is the mass of the block?

Since it is pulled at constant velocity applied force equals friction force

$F_{app} = F_{fric} = 56N$

$F_{fric} = \mu F_N \rightarrow \frac{F_{fric}}{\mu} = F_N$

$\frac{56N}{0.34} = 164.7059 N$

$F_N = 164.7059 N = F_g$

since it isn't accelerating up or down

$\rightarrow$

$F_g = mg$ so $\frac{F_g}{g} = m$

$\frac{164.7059 N}{9.8 m/s^2} = 16.8 kg$

$\approx (17 kg)$

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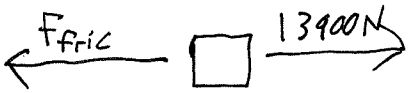
10. A 1425 kg rocket car exerts 13 900 N of force and accelerates from 0 to 100.0 **km/h** in 3.25 s. What is the coefficient of friction acting on the car?

$$\frac{100\,km}{hr} \times \frac{1\,hr}{3600\,sec} \times \frac{1000\,m}{1\,km} = 27.7778\,m/s$$

$$a = \frac{\Delta v}{t} = \frac{27.7778\,m/s}{3.25\,s} = 8.547\,m/s^2$$

$$F_{net} = ma = 1425\,kg \times 8.547\,\frac{m}{s^2} = 12\,179.49\,N$$



F_{net} = winners − losers

$12179.49 = F_{app} - F_{Fric}$

$F_{Fric} = 13900 - 12179.49$

$= 1720.51\,N \simeq 1720\,N$

11. I deicide to push a 35.0 kg chair while in an elevator accelerating upwards at 2.50 m/s^2. The coefficient of static friction between the chair and the floor is 0.460. With what force must I push the chair so that it starts to move?

In this case F_N is not equal to F_g

Force needed to start it moving is equal to force of static friction

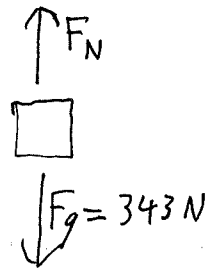
$$F_{Fric} = \mu F_N$$

$$= 0.460 \times 430.5\,N$$

$$= 198.03\,N$$

Need to apply approx 200N

$\simeq 2.0 \times 10^2\,N$ force



$F_{net} = ma$

$= 35.0 \times 2.5$

$= 87.5\,N$ up

$F_N = 343 + 87.5$

$= 430.5\,N$

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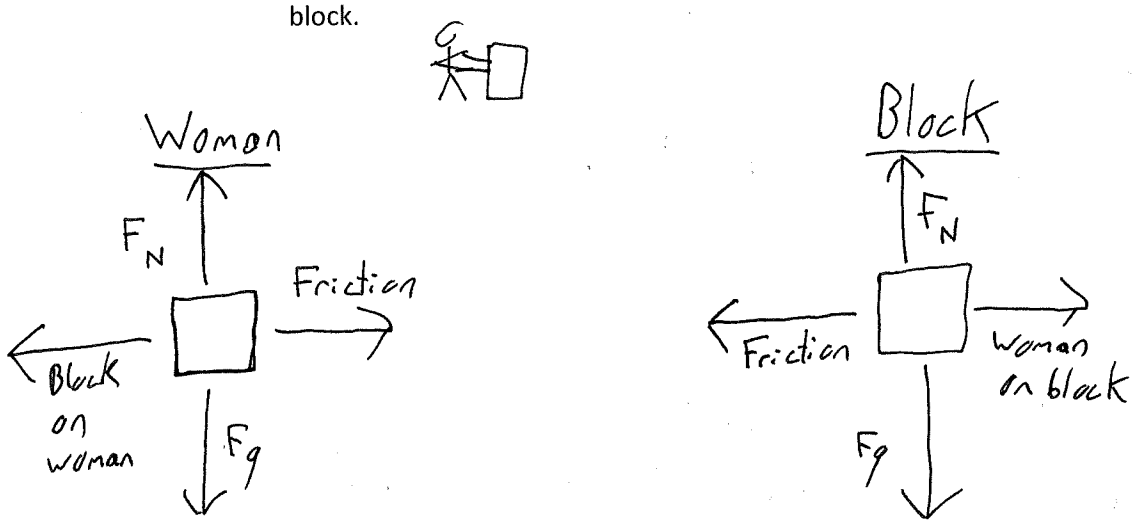
12. A 76 kg woman attempts to push a 150 kg block across the ice which has coefficient of static friction of 0.13 with the block.
    a. Draw two FBDs showing the forces acting on the woman and the forces acting on the block.



    b. If the woman's shoes have a coefficient of static friction with the ice of 0.21 will she be able to get the block moving?

Force needed to start block moving $= F_{fric} = \mu F_N = 0.13 \cdot 150 \times 9.8 = 191.1\ N$

Max force she can apply without slipping $= F_{fric} = \mu F_N$
$= 0.21 \times 76 \times 9.8$
$= 156.408\ N$

No, she will slip

    c. The woman puts on a backpack and now she can push the block. What was the minimum mass of the backpack?

The force of friction for the woman must equal 191.1 N,

$F_{fric} = \mu F_N = \mu F_g = \mu m g$

$m = \frac{F_{Fric}}{\mu g} = \frac{191.1\ N}{0.21 \times 9.8} = 92.86\ kg$

$92.86\ kg - 76\ kg = 17\ kg$ Backpack of 17 kg increases her friction so she can push block