**Example 1:** A 20.0 kg box at rest is pulled horizontally by rope with a force of 100 N. What is the coefficient of static friction if the box is about to start moving?

**FN**

**FS** = **µSFN** **FT** = 100 N

(maximum)

**Fg** = **mg** = (20 kg)(9.8 m/s2) = 196 N

Horizontal Forces

*\*box not moving horizontally so ax* = *0 m/s2*  
∑**Fx**= **max**

**FT**–**Fs** =**ma**   
100 N – **Fs** = (20 kg)(0 m/s2)

100 N – **Fs** = 0 N

**Fs** = 100 N

Vertical Forces

*\* box not moving vertically, so ay = 0 m/s2*∑**Fy**= **may**

**FN**–**Fg** = (20 kg)(0 m/s2)  
**FN**– 196 N = 0 N

**FN**= 196 N

Conclusion

**FS** = **µSFN**

100 N = **µS**(196 N)

100 N/196 N = **µS**

**µS** = 0.51

**Example 2:** A 20.0 kg box is pulled horizontally by rope with a force of 60 N. Friction is 20.0 N. What is the acceleration if the box is speeding up?

**FN**

**FK** = 20 N **FT** = 60 N

**Fg** = **mg** = (20 kg)(9.8 m/s2) = 196 N

Horizontal Forces  
∑**Fx**= **max**

**FT**-**FK** =**ma**   
60 N - 20.0 N = (20 kg)**a**

40 N = (20 kg) **a**

40 N/20 kg = **a**

**a** = 2 m/s2

Vertical Forces

*\* box not moving vertically, so ay = 0 m/s2*∑**Fy**= **may**

**FN**–**Fg** = (20 kg)(0 m/s2)  
**FN**– 196 N = 0 N

**FN**= 196 N

**Example 3:** A 20.0 kg box is pulled horizontally by rope with a force of 150 N. What is the coefficient of kinetic friction if the box moves at a **constant velocity** of 4 m/s?

\*It is important that the velocity is constant, but the value of the velocity is not important.

**FN**

**Fk** = **µkFN** **FT** = 150 N

**Fg** = **mg** = (20 kg)(9.8 m/s2) = 196 N

Horizontal Forces  
*\* box moving at a constant velocity horizontally, so ax = 0 m/s2*

∑**Fx**= **max**

**FT**-**FK** =**ma**   
100 N - **FK** = (20 kg)(0 m/s2)

100 N - **FK** = 0 N

**FK**= 150 N

Vertical Forces

*\* box not moving vertically, so ay = 0 m/s2*∑**Fy**= **may**

**FN**–**Fg** = (20 kg)(0 m/s2)  
**FN**– 196 N = 0 N

**FN**= 196 N

Conclusion

**FK** = **µKFN**

150 N = **µK**(196 N)

150 N/196 N = **µK**

**µK** = 0.77

**Example 4:**  A 20 kg box was pushed and it is sliding to the right across a table. The hand that applied the push is no longer touching the box. The coefficient of static friction between the box and the table is 0.8. The coefficient of kinetic friction between the box and the table is 0.5. What is the acceleration of the box while it is sliding?

*\*Kinetic friction is acting on the box because it is sliding. Static friction does not act on the box, so we don’t care about the coefficient of static friction*

**FN**

**Fk** = **µkFN**

**Fg** = **mg** = (20 kg)(9.8 m/s2) = 196 N

Vertical Forces

*\* box not moving vertically, so ay = 0 m/s2*∑**Fy**= **may**

**FN**–**Fg** = (20 kg)(0 m/s2)  
**FN**– 196 N = 0 N

**FN**= 196 N

Force of Kinetic Friction

**FK** = **µKFN**

**Fk** = (0.5)(196 N)

**FK** = 98 N

Horizontal Forces

∑**Fx**= **max**

-**FK** =**ma**   
- 98 N = (20 kg)**a**

- 98 N/20 kg = **a**

**a =** -4.9 m/s2

**Practice Problems: Redemption Quiz Ticket**

**\****All four must be solved correctly with all work shown for the opportunity to take a redemption quiz*

1. A 15.0 kg block is pulled by a horizontal force of 30.0 N along a rough horizontal surface at constant velocity. What is the coefficient of friction?

2. If the coefficient of kinetic friction between a 35 kg crate and the floor is .30, what horizontal force is required to move the crate at a steady speed across the floor? What horizontal force is required if µk is zero?

3. A block of mass 1.95 kg slides on a smooth, horizontal surface. The block now encounters a rough patch with a coefficient of kinetic friction given by µk = 0.260. What is the acceleration of the block when it is in the rough patch?

4. A 2500 kg car traveling 14.0 m/s on an icy, level road approaches an intersection. The brakes lock and the car skids 25.0m. What is the coefficient of friction between the tires and the surface? Hint: Use motion equations to find the acceleration, then draw the FBD and analyze the forces.

**Redemption Quiz Scoring**

**\****the redemption quiz is 10 points. Anyone that scored below 75 and completes these problems may take the redemption quiz. Your exam score will be adjusted as follows.*

x = 75 – (original exam score)

y = (redemption quiz score) ÷ 10

New exam score = (original exam score) + xy

**Example:** Your original score is 30, your redemption quiz score is 9

x = 45

y = 0.9

New exam score = 72

**But I got higher than a 75%... can I still get bonus points???**

If you correctly complete all 4 practice questions, you can earn 4 bonus points added directly to your exam score.