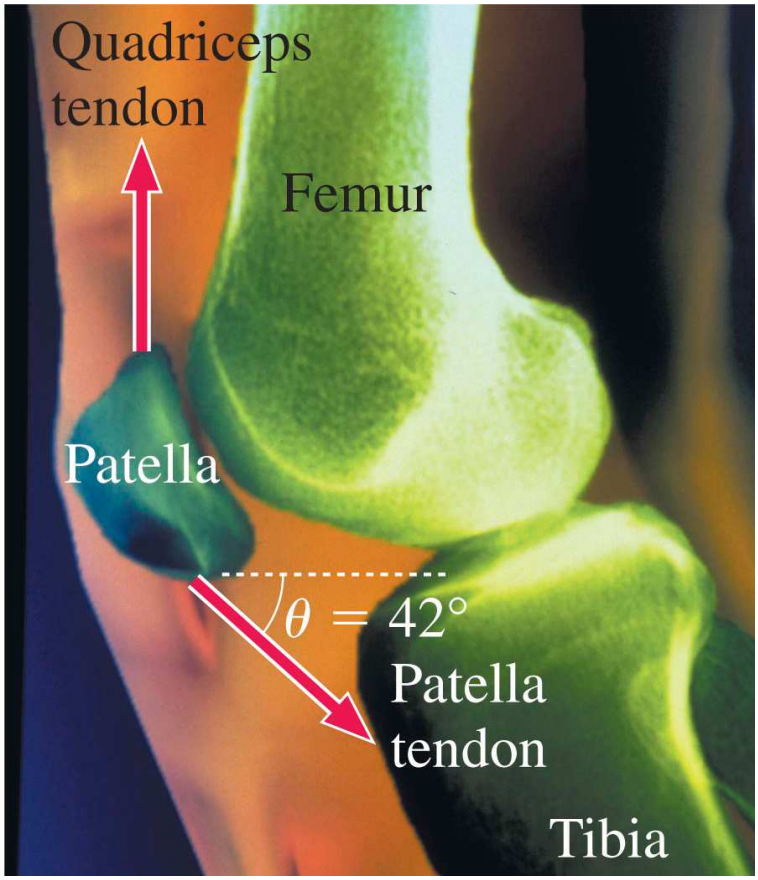
Physics 151
Homework Assignment #4
Due June 27

#1 When you bend your knee, the quadriceps muscle is stretched. This increases the tension in the quadriceps tendon attached to your kneecap (the patella), which in turn, increases the tension in the patella tendon that attaches your kneecap to your lower leg bone (the tibia). Simultaneously, the end of your upper leg bone (the femur) pushes outward on the patella. This figure shows how these parts of a knee joint are arranged. What is the magnitude and direction of the force exerted by the femur if the tendons are oriented as in the figure and the tension in each tendon is $50\,N$. Assume your knee is stationary and that the weight of the patella itself is negligible.



#2 A 0.4-kg bullfrog is sitting at rest on a log that is inclined 26° above the horizontal. The coefficient of static friction between the frog and the log is 0.65.

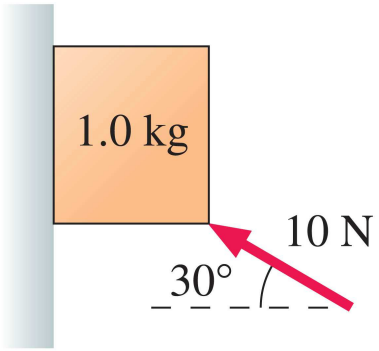
(a.) What forces are acting on the frog?

(b.) Draw the frog's free body diagram.

(c.) What is the magnitude of the normal force acting on the frog?

(d.) What is the magnitude of the static friction acting on the frog?

#3 A 1.0-kg wooden block is pressed against a vertical wooden wall by a 10-N force as shown.



(a.) If the block is initially at rest, will it move upwards, move downwards or stay at rest? For full points, your answer must include a free-body diagram, the proper calculations, and an explanation of how you determined your answer from your calculations.

(b.) If the block stays at rest, what is the magnitude of the static frictional force acting on it? If the block slides, what is its acceleration?

#4 A 12-kg crate is placed on a horizontal conveyor belt. The materials of the crate and the belt are such that $\mu_s = 0.6$ and $\mu_k = 0.35$.

(a.) Draw a free-body diagram showing all the forces on the crate if the conveyor belt runs at constant speed.

(b.) Draw a free-body diagram showing all the forces on the crate if the conveyor belt is speeding up.

(c.) What is the maximum acceleration the belt can have without the crate slipping?

(d.) If the belt's acceleration exceeds the value determined in part (c.), what is the acceleration of the crate?

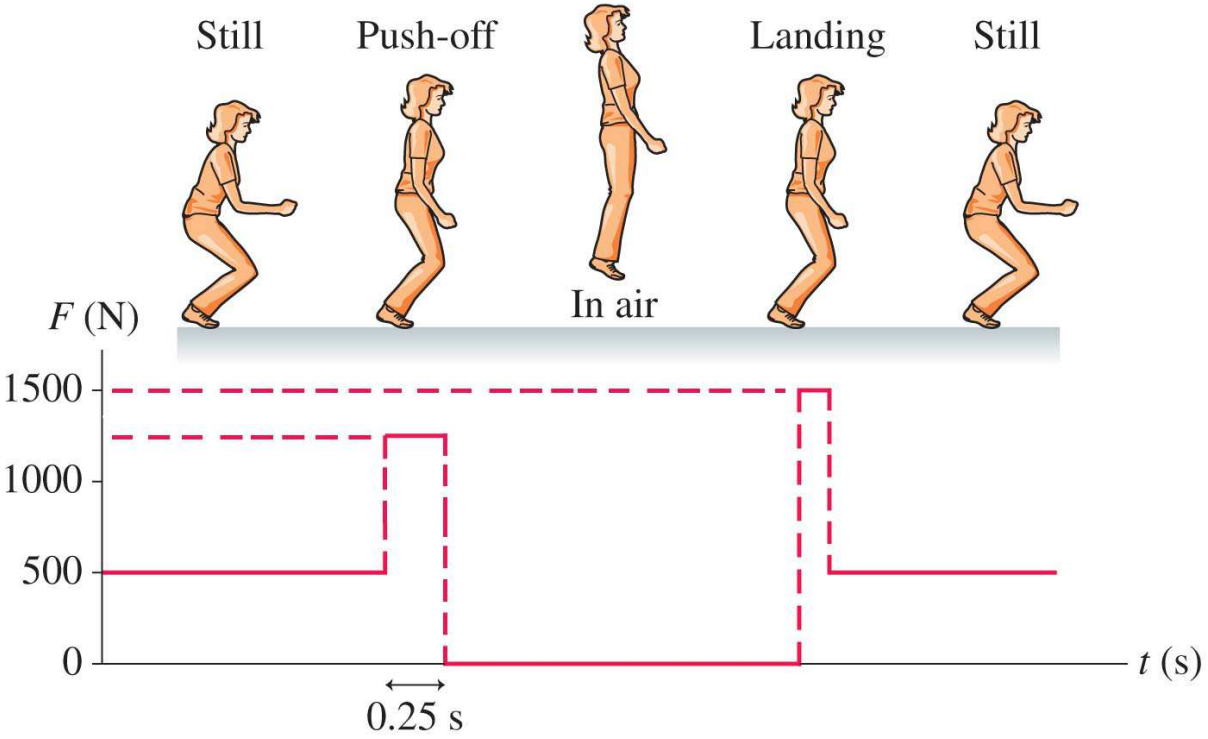
#5 Researchers often use *force plates* to measure the forces that people exert against the floor during movement. A force plate works like a bathroom scale, but it keeps a record of how the readings change with time. The figure shows the data from a force plate as a woman jumps straight up and the lands.

(a.) What was the vertical component of her acceleration during push-off?

(b.) What was the woman's speed as her feet left the floor?

(c.) What was the vertical component of her acceleration while in the air?

(d.) What was the vertical component of her acceleration during the landing?



#6 A 1500-kg car is being used to push a 2500-kg truck that has a dead battery. When the car's driver steps on the accelerator, the drive wheels on the car push backward on the ground with a force of 4000 N.

(a.) What is magnitude and direction of the force that the car exerts on the truck?

(b.) What is magnitude and direction of the force that the truck exerts on the car?