The Frictional Force

Pre-Class Questions

1. Why is the maximum static friction less than the kinetic friction?
2. Why is the frictional force related to the normal force and not the weight?
3. Are there standard values for the COF for specific materials?
4. Why do we sometimes choose a coordinate axis along the incline?
5. What's the point of the free body diagrams?

Problem Set #12 (due next time)

Lecture Outline

1. Coefficient of Kinetic Friction
2. Coefficient of Static Friction

Pre-Class Summary:

We defined the coefficients of static and kinetic friction,

Definition of Coefficient of Static Friction $\mu_s \equiv \frac{F_{sf,\max}}{F_n}$

Definition of Coefficient of Kinetic Friction $\mu_k \equiv \frac{F_{kf}}{F_n}$

and used them to describe the following properties of the frictional force.

- The force of static friction is always less than or equal to the coefficient of static friction times the normal force.

$$F_{sf} \leq \mu_s F_n$$

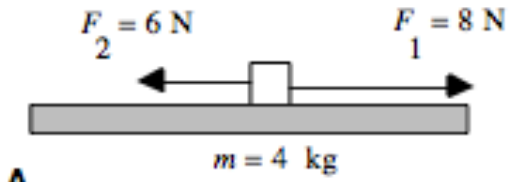
- The maximum value of the force of static friction is equal to the coefficient of static friction times the normal force.

$$F_{sf,\max} = \mu_s F_n$$

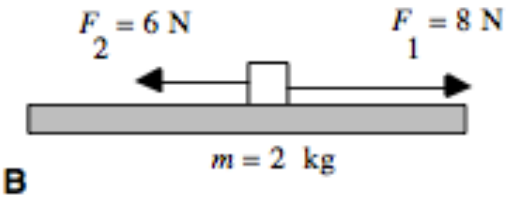
- The maximum force of static friction is generally greater that the force of kinetic friction.
- The force of kinetic friction is equal to the coefficient of kinetic friction times the normal force.

$$F_{kf} = \mu_k F_n$$

Two forces act on identical objects that are on rough surfaces, as shown below. The forces of maximum static and kinetic friction for each case are both 1 N. Rank these situations from greatest change in velocity to least change in velocity. (Note: All vectors directed to the right are positive, and those to the left are negative. Also, 0 m/s > -10 m/s.) All objects start at rest.



A



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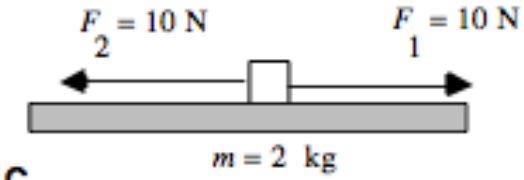

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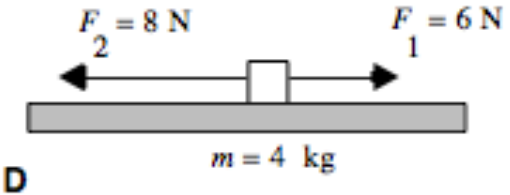

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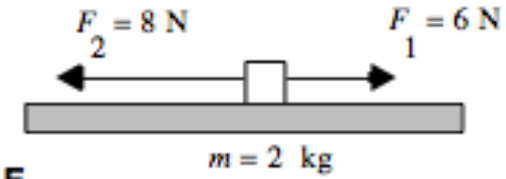

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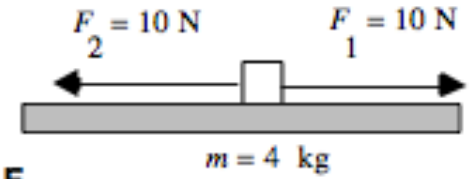

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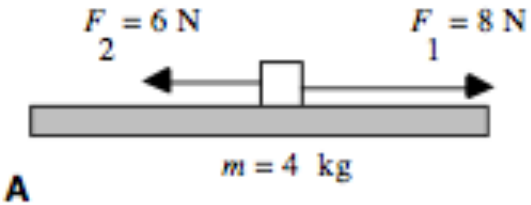
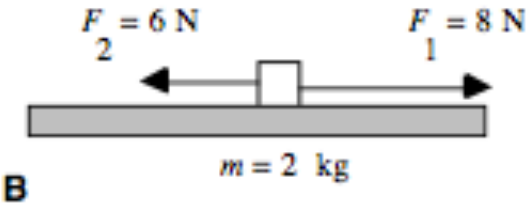
Two forces act on identical objects that are on rough surfaces, as shown below. The forces of maximum static and kinetic friction for each case are both 2 N. Rank these situations from greatest change in speed to least change in speed. All objects start at rest.



A



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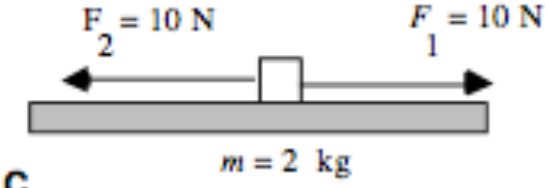

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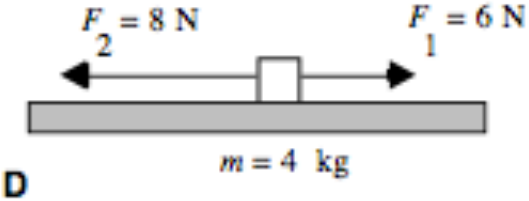

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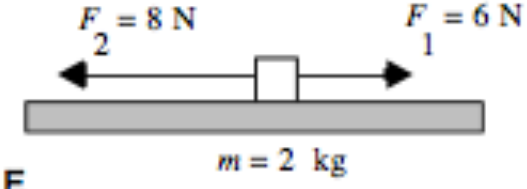

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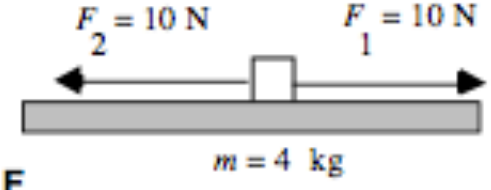

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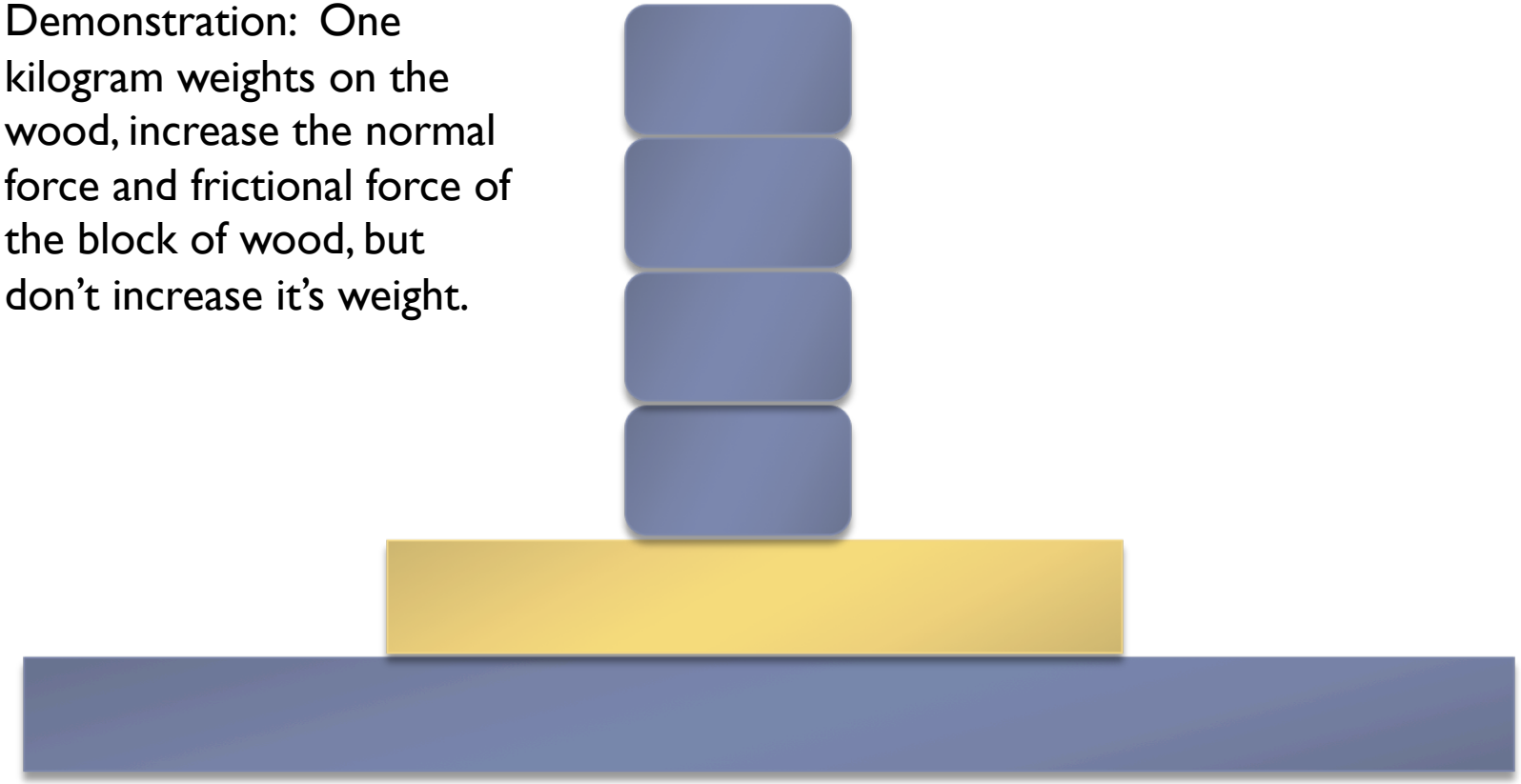
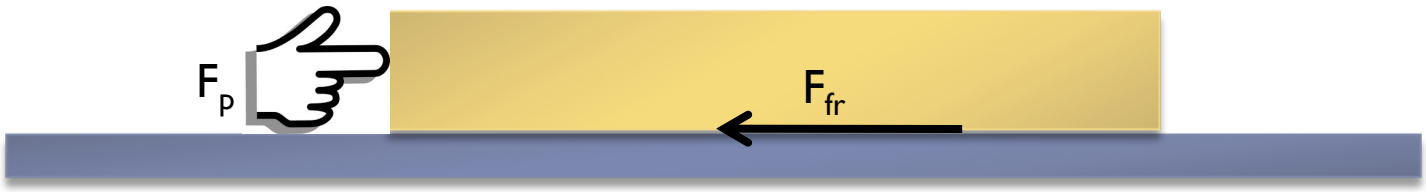
Demonstration: One kilogram weights on the wood, increase the normal force and frictional force of the block of wood, but don't increase it's weight.



Example 1: A Fiat 500 has a mass of 900kg and accelerates from zero to 60mph (26.8m/s) in 7.8s. Assuming no air resistance, find (a)the acceleration, (b)the frictional force, (c)the normal force, and (d)the coefficient of kinetic friction with the road.

Example 2: A Fiat 500 has a mass of 900kg and a COKF of 0.350. Find the acceleration when it heads up a 15° hill under the same power as in the last example.



F_{fr}

F_p

Example 3: A 900kg Fiat 500 rests on a 20° incline. Find (a)the frictional force and (b) minimum COSF needed to keep it at rest.

Example 5: Assuming the maximum COSF between the wall and the 80.0kg man is 0.45. Find the minimum normal force required to support this pest control expert.

Lecture 12- Summary

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- The force of kinetic friction is equal to the coefficient of kinetic friction times the normal force.

$$F_{kf} = \mu_k F_n$$