Friction, It's a Drag

Identify the Variables in the Following Equations:

$$\mu_s = \frac{F_{s\,max}}{F_N} \qquad \mu_k = \frac{F_k}{F_N}$$

MATERIAL 1	MATERIAL 2	Coefficients Of Friction (μ)	
		Static	Sliding
Aluminum	Aluminum	0.42	0.34
Glass	Glass	1.0	0.4
Leather	Oak (Parallel grain)	0.61	0.52
Oak	Oak (Parallel grain)	0.62	0.48
Oak	Oak (Cross grain)	0.54	0.32
Rubber	Asphalt (Dry)	1.0	0.8
Rubber	Asphalt (Wet)	0.7	0.30
Rubber	Ice	0.2	0.15

Problem 1: An aluminum box (m = 45 kg) on a horizontal aluminum surface is pushed by a horizontal force of 200 N.

(a) Draw the Free-Body Diagram (FBD)

(b) Calculate F_N

(c) Calculate $\mathbf{F_{s,max}}$ and $\mathbf{F_k}$

(d) Does the box move?

(e) If not, what is the static friction force?

(f) If so, what is the acceleration?

Problem 2: A leather bound book (m = 2 kg) on a horizontal oak surface is pushed by a 20 N horizontal force.

(a) Draw the Free-Body Diagram (FBD)

(b) Calculate F_N

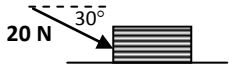
(c) Calculate $\mathbf{F_{s,max}}$ and $\mathbf{F_k}$

(d) Does the box move?

(e) If not, what is the static friction force?

(f) If so, what is the acceleration?

Problem 3: A leather bound book (m = 2 kg) on a horizontal oak surface is pushed by a force, as shown:



(a) Draw the Free-Body Diagram (FBD)

(b) Calculate F_N

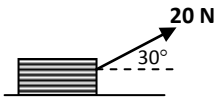
(c) Calculate $\mathbf{F_{s,max}}$ and $\mathbf{F_k}$

(d) Does the book move?

(e) If not, what is the static friction force?

(f) If so, what is the acceleration?

Problem 4: A leather bound book (m = 2 kg) on a horizontal oak surface is pushed by a force, as shown:



(a) Draw the Free-Body Diagram (FBD)

(b) Calculate F_N

(c) Calculate $\mathbf{F_{s,max}}$ and $\mathbf{F_k}$

(d) Does the book move?

(e) If not, what is the static friction force?

(f) If so, what is the acceleration?

Problem 5: A refrigerator (m = 120 kg) is being pushed by a horizontal force F. The coefficient of static friction between the refrigerator and the floor is 0.25, and the coefficient of kinetic friction is 0.18.

(a) Draw the Free-Body Diagram (FBD)

(b) Calculate $\mathbf{F_{s,max}}$ and $\mathbf{F_k}$

(c) What minimum force F is required to get the refrigerator to move?

(d) If F is 300 N, what is the net force on the refrigerator?

(e) If F is 300 N, what is the acceleration?

(f) What if $F < F_f$, while the refrigerator is moving?