

DRY FRICTION (pp. 71-2)

$$F_{static} = \mu_{static} F_{normal}$$

$$F_{kinetic} = \mu_{kinetic} F_{normal}$$

1.

$$\Sigma F_n = 0: F_{normal} - mg = 0$$

$$F_{normal} = mg = 50 \times 9.81 = 490.5$$

$$F_{static} = \mu_{static} F_{normal} = 0.95 \times 490.5 = 466 \text{ N}$$

$$F_{kinetic} = \mu_{kinetic} F_{normal} = 0.90 \times 490.5 = 441 \text{ N}$$

3.

$$\Sigma F_n = 0: F_{normal} - mg = 0$$

$$F_{normal} = mg = 35 \times 9.81 = 343.4$$

Since object is in motion :

$$F_{kinetic} = \mu_{kinetic} F_{normal} = 0.90 \times 343.4 = 188.8 \text{ N in negative direction}$$

5.

Since there are only three forces and they must add to zero for statics you can apply the triangle rule :

$$\Sigma F = 0: \underline{F}_{friction} + \underline{F}_{normal} + \underline{W} = 0$$

by constructing the triangle we see that :

$$F_{friction} = W \sin 15 = 50 \times 9.81 \times 0.25882 = 127.0 \text{ N up the incline}$$

7.

$$\Sigma F_n = 0:$$

$$F_{normal} - mg \cos 12^\circ + F_{applied} \sin 45^\circ = 0$$

$$F_{normal} = 30 \times 9.81 \times \cos 12^\circ - 200 \sin 45^\circ = 146.4$$

$$F_{static} = \mu_{static} F_{normal} = 0.80 \times 146.4 = 117.2$$

$$\text{Assume } \Sigma F_t = 0:$$

$$F_{equilibrium} - mg \sin 12^\circ + F_{applied} \cos 45^\circ = 0$$

$$F_{equilibrium} = 30 \times 9.81 \times \sin 12^\circ - 200 \cos 45^\circ = -80.2$$

since this absolute value is smaller than F_{static} friction is 80.2 N down the incline.

9.

$$\Sigma F_n = 0: F_{normal} - mg - F_{applied} \sin 13^\circ = 0$$

$$F_{normal} = 50 \times 9.81 + 500 \sin 13^\circ = 603.0$$

$$F_{static} = \mu_{static} F_{normal} = 0.80 \times 603 = 482.4 \text{ N}$$

$$\text{Assume } \Sigma F_t = 0: F_{equilibrium} + F_{applied} \cos 13^\circ = 0$$

$$F_{equilibrium} = -500 \cos 13^\circ = -487.2$$

since absolute value is greater than F_{static} the body is moving (friction = $F_{kinetic}$).

11.

$$\Sigma F_n = 0: F_{normal} - W \cos 10^\circ = 0$$

$$F_{normal} = 250 \cos 10^\circ = 246.2$$

$$F_{static} = \mu_{static} F_{normal} = 0.500 \times 246.2 = 123.10 \text{ N}$$

To get the box moving the friction must equal F_{static} .

$$\Sigma F_t = 0: -F_{static} - W \cos 10^\circ + F_{applied} = 0$$

$$F_{applied} = F_{static} + 250 \sin 10^\circ = 123.10 + 43.41 = 166.5 \text{ N}$$

13.

$$F_{static} = \mu_{static} F_{normal} = 0.950(150.0 \times 9.81) = 1398 \text{ N}$$

$$F_{kinetic} = \mu_{kinetic} F_{normal} = 0.900(150.0 \times 9.81) = 1324 \text{ N}$$

15.

$$F_{normal} = 10.00 \times 9.81 = 98.1 \text{ N}$$

$$\mu_{static} = \frac{F_{static}}{F_{normal}} = \frac{25.0}{98.1} = 0.255$$

$$\mu_{kinetic} = \frac{F_{kinetic}}{F_{normal}} = \frac{20.0}{98.1} = 0.204$$

17.

$$F_{normal} = 30.0 \times 9.81 = 294.3 \text{ N}$$

$$\mu_{static} = \frac{F_{static}}{F_{normal}} = \frac{225}{294.3} = 0.765$$

$$\mu_{kinetic} = \frac{F_{kinetic}}{F_{normal}} = \frac{215}{294.3} = 0.731$$