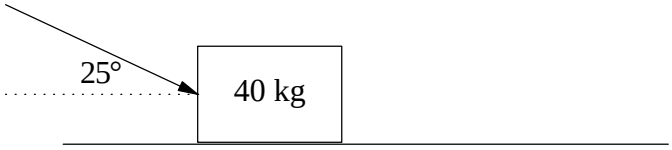
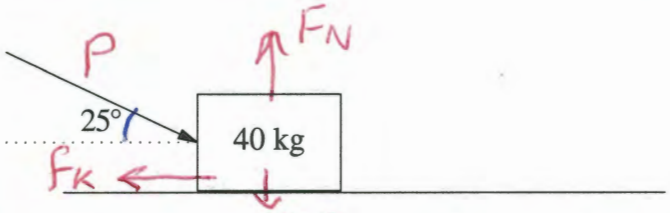
4. (20 pts.) A shopper pushes a 40 kg shopping cart at *constant speed* along a horizontal fbor. The force is directed at an angle of 25° *below* the horizontal. The shopping cart has wobbly wheels and presents an effective friction force of 86.5 N opposing the motion. How much work is done *by the shopper* in pushing the cart a distance of 80 m around the store?



SOLUTIONS.

4. (20 pts.) A shopper pushes a 40 kg shopping cart at *constant speed* along a horizontal floor. The force is directed at an angle of 25° *below* the horizontal. The shopping cart has wobbly wheels and presents an effective friction force of 86.5 N opposing the motion. How much work is done *by the shopper* in pushing the cart a distance of 80 m around the store?



Way #1: $K_i + W_{Total} = K_f$.

Since speed = constant, $K_i = K_f$, and $W_{TOTAL} = 0$.

Work done by gravity = work done by normal force = 0.

$\therefore \underbrace{P\cos 25^\circ\, d}_{\text{Shopper}} - \underbrace{f_K d}_{\text{Friction}} = 0$

$W_{shopper} = f_K d = (86.5)(80) = \boxed{6920\ J}$

Way #2

$\Sigma F_x = ma_x$ $\qquad$ $\Sigma F_y = ma_y$

$P\cos 25^\circ - f_K = 0$ $\qquad$ $-P\sin 25^\circ - mg + F_N = 0$

$P = \frac{f_K}{\cos 25^\circ} = \frac{86.5}{\cos 25^\circ} = 95.4\ N$

Work done by shopper $= P\cos 25^\circ\, d$

$= (95.4)(\cos 25^\circ)(80) = \boxed{6920\ J}$