STAEDTLER® No. 937 811E Engineer's Computation Pad

••29 Body $A$ in Fig. 6-36 weighs 102 N, and body $B$ weighs 32 N. The coefficients of friction between $A$ and the incline are $\mu_s = 0.56$ and $\mu_k = 0.25$. Angle $\theta$ is 40°. Let the positive direction of an $x$ axis be up the incline. In unit-vector notation, what is the acceleration of $A$ if $A$ is initially (a) at rest, (b) moving up the incline, and (c) moving down the incline?

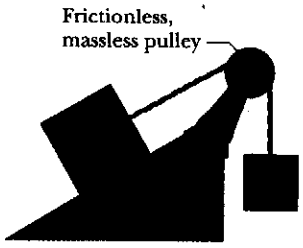
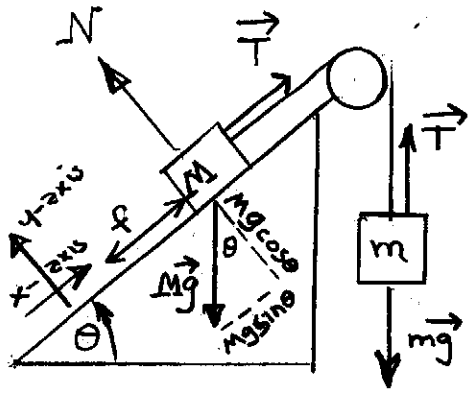



FIG. 6-36 Problems 29 and 30.




THE INITIAL QUESTION IS: IF A=M IS INITIALLY AT REST WILL IT REMAIN AT REST AS A RESULT OF A LARGE ENOUGH MAXIMUM VALUE OF STATIC FRICTION. NOTE STATIC FRICTION CAN ACT UP OR DOWN THE INCLINE DEPENDING ON THE DIRECTION OF THE IMPENDING MOTION

EQ$^n$ OF MOTION FOR B=m: $\vec{F}^{net}_{on\,m} = m\vec{a} \Rightarrow mg - T = ma$ (Positive vectors down) ✱

EQ$^n$ OF MOTION FOR A=M: $\vec{F}^{net}_{on\,M} = M\vec{a} \Rightarrow F^{net}_y = Ma_y \equiv 0$

$F^{net}_{y\,on\,M} = N - Mg\cos\theta = 0 \Rightarrow N = Mg\cos\theta = 102\cos 40^\circ = 78.1\,\text{Newtons}$

★ $F^{net}_{x\,on\,M} = Ma_x = Ma \Rightarrow T - Mg\sin\theta + f = Ma$ (add this to Eq$^n$ ✱)

$\Rightarrow mg - Mg\sin\theta + f = (m+M)a \Rightarrow f = (m+M)a + Mg\sin\theta - mg$

$\Rightarrow f = (m+M)a + 102\sin 40^\circ - 32 = \left(\frac{102+32}{g}\right)a + 65.6 - 32$

$f = f_s$ ↗ $f = 13.7a + 33.6$ NOTE $f_s \le \mu_s N = \mu_s Mg\cos\theta = 0.56(102)\cos 40^\circ = 43.8\,N$

a) SINCE THE SYSTEM IS INITIALLY @ REST ($v=0$), IT CAN MAINTAIN $v=0$ WITH $a \equiv 0$ SINCE $f = f_{static} = 33.6 \le f_{s,max} = 43.8\,N$

NOTE: SINCE $f > 0 \Rightarrow$ IT POINTS UP THE INCLINE RESISTING M SLIDING DOWN THE INCLINE

b) SINCE M IS MOVING UP THE INCLINE $\vec{f} = \vec{f}_k$ POINTS DOWN THE INCLINE

★ BECOMES $T - Mg\sin\theta - (f_k = \mu_k N) = Ma$ (add to ✱)

$\Rightarrow mg - Mg\sin\theta - \mu_k Mg\cos\theta = (m+M)a$

$\Rightarrow a = [32 - 65.6 - 0.25(78.1)]/13.7 = -3.88\,\frac{m}{s^2}$ $\Rightarrow \vec{a}$ IS DOWN INCLINE

c) SINCE M IS MOVING DOWN THE INCLINE $\vec{f} = \vec{f}_k$ POINTS UP THE INCLINE

★ BECOMES $T - Mg\sin\theta + (f_k = \mu_k N) = Ma$ (add to ✱ & ÷ m+M)

$\Rightarrow a = [mg - Mg\sin\theta + \mu_k Mg\cos\theta]/(m+M)$

$a = [32 - 65.6 + 19.5]/13.7 = -1.03\,m/s^2$ $\Rightarrow \vec{a}$ IS DOWN THE INCLINE