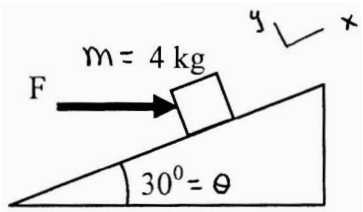
Physics 108.002 Name_____
Test 4
November 5, 2002 Grade _____

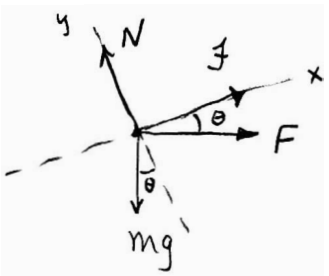
1. A 4-kg block rests on a 30^0 incline. The coefficient of static friction between the block and the incline is 0.30. How large a horizontal force must push on the block if the block is to be on the verge of sliding down the incline?

Figure



$\mu = 0.30$

Free Body Diagram on m



Theory

NSL on m

$\sum F_x = ma_x$

$f + F\cos\theta - mg\sin\theta = 0$

$\sum F_y = ma_y$

$N - F\sin\theta - mg\cos\theta = 0$

$N = F\sin\theta - mg\cos\theta$

$f = \mu N$

$\mu N + F\cos\theta - mg\sin\theta = 0$

$\mu[F\sin\theta - mg\cos\theta] + F\cos\theta - mg\sin\theta = 0$

$$F = \frac{mg[\sin\theta + \mu\cos\theta]}{\mu\sin\theta + \cos\theta}$$

Calculation

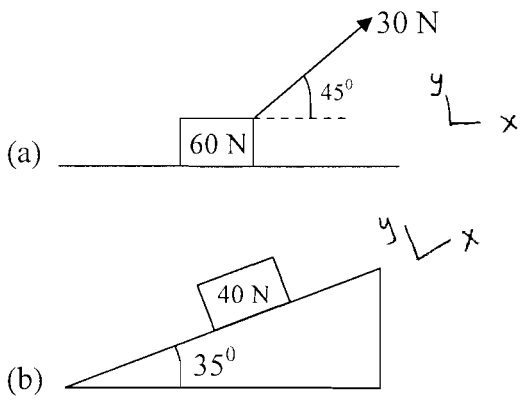
$$F = \frac{4\,kg(9.81\,m/s^2)[\sin 30^\circ + 0.3\cos 30^\circ]}{0.3\sin 30^\circ + \cos 30^\circ}$$

$F = 29.3\ N$

Answer 29.3 N

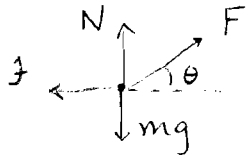
2. Find the normal force acting on the block in each of the equilibrium situations shown below.

Figure



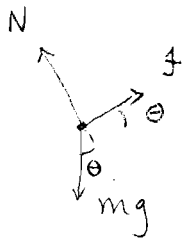
Free Body Diagrams

(a)



$F = 30\ N$
$\theta = 45°$
$mg = 60\ N$

(b)



$\theta = 35°$
$mg = 40\ N$

Theory

(a) NSL on m

$\Sigma F_y = ma_y$

$N - mg + F\sin\theta = 0$

$N = mg - F\sin\theta$

(b) NSL on m

$\Sigma F_y = ma_y$

$N - mg\cos\theta = 0$

$N = mg\cos\theta$

Calculation

(a) $N = 60\ N - 30\ N \sin 45°$

$N = 38.8\ N$

(b) $N = 40\ N \cos 35°$

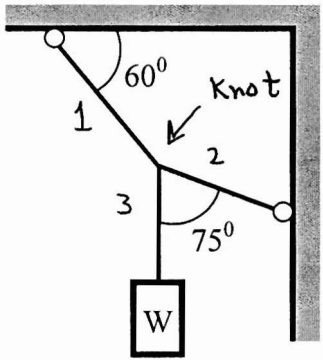
$N = 32.8\ N$

Answers (a) 38.8 N

(b) 32.8 N

3. For the equilibrium situation below the cords are strong enough to withstand a maximum tension of 100 N. What is the largest value of W that they can support as shown?

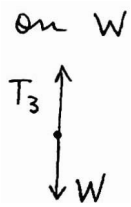
Figure

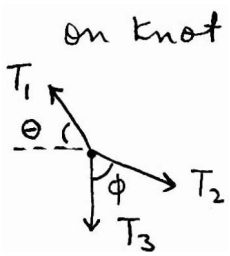


$\theta = 60°$

$\phi = 75°$

Free Body Diagrams





Theory

Assume $T_1 = 100\ N$

Find T_2 and T_3

NSL on W

$\Sigma F_y = ma_y$

$T_3 - W = 0$

$T_3 = W$

NSL on Knot

$\Sigma F_x = ma_x$

$T_2 \sin\phi - T_1 \cos\theta = 0$

$T_2 = \dfrac{T_1 \cos\theta}{\sin\phi} < 100\ N$ (Good)

$\Sigma F_y = ma_y$

$T_1 \sin\theta - T_2 \cos\phi - T_3 = 0$

$T_3 = T_1 \sin\theta - \left[\dfrac{T_1 \cos\theta}{\sin\phi}\right]\cos\phi$

Calculation

$W = T_3 = T_1 \sin\theta - \left[\dfrac{T_1 \cos\theta}{\sin\phi}\right]\cos\phi$

$W = 73.3\ N$

Answer 73.2 N