PHY 110 Spring 2018 Quiz 4 Solution

1. A 2 kg block slides down a rough 40° incline with constant speed. What is μ_k, the coefficient of kinetic friction between the block and the incline?

a) 0.54 b) 0.64 c) 0.74 **d) 0.84**

From sum of forces perpendicular to the incline, we find $N = mg\cos\theta$. *Since the block moves with constant speed, the acceleration down the slope is zero, so the sum of forces in that direction must also be zero.*

$$mg\sin\theta - \mu_k mg\cos\theta = 0 \quad \mu_k = \tan\theta = \tan(40°) = 0.84$$

2. A 5 kg block sits on a smooth horizontal surface. A rope is attached to the right side of the block and angled 30° above the horizontal. If the tension in the rope is 12 N, what is the acceleration of the block?

a) 1.57 m/s^2 **b) 2.08 m/s^2** c) 3.63 m/s^2 d) 4.19 m/s^2

$$+\rightarrow \sum F_x = P\cos\theta = ma_x \quad a_x = \frac{P\cos\theta}{m} = \frac{(12)\cos(30)}{5} = 2.08\frac{m}{s^2}$$

3. Now suppose that friction acts between the block and the surface in problem #2. What minimum value of μ_s, the coefficient of static friction, is required to keep the block from moving?

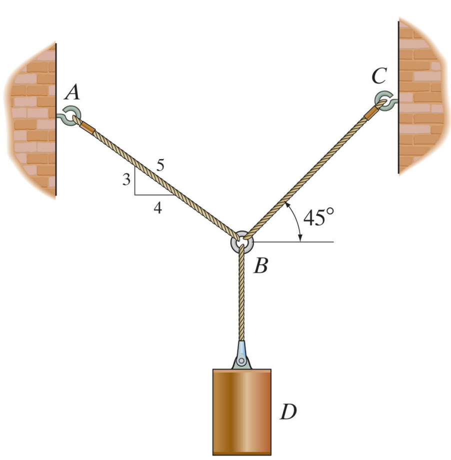
a) 0.241 b) 0.375 c) 0.466 d) 0.518

Now we have to solve the sum of forces in the vertical direction in order to find N, which we need to calculate the friction force.

$$+\uparrow \sum F_y = P\sin\theta + N - mg = 0 \quad N = mg - P\sin\theta$$

$$+\rightarrow \sum F_x = P\cos\theta - \mu_k N = 0$$

$$\mu_k = \frac{P\cos\theta}{N} = \frac{P\cos\theta}{mg - P\sin\theta} = \frac{12\cos(30)}{(5)(9.81) - 12\sin(30)} = 0.241$$



4. Assume that the cylinder at *D* has a mass of 60 kg and that the ring at *B* has negligible mass. Find the tension in cable *BA*.

a) 420 N b) 561 N c) 644 N d) 738 N

By inspection, the tension in cable BD is (60)(9.81).

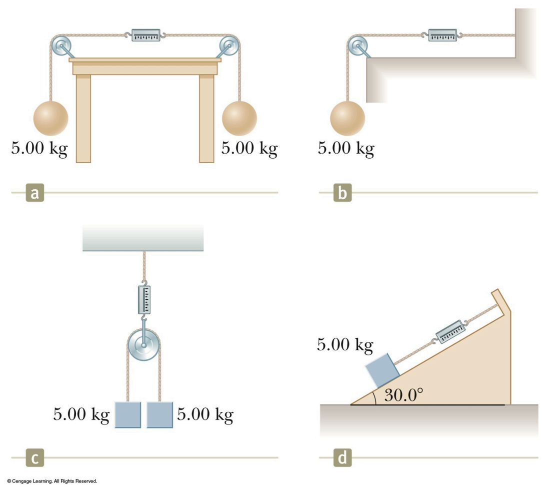
$$+\rightarrow \sum F_x = \frac{T_{BC}}{\sqrt{2}} - T_{BA}\left(\frac{4}{5}\right) = 0,\ so\ \frac{T_{BC}}{\sqrt{2}} = T_{BA}\left(\frac{4}{5}\right)$$

$$+\uparrow \sum F_y = \frac{T_{BC}}{\sqrt{2}} + T_{BA}\left(\frac{3}{5}\right) - mg = 0$$

$$T_{BA}\left(\frac{4}{5}\right) + T_{BA}\left(\frac{3}{5}\right) = (60)(9.81),\ so\ T_{BA} = \frac{5}{7}(60)(9.81) = 420\,N$$

5. In the figures below, assume no friction is present and that pulleys have no mass. Consider the readings on the spring scales in each figure and choose the true statement below.

a) Scale *c* has largest reading; *d* has smallest reading.
b) Scale *a* has largest reading; *b* has smallest reading.
c) Scale *c* has largest reading; *b* has smallest reading.
d) Scale *a* has largest reading; *d* has smallest reading.



The spring scale gives the tension in the string just as if the scale were replaced with a length of string. In case a, the scale reads the weight of a 5 kg mass, just as if one end of the scale were attached to a wall as in case b. The scale in case c shows the weight of 10 kg. The scale in case d shows only $mg\sin\theta$*, which is half the weight of a 5 kg mass.*

The acceleration due to gravity is 9.81 m/s^2 or 32.2 ft/s^2.
Newton's 2nd Law $\sum \vec{F} = m\vec{a}$
Static friction $f_s \le \mu_s N$
Kinetic friction $f_k = \mu_k N$