

~~3.9 Pushing a Book against the Wall.~~

~~You are holding a book against a vertical wall by pushing upwards with your hand. The angle between your force and the vertical is α ($< 90^\circ$). The mass of the book is m and the coefficient of static friction is μ . If you push too hard, the book will start to slide upwards, if you don't push hard enough, the book will slide down.~~

- ~~a) Draw "free-body" diagrams for these two cases when the book is just about to start sliding.~~
- ~~b) Calculate the magnitude of your force (as a function of α) to just prevent slipping, in both cases.~~
- ~~c) Calculate the force (as a function of α) for which the friction becomes zero. Evaluate your result for $\alpha = 0^\circ$ and 90° .~~
- ~~d) For what values of μ (as a function of α) is it impossible to make the book slide upwards?~~

~~3.10 Brain Teaser I – What's the Use of Wide Tires?~~

~~Race cars have very wide tires. The maximum frictional force exerted by the road on the tires only depends on the weight of the car and on the friction coefficient between the tires and the road; thus it is independent of the width of the tires (as demonstrated in lectures). Why then would race cars have wide tires? (This problem is from "The Flying Circus of Physics" by Earl Walker, John Wiley & Sons.)~~

~~3.11 Pushing a Box~~ page 154, problem 15.

~~3.12 Pulley and Incline~~ page 157, problem 43.

~~3.13 Sliding Stick Across Fingers – Lecture Demo.~~

~~Hold a yardstick horizontally on your index fingers and slide your fingers together smoothly. The stick slides first on one finger, then on the other and it keeps alternating. This was demonstrated in lectures. Try it for yourself, it's great fun! Why does this happen? (This problem is from "The Flying Circus of Physics" by Earl Walker, John Wiley & Sons.)~~

~~3.14 Spring Oscillations~~ page 157, problem 47.

~~Continue this problem:~~

~~We hang an object of mass 3 kg on the spring of problem 47, and we make it oscillate in vertical direction. Assume that the mass of the spring is negligibly small, and that $g = 10\text{m/s}^2$.~~

- ~~a) What is the angular frequency (in rad/sec)?~~
- ~~b) What is the period of the oscillations (in sec)?~~
- ~~c) What is the frequency (in Hz)?~~

~~3.15 Brain Teaser II – Not so Intuitive!~~

~~If you are standing at the equator at sunrise, where must you point a laser cannon to hit the sun dead center? The entire sun has just become visible above the horizon.~~

Reminder.

There are 26 recitation sections. If you want to change, for whatever reason, please go to the physics education office (4-352).

If you had NO apriori knowledge about the motion, there are three possibilities: 1) ~~m_1 is accelerated up-hill, 2) m_1 is accelerated down-hill, 3) there is NO acceleration; m_1 and m_2 stay put.~~ To decide, you now have to know the static friction coefficient. As derived in lectures:

~~1) will be the case if~~

$$m_2 g > m_1 g \sin \theta + \mu_s m_1 g \cos \theta \quad (3)$$

~~2) will be the case if~~

$$m_2 g < m_1 g \sin \theta - \mu_s m_1 g \cos \theta \quad (4)$$

~~3) will be the case if neither condition 1) nor condition 2) is met (the frictional force is then in general less than the maximum value possible). It could be directed in the $+x$ direction or the $-x$ direction, it could even be zero. Once you find that e.g. condition 1 is met, you can now proceed. However, you now know that the object is moving, the frictional force is therefore $\mu_k N$, and you proceed with eqs. (1) and (2). Since the author of this problem only gives you the kinetic friction coefficient, he is telling you in an indirect way that the acceleration will not be zero. You can now test for the direction of the acceleration, by using eqs. (3) and (4), replacing μ_s by μ_k , and you will conclude that indeed m_1 is being accelerated up-hill.~~

Problem 3.13

Let N_1 and \mathcal{F}_1 be the normal and frictional forces for one finger, and let N_2 and \mathcal{F}_2 be the normal and frictional forces for the other finger. The key to understanding this problem is to realize that the fraction of weight supported by each finger can be different. Clearly the finger closest to the center of the yardstick will bear a larger fraction of the weight and hence will exert a larger normal force on the yardstick.

Imagine starting each finger under a separate end of the yardstick. Initially each finger shares the weight equally, but as you attempt to move your fingers one of them, say finger 1, starts to slide. (To avoid sliding you would have to start with your fingers exactly the same distance from each end and move with exactly the same speed. Clearly human fingers are not capable of this. And the yardstick itself is too irregular for that precision.) Immediately after finger 1 slides, both fingers still share the weight equally ($N_1 = N_2$), but because the kinetic coefficient of friction is less than the static coefficient the friction on finger 2 is greater than the friction on finger 1 ($\mathcal{F}_2 = \mu_s N_2 > \mu_k N_1 = \mathcal{F}_1$). As finger 1 continues to slide in, it will bear more of the weight of the yardstick until N_1 is large enough that $\mathcal{F}_1 = \mu_k N_1 = \mu_s N_2 = \mathcal{F}_2$. As finger 1 moves in just a bit more, finger 2 will no longer be able to sustain the frictional force from 1, and hence finger 2 will move and finger 1 will stop. The whole procedure will begin again.

Problem 3.14

~~Let $k = 150$ N/m, and $L = 0.15$ m. To stretch the spring to twice the relaxed length L requires the force~~

$$F = k|2L - L| = kL = (150)(0.15) = 22.5 \text{ N}$$