Friday warm-up: Forces II

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1 Memory Bank

- $\vec{r} = r\cos(\omega t)\hat{i} + r\sin(\omega t)\hat{j}$ ... Position for uniform circular motion, with angular velocity ω.
- $\vec{F}_{\mathrm{C}} = -m\vec{r}\omega^2$ ... The centripetal acceleration given the speed v around a circular path r.
- $\vec{f} = -\mu N\hat{i}$ ... Force of friction in the horizontal direction, given a normal force N.

2 Forces, II

1. Consider the banking plane in Fig. 1. Suppose the mass of the plane is 10^4 kg. (a) If the lift force $\vec{L}$ has a magnitude of 1.02×10^5 N, what is the bank angle such that the plane flies level? (b) What is the centripetal force? (c) Note that the *period* T of circular motion is $T = 2\pi/\omega$. If T for the motion of the plane is 2 minutes, what is the radius r of the path?

2. Consider the parallel springs in Fig. 2. (a) If $k_1 = 15$ N m^{-1}, and $k_2 = 30$ N m^{-1}, what applied force will squeeze the springs by 5cm? (b) If instead the springs were connected *in series* (back to back), convince yourself that

$$k_1\Delta x_1 = k_2\Delta x_2 = k_{\mathrm{total}}\Delta x_{\mathrm{total}} \quad (1)$$

Since $\Delta x_{\mathrm{total}} = \Delta x_1 + \Delta x_2$, solve for k_{total}. What is the equivalent formula for k_{total} for the parallel springs?

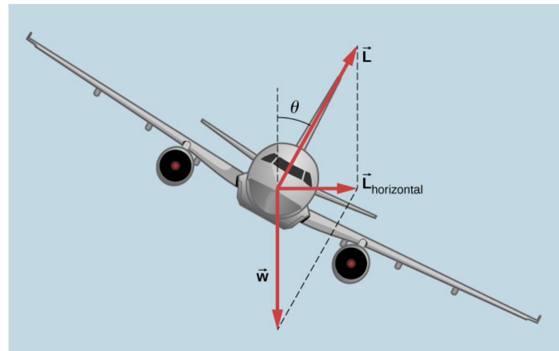

Figure 1: A plane banks during flight, with the forces of lift and weight resulting in a centripetal force.

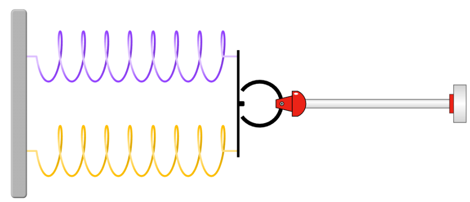

Figure 2: Two springs with k_1 and k_2, connected in parallel.

3. The force of friction is proportional to the normal force balancing the weight of a system. (a) Suppose the coefficient of kinetic friction *mu* between rubber and concrete is 0.7, and 0.35 if the pavement is wet. If the friction of sliding tires across pavement slows a vehicle from initial speed v_i to a final speed $v_f = 0$, what is the ratio of stopping distances? Assume the mass of the vehicle is m. (b) What is the stopping distance of a 2000 kg minivan on wet pavement, if $v_i = 100$ km per hour?