Midterm 2 for Calculus-Based Physics-1: Mechanics (PHYS150-01)

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1 Vectors and Newton's Laws

1.	Let $ec{F}_1=rac{3}{2}\hat{x}+2\hat{y}$ N, and $ec{F}_2=-2\hat{x}+$		Give the magnitude o	f each force.	b) What is the	net force? c)
	What is the angle between these two	forces?				

- 2. Imagine you are sitting in an airplane that has just lifted off with an acceleration vector 45 degrees with respect to horizontal. Draw a free-body diagram corresponding to you, showing all forces acting on you.
- 3. Imagine you are riding a skateboard down a hill. Draw a free-body diagram corresponding to you, showing all forces acting on you.

2 Newton's Laws, and Circular Motion

bank.png

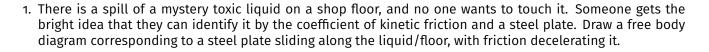
Figure 1: Let the weight be \vec{w} , and the total lift be \vec{L} , which may be be broken into two components: the turning force (equal to centripetal force $\vec{f}_{\rm C}$) and vertical lift (which balances weight).

- 1. When banking, the free-body diagram of a jet-fighter resembles Fig. ??. To bank while maintaining altitude, the lift force \vec{L} must both balance the weight \vec{w} and provide the centripetal force $\vec{f}_{\rm C}$. Let the mass of the aircraft be m, the radius of the turn be r, and the angle between \vec{L} and horizontal be θ .
 - Show that the angular velocity of the turn, ω , is $\omega = \sqrt{\frac{L\cos\theta}{rm}}$

• If ω is the angular velocity, then the *period* is $T=2\pi/\omega$. This is the time required to fly in a complete circle. Show that one-half period is $\frac{T}{2}=\pi\sqrt{\frac{rm}{L\cos\theta}}$. This is the time required to turn.

• Let $L=8\times 10^5$ N, $m=2\times 10^4$ kg, $r=\frac{1}{2}$ km, and $\theta=60$ degrees. How long does it take the jet fighter to turn?
What is the speed of the jet fighter?
- A: 10 m/s - B: 20 m/s - C: 100 m/s - D: 120 m/s

3 Frictional Forces



- 2. What is the coefficient of kinetic friction, μ_k , if a steel plate with an initial speed of 5 m/s comes to a stop after 2.5 seconds, assuming g=10 m/s²? (Use the definition of acceleration $\Delta v/\Delta t=a$).
 - 0.1
 - 0.2
 - 0.5
 - 1.2
- 3. Suppose they get a sample of the mystery liquid in a vile. They assume the drag force is given by Stoke's Law, $F_{\rm D}=6\pi r\eta v$, where v is the velocity of a particle moving through they fluid, r is the radius of the particle, and η is the viscosity. They drop a bead with r=1 mm and a mass of one gram into the fluid, and observe the bead sink with a constant (terminal) velocity of 1 m/s. What is the viscosity of the fluid? Units: kg/(m s).
 - $5/(3\pi)$ kg/(m s)
 - $5/(30\pi)$ kg/(m s)
 - 10 kg/(m s)
 - 5 kg/(m s)