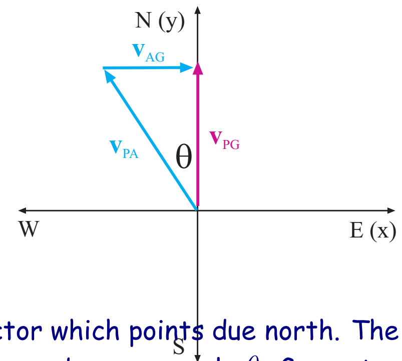
Name________________________

Mar. 15, 2006

Quiz #3 — Spring 2006

Phys 2110

1. A plane has an airspeed (speed *with respect to the air*) of 95.7 mph. The pilot wishes to fly due north, but a wind is blowing at 50 mph toward the east.



a) In what direction must the pilot head the plane in order to go in the desired direction? (You may want to use the space at the right to draw some vectors to help in your answer...)

The figure shows the vectors for the plane's velocity wrt the wind and the wind's velocity wrt the earth. They add up to give a vector which points due north. The plane's heading must point in a direction somewhat west of due north, say by some angle θ. Geometry gives

$$\sin\theta = \frac{(50.0 \text{ mph})}{(95.7 \text{ mph})} \qquad \Longrightarrow \qquad \theta = 31.5^\circ$$

so the plane should head in a direction $\boxed{31.5^\circ}$ west of north.

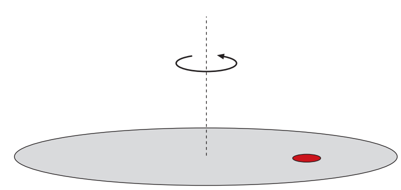
b) If the plane is given the heading you found in (a), what is its speed with respect to the ground?

The velocity of the plane wrt the ground has magnitude

$$v_{pg} = (95.7 \text{ mph})\cos\theta = 81.6 \text{ mph}$$

This is the plane's speed as seen by people on the ground.

2. A coin of mass 5.70 g rests on a turntable which is turning at 50 rpm. It is 10.0 cm from the center.



a) What is the speed of the coin?

The circumference of the circular path of the coin is

$$C = 2\pi(0.10 \text{ m}) = 0.628 \text{ m}$$

In each minute the coin moves 50 times this length (since it makes 50 revolutions) hence its speed is

$$v = \frac{50(0.628 \text{ m})}{(60.0 \text{ s})} = 0.524\tfrac{\text{m}}{\text{s}}$$

(There are other ways to get this answer.)

b) What is the magnitude and direction of the net force on the coin?

The coin moves in a circle with constant speed. The net force on it points *toward the center of the circle* and has magnitude

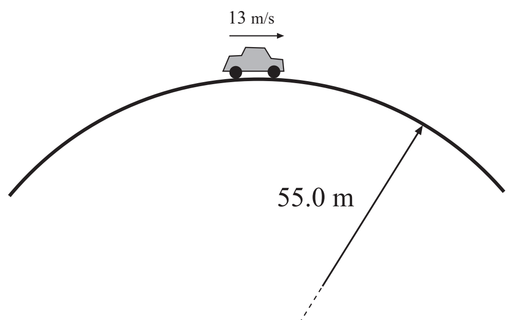
$$F_r = \frac{mv^2}{r} = \frac{(0.00570\ \mathrm{kg})(0.524\frac{\mathrm{m}}{\mathrm{s}})^2}{(0.10\ \mathrm{m})} = 1.56 \times 10^{-2}\ \mathrm{N}$$

c) (Still referring to the coin on the turntable:) Where does this force come from?

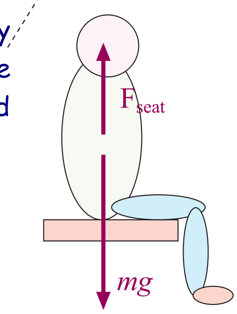
It is the force of static friction pointing toward the center of the circle that makes the coin move in a circular path.

3. You are in a car which going over the top of a hill at a constant speed of $13.0\frac{\mathrm{m}}{\mathrm{s}}$. The hill has a radius of curvature of 55.0 m.

Suppose you have a mass of 75 kg. Find your *apparent* weight at the top of the hill. (Recall that your apparent weight is the force that the seat exerts upward on *you*.)



the forces acting on you at the top of the hill are shown at the right; gravity mg down, the force of the seat up. The net force points toward the center of the circular path (downward) and has magnitude mv^2/R. So adding up the downward force, get:



$$mg - F_{\mathrm{seat}} = \frac{mv^2}{R} \qquad \Longrightarrow \qquad F_{\mathrm{seat}} = mg - \frac{mv^2}{R}$$

Plug in the numbers:

$$F_{\mathrm{seat}} = (75\ \mathrm{kg})(9.8\frac{\mathrm{m}}{\mathrm{s}^2}) - \frac{(75\ \mathrm{kg})(13\frac{\mathrm{m}}{\mathrm{s}})^2}{(55\ \mathrm{m})} = 505\ \mathrm{N}$$

You must show all your work and include the right units with your answers!

$$\mathbf{F}_{\mathrm{net}} = m\mathbf{a} \qquad f_{\mathrm{s,\,max}} = \mu_{\mathrm{s}} n \qquad f_{\mathrm{k}} = \mu_{\mathrm{k}} n \qquad \mathbf{v}_{AC} = \mathbf{v}_{AB} + \mathbf{v}_{BC}$$

$$s = \theta r \qquad v = \frac{2\pi r}{T} \qquad v_t = \omega r \qquad a_t = r\alpha$$

$$a_r = \frac{v_t^2}{r} = \omega^2 r \qquad a_t = \frac{dv_t}{dt} \qquad F_r = \frac{mv_t^2}{r} \qquad F_t = m\frac{dv_t}{dt}$$

$$\omega_f = \omega_i + \alpha\Delta t \qquad \theta_f = \theta_i + \omega_i \Delta t + \tfrac{1}{2}\alpha(\Delta t)^2 \qquad \omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$$

$$\mathbf{F}_{\mathrm{A\ on\ B}} = -\mathbf{F}_{\mathrm{B\ on\ A}} \qquad \mathbf{p} = m\mathbf{v} \qquad \mathbf{P} = \sum_i \mathbf{p}_i \quad \text{is conserved for isolated system}$$