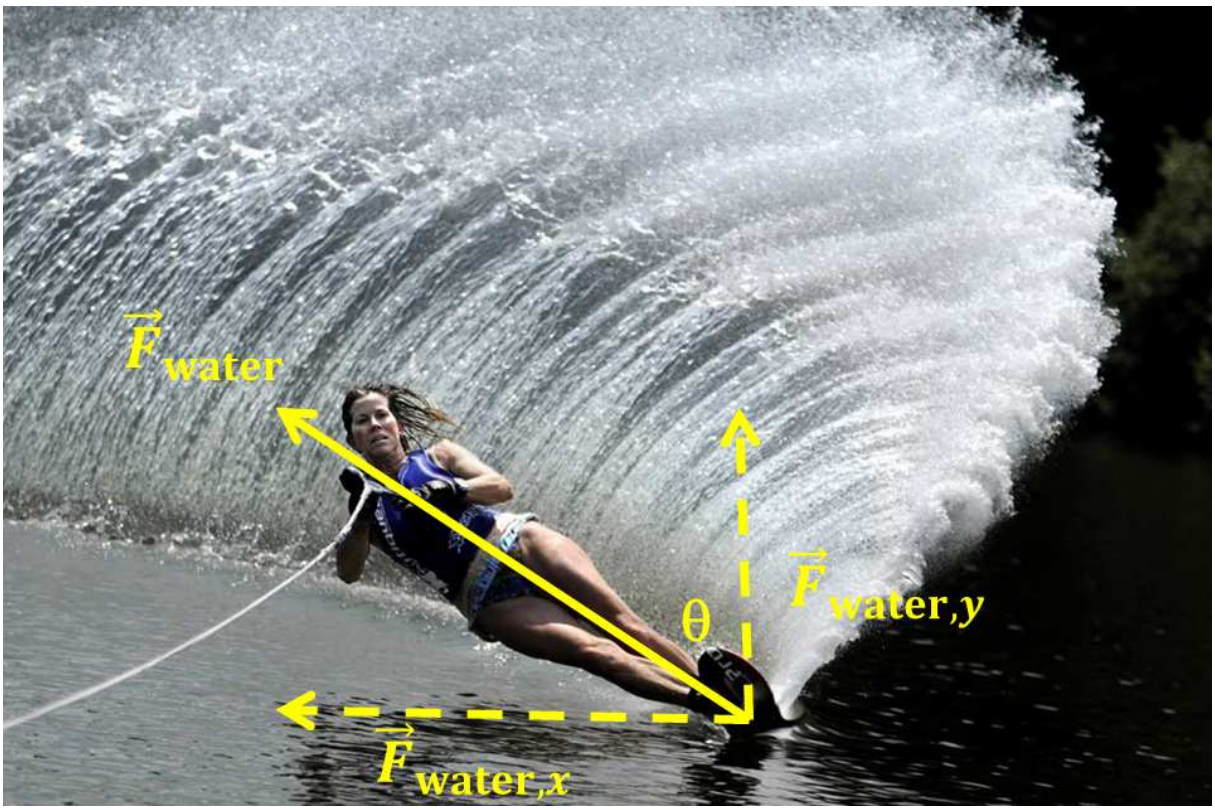
Problem Set #6
Physics 131

28 September 2022

1. I pilfered an image of a water skier from the internet (see below). The path of water behind her clearly shows that she is moving in a circular path. Assume her speed is constant just before and just after the photo was taken. The rope is in the direction of the her velocity and perpendicular to her lean direction. The rope's tension (as well as air resistance) thus acts perpendicular to the plane formed by the components of the water's force on the skier (see below). Besides a force from the water, the skier has a weight force (not shown).



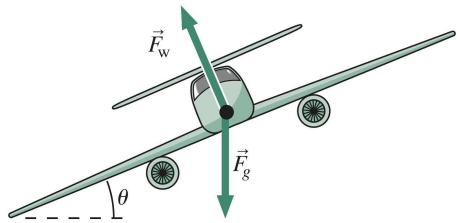
   (a) Make a free-body diagram of the skier that shows only the forces in the plane shown in the above figure. That means that rope tension and air resistance will *not* be on your free-body diagram.

   (b) In which direction does the net force in the plane of interest point? In which direction in that plane does the acceleration point?

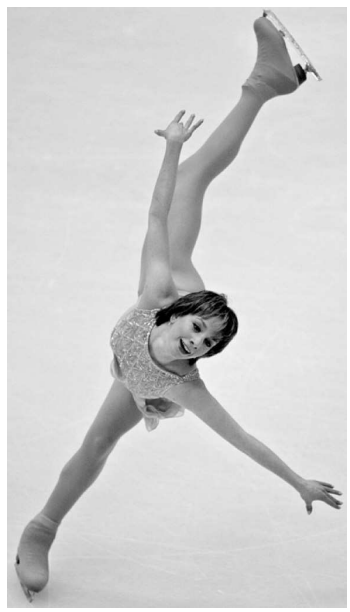
   (c) Set up Newton's second law and determine the magnitude of the skier's centripetal acceleration. You will need to determine the angle θ using a protractor. I've not given you the skier's mass because you don't need it here.

   (d) Suppose the radius of the skier's circle was 65 ft. Determine the skier's speed in both ft/s and mph.

2. When a plane turns, it banks as shown in the figure below so as to give the wings' lifting force, $\vec{F}_w$, a horizontal component that turns the plane. If a plane is flying level at 950 kph and the banking angle is not to exceed 40°, what's the minimum curvature radius for the turn?



3. A *spiral* is an ice-skating position in which the skater glides on one foot with the other held above the hip level. It's a required element in women's singles figure skating competition and is related to the arabesque performed in ballet. The figure below shows skater Sarah Hughes executing a spiral during her gold-medal performance at the 2002 Winter Olympics in Salt Lake City.



Circle the correct answer for each of the four questions below. Show me a little work on the last one to justify your answer.

(a) From the photo, you can conclude that the skater is

A. executing a turn to her left.
B. executing a turn to her right.
C. moving in a straight line out of the page.

(b) The net force on the skater

A. points to her left.
B. points to her right.
C. is zero.

(c) If the skater were to execute the same maneuver but at higher speed, the tilt evident in the photo would be

A. less.

B. greater.

C. unchanged.

(d) The tilt angle θ that the skater's body makes with the vertical is given approximately by $\theta = \tan^{-1}(0.5)$. From this you can conclude that the skater's centripetal acceleration has approximate magnitude

A. $0\,\mathrm{m/s^2}$.

B. $0.5\,\mathrm{m/s^2}$.

C. $5\,\mathrm{m/s^2}$.

D. that can't be determined without knowing the skater's speed.

Due date: **5 October 2022** (*beginning of class*)