## 1. Two students, Alan and Beth, ride a “Tilt-a-Whirl,” which is essentially a spinning platform whose rotation axis is tilted with respect to vertical. (See side view diagram below.) At the instant shown, the platform spins at a constant rate.


### At the instant shown, for whom is the local acceleration due to gravity larger in magnitude: for *Alan,* for *Beth,* or is it *the same magnitude for both?* Explain your reasoning in words and with one or more diagrams.

2. A single fuzzy die is suspended from a string tied to the rear view mirror of a car. (There had been two fuzzy dice at one time, but the string for the other die broke.)



The car travels at constant speed *vo* on a flat, circular track at a distance *D* from the center of the track.

A. Draw free-body diagrams for the fuzzy die (a) in the frame of the *ground* and (b) in the frame of the *car.* Draw your diagrams so that they correspond to the instant shown in the pictures above. Clearly label all forces, including fictitious “forces.”

B. In the car frame, how, if at all, does the *local* acceleration due to gravity *(g′)* differ from the *actual* acceleration due to gravity *(g)?* Discuss both magnitude and direction. Explain your reasoning.

C. The driver’s coffee cup, which is partially full, is in a cup holder that prevents it from spilling. In terms of the given quantities, determine the angle ** that the surface of the liquid in the cup makes with horizontal. Show all work.

3. A car travels along a circular track of radius *D* that is banked at an angle  with respect to horizontal. The car moves with constant speed *vo* relative to the track. A single fuzzy die (*not* shown in the diagrams below) is suspended from a string tied to the rear view mirror of the car. (Originally there were two fuzzy dice, but the string for the other die broke some time ago.)

*Note:* In answering all parts of this problem, ignore the rotation of the Earth.

A. Draw free-body diagrams for the fuzzy die (a) in the frame of the *ground* and (b) in the frame of the *car.* Draw your diagrams so that they correspond to the instant shown in the pictures above. Clearly label all forces, including fictitious “forces.”

B. In the frame of the car, is the magnitude of the local acceleration due to gravity *greater than, less than,* or *equal to* that of the actual acceleration due to gravity? Explain how you can tell.

C. The driver’s coffee cup, which is partially full, is in a cup holder that prevents it from spilling. The driver observes that the surface of the liquid in the cup is parallel to the floor of the car.

In terms of the given quantities, determine an expression for the angle ** that the banked track makes with horizontal. Show all work.