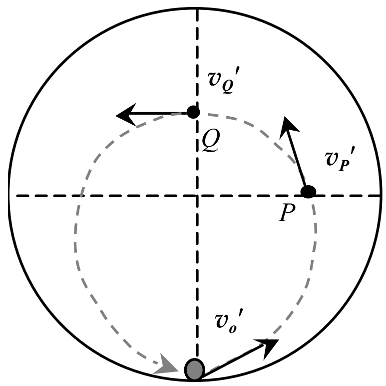
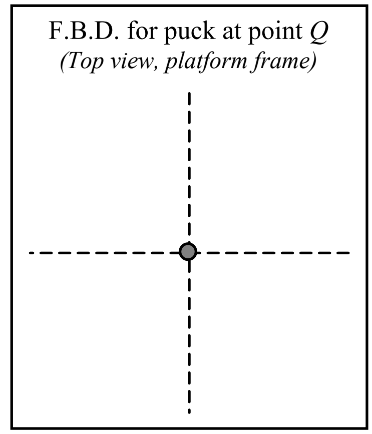
1. A level, frictionless platform spins at a *constant* rate in an *unknown* direction relative to an inertial frame of reference. A puck is launched from the edge of the platform. As measured in the platform frame, the puck follows the curved path shown and eventually returns to the same location at which it was launched.

   a. In the space provided, indicate the directions *and* relative magnitudes of (i) the centrifugal "force" and (ii) the Coriolis "force" experienced by the puck at point *Q*. Explain how you can tell.

Top view in *platform* frame





   b. Is the platform spinning *clockwise* or *counter-clockwise* relative to an inertial frame? Explain how you can tell.

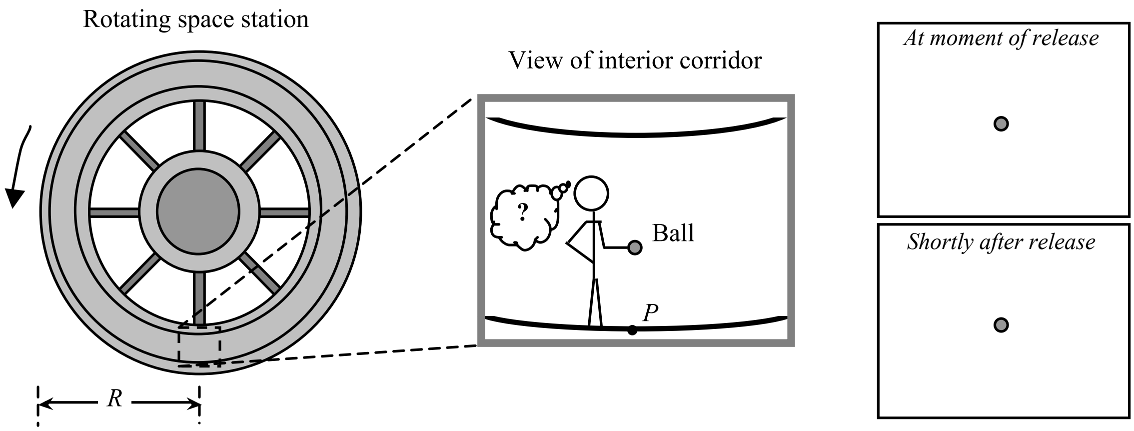
   c. When the puck passes through point *P,* is the puck moving with *increasing speed, decreasing speed,* or *constant speed* as observed in the platform frame? Explain how you know.

      How, if at all, would your above answer about the motion of the puck at point *P* change if instead you were to consider the lab frame (*i.e.,* an inertial frame)? Explain how you know.

2. A pebble is dropped from the top of an empty elevator shaft inside the Empire State Building. The point of release is directly above a point *P* marked on the floor at the bottom of the shaft.

   Taking the rotational motion of the Earth into account, consider any westward or eastward deflection of the pebble as it falls. That is, would the pebble land *slightly west of point P, slightly east of point P,* or *neither?* Explain your reasoning *without* performing any calculations. Draw one or more diagrams to illustrate your thinking.

3. Consider a space station of radius R in deep space that rotates at a constant angular speed ω. The inhabitants of the space station experience a simulated "gravity."



a. If the simulated "gravity" is equal to $0.5g$ and the distance R between the hub of the space station and the floor of the interior corridor is 250 m, determine ω in rad/sec. Show all work, and explain which fictitious "force" gives rise to this simulated "gravity."

b. Suppose that someone inside the station held a small ball directly above a point P marked on the floor of the corridor and released the ball. (See interior view shown above.)

In the spaces provided above, draw free-body diagrams (including fictitious "forces") for the ball (i) at the moment of release, and (ii) at a moment shortly after release.

c. On the basis of your results, would the ball hit the floor *to the left of, to the right of,* or *directly at* point *P?* Explain.

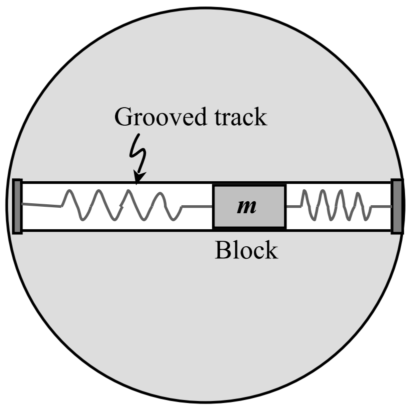
How, if at all, would your answer be different if the space station were rotating in the opposite direction? Explain.

d. On the basis of your results above, if a different space station were designed so that the simulated "gravity" were equal to $1.0g$, would the simulated "gravity" be indistinguishable from the gravitational field experienced on the Earth's surface? Explain.

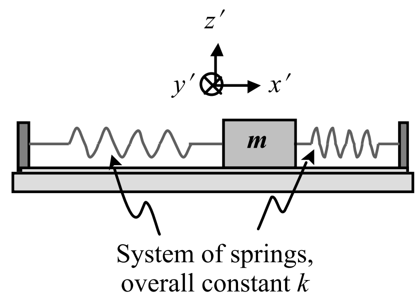
4. A smooth block of mass m is placed on a grooved track that is attached onto a circular platform. The track is parallel to the x'-axis of a coordinate system that remains fixed to the platform. Identical (massless) springs are used to connect the block to each end of the track; let k denote the overall spring constant of the system of springs. (Ignore all effects due to friction.)

   The platform is made to spin at a constant angular velocity $\omega_p \hat{k}'$. As observed in the platform frame, the block is released from rest at a location $x'_o = +A_o$.

Top view in platform frame
(shortly after release)



Side view in platform frame
(shortly after release)



a. i. There exists a range of values for ω_P for which the block undergoes *simple harmonic motion* along the x'-axis, as viewed in the platform frame. Determine this range of values for ω_P. Explain your reasoning and show all work.

   (*Hint:* Remember, the block moves only along the x'-axis. You may find it helpful to draw an appropriate free-body diagram for the block.)

   ii. For a case in which the block undergoes simple harmonic motion, determine an expression (in terms of ω_P and the given quantities) for the period of oscillation of the block. Show all work.

b. The grooved track must continually exert a (normal) force on the block in order to keep it in the track. This force attains a <u>maximum</u> value at certain times during the motion.

   Consider the instant when the force by the track <u>first</u> attains this maximum value after the block is released. For that instant, (i) determine the *magnitude* of that force in terms of the given quantities, and (ii) describe the *direction* of the force in terms of the platform coordinate system. Show all work.

c. Under what conditions, if any, does the rotation of the platform cause the block to remain *at rest in the frame of the platform?* Explain your reasoning and show all work.

