Set #1 - for Wednesday January 15

Read RHK Ch. 8; Ch. 9: 9.1-9.3; Ch. 10: 10.1, 10.2
K&K Ch. 6: 6.1-6.4; Ch. 7: 7.1, 7.2 (to p. 292); Note 7.1 (p.326); Ch. 8: 8.5 (to p. 361); Note 8.2 (p.371)

"Read" covers this and next week lecture material

Solve

From RHK **Ch. 8** Exercises 9, 24, 33; Problems 1, 4, 9, 10, 13

From K&K **Ch. 2** Problem 2.33
Ch. 8 Problems 8.8, 8.9

Problem 1. In Note 7.1 in K&K, we started out with a vector $\vec{r}$ directed along the positive x-axis and it was rotated first by an angle $\hat{k}\Delta\theta_z$ about the z-axis and next by an angle $\hat{j}\Delta\theta_y$ about the y-axis. We got the rotated vector

$$\vec{r}_{12} = \hat{i}\cdot r\cos\Delta\theta_z\cos\Delta\theta_y + \hat{j}\cdot r\sin\Delta\theta_z - \hat{k}\cdot r\cos\Delta\theta_z\sin\Delta\theta_y$$

a) Show that if we change the order of these rotations, that is, first rotate about the y-axis and next about the z-axis, we get the new rotated vector

$$\vec{r}_{21} = \hat{i}\cdot r\cos\Delta\theta_y\cos\Delta\theta_z + \hat{j}\cdot r\cos\Delta\theta_y\sin\Delta\theta_z - \hat{k}\cdot r\sin\Delta\theta_y.$$

b) Show that $\vec{r}_{21} = \vec{r}_{12}$ if the rotation angles are very small.

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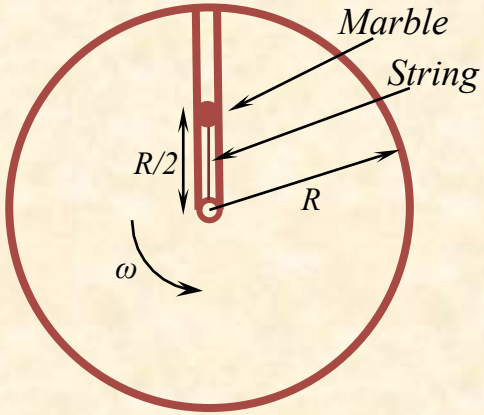
Problem 2. A disc of radius R rotates about a vertical axis passing through the center of the disc and perpendicular to the plane of the disc. The disc rotates with constant angular velocity ω. A small marble can glide radially along a groove carved on the disc. The marble is kept at rest (relative to the disc) at the midpoint of the groove and by means of a string attached to the center of the disc, as shown in the figure below.

a) Find the tension in the string.

b) Suddenly the string breaks. Find the velocity of the marble, relative to the disc, when it reaches the rim. Neglect friction.

c) After the string breaks, find the magnitude and direction of the force that the wall of the groove exerts on the marble.



Problem 3. A bullet leaves the barrel of a rifle with a speed of 300 m/s and moves up along the vertical axis. The shot is made at the latitude of 60° N. Determine how far in the direction to East or to West will the bullet land. Solve the problem in the Earth frame.

Clarification: Vertical orientation of the rifle is tuned using hanging weight.

Good luck, Dr. B