Physics 161, Homework 10

Due 12:00 pm, Monday, May 12; No Exceptions

Lubna Rana, Sections 0201-0206

Read Chapter 11, Sections 11.1-11.5 Make sure you do <u>all</u> the example problems in the chapter.

Short Answer Questions S1, S2, S3 ; Problems P1, P2, P3, P4, P5, P6, P7

Special Note: Please always:

1). PRINT your name and SECTION NUMBER CLEARLY on the front page of your HW. <u>Failure to do so will now cost you points.</u>

2). STAPLE all your pages. It is <u>your responsibility</u> to make sure that your hw gets submitted in one piece.

3). DO ALL THE PROBLEMS IN ORDER.

4). Show <u>complete work and write logically consistent explanations</u> for all questions and problems to receive credit.

5). Write units next to all dimensionful quantities.

Short Answer Questions:

S1). A penguin of mass m falls from rest at point A, a horizontal distance d from the origin as shown.

a). Find an expression for the angular momentum of the falling penguin about O.

b). What torque does the weight mg acting on the penguin exert about the origin?

c). Is the angular momentum of the penguin about point O constant? Should it be?

d). Answer parts (a) and (b) for the case where the torque and the angular momentum are measured with respect to point A.

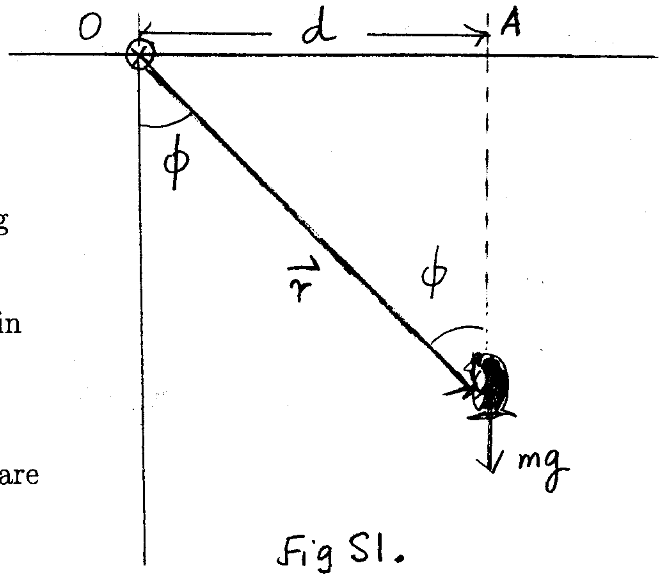


Fig S1.

S2). A cockroach rides the rim of a disk rotating counterclockwise. If it then walks along the rim in the direction of the rotation, will the following increase, decrease or remain the same?

(a) the angular momentum of the cockroach-disk system; (b) the angular momentum and the angular velocity of the cockroach; (c) the angular momentum and the angular velocity of the disk? (d). What are your answers if the cockroach walks in the opposite direction?

S3). A particle with mass m has position vector $\vec{r}$ ($r = 3m$) and velocity $\vec{v}$ ($v = 4m/s$) as shown in Fig S4. It is acted on by a force $\vec{F}$ ($F = 2N$).

a). Rewrite $\vec{r}$, $\vec{v}$ and $\vec{F}$ in terms of unit vectors $\hat{\imath}$ and $\hat{\jmath}$.

b). Using your result from above calculate $\vec{L} = \vec{r} \times \vec{p}$ and $\vec{\tau} = \vec{r} \times \vec{F}$ about the origin.

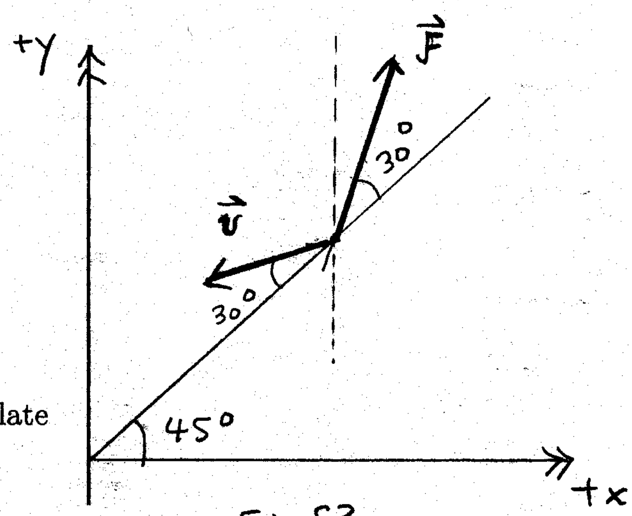


Fig S3.

Problems:

P1). *Serway & Beichner, Chpater 10, Problem 39*

P2). *Serway & Beichner, Chapter 11, Problem 4*

P3). After being given an initial push, a marble rolls without slipping up along a plane inclined at an angle θ. The marble has a mass M and radius R.

a). What is the acceleration (magnitude and direction) of the marble's center of mass?

b). If the mass of the marble were larger, would this acceleration be larger, smaller or the same? If the radius of the marble were larger, would this acceleration be larger smaller or the same?

c). What is the friction force, (magnitude and direction) exerted on the marble by the inclined plane?

P4). *Serway & Beichner, Chapter 11, Problem 60*

P5). *Serway & Beichner, Chapter 11, Problem 63*

P6). A playground ride consists of a disk of mass M and radius R mounted on a low friction axle. A kid of mass m runs at speed v_0 on a line tangential to the disk and jumps onto the outer edge of the disk.

a). If the disk was initially at rest, now how fast is it rotating?

b). If you were to calculate the initial and final kinetic energies of the kid-ride system, would they be equal. If yes then why and if not then account for the missing or extra energy?

c). Calculate the change in the *linear* momentum of the kid-ride system but not including the axle. What caused this change?

d). The kid moves to a location a distance $R/2$ from the axle. Now what is the angular speed?

e). If you were to calculate the initial and final kinetic energies in part (d), would they be equal? If yes then why and if not then account for the missing or extra energy.

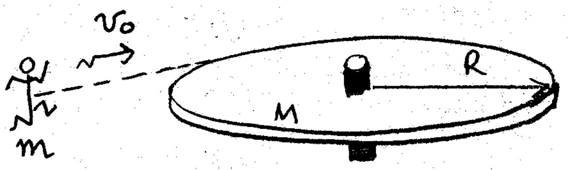
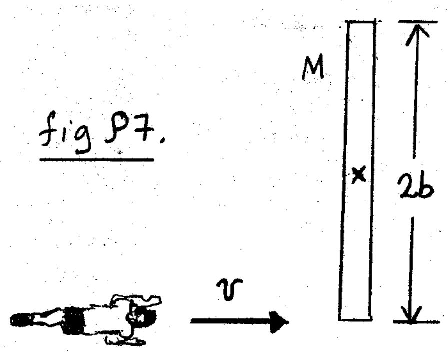


Fig P6.

fig P7.



P7). Consider a system that consists of a student ($m = 70kg$) and a plank. The plank is uniform and narrow, with a length $2b = 5m$ and a mass $M = 50kg$. Initially, the plank is at rest on a frictionless horizontal surface. The student runs toward the plank in a direction at right angles to its length with a velocity $v = 3m/s$, then jumps onto the end.

(a). Determine the position of the plank a time $1.2s$ later. **Please do not plug in numbers until you have reached a reasonable point at each stage of the problem.**

(b). Draw the trajectory of the center of mass before and after the student jumps onto the plank.

Hint: S & B Example problem 11.11, pg 344 is quite similar. One difference is that in Ex. 11.11, the collision is elastic, whereas, here, the student and the plank stick together so the collision is inelastic.