Announcements

- Homework 7 due on Monday!
- CompDay 8 on orbits on Monday
- Fun fact: this lecture was my last in-person lecture last Spring before we went fully remote for Covid...
- Responses: `rembold-class.ddns.net`

Today's Objectives

- To gain some understanding of the basic properties of central forces
- To follow how we can reduce 6 needed coordinates much less
- To understand how to look at the energies of central force problems

Q1

A conservative central force has all of the following properties except one. Which is the odd one out?

A) It is spherically symmetric
B) Its magnitude depends only on the distance to some "center"
C) It points toward some "center"
D) Its corresponding potential energy depends only on the distance to some "center"

Q2

2 particles exerting a conservative central force on one another in three dimensions means we are starting with needing 6 generalized coordinates. Looking at things in the center of mass frame reduces this number of needed coordinates to:

A) 1
B) 2
C) 3
D) 4

Q3

Why are we safe to look at the problem from the center of mass frame?

A) Because $\dfrac{\partial \mathcal{L}}{\partial \vec{\mathbf{R}}} = 0$

B) Because $\dfrac{\partial \mathcal{L}}{\partial \dot{\vec{\mathbf{R}}}} = 0$

C) Because $\dfrac{\partial \mathcal{L}}{\partial \vec{\boldsymbol{r}}} = 0$

D) Because $\dfrac{\partial \mathcal{L}}{\partial \dot{\vec{\boldsymbol{r}}}} = 0$

Q4

In order to further simplify the problem, we need to look at the total angular momentum of the system. What condition does *not* need to be true to allow us to determine that the orbital motion must take place in a single plane?

A) We must have placed our origin at the center of mass

B) We must have no outside torques acting on the system

C) We must have $\vec{r}$ and $\dot{\vec{r}}$ pointing in the same direction

D) We must have the angular momentum conserved

Q5

The potential energy of a coulombic force is given by:

$$U = k\frac{q_1 q_2}{r}$$

What is the equation of motion for the separation between an electron with charge $-e$ and a proton with charge e, if they have an initial angular momentum of ℓ with respect to the center of mass?

A) $\ddot{r} = \dfrac{\ell^2}{\mu^2 r^3} - k\dfrac{e^2}{\mu r^2}$

B) $\ddot{r} = \dfrac{\ell^2}{\mu r^3} - k\dfrac{e^2}{r^2}$

C) $\ddot{r} = \dfrac{\ell}{\mu r} + k\dfrac{e^2}{\mu r^2}$

D) $\ddot{r} = \dfrac{\ell}{r} + k\dfrac{e^2}{r^2}$

Q6

Which plot of the effective potential energies to the right depicts the orbit with the greatest angular momentum?

A)

B)

C)

D)