

Physics 2211 GPS Week 12

Problem #1

Consider a system consisting of two particles connected by a spring of negligible mass:

$m_1 = 5$ kg, vector $\vec{v}_1 = \langle 5, -10, 15 \rangle$ m/s

$m_2 = 10$ kg, vector $\vec{v}_2 = \langle -10, 0, -5 \rangle$ m/s

(a) What is the total momentum \vec{p}_{total} of this system?

(b) What is \vec{V}_{CM} , the velocity of the center of mass of this system?

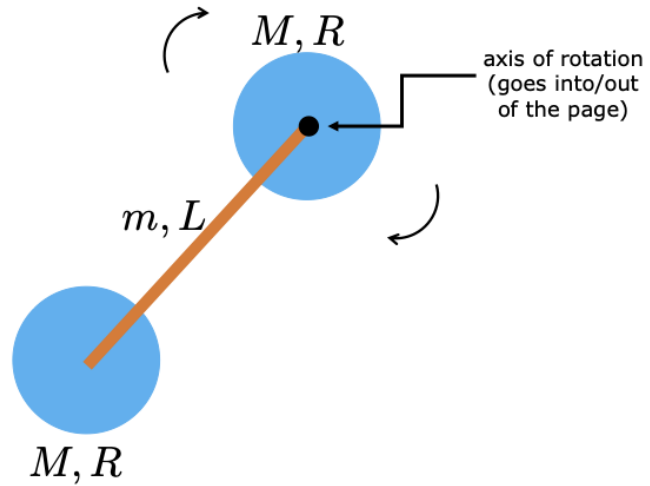
(c) What is K_{trans} , the translational kinetic energy of this system?

(d) What is K_{total} , the total kinetic energy of this system?

(e) What is K_{rel} , the kinetic energy of this system relative to the center of mass?

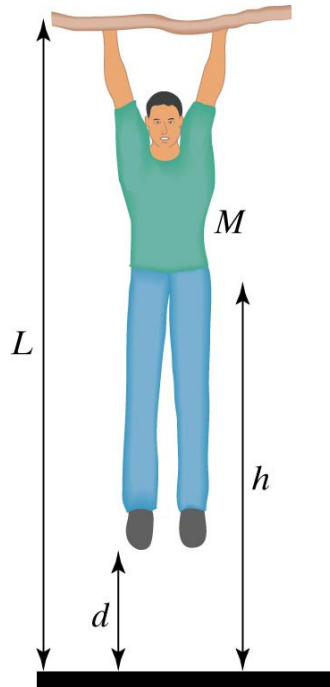
Problem #2

A barbell is made up of two solid spheres of mass M and radius R whose centers are attached to the ends of a thin rod that has mass m and length L . The entire thing rotates about an axis that goes through the center of sphere 1. Determine the total moment of inertia of the barbell about this axis of rotation. Hint: remember the parallel axis theorem.



Problem #3

You hang by your hands from a tree limb that is a height $L = 6$ m above the ground, with your center of mass a height $h = 5$ m above the ground and your feet a height $d = 4$ m above the ground, as shown in the figure (not to scale). You then let yourself fall. You absorb the shock by bending your knees, ending up momentarily at rest in a crouched position with your center of mass a height $b = 0.25$ m above the ground. Your mass is $M = 110$ kg. Hint: this problem is like the lemur problem from the homework, but backwards.



- (a) Starting from the energy principle, find your speed just before your feet touch the ground.

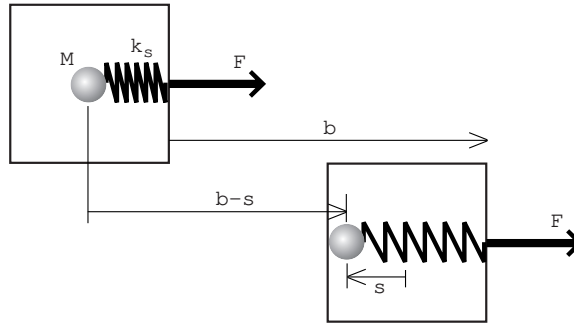
(b) Starting from the energy principle (point particle model) and assuming that the contact force of the ground on your feet is constant, find the magnitude of the contact force during your landing.

(c) What is the (real) work done by the contact force?

(d) Starting from the energy principle (real model), find the change in your internal energy during landing.

Problem #4

A thin box in outer space contains a large ball of clay of mass M , connected to an initially relaxed spring of stiffness k_s . The mass of the box is negligible compared to M . The apparatus is initially at rest. Then a force of constant magnitude F is applied to the box. When the box has moved a distance b , the clay makes contact with the left side of the box and sticks there, with the spring stretched an amount s . See the diagram for distances.



(a) Immediately after the clay sticks to the box, how fast is the box moving?

(b) What is the increase in thermal energy of the clay?