HW 3

Due May 27, 2009 in recitation

Please answer all questions clearly and concisely. While you need not transcribe the question completely, it should be clear from your answer alone what you are talking about.

You are strongly encouraged to discuss the homework with your classmates, but you must complete the written homework by yourself, and of course, the material you submit must be your own.

Remember, show all of your work!

1. A particular system has a potential energy of the form:

$$U(x) = -x^2 e^{-x^2}$$

where x is given in meters, and U is given in Joules.

   (a) Using whatever program you like (or freehand), please sketch the energy diagram.

   (b) In what range of x is the for attractive?

   (c) Are there any equilibrium points? Stable or unstable? (Please justify)

   (d) At some moment, you have a particle at $x = 1$, and you give it 0.2J of kinetic energy. What is the total mechanical energy of the particle?

   (e) If the particle is bound, what is the maximum possible distance that it can get from the origin?

2. Consider 3 isolated particles, with mass, $m_1 = 1kg$, $m_2 = 2kg$, $m_3 = 3kg$, with initial positions at:

$$\begin{aligned} \vec{r}_1(0) &= 2m\hat{i} - 4m\hat{j} \\ \vec{r}_2(0) &= 2m\hat{i} + 2m\hat{j} \\ \vec{r}_3(0) &= -4m\hat{i} \end{aligned}$$

and

$$\begin{aligned} \vec{v}_1 &= 10m/s\hat{i} \\ \vec{v}_2 &= -8m/s\hat{i} + 6m/s\hat{j} \\ \vec{v}_3 &= 0 \end{aligned}$$

   (a) Where is the center of mass at $t = 0$?

   (b) What is the total momentum of the system?

   (c) What is the total kinetic energy of the particles?

   (d) Where is the center of mass at $t = 2s$?

(over)

(e) Suppose at some time, the particles bounce around a bit, and at the end of the collision, particles 1 & 2 are stuck together, and fly off with a velocity of $\vec{v}_{12} = 4m/s\hat{i}$. If the "collision" took 0.1s, what is the force on particle 1 during the collision?

(f) What is the resulting velocity for particle 3 after the collision?

(g) What is the total kinetic energy of the particles after the collision? Is the collision elastic or inelastic?

3. A 20kg is moving in the x-direction with a speed of 10m/s. It elastically collides into a 10 kg mass initially at rest.

(a) What is the speed of te 10kg mass after the collision?

(b) Suppose the 10kg mass subsequently collides elastically with a 5kg mass. What is the speed of the 5 kg mass?