Physics 172 – Recitation 04

Spring 2012

As you work on today's problems remember that every time you use a fundamental principle you must explain clearly what physical system you are applying the principle to and which objects in the system's surroundings are interacting significantly with it.

Problem 1. Jack is pulling straight up on a thin rope attached to a bucket to lift some hand tools up to the roof where he is making repairs. The mass of the pail is 2 kg, and the total mass of the tools it contains is 8 kg.

a) At the moment, the pail is moving slowly straight upward at constant speed. What force is Jack exerting on the rope?

b) What is the net force exerted on the tools in the bucket? What objects in their surroundings are they interacting significantly with?

c) How does the force Jack is exerting on the rope at the moment compare to the average force that he has exerted on the rope from the time he started to lift the bucket of tools until now?

[Checkpoint 1 – Notice how the present motion of an object depends on the forces that acted on it at all earlier times, but that the way in which the object's motion changes in the next time step depends only on the forces acting on it right now.]

Problem 2. At t = 532.0 s after midnight an astronaut measures the location of a survey probe he launched from his spaceship toward an asteroid. In the coordinate system he is using the probe's position vector at that time is $\vec{r}_p = \left\langle 3\times10^5, 7\times10^5, -4\times10^5 \right\rangle m$ and the asteroid's position vector is $\vec{r}_a = \left\langle 9\times10^5, -3\times10^5, -12\times10^5 \right\rangle m$. The mass of the probe is 1400 kg and the mass of the asteroid is 7×10^{15} kg. No other objects are nearby.

a) What is the net force acting on the probe-asteroid system? What is the net force acting on the survey probe?

b) At t = 532.0 s the asteroid is at rest in the astronaut's coordinate system and the momentum of the survey probe is $\vec{p}_p = \left\langle 3, 5, -4 \right\rangle kg\ m/s$. Estimate the momentum of the probe-asteroid system Δt = 10 s later. Estimate the momentum of the survey probe at that later time.

c) Estimate the position of the survey probe at t = 542 s after midnight.

d) Was Δt = 10 s a short enough time interval to make single-step estimates of the probe momentum and position at t = 542 s reasonably accurate?

[Checkpoint 2]

Problem 3.

A worker at an ice rink must move a crate containing a new treadmill across the ice to the local hockey team's training room. The crate and its contents have a total mass M=220 kg. The mass of the treadmill inside the crate is 150 kg.

The crate is at rest on the ice when the worker begins to push on it. He exerts a constant force $\vec{F}$ with a magnitude of 100 N on the crate for several seconds.

a) Estimate the speed of the crate 1 second after the worker begins to push on it.

b) Estimate the magnitude of the net force acting on the treadmill while the worker is pushing on the crate. In what direction does this force point? With what objects in the treadmill's surroundings is it interacting significantly? Explain how the forces each of these objects exerts on the treadmill add up to the net force acting on it.

[Checkpoint 3]