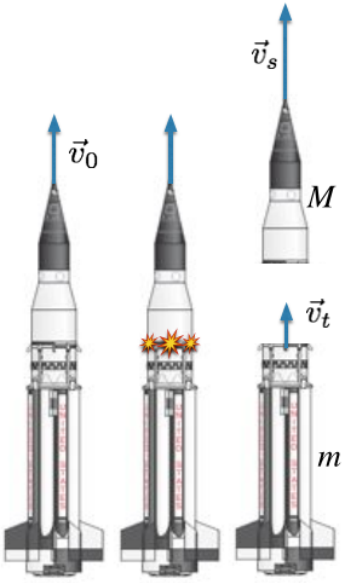
Midterm #2, Phys 1501, Fall 2013

PLEASE LABEL AND CIRCLE OR BOX YOUR ANSWERS!

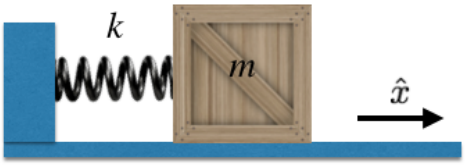


1. The final stage of a space shuttle (M=2 million kg) launch sequence involves the release of the empty external tank (m=350,000 kg). With all rockets off, the shuttle and tank move at a constant speed v_0=7950m/s vertically. A small explosion separates the tanks and shuttle, pushing the tank away directly behind the shuttle. Neglect effects of gravity.

(a) If the shuttle is now moving v_s=8000m/s vertically, what is the tank's speed v_t?

(b) The explosion lasts 1.5 seconds. What was the average force on the shuttle during the explosion?

2. A hoop ($I_{hoop,cm}=mR^2$) and a sphere ($I_{sphere,cm}=2/5mR^2$) with the same mass and radius roll without slipping along a flat surface with the same speed *V*. They each then roll up a ramp to their maximum heights H_h *and* H_s before stopping to return down the ramp. Determine the ratio H_h/H_s.



3. Consider springs (spring constant k=18N/m) attached to a box (mass m=0.5kg) above a frictionless surface in the two arrangements shown. The springs are at their equilibrium length in each case.

(a) Draw a free body diagram for each case when the box is displaced to the right.

(b) Which case has the higher oscillation frequency? Why?

(c) The box in the lower panel starts from equilibrium and is kicked at time t=0, so that it moves to the left initially at a speed 1m/s. Find the position $x(t)$ for the box in terms of the time in seconds and plug in the numbers given. Sketch a graph of $x(t)$, labeling the time t=0, the amplitude and period of the oscillation.

4. A fly fishing reel consists of a large cylinder ($I_{cyl,cm}=1/2MR^2$) with radius R=6cm and mass M=100g, with a small cylindrical handle of mass m=20g and radius r =1cm ($I_{handle,cm}=1/2mr^2$) attached to the perimeter of the reel, a distance R from the center as shown. The reel spins freely, the fishing line does not stretch but moves frictionlessly through the guides along the rod, which does not bend and is held fixed.

(a) Find the moment of inertia of the reel and handle about its rotational axis.

(b) A fish bites, is hooked, and accelerates in such a way that the tension in the line is 1N. Find the acceleration of the fish.

(c) The "drag" acts like a brake, completely stopping the rotation of the reel unless a minimum torque τ_{min} is applied. If the drag was set to τ_{min}=0.33Nm, could the fish in part (b) accelerate at all? Explain your answer.