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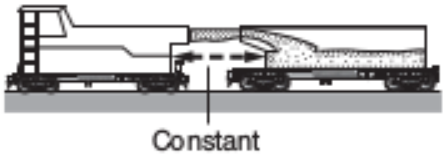
Physics 24a - Section 1
Momentum
Monday, February 22, 2016

4.{13,15,21,23,24}

1 - Sand sprayer - KK 4.13 A sand-spraying locomotive sprays sand horizontally into a freight car as shown in the sketch. The locomotive and freight car are not attached. The engineer in the locomotive maintains his speed so that the distance to the freight car is constant. The sand is transferred at a rate $dm/dt = 10\text{kg/s}$ with a velocity 5m/s relative to the locomotive. The freight car starts from rest with an initial mass of 2000kg. Find its speed after 100s.



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2 - Women and flatcar - KK 4.15 N women, each with mass m, stand on a railway flatcar of mass M. They jump off one end of the flatcar with speed u relative to the car. The car rolls in the opposite direction without friction.

(a) What is the final velocity of the flatcar if all the women jump off at the same time?

(b) What is the final velocity of the flatcar if they jump off one at a time? (The answer can be left in the form of a sum of terms.)

(c) Does case (a) or case (b) yield the larger final velocity of the flatcar? Can you give a simple physical explanation for your answer?

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3 - Force on a fire truck - KK 4.21 A fire truck pumps a stream of water on a burning building at a rate K (kg/s). The stream leaves the truck at angle θ with respect to the horizontal and strikes the building horizontally at height h above the nozzle, as shown. What is the magnitude and direction of the force on the truck due to the ejection of the water stream?

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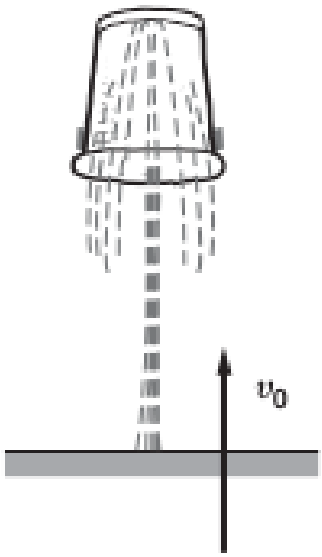
4 - Suspended garbage can* - KK 4.23 An inverted garbage can of weight W is suspended in air by water from a geyser. The water shoots up from the ground with a speed v_0, at a constant rate K (mass/time). The problem is to find the maximum height at which the garbage can rides. Neglect any effect of the falling water after it rebounds elastically from the garbage can.



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5 - Growing raindrop - KK 4.24 A raindrop of initial mass M_0 starts falling from rest under the influence of gravity. Assume that the drop gains mass from the cloud at a rate proportional to the product of its instantaneous mass and its instantaneous velocity:

$$\frac{dM}{dt} = kMV$$

where k is a constant.
Show that the speed of the drop eventually becomes effectively constant, and give an expression for the terminal speed. Neglect air resistance.

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