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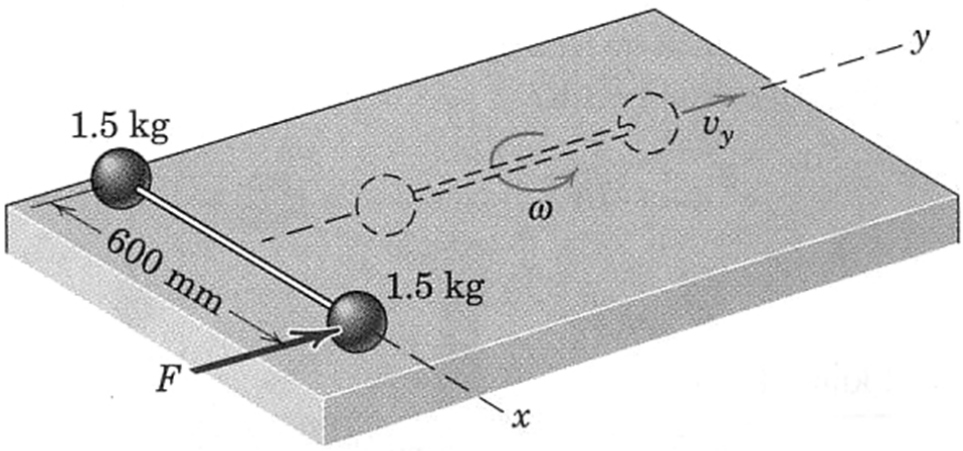
2.003/1.053 Dynamics and Controls I
Spring 2007
Problem Set 3

Issued on Monday, February 26^{th}
Due in lecture on Monday, March 5^{th}

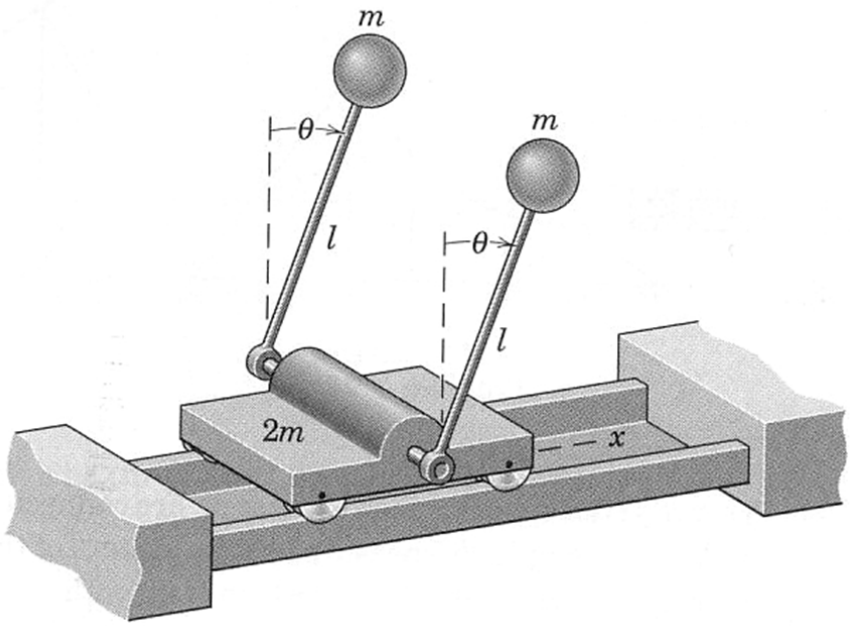
1 Sliding dumbbell

The two spheres are rigidly connected to the rod of negligible mass and are initially at rest on the smooth horizontal surface. A force F is suddenly applied to one sphere in the y-direction and imparts an impulse of 10 Ns during a negligibly short period of time. As the spheres pass the dashed position, calculate the velocity of each one.



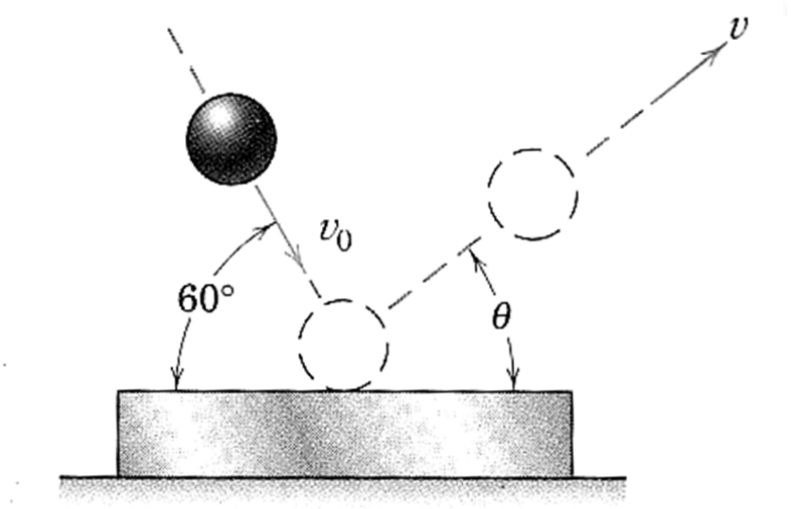
2 Carriage and pendulum

The carriage of mass $2m$ is free to roll along the horizontal rails and carries the two spheres, each of mass m, mounted on rods of length l and negligible mass. The shaft to which the rods are secured is mounted in the carriage and is free to rotate. If the system is released from rest with the rods in the vertical position where $\theta = 0$, determine the velocity v_x of the carriage and the angular velocity $\dot{\theta}$ of the rods for the instant when $\theta = 180\,^\circ$. Treat the carriage and the spheres as particles and neglect any friction.



3 Restitution coefficient

The steel ball strikes the heavy steel plate with a velocity $v_0 = 24$ m/s at an angle of 60° with the horizontal. If the coefficient of restitution is $e = 0.8$, compute the velocity v and the direction θ with which the ball rebounds from the plate.



4 Basketball collision

During a pregame warmup period, two basketballs collide above the hoop when in the positions shown. Just before impact, ball 1 has a velocity $\mathbf{v}_1$ which makes a 30° angle with the horizontal. Also, during impact, an imaginary line between the center of mass of the two balls makes a 30° angle with the horizontal. If the velocity $\mathbf{v}_2$ of ball 2 just before impact has the same magnitude as $\mathbf{v}_1$, determine the two possible values of the angle θ, measured from the horizontal, which will cause ball 1 to go directly through the center of the basket. The coefficient of resitution is $e = 0.8$.