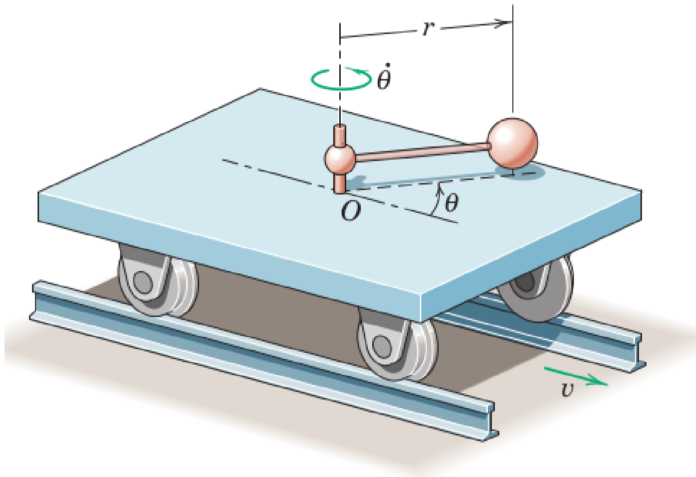
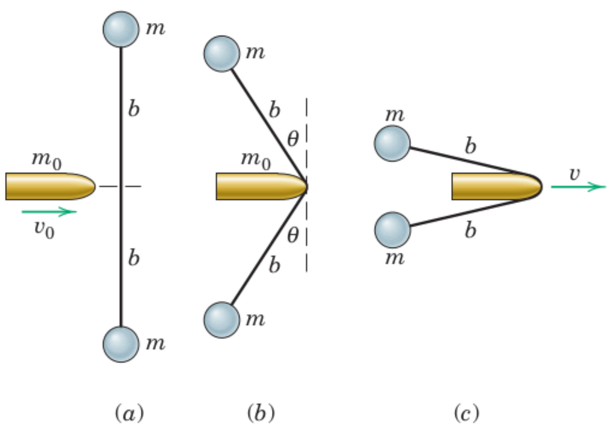
DYNAMICS (ME232)

Tutorial-4: Kinetics of Systems of Particles

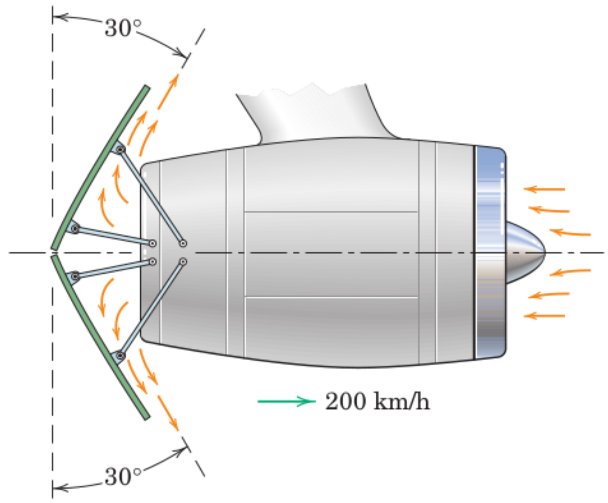
1. The small car, which has a mass of 20 kg, rolls freely on the horizontal track and carries the 5-kg sphere mounted in the light rotating rod with $r = 0.4$m. A geared motor drive maintains a constant angular speed $\dot{\theta} = 4$rad/s of the rod. If the car has a velocity $v = 0.6$ m/s when $\theta = 0$, calculate v when $\theta = 60°$. Neglect the mass of the wheels and any friction.



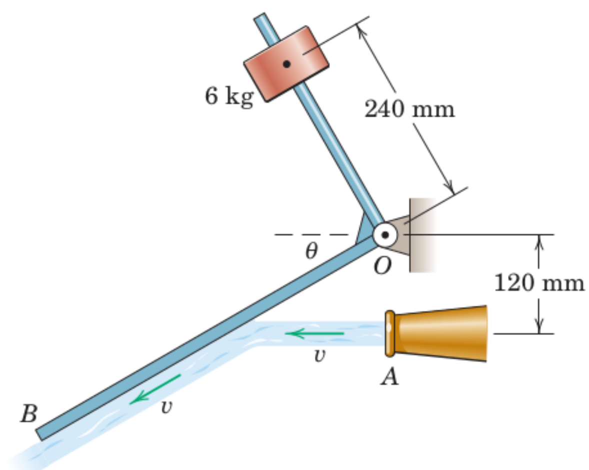
2. The two small spheres, each of mass m, are connected by a cord of length $2b$ (measured to the center of the spheres) and are initially at rest on a smooth horizontal surface. A projectile of mass m_0 with a velocity v_0 perpendicular to the cord hits it in the middle, causing the deflection shown in part b of the figure. Determine the velocity v of mass m_0 as the two spheres near contact, with θ approaching 90° as indicated in part c of the figure. Also find $\dot{\theta}$ for this condition.



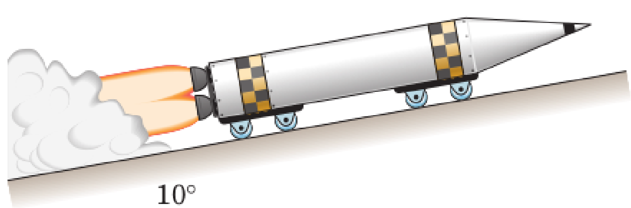
3. A jet-engine thrust reverser to reduce an aricraft speed of 200 km/h after landing employs folding vanes which deflect the exhaust gases in the direction indicated. If the engine is consuming 50 kg of air and 0.65 kg of fuel per second, calculate the brakeing thrust as a fraction n of the engine thrust without the deflector vanes. The exhaust gases have a velocity of 650 m/s relative to the nozzle.



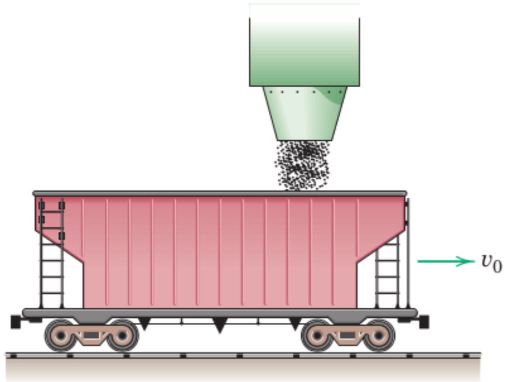
4. A high-speed jet of air issues from the 40-mm-diameter nozzle A with a velocity v of 240 m/s and impinges on the vane OB, shown in tis edge view. The vane and its right-angle extension have negligible mass compared with the attatched 6-kg cylinder and are freely pivoted about a horizontal axis through O. Calculate the angle θ assumed by the vane with the horizontal. The air density under the prevailing conditions is 1.206 kg/m^3. State any assumption.



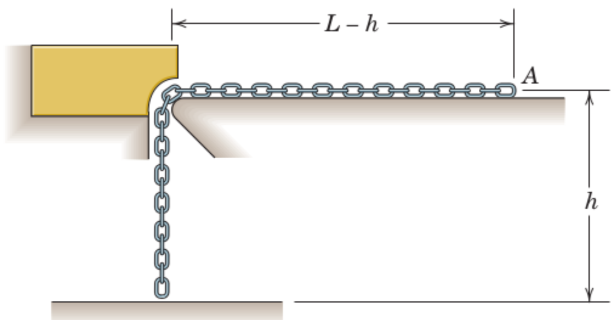
5. A small rocket-propelled vehicle has an initial mass of 60 kg, including 10 kg of fuel. Fuel is burned at the constant rate of 1kg/s with an exhaust velocity relative to the nozzle of 120 m/s. Upon ignition the vehicle is released from rest on the 10° incline. Calculate the maximum velocity v reached by the vehicle. Neglect all friction.



6. A coal car with an empty mass of 25 Mg is moving freely with a speed of 1.2 m/s under a hopper which opens and released coal into the moving car at the constant rate of 4 Mg per second. Determine the distance x moved by the car during the time that 32 Mg of coal are deposited in the car. Neglect any frictional resistance to rolling along the horizontal track.



7. The open-link chain of length L and mass ρ per unit length is released from the rest in the position shown, where the bottom link is almost touching the platform and the horizontal section is supported on a smooth surface. Friction at the corner guide is negligible. Determine (a) the velocity v_1 of end A as it reaches the corner and (b) its velocity as it strikes the platform. (c) Also specify the total loss Q of energy.



8. In the figure shown an impulse-turbine wheel for a hydroelectric power plant which is to operate with a static head of water of 300 m at each of its six nozzles and is to rotate at the speed of 270 rev/min. Each wheel and generator unit is to develop an output power of 22000 kW. The efficiency of the generator may be taken to be 0.90, and an efficiency of 0.85 for the conversion of the kinetic energy of the water jets to energy delivered by the turbine may be expected. The mean peripheral speed of such a wheel for greatest efficiency will be 0.47 times the jet velocity. If each of the buckets is to have the shape shown, determine the necessary jet diameter d and wheel diameter D. Assume that the water acts on the bucket which is at the tangent point of each jet stream.