Ph.D. Qualifying examination

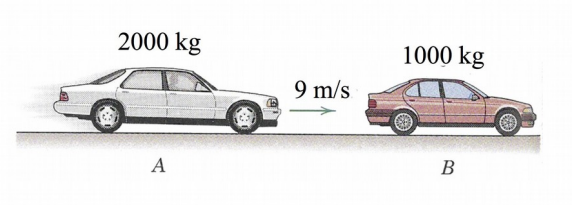
Dynamics

Fall 2018

Notes:

1. Duration: 2.5 hours
2. Closed book, closed notes (one sheet of formulas is allowed).
3. Four problems (all of the same value)
4. Calculator is allowed.
5. Laptops, cell phones, and similar internet-connected devices are not allowed.

Problem 1.

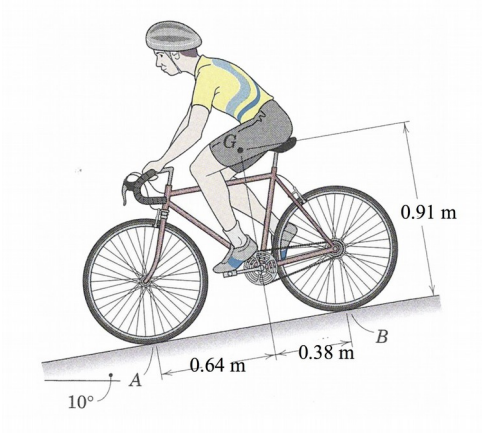


Car B is initially stationary and is struck by car A moving with initial speed $v_1 = 9$ m/s. The cars become entangled and move together with speed v' after the impact. If the duration of the collision is 0.1 s, determine:

1. the common final speed v';
2. the average acceleration of each car during the collision;
3. the magnitude R of the average force exerted by each car on the other car during impact.

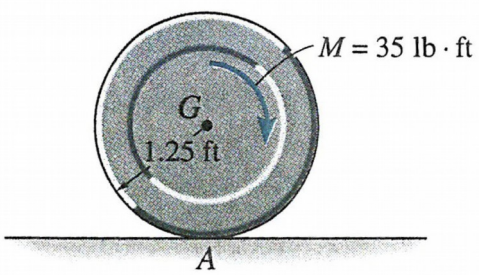
Assume that brakes are released during the collision. State any other assumptions.

Problem 2.



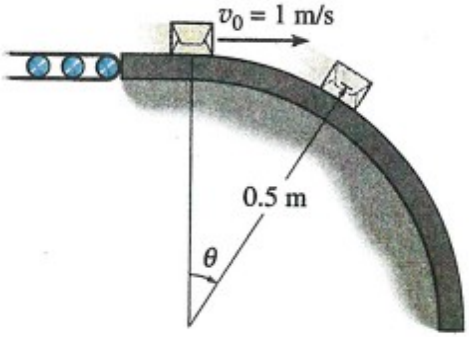
The bicyclist applies the brakes as he descends the 10º incline. What deceleration *a* would cause the dangerous condition of tipping about the front wheel (a.k.a. front wheelie or endo)? The combined center of mass of the rider and bicycle is at *G*.

Problem 3.



The 50-lb wheel shown has a radius of gyration of 0.7 ft. If a 35 ft·lb moment is applied to the wheel, determine the acceleration of its center of mass G. The coefficients of static and kinetic friction between the wheel and plane at A are $\mu_s = 0.3$ and $\mu_k = 0.25$, respectively.

Problem 4.



Packages having a mass of 2 kg are delivered from a conveyor belt to a smooth circular ramp with a velocity $v_0 = 1$ m/s as shown in the figure. If the radius of the ramp is 0.5 m, determine the angle $\theta = \theta_{max}$ at which each package begins to leave the surface. State any necessary assumptions.