Ph.D. Qualifying examination

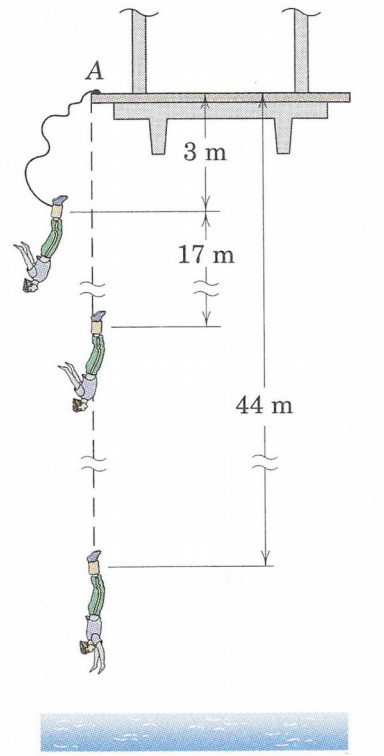
Dynamics

Spring 2019

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.

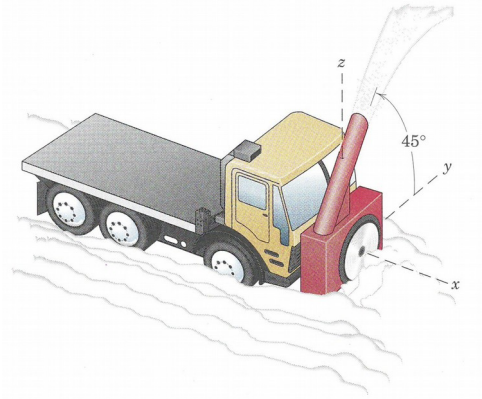


An 80-kg bungee jumper jumps from a bridge at point *A* with the bungee cord secured to the ankles. The jumper falls 20 m before the 17-m long elastic portion of the bungee cord begins to stretch, and drops a total of 44 m before reversing direction. Neglecting any energy losses, determine:

1. the stiffness k of the cord per meter of length;
2. the maximum velocity v_{max} achieved during the fall;
3. the maximum acceleration a_{max};

State any assumptions.

Problem 2.

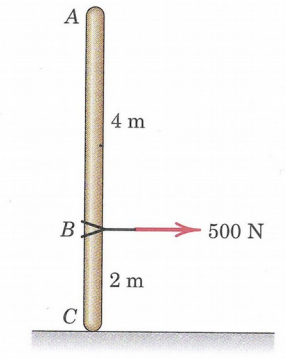


A snowplow advances through a snow drift on a level road at a constant speed of 20 km/h. The plow discharges 60,000 kg of snow per minute from its 45° chute with a velocity of 12 m/s relative to the plow. Calculate the traction force on the tires in the direction of motion necessary to move the plow forward, and the lateral force between the road and the tires.

Problem 3.

In an interview for an engineering position, the candidate is presented with two spheres that are apparently identical. They have the same mass, the same diameter and the same surface finish. The only difference is that one sphere is hollow, the other is solid. Devise a simple experiment that does not require any instrumentation to determine which is which. Explain.

Problem 4.



The uniform 50-kg pole ABC is balanced in the verical position when a 500-N horizontal force is suddenly applied at B. If the coefficient of kinetic friction between the pole and the ground is 0.3, determine the initial acceleration of point *A*.