

# **Ph.D. Qualifying Examination**

## **Dynamics**

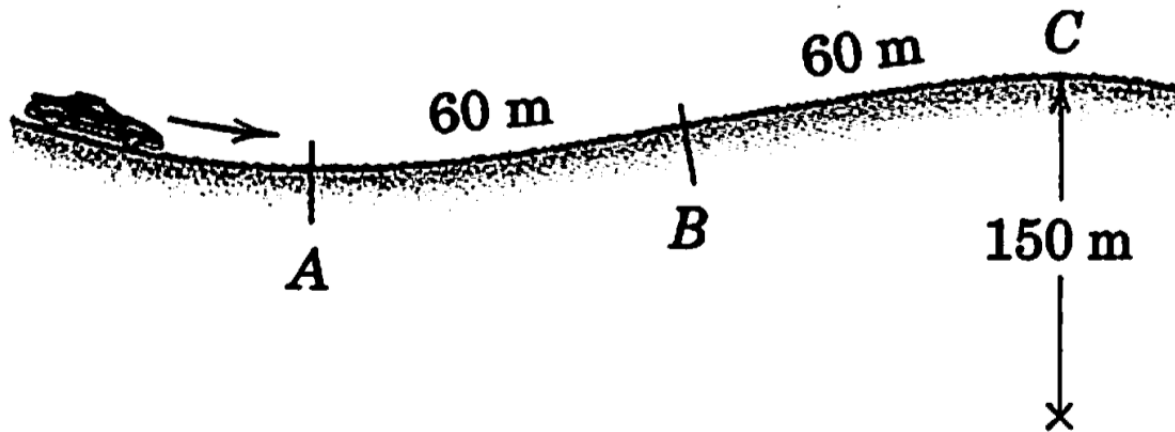
**Spring 2015**

Notes:

1. Duration: 2.5 hours
2. Closed book, closed notes (one sheet of formulas is allowed).
3. Suggested textbook(s) for study: any recent edition of Meriam & Kraige or Hibbeler
4. Topics covered: Newtonian dynamics of particles and rigid bodies (2-D only), including work-energy methods and impulse-momentum methods.
5. Topics NOT covered: Lagrangian methods of analysis.
6. Nature of exam: 4 problems; calculator is recommended.

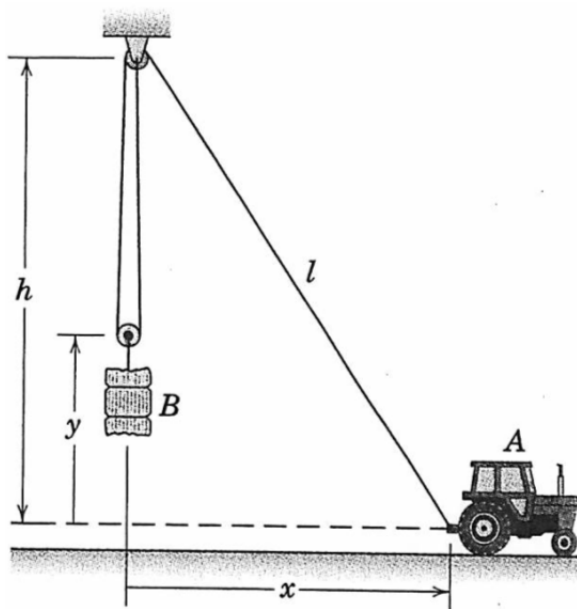
**Problem 1.**

To anticipate the dip and hump in the road, the driver of a car applies her brakes to produce a uniform deceleration. Her speed is 100 km/h at the bottom A of the dip and 50 km/h at the top C of the hump, which is 120 m along the road from A. If the passengers experience a total acceleration of  $3 \text{ m/s}^2$  at A and if the radius of curvature of the hump at C is 150 m, calculate (a) the radius of curvature  $\rho$  at A, (b) the acceleration at the inflection point B, and (c) the total acceleration at C.



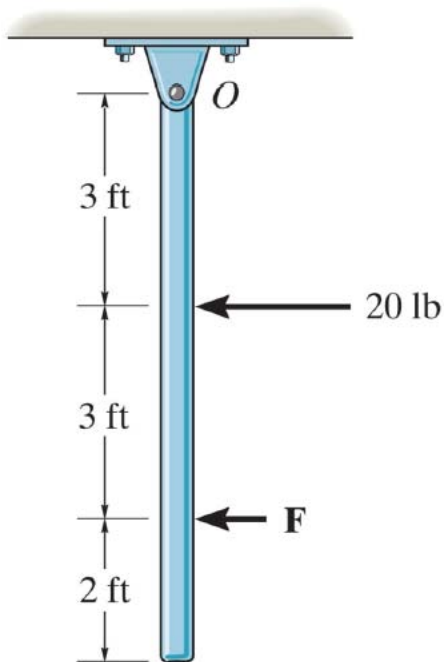
**Problem 2.**

The tractor A is used to hoist the bale B with the pulley arrangement shown. If A has a forward velocity  $v_A$ , determine an expression for the upward velocity  $v_B$  of the bale in terms of  $x$  and  $l$ .



**Problem 3.**

At the instant shown, two forces act on the 30-lb slender rod, which is pinned at O. Determine the magnitude of force F and the initial angular acceleration of the rod so that the horizontal reaction that the pin exerts on the rod is 5 lb directed to the right. For the slender rod:  $I_G = 1/12ml^2$ ;  $I_o = 1/3ml^2$ .



**Problem 4.**

The collar of negligible size has a mass of 0.25 kg and is attached to a spring having an unstretched length of 100 mm. If the collar is released from rest at A and travels along the smooth guide, determine its speed just before it strikes B.

