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科目： 動力學
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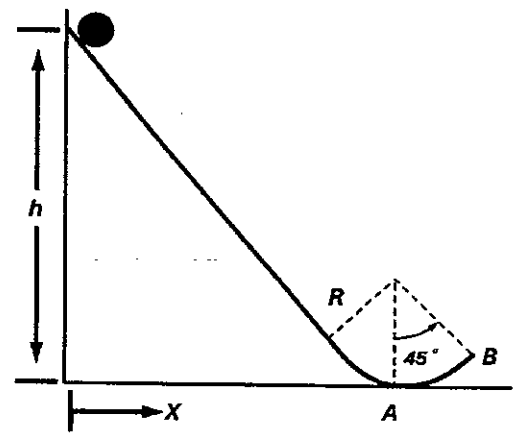
國立臺灣大學 115 學年度碩士班招生考試試題

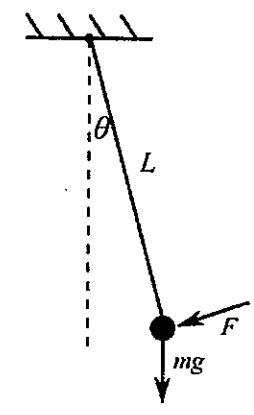
1. (25%) A 250-kg refrigerator is placed on the horizontal flatbed of a truck. The coefficient of static friction between the refrigerator and the truck bed is $\mu_s = 0.30$. The truck starts from rest and accelerates in a straight line with constant acceleration. Determine the minimum time required for the truck to reach a speed of 100 km/h such that the refrigerator does not slip on the truck bed.

2. (25%) A small sphere of mass m is released from rest at a height h above the ground along a frictionless track. The lower part of the track forms a circular arc of radius R. Point A represents the lowest point of the track, and the track terminates at point B, such that the radius to B makes an angle of 45° with the vertical.
   (a) (7%) At point A, draw the free-body diagram (FBD) of the sphere and clearly label all forces acting on it. Using the FBD, determine the magnitude of the normal force exerted by the track on the sphere at point A.
   (b) (7%) At point B, draw the FBD of the sphere and clearly label all forces acting on it. Using the FBD, determine the magnitude of the normal force exerted by the track on the sphere at point B.
   (c) (6%) At what speed does the sphere leave the track at point B?
   (d) (5%) After leaving the track at point B, the sphere travels through the air and lands on the ground level. Calculate the horizontal distance from point A to the landing point.



3. (25%) Two trains, P and Q, travel in the same direction on the same set of tracks. Train P starts from rest at position d, and train Q starts from the origin with initial velocity v_0. P speeds up with constant acceleration a, and Q slows down with constant acceleration $-a$. Find the maximum value of v_0 (in terms of d and a) such that no collision occurs?

4. (25%) A child of mass m sits on a swing of length L. Let θ denote the angle between the swing and the vertical. The swing is initially pulled to an angle θ_0 with zero velocity. The swing is then released, and at the same time the child's father applies a constant tangential force F to the swing. In the case of $\theta_0 = 1/10$ radian and $F = mg/10$, where g is the gravitational acceleration. Using the small-angle approximation $\sin\theta \approx \theta$, determine the time duration for the swing from the initial position to reach its lowest point.



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