THE UNIVERSITY OF ADELAIDE
DEPARTMENT OF MECHANICAL ENGINEERING

EXAMINATION FOR THE DEGREE OF B.E.

2391: DYNAMICS

NOVEMBER, 2000

TIME: 2 HOURS

[In addition the candidates are allowed ten minutes before the exam to read the paper.]

[Notes and textbooks are **not** permitted in the examination room.]

[Calculating devices are permitted, as is the Dynamics formula sheet.]

Attempt ALL **FOUR** questions.

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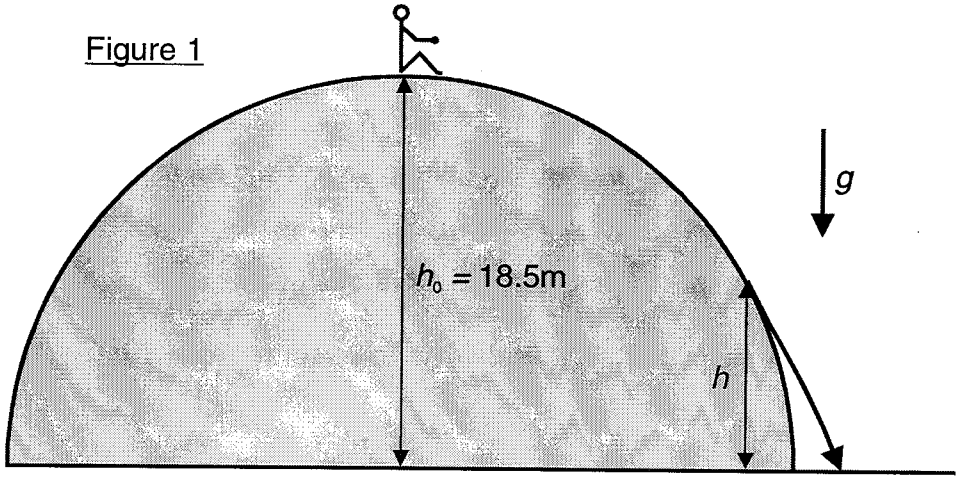
1) A person sits atop a hemispherical hill of height $h_0 = 18.5\text{m}$ as shown in Figure 1. There is no friction between the person and the surface of the hill. The person is given a gentle nudge away from the top of the hill so that they begin sliding across the surface. At some point they will cease to stay in contact with the surface, and become airborne.

$g = 9.81\text{ms}^{-2}$ is the acceleration due to gravity.

Figure 1



At what height above the ground (h) will the person lose contact with the surface?

(20 Marks)

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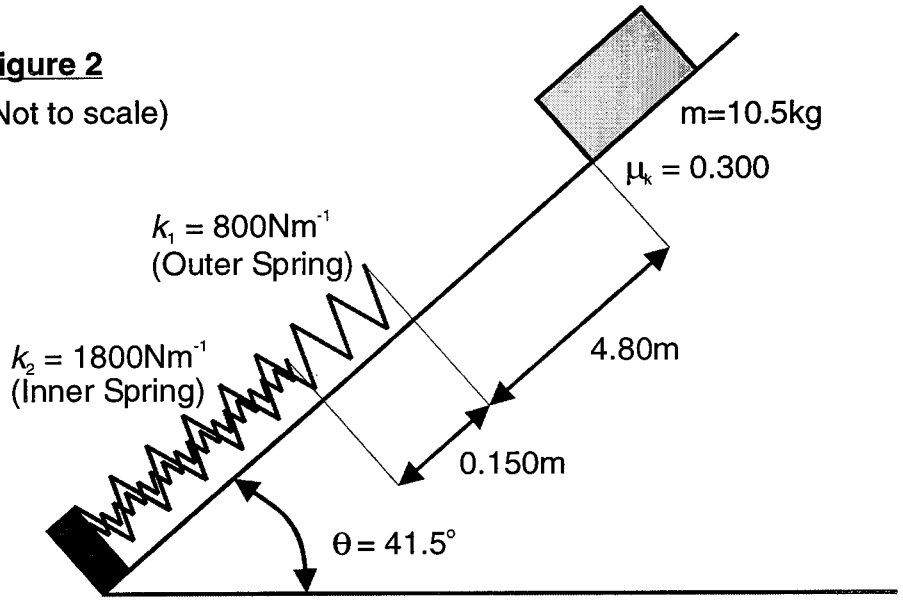
2) A block of mass m = 10.5kg is released from rest on a rough inclined surface (μ_k = 0.300) as shown in Figure 2. The block slides down the surface a distance 4.80m , as shown, before coming in contact with the first of 2 concentrically located springs, causing it to compress. After sliding a further 0.150m it contacts the second, inner spring. The inner spring has a stiffness k_2=1800Nm^{-1}, while the outer spring has stiffness k_1=800Nm^{-1}. Initially the springs are not compressed or extended.

Acceleration due to gravity = g = 9.81ms^{-2}.

The coefficient of kinetic friction between the block and plane is μ_k = 0.300.

Figure 2

(Not to scale)



Assuming there is no energy loss on impact with the springs, what will the maximum compression of the inner spring be? **(20 Marks)**

3) A ball is dropped from a height of 1.50m onto a frictionless and immovable plane inclined at 32° to the horizontal. The point of contact between the plane and ball is located a horizontal distance of 0.500m to the left of the base of the slope.

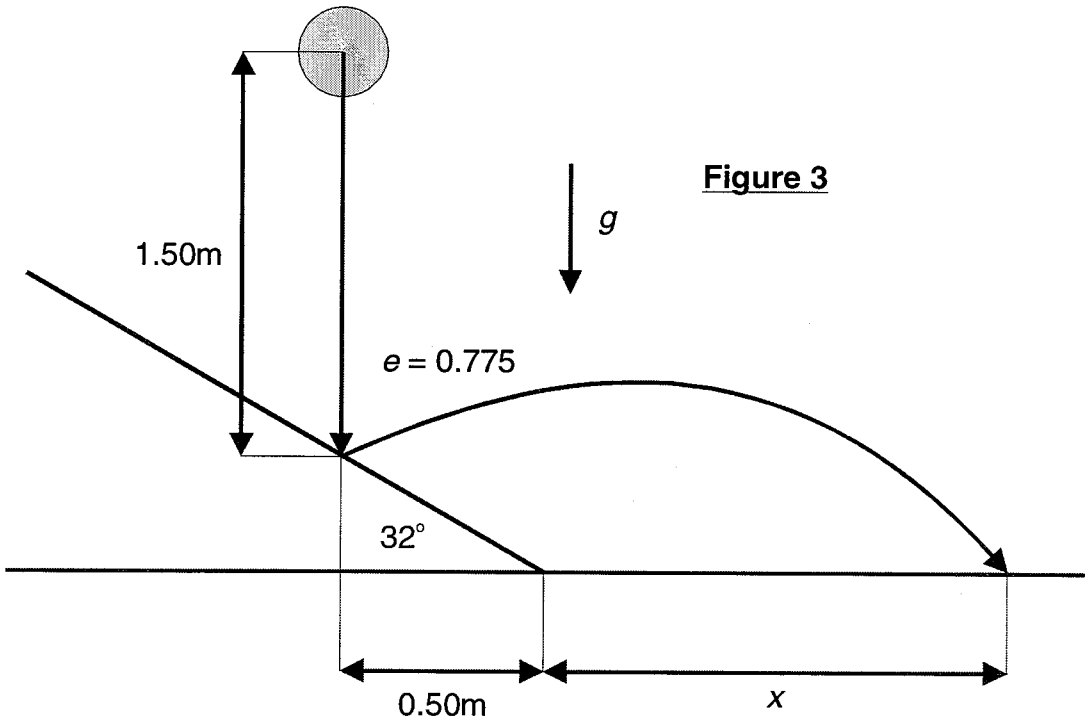


Figure 3

How far onto the flat section of ground does the ball land, measured from the base of the slope if the coefficient of restitution between the ball and plane is $e = 0.775$? **(20 Marks)**

4) A rigid rod *AD*, has wheels connected at fixed points, *A* and *B*, along its length. The wheels are constrained to move in tracks as shown in Figure 4. If, at the instant shown the velocity of *B* is 0.750 ms^{-1} downwards and is constant (zero acceleration) what is the acceleration of the point *D*? **(20 Marks)**

To find this, first find the angular velocity (ω), and angular acceleration (α) of the rod, by considering the motion of *A* relative to *B*.

Figure 4