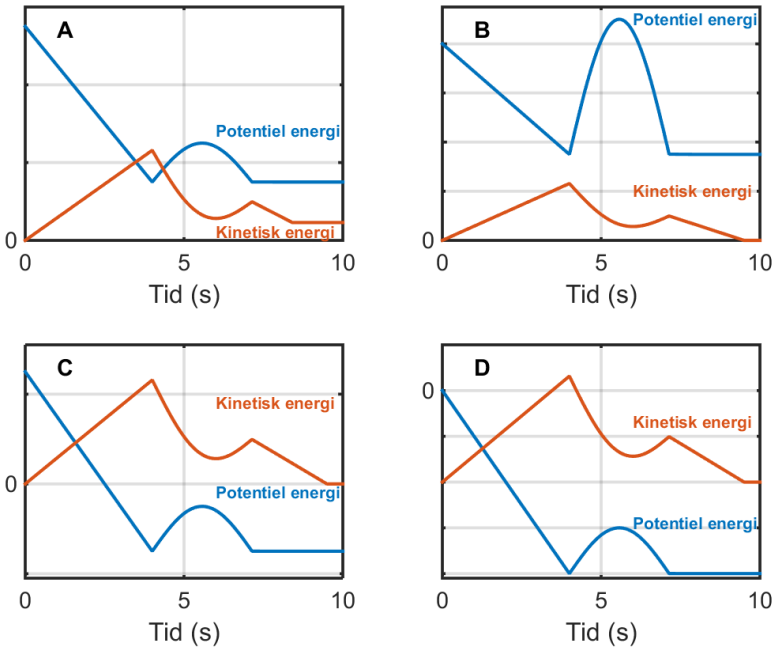
Problem 1.

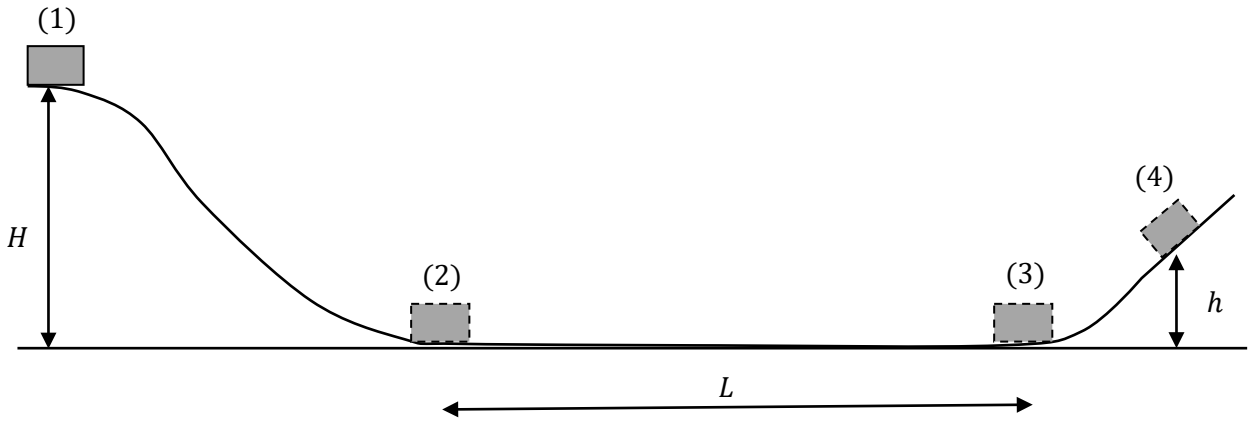
A snowboarder first slides down a hill and then across a ramp, where the ramp's angle with the hill gives her an upward velocity component. The snowboarder starts from rest at time t = 0 and reaches a maximum speed of 40 km/hr down the hill, jumping 20 meters and finishing at rest at time t = 10 s.

Which of the following graphs is the best representation of her jump?



A) Graph A
B) Graph B
C) Graph C
D) Graph D
E) Do not know

Problem 2.



A block is initially at rest in position (1) at height H above the ground. It slides down a slippery hill to the beginning of a horizontal segment (2). The horizontal segment is L long and has a rough surface. At the end of the horizontal segment, the block is in position (3). After the horizontal segment, the block goes up a second slippery hill. The block reaches a height h before it comes to a halt.

Consider the motion from (3) to (4) and determine the speed of the block in position (3).

a) The speed of the block at (3) is

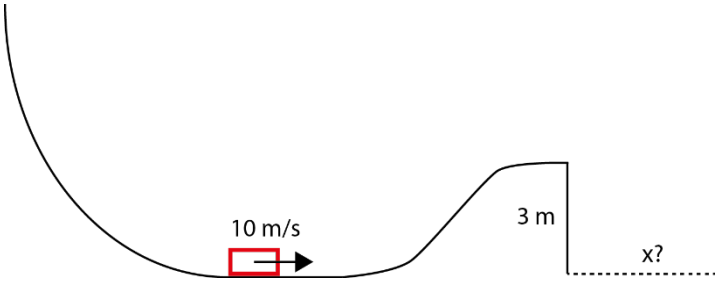
A) $v = \sqrt{2gH}$
B) $v = \sqrt{2g(H-h)}$
C) $v = \sqrt{gH}$
D) $v = \sqrt{2gh}$
E) Do not know

b) The friction force's work on the horizontal segment of length L is

A) $= mg(H-h)$
B) $W = -mgL$
C) $W = mg(h-H)$
D) $W = -\frac{1}{2}mv^2$
E) $W = mgh$
F) Do not know

Problem 3.

You are riding a sled down an icy hill. You reach a speed of 10 m/s at the bottom of the hill. Your friends have built a 3 m tall slippery ramp, which you launch yourself from. The ramp is horizontal just before the jump.

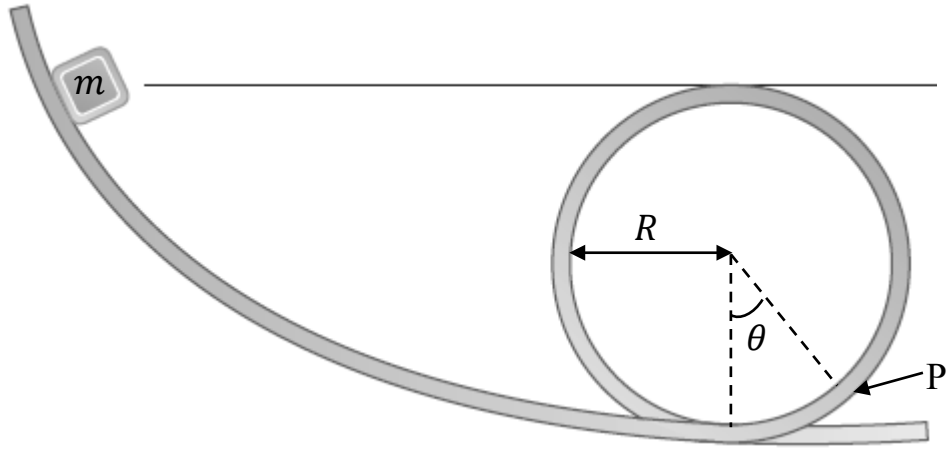


How far are you airborne in the horizontal direction from the edge of the ramp (x on the drawing)?

A) 5.0 m
B) 7.8 m
C) 3.5 m
D) 4.2 m
E) Do not know

Problem 4.

A small block, whose length can be ignored, is initially at rest in the shown position. The block is released from rest and slides down a smooth track. The center of the track follows a circular trajectory with radius R.



In the following, we consider the motion of the block in the circular part of the track.

a) Make a force-diagram for the block when it is at point P.
b) Determine the speed of the block as a function of the angle θ when it moves along the circular part of the track.
c) Determine the angle θ_c when the block loses contact with the track.

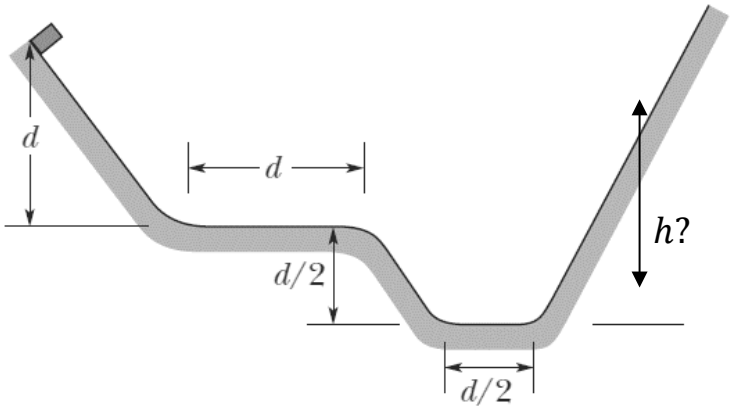
Problem 5.

A weight with mass $m = 1.20$ kg is dropped from a height $h = 0.80$ m over a vertical spring with spring constant $k = 1600\ \mathrm{N/m}$.

a) Determine the maximum compression, d, of the spring.

Problem 6.

A block is initially at rest and slides in a valley. The figure below illustrates the valley's shape and the block's initial position. The two horizontal segments have a kinematic coefficient of friction of $\mu_k = \frac{1}{2}$. The rest of the valley's segments are smooth.



At what height, h, above the short horizontal segment is the block stationary for the first time?

A) $h = 0$ (the block stops before it begins to move upwards)
B) $h = \frac{1}{4}d$
C) $h = \frac{1}{2}d$
D) $h = \frac{3}{4}d$
E) $h = d$
F) $h = \frac{5}{4}d$
G) $h = \frac{3}{2}d$
H) Do not know

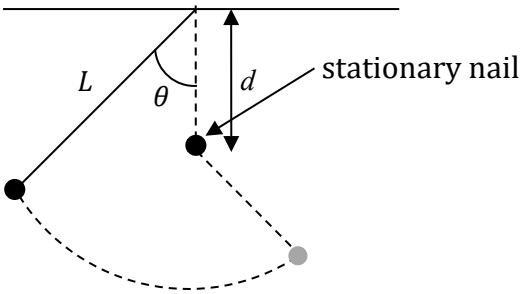
Problem 7.

A pendulum consists of a string with length R and a small weight with mass m. The weight is dropped from rest at a position where the string is at angle θ with the vertical.

a) What is the speed of the weight when the string is parallel to the vertical for the first time?
b) How large is the tension when the string is parallel to the vertical for the first time?

Problem 8.

A pendulum consists of a particle with mass m at the end of a string of length L. The pendulum is released from rest with $\theta = 90°$ and during the motion, the string hits a stationary nail. The nail is fixed a distance d below the point of attachment of the string. When the string hits the nail, the now shorter pendulum rotates with the nail as the rotation center.



a) Show that if the pendulum is released, and is to make a full rotation, the smallest value of d is equal to $\frac{3}{5}L$.