PHY 211 Homework 10

Due April 1, 2020

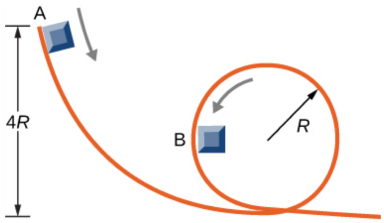
Problem 1. A 2.0 kg block starts sliding up a slope inclined at 37° to the horizontal. Its initial speed is 10 m/s. The coefficient of kinetic friction between the block and slope is $\mu_k = 0.3$.

(a) Use the work–energy theorem to determine how far the block slides up the slope before momentarily coming to rest.

(b) After stopping, the block slides back down the slope. What is its speed when it reaches the bottom? (Hint: For the round trip, does gravity do any work on the block?)

Problem 2. Coal is lifted out of a mine a vertical distance of 50 m by an engine that supplies 500 W of power to a conveyer belt. How much coal per minute can be brought to the surface? Ignore the effects of friction.

Problem 3. A small block of mass m slides without friction around the loop-the-loop apparatus shown. Assume the loop part is circular for this problem.



(a) If the block starts from rest at A, what is its speed at B?

(b) What is the force of the track on the block at B?

Energy–momentum problems

For each of the following problems, make sure to clearly identify the "initial" and "final" situations you are discussing. State whether momentum and/or energy is conserved from the initial to final situation, and why. Then write down the appropriate conservation laws to solve.

Problem 4. A 2000 kg railway freight car coasts at 4.4 m/s underneath a grain terminal, which dumps grain directly down into the freight car. If the speed of the loaded freight car must not go below 3.0 m/s, what is the maximum mass of grain that it can accept?

Problem 5. A 100 g firecracker is launched vertically into the air and explodes into two pieces at the peak of its trajectory. If a 72 g piece is projected horizontally to the left at 20 m/s, what is the speed and direction of the other piece?

Problem 6. A family is skating. The father (mass 75 kg) skates at 8.2 m/s and collides and sticks to the mother (50 kg), who was initially moving at 3.3 m/s and at 45° with respect to the father's velocity. The pair then collides with their daughter (30 kg), who was stationary, and the three slide off together. What are the components of their final velocity?

Problem 7. Two billiard balls are at rest and touching each other on a pool table. The cue ball travels at a speed v along the line of symmetry between these balls and strikes them simultaneously. If the collision is elastic, what is the velocity of the three balls after the collision? You can ignore the effects of rolling.

Hint: you need the angle θ away from the horizontal the balls will move along which you can find by finding the angle from center to center shown in the figure. Since the force acts along this line, this will be the direction of motion for struck balls. The cue ball will still be moving after the collision — it will definitely be along the line it came in on, but will it be forward or backward?