

## PCS211 P2022 Tutorial 5

1. You have been hired to design a spring-launched roller coaster that will carry two passengers per car. The car goes up a 10-m-high hill, then descends 15 m to the track's lowest point. You've determined that the spring can be compressed a maximum of 2.0 m and that a loaded car will have a maximum mass of 400 kg. For safety reasons, the spring constant should be 10 % larger than the minimum needed for the car to just make it over the top.

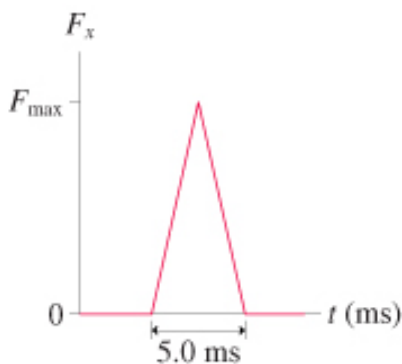
- (a) What spring constant should you specify?
- (b) What is the maximum speed of a 350 kg car if the spring is compressed the full amount?

2. A horizontal spring with spring constant 100 N/m is compressed 20 cm and used to launch a 2.5 kg box across a frictionless, horizontal surface. After the box travels some distance, the surface becomes rough. The coefficient of kinetic friction of the box on the surface is 0.15. Use work and energy to find how far the box slides across the rough surface before stopping.

3. Six dogs pull a two-person sled with a total mass of 220 kg. The coefficient of kinetic friction between the sled and the snow is 0.080. Starting from rest, the sled accelerates at  $0.75 \text{ m/s}^2$  until it reaches a cruising speed of 12 km/h.

- (a) What is the team's maximum power output during the acceleration phase?
- (b) What is the team's power output during the cruising phase?

4. A 200 g ball is dropped from a height of 2.0 m, bounces on a hard floor, and rebounds to a height of 1.5 m. The figure shows the impulse received from the floor. What maximum force does the floor exert on the ball?



5. A 20.0 kg wood ball hangs from a 2.0 m -long wire. The maximum tension the wire can withstand without breaking is 400 N. A 1.00 kg projectile traveling horizontally hits and embeds itself in the wood ball. What is the largest speed this projectile can have without causing the cable to break?