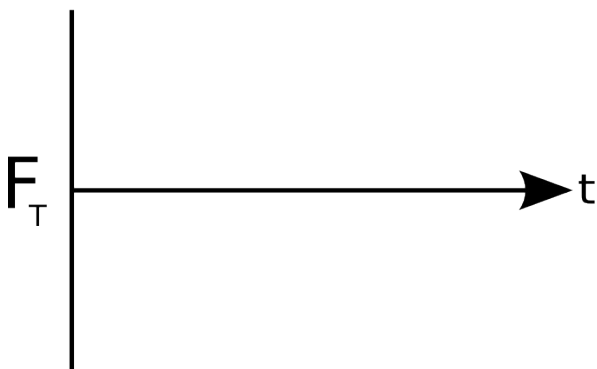


# Systems of Particles – Set 3

A HUGE truck, T and a Prius, P, move towards each other, collide and stick. Let  $F_P$  be the force experienced by the Prius and let  $F_T$  be the force experienced by truck.



- $F_P$  is \_\_\_\_  $F_T$ .
  - Greater than
  - The same as
  - Less than
  
- The amount of time that  $F_P$  is applied is \_\_\_\_ the time that  $F_T$  is applied.
  - Greater than
  - The same as
  - Less than
  
- Sketch a graph showing a plausible  $F_P$  as a function of time and another graph showing  $F_T$  function of time. Be sure to consider the *sign* of each force.



5. Compare the impulses on the two. What's the same? What's different?
4. The *magnitude* of the change in momentum of the Prius is \_\_\_ the *magnitude* of the change in momentum of the truck.
- a) Greater than
  - b) The same as
  - c) Less than
5. The magnitude of the acceleration of the Prius is \_\_\_\_ the magnitude of the acceleration of the truck.
- a) Greater than
  - b) The same as
  - c) Less than

You are in a car accident in which you collide with a concrete wall at 30 mi/hr. You are not wearing your seat belt and stop yourself using the reaction force of the windshield against your head. Let's assume that you don't go through the window.

a) What is the average force on your head, assuming the impact lasts 0.01 seconds. Compare that force to the weight of a person. (the *mass* of a person is about 70 kg, what's their weight?)

b) Now, you're wearing your seatbelt so you get to take advantage of the car's crumple zones. Crumple zones cause the impact to take place over 0.1 seconds. NOW what's the average force?

## Systems of Particles – Set 3

4

A 4000 kg railroad car collides and sticks to a chain of three other 4000 kg cars initially sitting at rest on a rough track. The four cars travel together down the rough track for 1.5 m before they stop. Assuming  $\mu_k = 0.10$ , what is the velocity of the first car at impact?

Answer these important questions before “solving” this problem:

Does the train car conserve momentum throughout the entire problem? Why not?

Is there a sub-problem where conservation of momentum can be applied? What is it?

What other physics principal are you going to use to solve the problem?

Draw a picture (or pictures) showing the action.

Do the math and solve the problem.

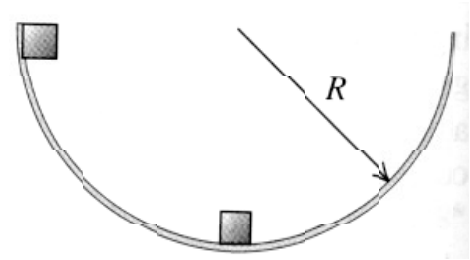
You are driving West along Summit Ave, lawfully doing the speed limit (50 km/hr) in your new car which (as you've read in the owners manual) has a mass of 1500 kg. Sleepy McSnoozer is driving South along Cleveland in his 1965 Ford pickup truck loaded with bags of cement. His truck (plus cement) weighs 2300 kg. Sleepy runs the red light and smashes into your car. The cars fuse together and skid to a stop.

Certain that Sleepy was speeding, you measure the skid mark and find that the length of the skid is  $L = 18$  m. You look up the rubber/asphalt coefficient of friction and find that it is  $\mu_k = 0.6$ .

- a) What was Sleepy's velocity? Was he speeding? The speed limit is 50 km/hr.
- b) How *long* did the skid last?

Two masses,  $m_1$  and  $m_2$ , are released from rest in a frictionless hemispherical bowl of radius  $R$  from the positions shown in the figure. The upper mass collides with and sticks to the lower mass and the two slide up the other side together.

Derive an expression for their final height of the combined masses.



## Systems of Particles – Set 3

7

A large fish will soon make a dish of a smaller fish. What is the velocity of the large fish and his dinner immediately after he eats? Give both the magnitude and direction of the final velocity with respect to the x-axis.

$$\begin{aligned}m_{\text{large fish}} &= 4.0 \text{ kg} \\v_{0 \text{ large fish}} &= 1.0 \text{ m/s} \\ \alpha_{\text{large fish}} &= 25.0^\circ\end{aligned}$$

$$\begin{aligned}m_{\text{small fish}} &= 0.20 \text{ kg} \\v_{0 \text{ small fish}} &= 5.0 \text{ m/s} \\ \beta_{\text{small fish}} &= 50.0^\circ\end{aligned}$$

