1) A 200 kg truck accelerates eastwards on a horizontal road in response to a gradually increasing frictional force from the ground. There is an unsecured 50 kg block sitting on the truck bed liner. There is friction between the block and the bed liner. An accelerometer is mounted in the truck. The block accelerates with the truck until the acceleration reaches 10 m/s$^2$. At that instant the block begins to slide and the truck’s accelerometer now reports a value of 11 m/s$^2$.

What are the coefficients of static and kinetic friction?
1B) A 200 kg truck can accelerate at 1.5 m/s². There is an unsecured 50 kg block sitting on the truck bed liner. There is friction between the block and the bed liner with static and kinetic coefficients of friction 0.50 and 0.40 respectively. The truck is descending on an incline which gradually gets steeper.

At what angle from horizontal does the friction force go zero?

If the angle increases to 36.9°, then will the box slide (a very steep 60% grade!)?

For experts at home: At what angle from horizontal does the box just begin to slide?
2) A pendulum swings from its turnaround point on the left (point 1) to its turnaround point on the right. At each of the points: On the left hand side figure sketch the radial acceleration vector(s) and on the right hand side figure sketch the tangential acceleration vector(s).

3) A toy car with mass \( m = 15.0 \text{g} \) rolls without friction along a track that goes over a hill. The hill is in the shape of an arc of radius \( R = 35.0 \text{cm} \). The force of gravity acts on the car at the point marked with an “x”. At the instant shown in the drawing its speed is 0.800 m/s in the direction shown. Draw an accurate free-body-diagram of the toy car in the box and find all of the following vector quantities indicated (both magnitude and direction). Clearly specify direction with respect to any unambiguous axis direction and make clear your choice of coordinate system. Show your work.

\[ \vec{F}_{net} = \]

\[ \vec{a}_{net} = \]

\[ \vec{v} = 0.800 \text{m/s}, \quad \alpha = 30^\circ \]
Newton’s 3rd Law and Circular Motion

Group Problem 04  Name_______________________

b. \( \ddot{a} = \)

c. \( \vec{N}_{T,C} = \)
   (Normal force by the track on the car.)

d. \( \vec{F}_{\text{centripetal}} = \)

e. \( \vec{F}_{\text{tangential}} = \)

f. \( \ddot{a}_{\text{centripetal}} = \)

g. \( \ddot{a}_{\text{tangential}} = \)

Is there a speed at which the normal force goes to zero? If so, what is it. What do you think happens next?
4) A neighbor’s child wants to go to a neighborhood carnival to experience the wild rides. The neighbor is worried about safety because one of the rides looks dangerous. She knows that you have taken physics and so asks your advice. The ride in question has a 10-lb chair which hangs freely from a 30-ft long chain attached to a pivot on the top of a tall tower. When a child enters the ride, the chain is hanging straight down. The child is then attached to the chair with a seat belt and shoulder harness. When the ride starts up the chain rotates about the tower. Soon the chain reaches its maximum speed and remains rotating at that speed. It rotates about the tower once every 3.0 seconds. When you ask the operator, he says that the ride is perfectly safe. He demonstrates this by sitting in the stationary chair. The chain creaks but holds and he weighs 200 lbs. Has the operator shown that this ride safe for a 50-lb child?