Unit: Newton’s Laws

I. Newton’s 3 Laws
   A. Types of Forces
   B. Drawing Force Diagrams
   C. Quantitative Analysis

II. Newton’s Laws and Pulleys
   A. Assumptions for strings and pulleys
   B. Static Pulleys
   C. Moveable Pulleys

III. Newton’s Laws and Friction
   A. Normal Component of Contact Force
   B. Static Friction
   C. Kinetic Friction

IV. Newton’s Laws and Circular Motion
   A. Centripetal Acceleration
   B. Centripetal Force

"today"
A ball swings in a horizontal circle at constant speed, as shown. Draw a force diagram for the ball from the top view. (You may neglect gravity.)
A 1.5 kg ball swings in a horizontal circle at a constant speed of 6.0 m/s, as shown. If the string is 2 m long, what is the tension in the string?
A 1.5 kg ball swings in a vertical circle, as shown. If the string is 2 m long, the tension in the string at the moment the ball is at the top is:

a. greater than $mv^2/r$

b. equal to $mv^2/r$

c. less than $mv^2/r$
A 1.5 kg ball swings in a vertical as shown. If the string is 2 m long, what is the tension in the string at the moment the ball is at the top (when \( v = 100.0 \text{ m/s} \))?
You are on a merry-go-round that is spinning very fast. When you let go, you are thrown to the outside (and completely off). What force threw you out?
You are given a joy ride in a trick plane at the bed and breakfast north of Houghton. The pilot does a complete vertical circle. Rate the magnitude of the normal force of your seat on you at the four positions shown from least to greatest.
The earth revolves around the sun once every year. We know that the sun is pulling the earth toward it. Why does the earth not plummet toward the sun, killing us all? (Explain with a force/velocity diagram.)
A 0.5 kg tetherball swings in a horizontal circle at constant speed. Draw a force diagram for the ball.
A 0.5 kg tetherball swings in a horizontal circle at constant speed. What is the magnitude of the tension in the 1 m string?
A 0.5 kg tetherball connected to a 1 m string swings in a horizontal circle at constant speed. What is the speed of the ball?
Which of the force diagrams below represents an object moving counterclockwise and slowing down?
You are at the fair in the vertical Loop of Death. When you are at the top of the ride, which way does the frictional force of the track on the cart point?
You are at the fair in the vertical **Loop of Death**. When you are at the top of the ride, the frictional force of the track on the cart is:

a) $f_{\text{track on cart}} < \mu mg$

b) $f_{\text{track on cart}} = \mu mg$

c) $f_{\text{track on cart}} > \mu mg$
You are at the fair in the vertical Loop of Death. When you are at the top of the ride, what is the magnitude of the frictional force of the track on the cart (in terms of m, g, r, and v)?
The double wheel shown below consists of an inner wheel that spins freely on the axle and an outer wheel that spins on the inner wheel. You grab the outer wheel and spin it clockwise. Which way does the frictional force of the outer wheel on the inner wheel, $f_{\text{outer on inner}}$, point?
You are racing around a circular track of radius 30m. You start from rest and accelerate at 10m/s². Draw a force diagram for your car after traveling once around.
You are racing around a circular track of radius 30m. You start from rest and accelerate at $10\text{m/s}^2$. What is the total horizontal force on your car after traveling once around?

$$v_f \approx 60\text{m/s}$$
You are racing around a circular track of radius 30m. You start from rest and accelerate at 10m/s². If the coefficient of static friction between the track and the car tires is $\mu_s = 0.3$, what is the minimum mass of your car (plus you) before it will slide off the track after traveling once around (when $v_f = 60$m/s)?
You are racing around a circular track of radius 30m. The track is slanted at 20° toward the center. You start from rest and accelerate at 10m/s². Draw a force diagram for your car after traveling once around (when $v_f = 60$ m/s).
You are racing around a circular track of radius 30m. The track is slanted at 20° toward the center. If the coefficient of static friction between the track and the car tires is $\mu_s = 0.3$, what is the maximum speed of your car (plus you) before it will slide off the track?