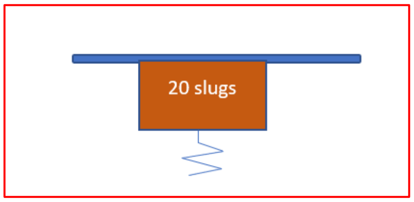
Particle FBDs and Newton's 2nd (*Use g = 9.81 m/s² = 32.2 ft/s²*)

1. For each underlined term, complete a FBD. ***Use F_{AB} format for all forces!*** Be sure to check Newton's 3rd.
   a) An engineering book sits on a desk in a classroom.
   b) A large box is accelerated upwards by a cable. The cable's other end is wound around a pulley wheel.

2. Complete a FBD for each underlined object. Use the symbols W, N, F_e and T where appropriate. For each FBD, calculate all forces.

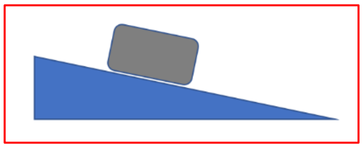
a) The rope's pull holds the crate in place against the stretched spring's force. The surface is frictionless.

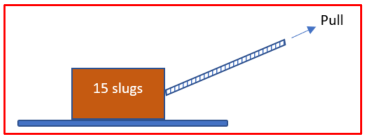


b) The spring stiffness constant is 200 lb/inch. The spring is compressed 5 inches and holds the 20 slug box in place against the ceiling.

3. After completing a FBD, choose either a "horizontal" axis system or "tilted" axis system. Then break all forces not aligned with an axis into components. You then may want to redraw the FBD. Finally, find the Normal force and the object's acceleration using Newton's 2nd.

a) The ramp's horizontal length is 8 meters while it's height is 3 meters. The ramp surface is smooth (i.e. basically frictionless). The crate has mass 100 kg.

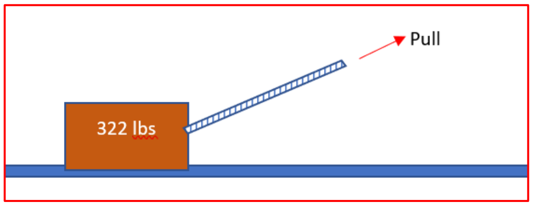




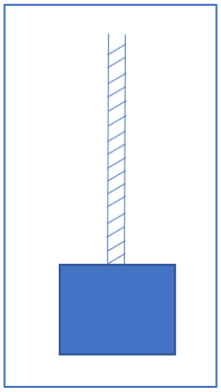
b) The rope's pull on the box is 200 lbs at 37 degrees above the horizontal. The surface is frictionless.

4. Find all the forces on and the acceleration of each box. A preliminary step should be to calculate the maximum possible value of static friction using μ_s*N.

a) The rope's pull is 70 N. The coefficient of static friction is 0.25 while that of kinetic friction is 0.15.



b) The rope's pull is 200 lbs at an angle of 30 degrees above the horizontal. The coefficient of static friction is 0.25 while that of kinetic friction is 0.15



5. Rope tension problems: In each case a rope pulls on a 483-pound crate. Determine the rope tension (after determining the magnitude and direction of the crate acceleration).

a) the crate is moving up.

t(secs)	0	1	2	3
speed (ft/sec)	0	3	6	9

b) The crate is moving down

t(secs)	0	1	2	3
speed (ft/sec)	0	3	6	9

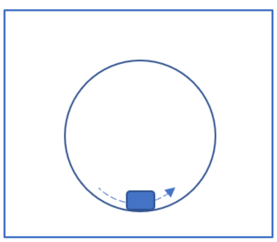
c) The crate is moving down

t(secs)	0	1	2	3
speed (ft/sec)	13	9	5	1

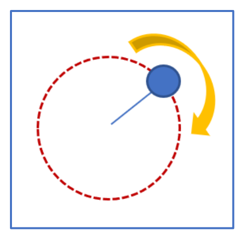
d) The crate is moving up.

t(secs)	0	1	2	3
speed (ft/sec)	13	9	6	9

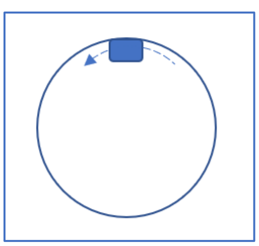
6. Circular Motion: In each case find all forces on the underlined object after completing a FBD with appropriately oriented n-t coordinates.



a) The <u>400 kg cart</u> (image to left) travelling with constant speed 20 meters/sec is at the bottom of the vertical loop of track. Friction on the cart is negligible.

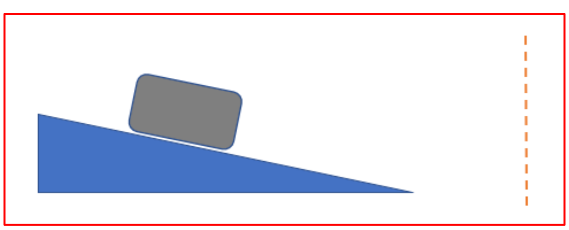


b) The <u>16.1 slug ball</u> (image to right) is whirled in a vertical circle at constant speed 8.9 feet/sec. The rope attached to the ball is 30 inches long. Find all forces when i) the ball is at the bottom of the circle ii) the ball Is at the top of the circle.



c) The <u>400 kg cart</u> (image to left) travelling with constant speed 20 meters/sec is at the bottom of the vertical loop of track. Friction on the cart is negligible

d) A <u>3220 lb car</u> takes a left-hand turn (horizontal surface) at constant speed 25 mph. The turn's radius of curvature is 80 feet.



7. The box represents a <u>500 kg bobsled</u> as it negotiates a frictionless horizontal banked turn at constant speed 30 mph. The turn has radius of curvature 50 feet with the turn center at the orange dashed line. Find the "ideal" banking angle. To solve the, you will need to break up the normal force into vertical and horizontal components.