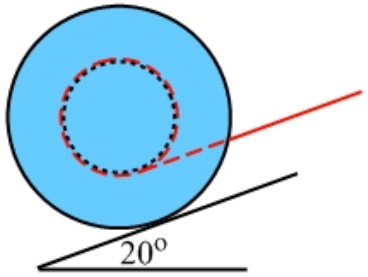
NS541 Session 10 (at-home) worksheet

Name: _____



A spool of mass *m* has a string wrapped around its axle, with the string coming away from the underside of the spool. The spool is on a ramp inclined at 20˚ with the horizontal, as shown in the figure. There is **no friction** between the spool and the ramp. Assuming you can exert as much or as little force on the end of the string as you wish (always directed up the slope) which of the following situations are possible? If a situation is possible, explain the condition necessary to achieve it. If the situation is not possible, explain why it is not possible.

(a) The spool remains completely motionless.

(b) The spool rotates about its center but does not move up or down the ramp.

(c) The spool has no rotation but moves down the ramp.

Situation 2 – Rolling a bowling ball down an incline.
In this situation, you release the ball from rest at the top of an incline, and the ball rolls without slipping down the incline. The angle of the incline is θ with respect to the horizontal. Keep your answers in terms of M, the mass of the ball, and g, the acceleration due to gravity.

Sketch the free-body diagram of the ball, for the situation of the ball rolling without slipping down the incline.

Apply Newton's second law:

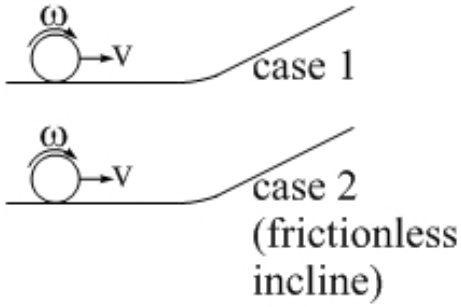
Apply Newton's second law for rotation:

Put your two equations together to solve for the ball's acceleration. Express the acceleration in terms of g and θ.

Find the force of friction that acts on the ball. Express the force of friction in terms of M, g and θ.

Situation 3 – Up the incline.

Case 1 and case 2 show two situations of a bowling ball traveling up an incline. In both cases, the ball is initially rolling without slipping with the same constant velocity along a horizontal surface before reaching the incline. In case 1, the ball then rolls without slipping up the incline. In case 2, the ball travels up a frictionless incline.



Draw two free-body diagrams. For case 1, show all the forces being applied to the ball as the ball rolls without slipping up the incline. If a force of friction acts on the ball, show clearly the direction of the force of friction as well as whether it is static friction (F_S) or kinetic friction (F_K). For case 2, show the forces being applied to the ball as the ball travels up the frictionless incline.

In which case does the ball travel farther up the incline before reversing direction?

[ ] case 1 [ ] case 2 [ ] equal in both cases

Justify your answer above conceptually, by referring to your free-body diagrams.

If you were to calculate the acceleration of the ball in case 1, and the force of friction acting on the ball in case 1, how would your answers compare to the answers you obtained for the situation of the ball rolling without slipping down the hill, on the previous page?