Problem 1  Work and Kinetic Energy: Loop

You are designing a new roller-coaster. The main feature of this particular design is to be a vertical circular loop-the-loop where riders will feel like they are being squished into their seats even when they are in fact upside-down (at the top of the loop). The coaster starts at rest from a height of 80 m above the ground, speeds up as it descends to ground level, and then enters the loop, which has a radius of 20 m.

Suppose a rider is sitting on a bathroom scale that initially reads \( W \) (when the coaster is horizontal and at rest). What will the scale read when the coaster is moving past the top of the loop? (You can assume that the coaster rolls on the track without friction).

Problem 2  Work and Kinetic Energy: Colliding Binary

Two identical stars, each having a mass and radius equal to that of our sun \((M = 2 \times 10^{29} \text{ kg} \text{ and } R = 7 \times 10^{8} \text{ m})\), are initially at rest in outer space. Their initial separation is the same as the distance between our sun and the earth, \(D = 1.5 \times 10^{11} \text{ m}\). Their gravitational interaction causes the stars to be pulled toward one another. Find the speed of the stars just before they collide.