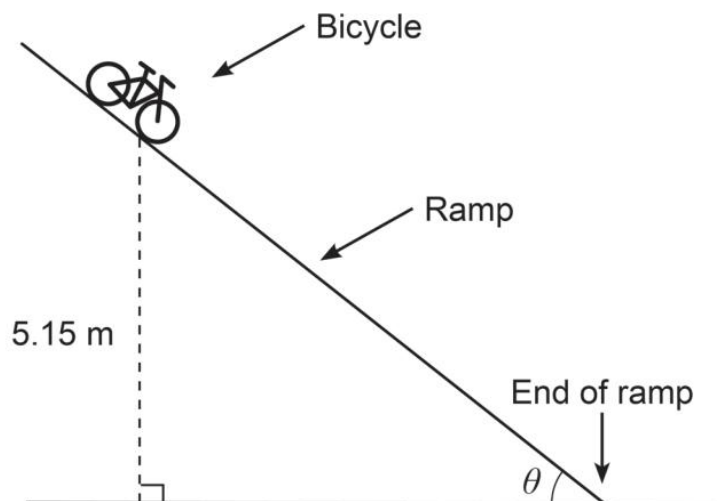


**Question 7****(10 marks)**

A bicycle rolls down a ramp from an initial height of 5.15 m as shown in the diagram below.



The speed,  $s$ , of the bicycle (in metres per second) when it reaches the end of the ramp is given by

$$s(\theta) = \sqrt{\frac{101 \sin(\theta) - \cos(\theta)}{\sin(\theta)}}$$

where  $\theta$  (in radians) is the ramp angle shown in the diagram.

- (a) Determine the speed of the bicycle at the end of the ramp, if the ramp angle is  $45^\circ$ .  
(2 marks)

- (b) Determine  $\frac{d}{d\theta} \left( \frac{101 \sin(\theta) - \cos(\theta)}{\sin(\theta)} \right)$ . Simplify your answer. (3 marks)

- (c) Hence, show that  $\frac{ds}{d\theta} = \frac{1}{2 \sin^2(\theta)} \sqrt{\frac{\sin(\theta)}{101 \sin(\theta) - \cos(\theta)}}$ . (2 marks)

- (d) Use the increments formula to estimate the change in  $s$  if the ramp angle is changed from  $45^\circ$  to  $46^\circ$ . (3 marks)