Problem 1

Write down an equation for the centripetal force acting on the mass m, in terms of the tension force F in the string and the angle θ that the string makes with the vertical. Write down a second equation relating the tension F and the angle θ to the weight of the mass.

$$F_{net} = F - F_g \tag{1}$$
$$= F - F\cos\theta \tag{2}$$

$$F_g = mg = F\cos\theta \tag{3}$$
$$m = \frac{F\cos\theta}{g} \tag{4}$$

Problem 2

Usin your equations from Question 1, derive an expression for the speed, v in terms of the radius r and the angle θ.

$$F_{net} = \frac{mv^2}{r} = F(1-\cos\theta) \tag{5}$$
$$v^2 = \frac{rF(1-\cos\theta)}{m} \tag{6}$$
$$v^2 = \frac{rF(1-\cos\theta)}{(F\cos\theta)/g} \tag{7}$$
$$v^2 = \frac{rg(1-\cos\theta)}{\cos\theta} \tag{8}$$
$$v = \sqrt{\frac{rg(1-\cos\theta)}{\cos\theta}} \tag{9}$$

Problem 3

Find an expression for the radius in terms of the angle θ and the length of the string, l, and hence write an expression for v in terms of l and θ.

$$r = l\sin\theta \tag{10}$$
$$\text{Hence} \quad v = \sqrt{\frac{l\sin\theta g(1-\cos\theta)}{\cos\theta}} \tag{11}$$
$$= l\tan(\theta)g(1-\cos\theta) \tag{12}$$