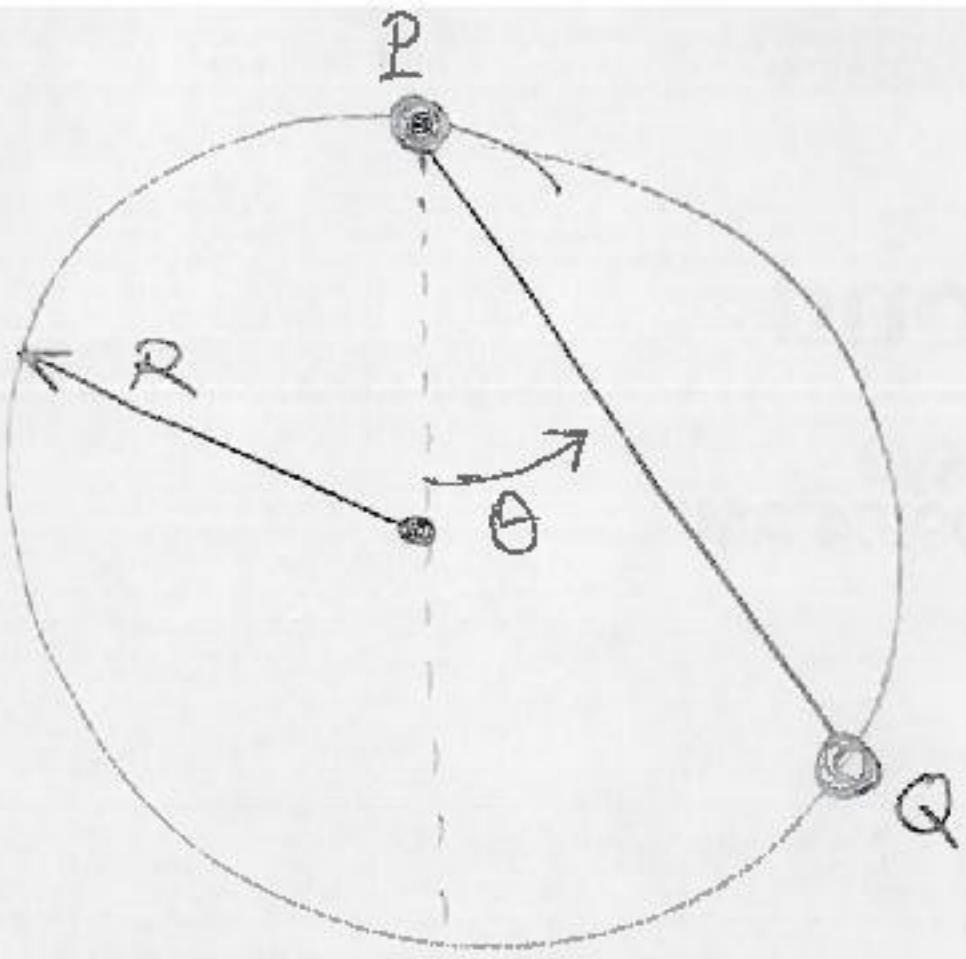
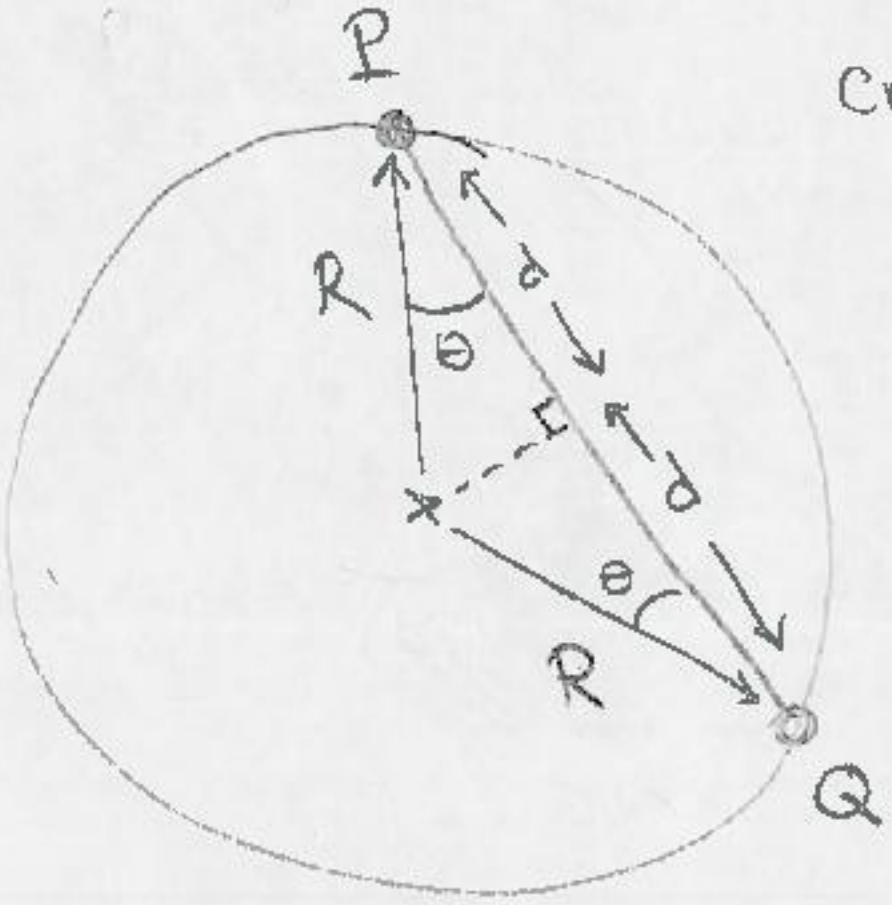


Circle of radius R.
String tied from top "P" to location "Q".
Bead slides down string without friction.

a) How long does bead take to slide to Q?

We need to know distance travelled + acceleration.



Acceleration is $a = g\cos\theta$

Create identical right triangles, as shown. The side of triangle

$$d = R\cos\theta$$

so total distance travelled is

$$\text{dist} = 2d$$
$$= 2R\cos\theta$$

Now use kinematics to compute time it takes to slide from P to Q:

$$\text{dist} = \cancel{v_0 t}^{\,0} + \tfrac{1}{2} a t^2$$

$$2R\cancel{\cos\theta} = \tfrac{1}{2}(g\cancel{\cos\theta})t^2$$

$$t^2 = \frac{4R}{g}$$

$$\rightarrow \boxed{t = 2\sqrt{\frac{R}{g}}}$$

Note time does not depend on angle θ

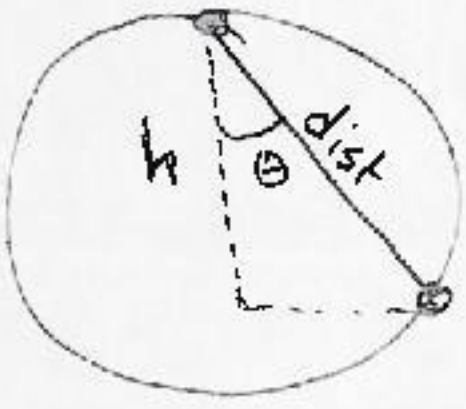
b) Speed at point Q can be found via kinematics, or via conservation of energy.

Kinematics: $v_f^2 = \cancel{v_0^2}^{\,0} + 2a(\text{dist})$

$$= 2(g\cos\theta)(2R\cos\theta)$$

$$= 4gR\cos^2\theta$$

$$\rightarrow \boxed{v_f = 2\cos\theta\sqrt{gR}}$$



energy $\frac{1}{2}mv_f^2 = mgh = mg(2R\cos\theta)\cos\theta$

$$= 2mgR\cos^2\theta$$

$$\rightarrow v_f^2 = 4gR\cos^2\theta$$

$$\boxed{v_f = 2\cos\theta\sqrt{gR}}$$