NEWTON'S PROBLEM: TO INFER FORCES FROM MOTIONS

The ***centripetal force*** retaining a body in uniform circular motion varies as

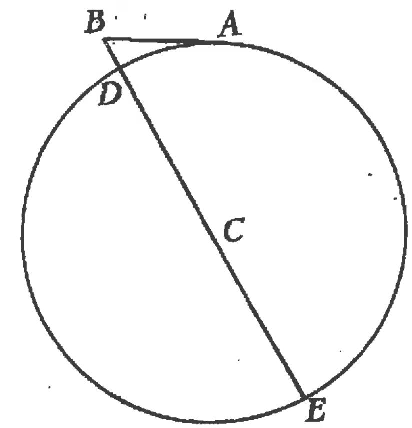
$$\mathbf{BD}/\delta t^2$$

which – by Euclid 3,36 – becomes

$$\propto (\mathbf{AB}^2/\mathbf{BE})/\delta t^2$$

which, as **B** approaches **A,**

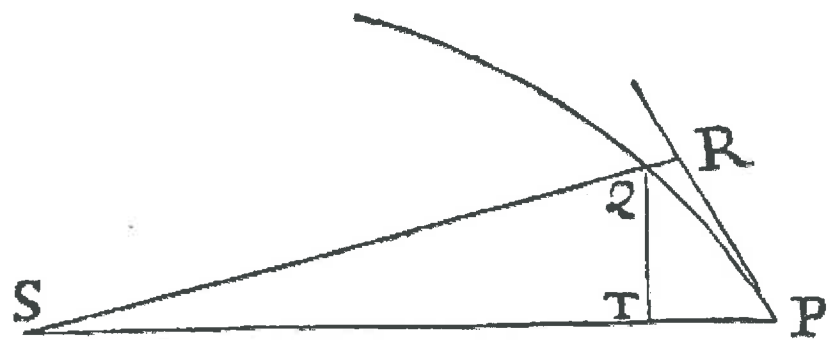
$$\propto v^2/r \propto r/P^2$$



***Problem*: How to generalize from uniform circular to arbitrary curvilinear motions – e.g. Kepler's ellipse?**

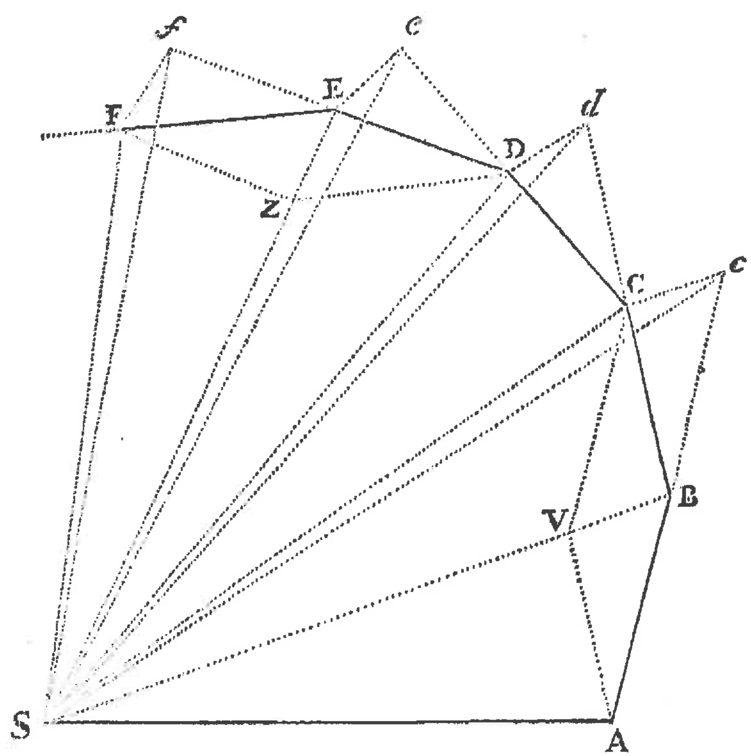
Hooke's Proposal: Consider Only Forces Directed Toward a Single Point in Space

Prop. 6: To infer the "centripetal" force, toward S, from the curvilinear motion:



force $\propto$ lim **QR/δt^2**

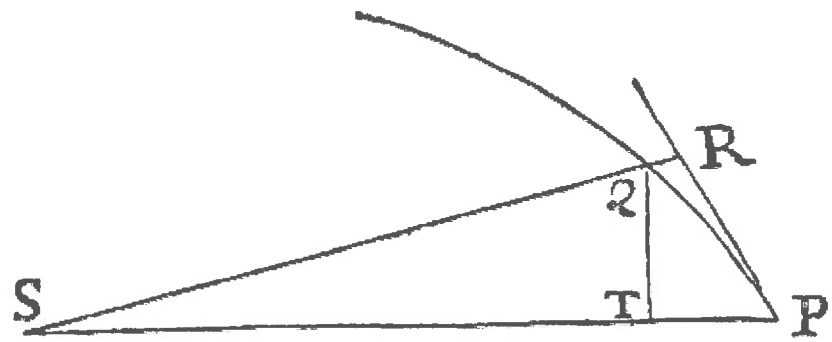
The Area Rule: the First Key



Theorem 1: If all departures of a body from uniform motion in a straight line are directed toward a single point in space S – i.e. the external force on the body is centripetal – then the body sweeps out equal areas in equal times with respect to S.

Newton's Basic Solution for Motion Under Centripetal Forces: the Second Key

Prop. 6: To infer the centripetal force, toward S, from the curvilinear motion:



force $\propto$ lim **QR/δ*t*²**

$\propto$ lim **QR/(QT²xSP²)**

$$\frac{1}{2r^2}\left(\frac{1}{r}+\frac{d^2}{d\theta^2}\left(\frac{1}{r}\right)\right)$$