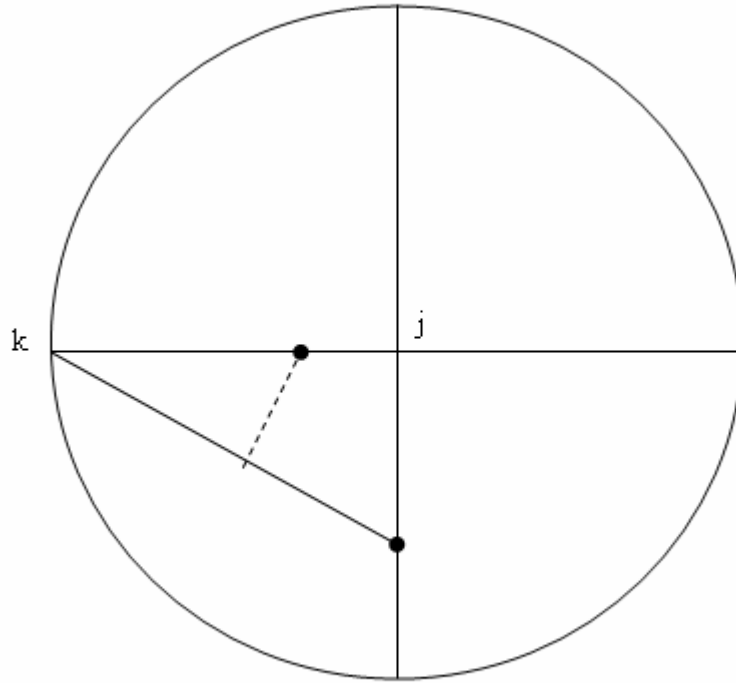


P Velocity

This chapter demonstrates a relationship between the radius of the hodograph velocity circle and the term GM that will contribute to the *a priori* proof of the Energy Equation.

The tangential velocity when the planet is at position p we designated V_{t90} . It is by inspection of a hodograph for a single orbit equal to the radius of the velocity circle. We may label the radius of the velocity circle V_2 . We can use the terms interchangeably when actual direction is not important, depending on the context, since they both refer to a velocity arrow of equal magnitude.



Note that we have represented the planet at position p and that the segment \overline{jk} represents the tangential velocity of the planet in this position and that the segment is also the radius of the velocity circle.

We can designate it to be V_{t90} or V_2 but we would like to refer to its magnitude and not be confused by its direction in the discussion below so we will call it V_2 . After all is related here and in subsequent chapters however, it is

interesting to note that the absolute value of the tangential velocity for position p plays such an important role in the orbital behavior of planets.

In a Chapter 36 we showed that areal velocity, which is constant all around the orbit, is $h = \sqrt{GM\sqrt{p}}$

At position p , $h = V_{t90} \times p$ by inspection of the wedge of area swept. Recall that h is twice the area of the triangular wedge below:

Recall that the wedge is swept in a tiny unit of time that we designate to be equal to 1 so that the far side of the wedge has a length equal numerically to the tangential velocity:

So since $h = V_{t90} \times p = V_2 \times p$ we can solve for p and state $p = \frac{h}{V_2}$

and since also $h = \sqrt{GM\sqrt{p}}$:

We can square the above equation to state $h^2 = GMp$ and

substitute $\frac{h}{V_2}$ for p :

$h^2 = GM \frac{h}{V_2}$ so that after dividing both sides by h :

$$h = \frac{GM}{V_2}$$

and $hV_2 = GM$

We will use this relationship between the radius of the velocity circle and the factors areal velocity and GM in order to extract the Energy Equation form the hodograph in the next chapters.