

cos ϕ is unity and $\phi = 0$ to 2π
hence the maximum and minimum
energy are $\frac{1}{2}mv^2(1 \pm \cos \phi)$
and $\frac{1}{2}mv^2(1 \mp \cos \phi)$

The total energy is con-
stant $\frac{1}{2}mv^2$ and $\cos \phi = 0$ in $\phi = 0$
~~and $\phi = \pi$ in $\phi = \pi$ in $\phi = \pi$~~

The total energy is
constant $\frac{1}{2}mv^2$ and $\cos \phi = 1$ in $\phi = 0$, i.e.
at $\phi = 0$ and $\phi = \pi$ in $\phi = \pi$
and $\cos \phi = -1$ in $\phi = \pi$, i.e.
at $\phi = \pi$ and $\phi = 0$ in $\phi = 0$