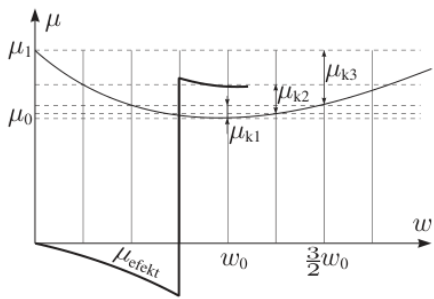
5. Vibration (10 pts)

1) $\mu mg\tau \ll v$.

2) $F = 0$, when $|v| < u$; $F = \mu mg$, when $|v| > u$.

3) The x-component of the frictional force cancels in average out, the y-component is left: $F = \mu mgv/\sqrt{v^2 + u^2}$.

4) $F = [\mu(v + u) + \mu(v - u)]mg$, if $v > u$ and $F = [\mu(u + v) - \mu(u - v)]mg$, if $v < u$ ($F > 0$ means that F and v are opposite to each other). It is easy to see that by small values of v, the force starts linearly decreasing [with $F(v = 0) = 0$] ($F < 0$ implies that force and velocity are in the same direction). At $u = v$, the graph exerts a jump, F becomes positive, and starts decreasing. The attached graph presents a sketch of the effective friction coefficient; the construction has been based on the lengths $\mu_{k1} = \mu(w_0/2) - \mu(w_0)$, $\mu_{k2} = \mu(w_0/4) - \mu(5w_0/4)$, and $\mu_{k3} = \mu(0) - \mu(3w_0/2)$.



5) The rest position is unstable, if $u < w_0$: the particle obtains the (stable) velocity u. If $u > w_0$, the rest position is stable, and the particle velocity remains 0.