Calculate Coefficient of Friction With Only Time and Distance

Kinetic:

If you push an object once and let it stop, the only force acting on it is friction.

$\Sigma F = F_f$

$ma = mg\mu_k$

$\mu_k = a/g$

We also know that impulse equals the change in momentum and the finale velocity is 0.

$\Sigma F t = m\Delta v$

$mat = m(-v)$

$a = -v/t$

When we plug these equations into each other, we get:

$\mu_k = (-v/t)/g$

$\mu_k = -v/gt$

$gt\mu_k = -v$

We know from energy that $KE_f - KE_i = F_f * d * cos(\theta)$ and that the initial KE is 0.

$-\frac{1}{2}mv^2 = -mgd\mu_k$

$v = \sqrt{2gd\mu_k}$

We can plug this into the previous equation and get:

$gt\mu_k = -(\sqrt{2gd\mu_k})$

$g^2t^2\mu_k^2 = 2gd\mu_k$

$g^2t^2\mu_k^2 - 2gd\mu_k = 0$

This equation can be factored and we can find μ by finding the roots:

$$\mu_k = \frac{-(-2gd)\pm\sqrt{(2gd)^2}}{2(g^2t^2)} \text{ or } \mu_k = \frac{4d}{2t^2g}$$

Static:

On an inclined plane, the only force acting on an object is gravity and static friction, which holds the object in place.

$\Sigma F = F_f - F_g$

If the object is at equilibrium and $\Sigma F = 0$ then:

$F_f = F_g$

$mgCos(\theta)\mu_s = mgSin(\theta)$

$$\mu_s = \frac{Sin(\theta)}{Cos(\theta)} \text{ or } \mu_s = Tan(\theta)$$ (θ refers to the angle at which the object starts moving)