

COE and Heat

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- **Heat (Q)** is created when work is done against friction.
- **$W_f = Q$**
- Heat (Q) is always added to the **“end”** side of the COE equation.
- You cannot have heat generated unless work has been done against friction.

COE

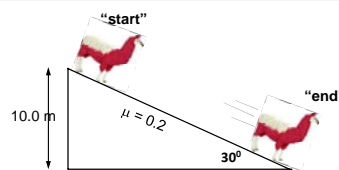
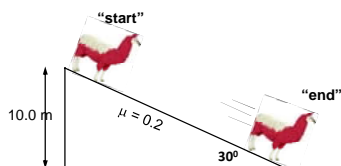
- When a moving object slides to a stop, friction is involved.
- Friction causes heat energy, Q
- Kinetic energy is changed into the same amount of heat energy.
- $KE = Q$
- Energy = Energy

More Formulas

- **$W_F = F_F d = Q$** WORK done by FRICTION, not weight
- **$W_F = F_N \mu d = Q_{\text{level}} = mg \mu d$**
– For this class $Q_{\text{level}} = mg \mu d$ is always true
- **$W_F = Q_{\text{incline}} = mg \cos \theta \mu d$**
– For this class $Q_{\text{incline}} = mg \cos \theta \mu d$ is always true

Problem

- Ralph the Wonder Llama begins from rest at the top of a 10 meter tall playground slide. If the coefficient of friction between Ralph and the slide is 0.2 how fast will he be going at the bottom of the slide?



COE: $PE_G = KE + Q$

Formula substitution: ~~$mgh = 1/2 mv^2 + mg \cos \theta \mu d$~~

Number substitution: $(9.8 * 10) = (.5)v^2 + 9.8 \cos 30^\circ (.2)(10/\sin 30)$

(notice that the distance that Ralph travels along the slide must be determined by using $\sin \theta = h/d$)

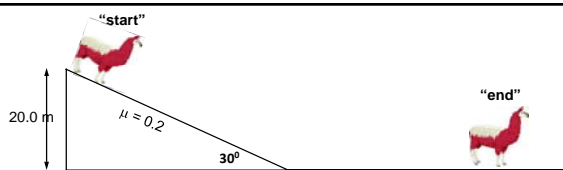
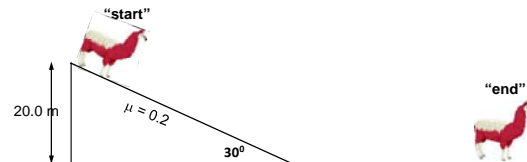
$v = 11.32 \text{ m/s}$

Solving COE Problems

- | | |
|----------------------|----------------------------|
| • At the "start" | • At the "end" |
| • Can it Fall | • Can it Fall |
| – Yes add PE_G | – Yes add PE_G |
| • Is it Moving | • Is it Moving |
| – Yes add KE | – Yes add KE |
| • Is work being done | • Is there Friction |
| – Yes add W | – Yes add Q |
| • Is there a spring | • Is there a spring |
| – Yes add PE_s | – Yes add PE_s |

Practice

- Ralph the Wonder Llama is at it again. This time he begins from rest at the top of a 20 meter tall playground slide. If the coefficient of friction between Ralph and the slide is 0.2 how far will he slide on level ground before coming to a stop?



COE: $PE_G = Q_i + Q_L$

Formula substitution: $mgh = mg\cos\theta\mu d + mg\mu d$

Number substitution: $20 = \cos 30^\circ (.2)(20/\sin 30) + (.2)d$

(notice that the distance that Ralph travels along the slide must be determined by using $\sin\theta = h/d$)

$\Delta X = 65.36 \text{ m}$