$N \cdot m$ $\qquad$ $kg\left(\frac{m}{s}\right)^2 \Rightarrow$ Joule

$$W_{net} = \int_i^f \vec{F}_{net} \cdot d\vec{r} = \frac{m v_f^2}{2} - \frac{m v_i^2}{2} = K_f - K_i = \Delta K$$

$$W_{gravity} = \int_i^f \vec{F}_{gr}\, d\vec{r} = -\left(mgy_f - mgy_i\right) = -(U_f - U_i)$$

$$-\left(U(\vec{r}_f) - U(\vec{r}_i)\right)$$

potential energy

If Work does not depend on path, depens only inital and final position $\Rightarrow$ force conservative

$$\int \vec{F}_{net} \cdot d\vec{r} = \Delta K = \int \underbrace{\left(\vec{F}_{cons} + \vec{F}_{non\ cons}\right)}_{\vec{F}_{net}} d\vec{r}$$

$$\Delta K = \underbrace{-(U_f - U_i)}_{\Delta U} + \int \vec{F}_{non\ cons}\, d\vec{r}$$

$$\Delta K + \Delta U = \int \vec{F}_{non\ cons}\, d\vec{r} = W_{non\ conservative\ forces}$$

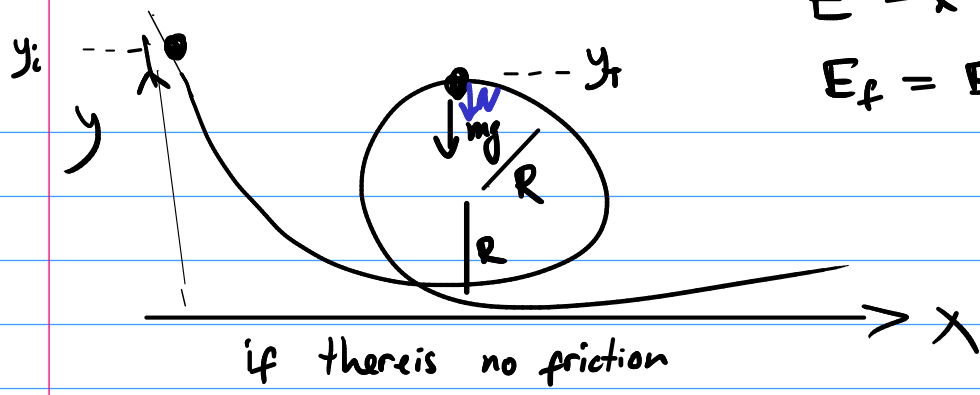
iff $W_{non\ cons} = 0 \Rightarrow$

$$K_f + U_f = K_i + U_i$$

Energy conservation

$\Delta K + \Delta U = 0$

$K_f - K_i + U_f - U_i = 0$



if there is no friction

$$E = K + U$$

$$E_f = E_i$$

K_i

$$E_i = mgy_i + 0$$

$$E_f = mgy_f + \frac{mv_f^2}{2}$$

$$E_i = E_f$$

$$\cancel{m}gy_i = \cancel{m}gy_f + \frac{\cancel{m}v_f^2}{2}$$

y: $N + mg = ma_c = m\frac{v_f^2}{R}$

0

$$\cancel{m}g = \cancel{m}\frac{v_f^2}{R}$$

$$\cancel{g}y_i = \cancel{g}\cdot y_f + \frac{\cancel{g}\cdot R}{2} \Rightarrow 2R + \frac{R}{2} = \boxed{\frac{5R}{2} = y_i}$$

Power

$$P = \frac{dW}{dt} =$$

$$W = \int_i^f dW = \int_i^f \vec{F} \cdot d\vec{r}$$

$$P = \frac{dW}{dt} = \frac{\vec{F} \cdot d\vec{r}}{dt} \Leftarrow \text{iff } \vec{F} = \text{const} = \vec{F} \cdot \frac{d\vec{r}}{dt}$$

$\vec{r}$

$$P = \vec{F} \cdot \vec{v}$$

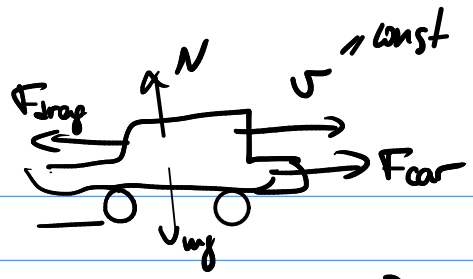
$[\text{Watts}] = J/s$

horse power

$1\,hp = 746\,W$

$\vec{F} \cdot \vec{dr} =$

$= F \cdot dr \cdot \cos\theta$



$P = 100\ hp = 746\ W \cdot 100$

$F_{net} = 0 = ma$ (a = 0)

$30\ \frac{mi}{h} = 31\ m/s$

$F_{car} v = F_{drag} v = \frac{1}{2} \rho C \cdot v^2 v = 8900\ N \cdot m/s$

($\rho = 1.2\ \frac{kg}{m^3}$, $C = 0.5$)

$P = F_{car} \cdot v = 8900 \cdot \frac{1\ hp}{746\ W} \simeq 11\ hp$