Power:

$$P \equiv \frac{dE}{dt}$$

The power of work done by a force

$$P = \frac{dW}{dt} = \frac{\vec{F} \cdot d\vec{x}}{dt} = \vec{F} \cdot \vec{v}$$

Unit $$P = \vec{F} \cdot \vec{v} \Rightarrow Nm/s = J/s = Watt\ (W)$$

$$1\,hp = 746\,W$$ .746 kW

A car's engine provides a constant output power of 100 hp (74,600 W).

What is its pushing force at

10m/s

$P = Fv$ $\quad F = \frac{P}{v}$

$F = \frac{74600}{10} = 7{,}460\ N$

30m/s

$F = \frac{74600}{30} = 2{,}486.67\ N$

A car's engine provides a constant output power of 100 hp (74,600 W).

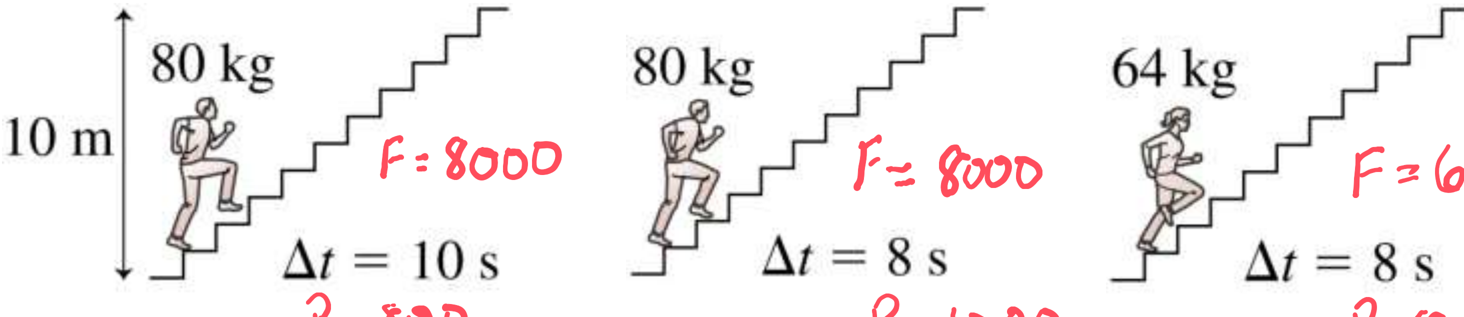
What is its pushing force at

10m/s $\quad$ $P=Fv$ $\quad$ $F=P/v=7{,}460N$

30m/s $\quad$ $P=Fv$ $\quad$ $F=P/v=2{,}486N$

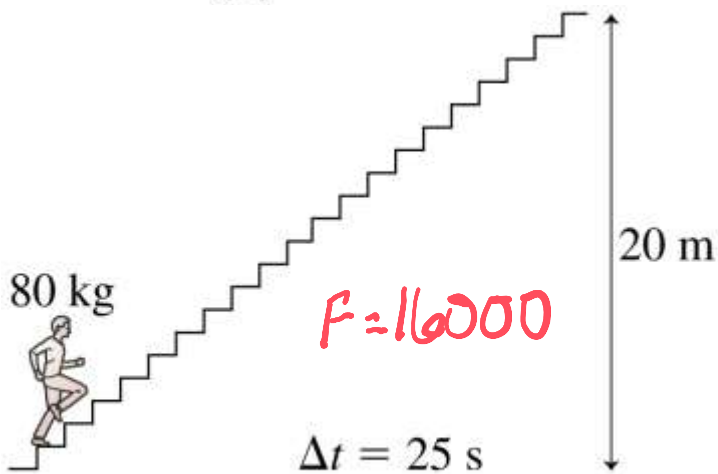
$P = Fv$ $F = mgh$

Four students run up the stairs in the time shown. Rank in order, from largest to smallest, their power outputs P_a to P_d.



$F = 8000$ $F = 8000$ $F = 6400$

(a) $P = 800$ **(b)** $P = 1000$ **(c)** $P = 800$



$F = 16000$

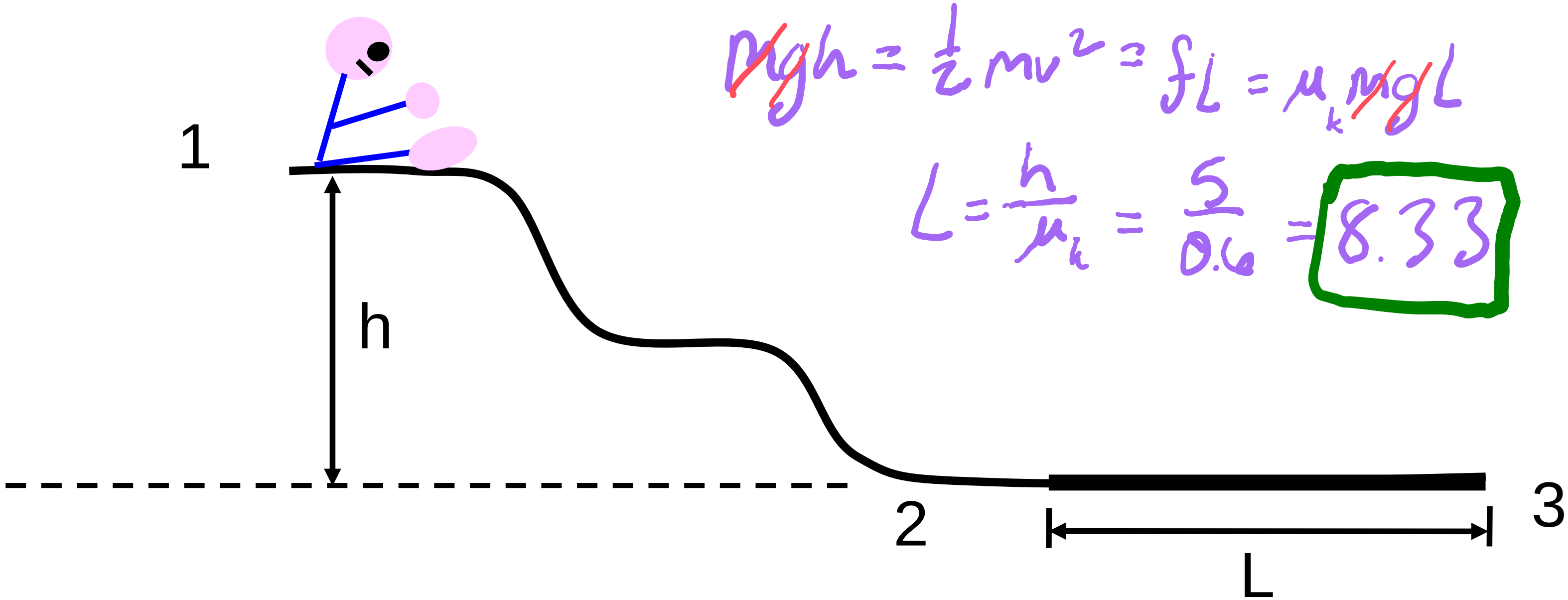
(d) $P = 640$

1. $P_b > P_a = P_c > P_d$
2. $P_d > P_a = P_b > P_c$
3. $P_d > P_b > P_a > P_c$
4. $P_b > P_a > P_c > P_d$
5. $P_c > P_b = P_a > P_d$

Ted decides to ride the rump roaster. He starts at the top of a 5 meter high frictionless slide. At the bottom he enters a sliding zone that has a coefficient of friction μ = 0.6 with his bottom. What is the minimum length L of the zone that will stop him, and does the length depend on Ted's mass? No

$$\cancel{m}gh = \frac{1}{2}mv^2 = fL = \mu_k \cancel{m}gL$$

$$L = \frac{h}{\mu_k} = \frac{5}{0.6} = \boxed{8.33}$$



Method 1

Two Steps:

1. Choose "initial" when Ted is at the top, and "final" when he is at the bottom before getting on the frictional track. Set the bottom to be y=0.

$$U_2 + K_2 = U_1 + K_1$$

$$0 + \frac{1}{2} m V_2^2 = mgh + 0$$

2. After getting on the frictional track, Ted's kinetic energy is decreased by the negative work done by the frictional force and he comes to a stop after traveling a distance of L.

$$W_{net} = \vec{f} \cdot \Delta \vec{x} = -\mu N L = -\mu m g L$$

$$W_{net} = K_3 - K_2 = 0 - \frac{1}{2} m V^2 = -\mu m g L$$

$$\mu m g L = \frac{1}{2} m V^2 = m g h_i$$

$$L = \frac{h_i}{\mu} = \frac{5\,m}{0.6} = 8.3\,m$$

With an external force, mechanical energy is not conserved. Need to include a term of the work done by the external force:

$$U_i + K_i + W_{ext} = U_f + K_f$$

If there is a friction (thermal energy):

$$W_{ext} = \vec{f} \cdot \Delta\vec{x} = \Delta E_{th}$$

Method 2

$$U_f + K_f = U_i + K_i + W$$

$$0 + 0 = mgh_i + K_i + W$$

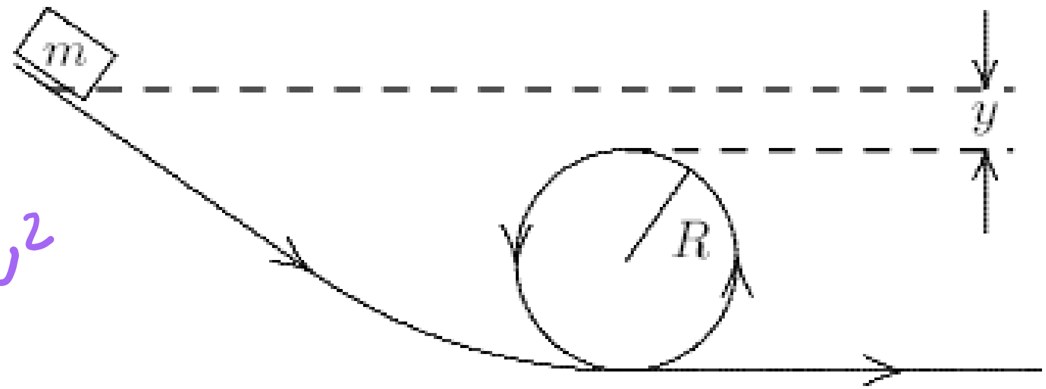
$$W = \vec{f} \cdot \Delta\vec{x} = -\mu mgL$$

$$mgh_i = -W = \mu mgL$$

$$L = \frac{h_i}{\mu} = \frac{5\,m}{0.6} = 8.3\,m$$

A small object of mass m starts from rest at the position shown and slides along the frictionless loop-the-loop track of radius R. What is the smallest value of y such that the object will slide without losing contact with the track?

$h = 2R + y$



$$mgh \geq mg \cdot 2R + \frac{1}{2}mv^2$$

$$\cancel{m}g + N = \cancel{m}\frac{v^2}{R}$$

$$v^2 = gR$$

$$\boxed{y \geq \frac{R}{2}}$$

$N = 0$

$v = v_{min}$