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

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

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

What is its pushing force at

10m/s

30m/s

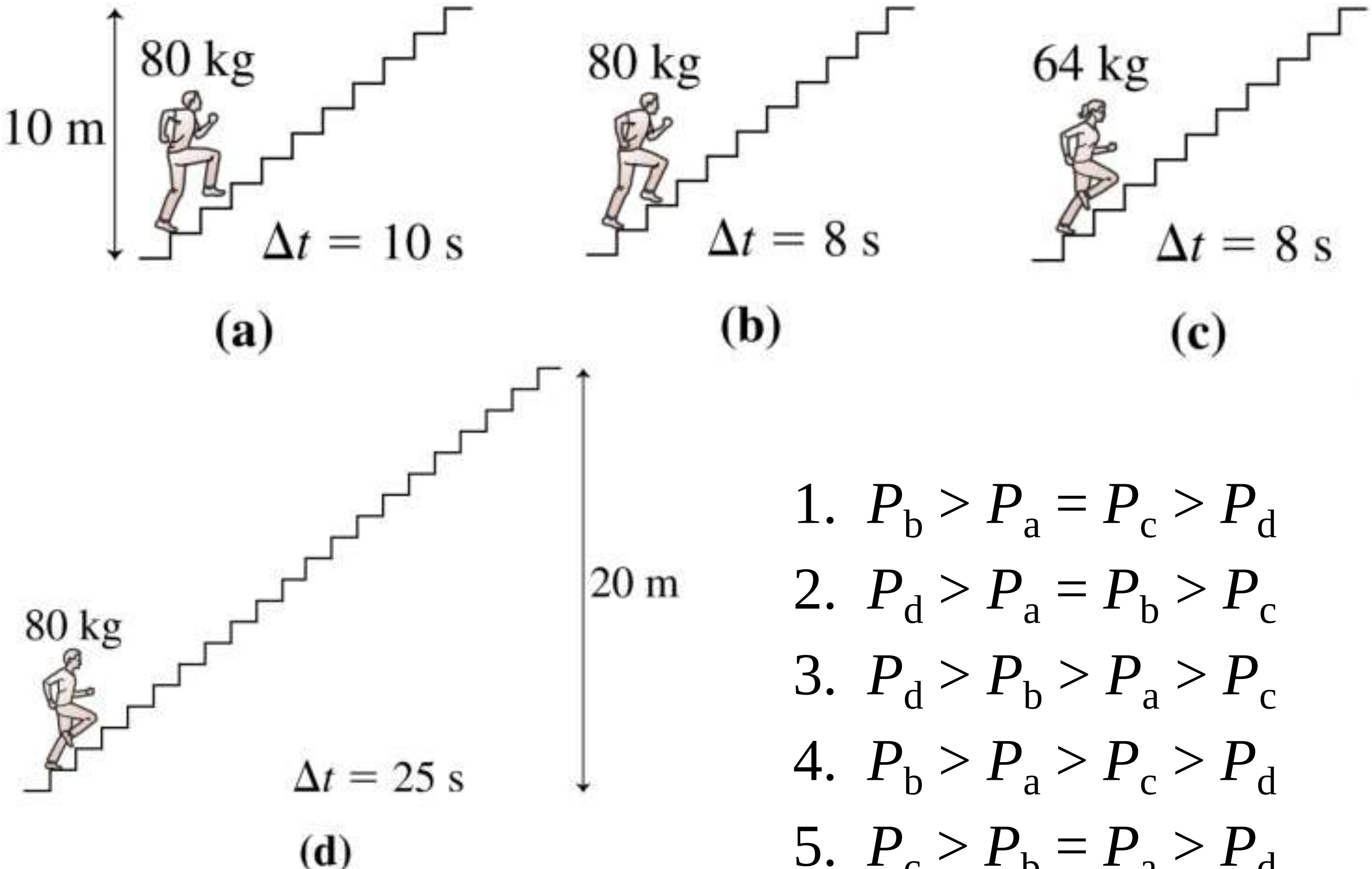
A car's engine provides a constant output power of 100 hp (74,600 W).

What is its pushing force at

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

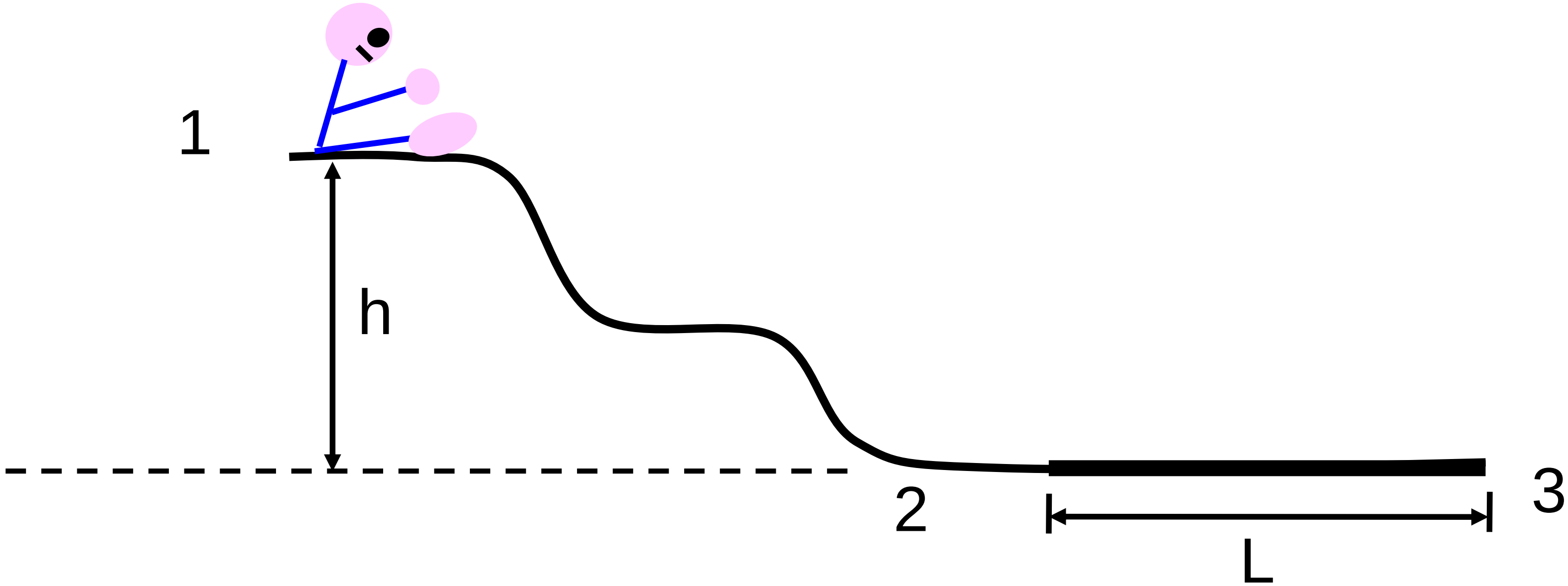
30m/s $\quad P=Fv \quad F=P/v=2{,}486N$

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.



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 $\mu = 0.6$ 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?



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.

$$W_{net} = \vec{f} \cdot \Delta\vec{x} = -\mu NL = -\mu mgL$$

$$W_{net} = K_3 - K_2 = 0 - \frac{1}{2} mV^2 = -\mu mgL$$

$$\mu mgL = \frac{1}{2} mV^2 = mgh_i$$

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

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?