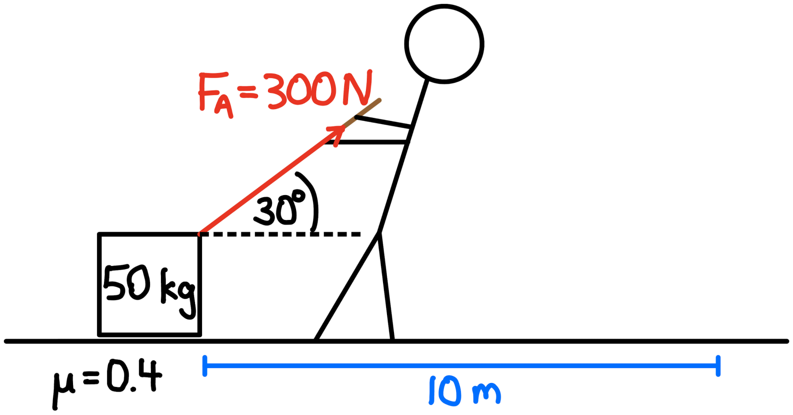
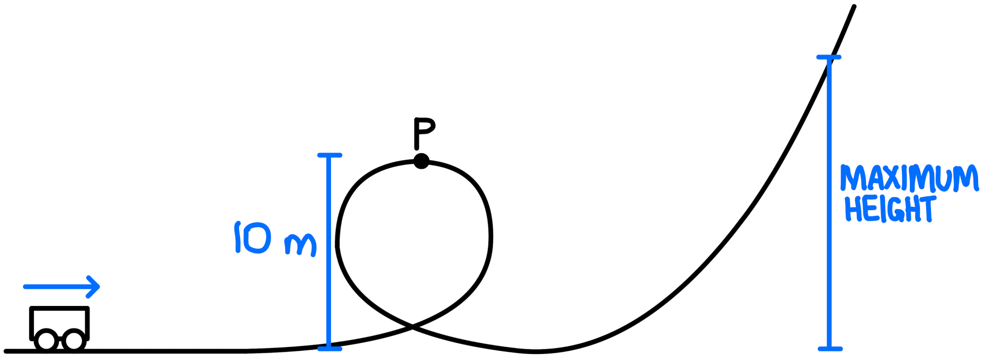
A 50 kg box starts from rest and is pulled 10 m across the floor as shown.



a) How much work does the person do on the box?
b) How much work does friction do on the box?
c) What is the total amount of work done on the box?
d) What is the final speed of the box? *Solve using energy*.

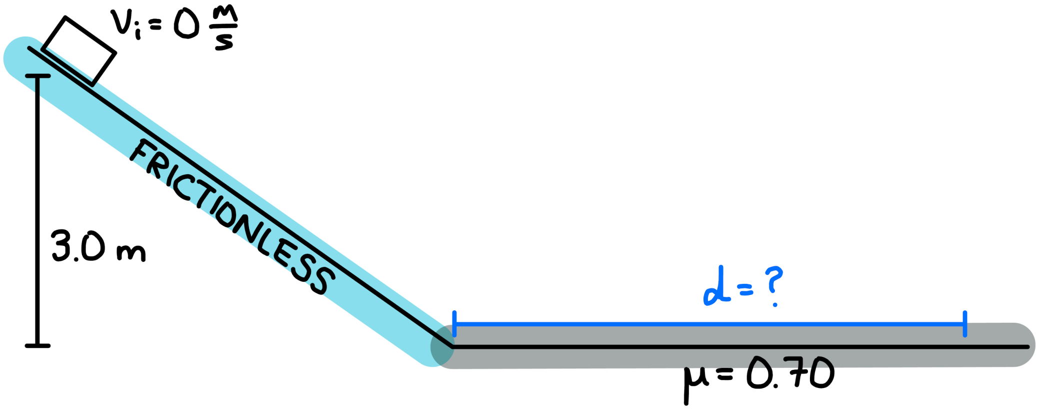
In an amusement park ride, a 400 kg car is given an initial speed of 90 km/h.



a) If 20 kJ of mechanical energy is lost due to friction by the time the car reaches point P, what is its speed at that point?

b) What maximum height does the car reach if a total of 40 kJ of mechanical energy is lost due to friction (from the beginning to the maximum height)?

A object starts from rest 3.0 m above the ground and slides down a frictionless incline and then along a rough horizontal surface.



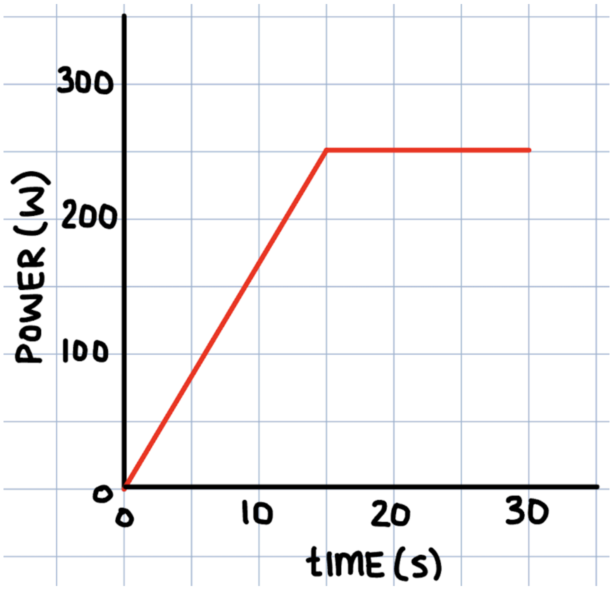
a) What is the speed of the object when it reaches the bottom of the incline?

b) How far does the block slide on the horizontal surface before coming to rest?

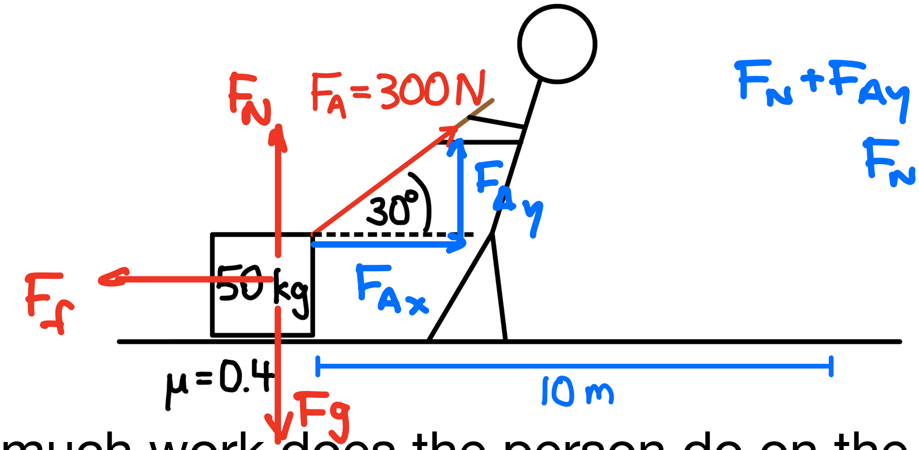
The graph shows the power output of a device used to accelerate a 150 kg object.

a) What is the final speed of the object if it starts from rest?

b) If the device consumes 9600 J of energy over the 30 seconds, what is the efficiency of the device?



A 50 kg box starts from rest and is pulled 10 m across the floor as shown.



$$F_N + F_{Ay} = F_g$$

$$F_N = F_g - F_{Ay}$$

$$= mg - F_A \sin 30°$$

a) How much work does the person do on the box?

$$W = F_{Ax} d$$

$$= F_A \cos 30° d$$

$$= (300)\cos 30°(10) = \boxed{2600 J}$$

b) How much work does friction do on the box?

$$W = -F_f d$$

$$= -\mu F_N d$$

$$= -\mu(mg - F_A \sin 30°)d$$

$$= -(0.4)[(50)(9.8) - (300)\sin 30°](10) = \boxed{-1360 J}$$

c) What is the total amount of work done on the box?

$$W_{NET} = 2598 J - 1360 J = \boxed{1240 J}$$

d) What is the final speed of the box? *Solve using energy*.

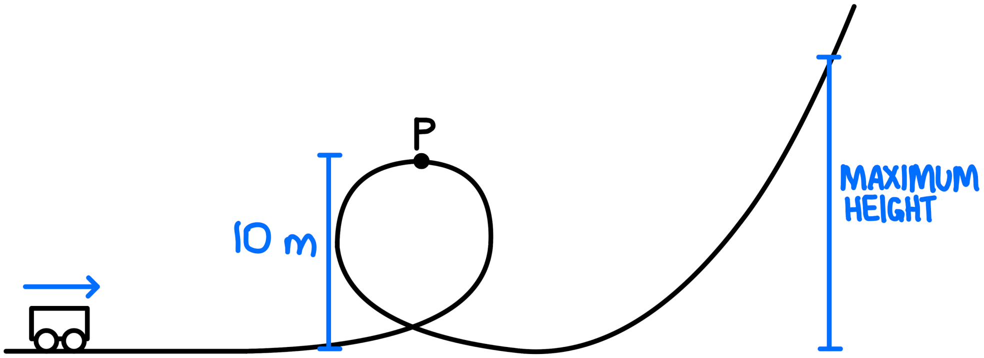
$$W = \Delta E_K$$

$$= E_{K_f} - \cancelto{0}{E_{K_i}}$$

$$= \frac{1}{2} m v_f^2$$

$$v_f = \sqrt{\frac{2W}{m}} = \sqrt{\frac{2(1240)}{50}} = \boxed{7.04 \frac{m}{s}}$$

In an amusement park ride, a 400 kg car is given an initial speed of 90 km/h.



a) If 20 kJ of mechanical energy is lost due to friction by the time the car reaches point P, what is its speed at that point?

$V_i = 90 \frac{km}{h} = 25 \frac{m}{s}$

$h_i = 0$

$V_f = ?$

$h_f = 10 m$

$m = 400 kg$

$Q = 20000 J$

$$E_i = E_f + Q$$

$$E_{k_i} + \overset{0}{\cancel{E_{p_i}}} = E_{k_f} + E_{p_f} + Q$$

$$\frac{1}{2}mv_i^2 = \frac{1}{2}mv_f^2 + mgh_f + Q$$

$$v_f = \sqrt{v_i^2 - 2gh_f - \frac{2Q}{m}}$$

$$= \sqrt{(25)^2 - 2(9.8)(10) - \frac{2(20000)}{400}}$$

$$= \boxed{18.1 \frac{m}{s}}$$

b) What maximum height does the car reach if a total of 40 kJ of mechanical energy is lost due to friction (from the beginning to the maximum height)?

$V_i = 90 \frac{km}{h} = 25 \frac{m}{s}$

$h_i = 0$

$v_f = 0$

$h_f = ?$

$m = 400 kg$

$Q = 40000 J$

$$E_i = E_f + Q$$

$$E_{k_i} + \overset{0}{\cancel{E_{p_i}}} = \overset{0}{\cancel{E_{k_f}}} + E_{p_f} + Q$$

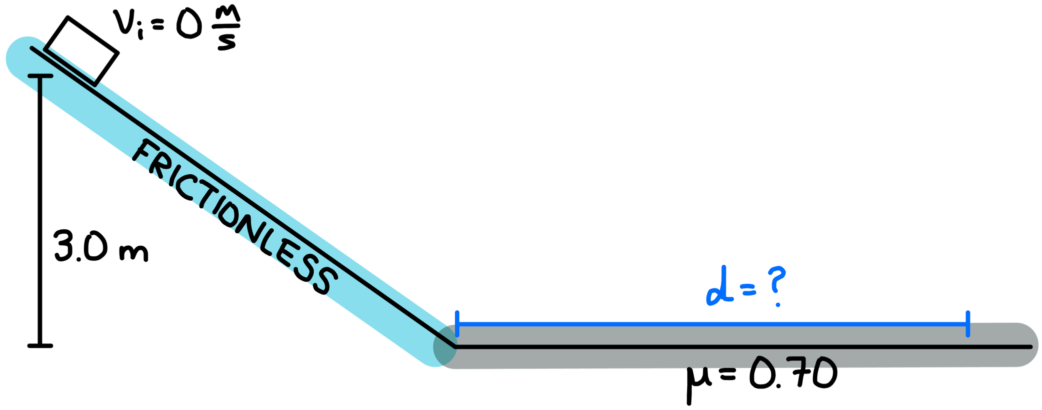
$$\frac{1}{2}mv_i^2 = mgh_f + Q$$

$$h_f = \frac{\frac{1}{2}v_i^2 - Q}{mg}$$

$$= \frac{v_i^2}{2g} - \frac{Q}{mg} = \frac{(25)^2}{2(9.8)} - \frac{40000}{(400)(9.8)}$$

$$= \boxed{21.7 m}$$

A object starts from rest 3.0 m above the ground and slides down a frictionless incline and then along a rough horizontal surface.



a) What is the speed of the object when it reaches the bottom of the incline?

$h_i = 3.0 \text{ m}$

$v_i = 0$

$h_f = 0$

$v_f = ?$

$$E_i = E_f$$

$$\cancelto{0}{E_{k_i}} + E_{p_i} = E_{k_f} + \cancelto{0}{E_{p_f}}$$

$$\cancel{m} g h_i = \frac{1}{2} \cancel{m} v_f^2$$

$$v_f = \sqrt{2gh_i}$$

$$= \sqrt{2(9.8)(3.0)}$$

$$= \boxed{7.67 \frac{m}{s}}$$

b) How far does the block slide on the horizontal surface before coming to rest?

$$Q = |\Delta E_K|$$

$$= |\cancelto{0}{E_{K_f}} - E_{K_i}|$$

$$= \frac{1}{2} m v_i^2$$

$$Q = F_f d$$

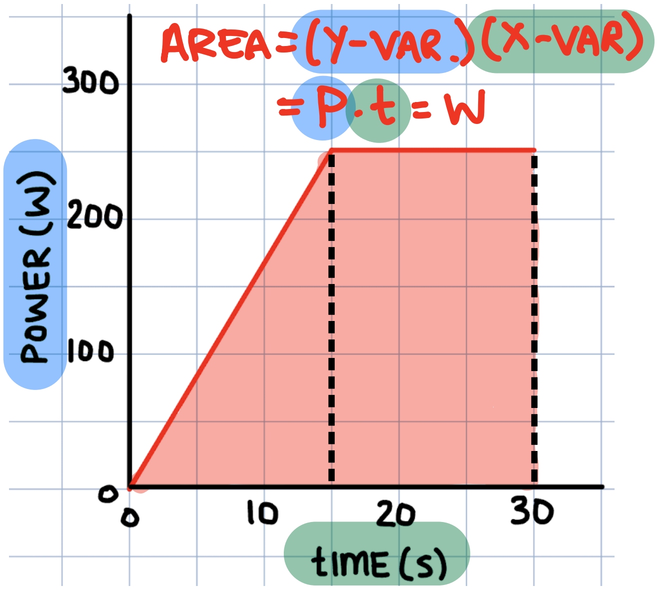
$$\frac{1}{2} m v_i^2 = \mu F_N d$$

$$\frac{1}{2} \cancel{m} v_i^2 = \mu \cancel{m} g d$$

$$d = \frac{v_i^2}{2\mu g}$$

$$= \frac{(7.67)^2}{2(0.70)(9.8)} = \boxed{4.29 \text{ m}}$$

The graph shows the power output of a device used to accelerate a 150 kg object.



a) What is the final speed of the object if it starts from rest?

$$W = \text{AREA}$$
$$= \tfrac{1}{2}(15)(250) + (15)(250)$$
$$= 5625\ \text{J}$$

$$W = \Delta E_K$$
$$= E_{Kf} - \overset{0}{\cancel{E_{Ki}}}$$
$$= \tfrac{1}{2} m v_f^2$$
$$v_f = \sqrt{\frac{2W}{m}} = \sqrt{\frac{2(5625)}{150}} = \boxed{8.66\ \tfrac{m}{s}}$$

b) If the device consumes 9600 J of energy over the 30 seconds, what is the efficiency of the device?

$$\text{EFFICIENCY} = \frac{E_{OUT}}{E_{IN}} = \frac{5625\ \text{J}}{9600\ \text{J}} = 0.586$$
$$= \boxed{58.6\ \%}$$