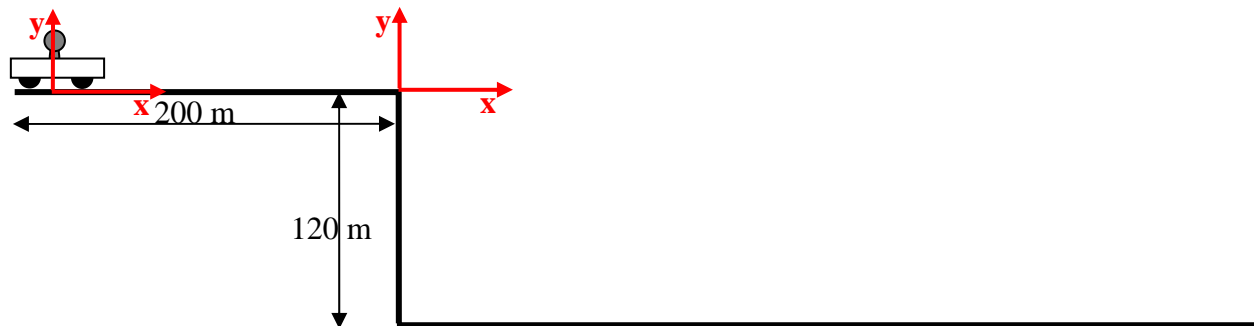


Physics 151 Class Exercise: Multi-Step Problems

1. A 1500 kg land speed car is at rest 200 m from the edge of a 120 m high cliff. The driver (distracted over an upcoming examination) turns on the jet thrusters (which together deliver 2400 N of force) just until he reaches the edge of the cliff. How far from the base of the cliff does he crash? (Hint: This is a multi-step problem. You should carefully strategize before beginning and try to break the problem up into a series of smaller problems.)



Strategy:

- A) Calculate the acceleration caused by the thrusters.
- B) Apply kinematics to calculate the horizontal velocity the car has as it leaves the edge of the cliff.
- C) Figure out the freefall time of the car.
- D) Determine the horizontal distance from the edge of the cliff by multiply the horizontal velocity by the time in the air.

A)
$$a = \frac{F}{m} = \frac{2400N}{1500kg} = 1.6 \frac{m}{s^2}$$

B) Known: $v_0 = 0$ Solve: Not Involved:
 $x = 200 \text{ m}$ v t
 $a = 1.6 \text{ m/s}^2$

$$v^2 = v_0^2 + 2ax$$

$$v = \sqrt{2ax} = \sqrt{2\left(1.6 \frac{m}{s^2}\right)(200m)} = 25.3 \frac{m}{s}$$

C) Move coordinate system to edge of cliff.
 Known: $v_{0y} = 0$ Solve: Not Involved:
 $y = -120 \text{ m}$ t v
 $a = -9.81 \text{ m/s}^2$

$$y = v_{0y}t + \frac{1}{2}at^2 = \frac{1}{2}at^2$$

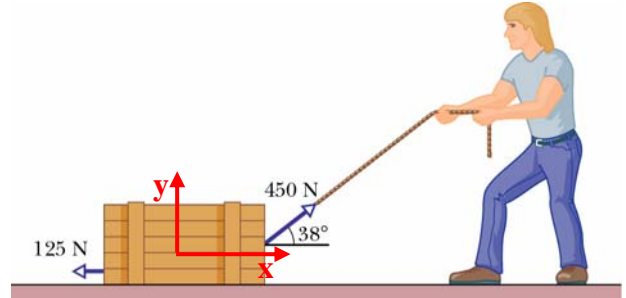
$$t = \sqrt{\frac{2y}{a}} = \sqrt{\frac{2(-120m)}{-9.81 \frac{m}{s^2}}} = 4.95s$$

D) $x = vt = \left(25.3 \frac{m}{s}\right)(4.95s) = 125m$

2. Jake drags a crate across the floor with a force of 450N at an angle of 38° with respect to the horizontal. A frictional force of 125 N acts in the negative horizontal direction due to the crate rubbing against the floor. If the crate is initially at rest and after 3.0 seconds has moved 14.5 m, what is the mass of the crate? (Hint: This is a multi-step problem. You should carefully strategize before beginning and try to break the problem up into a series of smaller problems.)

Strategy:

- A) Point positive direction of x-axis to the right.
Use Kinematics to determine the acceleration of the crate.
- B) Apply summation of forces in the x-direction to solve for the mass. No need to deal with forces in the y-direction.



A) Known: $v_0 = 0$
 $x = 14.5 \text{ m}$
 $t = 3.0 \text{ s}$

Solve: a

Not Involved: v

$$x = v_0 t + \frac{1}{2} a t^2 = \frac{1}{2} a t^2$$

$$a = \frac{2x}{t^2} = \frac{2(14.5 \text{ m})}{(3.0 \text{ s})^2} = 3.22 \frac{\text{m}}{\text{s}^2}$$

B)

$$\Sigma F_x = (450 \text{ N}) \cos 38^\circ - (125 \text{ N}) = m a_x$$

$$m = \frac{(450 \text{ N}) \cos 38^\circ - (125 \text{ N})}{a_x} = \frac{(450 \text{ N}) \cos 38^\circ - (125 \text{ N})}{\left(3.22 \frac{\text{m}}{\text{s}^2}\right)} = 71.3 \text{ kg}$$