Chpt 2 #16

Cheetah can accelerate from rest to a speed of 30.0 m/s in 7.06 s. What is its acceleration?

\[ a_x = \frac{\Delta V_x}{\Delta t} = \frac{V_f - V_0}{\Delta t} = \frac{30.0 \text{ m/s}}{7.06} \]

\[ a_x = 4.29 \text{ m/s}^2 \]

Chpt 2 #17

17. Professional Application

Dr. John Paul Stapp was a U.S. Air Force officer who studied the effects of extreme deceleration on the human body. On December 10, 1954, Stapp rode a rocket sled, accelerating from rest to a top speed of 282 m/s (1015 km/h) in 5.00 s, and was brought jarringly back to rest in only 1.40 s!

Calculate his (a) acceleration and (b) deceleration. Express each in multiples of \( g \) (9.80 m/s\(^2\)) by taking its ratio to the acceleration of gravity.

(a) \[ a_x = \frac{\Delta V_x}{\Delta t} = \frac{282 \text{ m/s}}{5.00 \text{ s}} = 56.4 \text{ m/s}^2 \]

(b) \[ a_x = \frac{\Delta V_x}{\Delta t} = \frac{282 \text{ m/s}}{1.40 \text{ s}} = 201 \text{ m/s}^2 \]

\( a \cdot 56.4 \text{ m/s}^2 \cdot \frac{1g}{9.8 \text{ m/s}^2} = 5.76g \) starting

\( b \cdot 201 \text{ m/s}^2 \cdot \frac{1g}{9.8 \text{ m/s}^2} = 20.6g \) stopping
24. While entering a freeway, a car accelerates from rest at a rate of 2.40 m/s² for 12.0 s. (a) Draw a sketch of the situation. (b) List the knowns in this problem. (c) How far does the car travel in those 12.0 s? To solve this part, first identify the unknown, and then discuss how you chose the appropriate equation to solve for it. After choosing the equation, show your steps in solving for the unknown, check your units, and discuss whether the answer is reasonable. (d) What is the car's final velocity? Solve for this unknown in the same manner as in part (c), showing all steps explicitly.

b) knowns: rest \( V_{x_0} = 0 \)  
\( a_x = 2.40 \text{m/s}^2 \quad t = 12.0 \text{s} \) 
\( x_0 = 0 \text{ sec sketch} \)

c) How far? Find \( x \) at \( t = 12.0 \text{s} \)

Use eqn II

\[
x = x_0 + V_{x_0} t + \frac{1}{2} a_x t^2
\]

\[
x = \frac{1}{2} \cdot 2.40 \text{m/s}^2 \cdot (12.0 \text{s})^2 = 173 \text{m}
\]

d) Find \( v \) at \( t = 12.0 \text{s} \)

Eqn 1

\[
v_x = V_{x_0} + a_x t = 2.40 \text{m/s} \cdot 12.0 \text{s} = \frac{28.8 \text{m}}{3}
\]
28. A powerful motorcycle can accelerate from rest to 26.8 m/s (100 km/h) in only 3.90 s. (a) What is its average acceleration? (b) How far does it travel in that time?

\[ a) \quad a_x = \frac{\Delta v}{\Delta t} = \frac{26.8 m/s}{3.90 s} = 6.87 \frac{m}{s^2} \]

b) \[ x = x_0 + v_{x0}t + \frac{1}{2} a_x t^2 \]

\[ x = \frac{1}{2} \times 6.87 \frac{m}{s^2} \times (3.90 s)^2 = 52.3 m \]

# 29

29. Freight trains can produce only relatively small accelerations and decelerations. (a) What is the final velocity of a freight train that accelerates at a rate of 0.0500 m/s² for 8.00 min, starting with an initial velocity of 4.00 m/s? (b) If the train can slow down at a rate of 0.550 m/s², how long will it take to come to a stop from this velocity? (c) How far will it travel in each case?

\[ a) \quad v_x = v_{x0} + a_x t = 4.00 \frac{m}{s} + 0.05 \frac{m}{s^2} \times 480 \text{ s} = 28.0 \frac{m}{s} \]

b) \[ \text{find } t \text{ for } v_x = 0 \quad a_x = -0.550 \frac{m}{s^2} \]

\[ v_x = v_{x0} + a_x t \quad t = \frac{-v_{x0}}{a_x} = \frac{-28.0 \frac{m}{s}}{-0.550 \frac{m}{s^2}} = 50.9 \text{ s} \]

c) How far \[ x = x_0 + v_{x0} t + \frac{1}{2} a_x t^2 \]

\[ \text{starting } x = 4 \frac{m}{s} \times 480 \text{ s} + \frac{1}{2} \times 0.05 \frac{m}{s^2} \times (480 \text{ s})^2 = 7680 \text{ m} \]

\[ \text{stopping } x = 0 + 28 \frac{m}{s} \times 50.9 \text{ s} + \frac{1}{2} (-0.550 \frac{m}{s^2} \times 50.9 \text{ s})^2 = 1826 \text{ m} \]
34. In World War II, there were several reported cases of airmen who jumped from their flaming airplanes with no parachute to escape certain death. Some fell about 20,000 feet (6000 m), and some of them survived with few life-threatening injuries. For these lucky pilots, the tree branches and snow drifts on the ground allowed their deceleration to be relatively small. If we assume that a pilot's speed upon impact was 123 mph (54 m/s), then what was his deceleration? Assume that the trees and snow stopped him over a distance of 3.0 m.

\[ y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2 \]

\[ v_y = 0, \quad y = 0 \]

\[ v_y = 3, \quad y = 0 \]

\[ f) \text{ find } a_y, \quad \text{eq III } \quad v_y^2 = v_{y0}^2 + 2a_y(y - y_0) \]

\[ = 0 = v_{y0}^2 + 2a_y(-y_0) \]

\[ 2a_y \cdot y_0 = v_{y0}^2 \]

\[ a_y = \frac{v_{y0}^2}{2y_0} = \frac{(54 \text{ m/s})^2}{2(3 \text{ m})} = \frac{486 \text{ m}^2}{3 \text{ s}^2} \]

Note acceleration is positive, i.e., in the upwards direction.