Problem Set 2: **Acceleration**

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0 Quiz

(a) What is the acceleration of free fall objects close to the earth's surface?

(b) You throw a rock straight down at the water from a bridge. It takes you 1.5 s to accelerate the rock to 25 m/s from rest, then it takes the rock 6 s to reach the water. Sketch a plot of the acceleration v time graph

(c) You are riding a bicycle heading due east. Can your acceleration vector ever point west? Explain why or why not.

1 Rocket Launch

A rocket is launched straight up with constant acceleration. Four seconds after liftoff, a bolt falls off the side of the rocket. The bolt hits the ground 6.0 s later. What was the rocket's acceleration?

2 Water Drops

Water drops fall from the edge of a roof at a steady rate. A fifth drop starts to fall just as the first drop hits the ground. At this instant, the second and third drops are exactly at the bottom and top edges of a 1.00 m tall window. How high is the edge of the roof?

3 Olympic Sprinters

A quite realistic model of Olympic sprinter's velocity in the 100 meter dash is given by

$$v_x = b(1 - e^{-ct})$$

where b and c are constants characteristic of the sprinter. We model Usain Bolt with $b = 11$ m/s and $c = .6$ s^{-1}.

(a) What was Bolt's acceleration at $t = 0$ s, 2 s, and 4 s?

(b) Find the expression for the distance traveled at time t.

(c) Your expression from part b is a transcendental equation, meaning you can't solve for t. However, it's not hard to use trial and error to find time needed to travel a specific distance. To the nearest 0.01 s, find the time Bolt needed to sprint 100.0 m.

4 Challenge Problem

A rubber ball is shot straight up from the ground with speed v_0. Simultaneously, a second rubber ball at height h directly above the first ball is dropped from rest.

(a) At what height above the ground do the balls collide?

(b) What is the max value of h for which a collision occurs before the first ball falls back to the ground?

(c) For what value of h does the collision occur at the instant when the first ball is at its highest point?