~ Free-Falling UP ~

PHYSICS 203
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I. WARM UPS

A. A rocket takes off from earth's surface and flies upwards with a constant acceleration of 24 m/s/s. How far will it travel in the first second? How far will it travel in the first 1/3 of a second?

B. **Version 1:** A cheese sandwich is sitting on a cafeteria table, at rest. Suddenly and mysteriously, it begins to move across the cafeteria, maintaining a constant acceleration throughout its motion. Amidst gasps and shrieks, one self-possessed young woman thinks to time the sandwich.

She discovers that it takes exactly 1 second to traverse the room and splatter against the cafeteria wall.

Later, she measures the room and discovers that it was exactly 48 feet from the sandwich's starting location to the wall where it spattered.

i. What was the sandwich's ***acceleration***, in ft/s/s?
ii. What was the sandwich's velocity at the instant that it slammed into the wall?

Version 2: Now imagine that the cheese sandwich took exactly 4 seconds to slam into the wall. All other factors, including the distance it traveled, remain the same.

i. What was its acceleration?
ii. What was its velocity at the instant it slammed into the wall?

II. Catch-22

Assume that near the surface of the Earth, an object free-falls at a ***constant acceleration*** of 22 miles/hr/sec.

A gigantic object is dropped from rest.

How far does the object descend
in the first MINUTE of free-fall?!

III. DERIVATION OF EQUATION #5:

Note the FIFTH equation written in the far-right column of the web-page, the one that says $x = ½at^2 + v_0t + x_0$.

Derive (i.e. ***prove***) that, if acceleration is constant, this equation is true.

In other words, show algebraically how this equation is just the result of combining three of the four equations above it, when ***acceleration is CONSTANT***. It is a handy short-cut for solving for displacement when you are given time, initial velocity and acceleration.

After you have shown how to derive the equation, feel free to use it to solve problems whenever convenient. Like, for the rest of this homework.

IV. Chopper.

Assume that a free-falling object accelerates ***down*** at a constant rate. Assume, further, that this rate, ***a***, is approximately 10 yard/second^2.

A helicopter carries a package of pumpkins high above a renown pumpkin patch.
The package dangles from a 10 yard rope dangling from the bottom of the helicopter.
The helicopter accelerates ***up*** at a perpetually constant rate of 15 yard/second^2.

Suddenly, at the moment the helicopter has achieved an ***upward instantaneous velocity*** of 20 yards/second, the rope breaks.

By how many yards are the helicopter and package separated precisely 4 seconds after the rope breaks?

V. Windows 9.8.

Assume that a free-falling object accelerates ***down*** at a constant rate.

Assume, further, that this rate, $\boldsymbol{a}$, is approximately 4 ***geshes***/second^2. It TRULY does not matter if you have never heard of a ***gesh***.

A. One day, a cat sits near a window and watches the world outside. The length of the window is 3 ***geshes*** from top to bottom.

   There is a ledge above the window. The distance between the ledge and the top of the window is unknown.

   At some moment, all of a sudden, a flower pot falls off the ledge and plummets past the window.

   The cat notices that the flower pot takes 1/4 second to traverse the entire vertical length of the window.

   In ***geshes***, how high above the top of the window is the ledge?

B. ***(Part B is EXTRA CREDIT)*** Later, the cat observes the flower pot zoom up and then down past the window. The landlord, standing somewhere below the window, has attempted to throw the pot back onto the ledge. Evidently he missed.

   The flower pot, therefore, has gone up, reached some peak height and fallen down. In this scenario, therefore, a cat has observed the flower pot free-fall a full 'round-trip': up and then down. The pot has spent a *total* of **1** second in front of the window (up+down).

   In ***geshes***, how high above the top of the window was the peak height attained by the pot for this round trip?

*** THIS LAST PROBLEM IS EXTRA CREDIT ***

VI. Mirror, Mirror.

Assume that a free-falling object accelerates ***down*** at a constant rate.

Assume, further, that this rate, ***a***, is approximately 10 **yards**/second^2. It TRULY does not matter if you have never heard of a **yard**.

A racquet ball is ***dropped*** from a height of 125 yards above the ground. At the exact same moment, a plum is thrust up from the ground (directly underneath the racquetball) at an initial velocity of 50 yards/second.

A. How much time will pass until the two objects meet?

B. At what height will the two objects meet?

C. Compute the racquetball's velocity ***relative to the plum*** at:

   i. The first instant of the experiment,

   ii. The instant that the two objects meet.