Kinematics Problems 1

Recall

$$\vec{d} = \vec{v_i}t + \frac{1}{2}\vec{a}t^2 \qquad \vec{d} = \left(\frac{\vec{v_f} + \vec{v_i}}{2}\right) \cdot t \qquad \vec{v_f} = \vec{v_i} + \vec{a}t \qquad \vec{v_f}^{\,2} = \vec{v_i}^{\,2} + 2\vec{a}\vec{d}$$

Strategy

1. Read the problem carefully. Try to visualize the actual situation. Make a sketch if necessary.
2. Identify the quantities that are given in the problem.
3. Identify the quantity that is unknown, the one you have to find.
4. Select the equation or equations that will relate the given and unknown quantities.
5. Make sure the equations can be applied to the problem. In other words, is the acceleration constant?
6. Rewrite equations as needed to solve for the unknown quantity.
7. Substitute the given values including proper units into the equation and solve. Be sure your answer is in the correct units.
8. Make a rough estimate to see if your answer is reasonable.

Example 1
A ball rolls down a hill with a constant acceleration of $2.0\ m/s^2$. If the ball starts from rest, what is its velocity at the end of $4.0\ s$? How far did the ball move?

Example 2
An electron is accelerated uniformly from rest to a velocity of $2\times10^{7}\ m/s$. If the electron traveled $0.1\,m$ while it was being accelerated, what was its acceleration? How long did the electron take to attain its final velocity?

Example 3
Calculate the total stopping distance for a car traveling at $50\ km/h$. The reaction time of the driver is $0.5\ s$, and the brakes are capable of decelerating the car at a rate of $-6\ m/s^{2}$.

Homework
Kinematics Worksheet #1

Kinematics Worksheet #1

1. A car traveling at $15\ m/s$ accelerates at $8.0\ m/s^2$ for $12\ s$. What distance does it travel in $12\ s$? ($756\ m$)

2. Newton's ant was loafing along on the pavement at $0.2\ m/s$ and was $4.5\ m$ from the safety of the gravel shoulder when it felt the vibrations of an oncoming vehicle. It had exactly $10\ s$ to accelerate to the safety of the gravel. Assuming that its flight was successful, what was its acceleration? ($0.05\ m/s^2$)

3. The driver of a Saturn traveling at $108\ km/h$ applies the brakes to provide a deceleration of $2\ m/s^2$. The car comes to rest in $225\ m$. How long did it take the car to come to rest? ($15\ s$)

4. Galileo is in a Boeing 747 moving at $10\ m/s$ along the runway when the pilot causes it to accelerate at $4.0\ m/s^2$. It requires $40.0\ s$ to reach takeoff speed.
   a. What is the takeoff speed? ($170\ m/s$)
   b. What is the minimum length of runway required? ($3600\ m$)

5. A jetliner, traveling northward, is landing with a speed of $250\ km/h$. Once the jet touches down, it has $750\ m$ of runway in which to reduce its speed to $22\ km/h$. Calculate the acceleration during landing. ($-3.2\ m/s^2$ or $3.2\ m/s^2\ [S]$)

6. A truck, traveling at a velocity of $33\ m/s$ due east, comes to a halt by decelerating at $11\ m/s^2$. How far does the truck travel in the process of stopping? ($49.5\ m\ [E]$)

7. With the plane standing on the runway, the pilot brings the engines to full thrust before releasing the brakes. The aircraft accelerates at $3.2\ m/s^2$. If the displacement of the plane at takeoff is $620\ m$, what is the plane's takeoff velocity? ($63\ m/s$)

8. A drag racer, starting from rest, speeds up for $402\ m$ with an acceleration of $17.0\ m/s^2$. A parachute then opens, slowing the car down with an acceleration of $-6.10\ m/s^2$. How fast is the car moving $3.5\times10^2\ m$ after the parachute opens?
   ($96.9\ m/s$)