Fascinating Freefall Facts

Understanding the effect of gravity

Kinematics Unit Outline

I. Vectors

II. Six Definitions:
Distance, Position, Displacement,
Speed, Velocity, Acceleration

III. Two Equations:
Velocity, Displacement

IV. Freefall

	The student will be able to:	HW:
1	Define and distinguish the concepts scalar and vector. Make the connection between the visual representation of a vector and its numerical representation of magnitude and direction angle. ✓	
2	Define, distinguish, and apply the concepts: distance, displacement, position. ✓	1, 2
3	Define, distinguish, and apply the concepts: average speed, instantaneous speed, constant speed, average velocity, instantaneous velocity, constant velocity. ✓	3 – 7
4	Define, distinguish, and apply the concepts: average acceleration and instantaneous acceleration, and constant acceleration. ✓	8 – 16
5	State the displacement and velocity relations for cases of constant acceleration and use these to solve problems given appropriate initial conditions and values. ✓	17 – 28
6	State and use the conditions of freefall, including the value of *g*, to solve associated problems.	29 – 41

Fascinating Freefall Facts

- Any and all objects under the sole influence of gravity have the same acceleration regardless of size or mass.
- The acceleration of gravity is denoted *g*. Its mean value near the earth's surface:

$$\mathbf{g} = 9.80 \text{ m/s}^2 \text{ downward}$$

- This value is quite accurate for any object in freefall when forces other than gravity are relatively small.

Values of g (in m/s^2)

Mexico City	9.779	Madrid	9.800
Jakarta	9.781	San Francisco	9.800
Manila	9.784	Washington DC	9.801
Rio de Janeiro	9.788	New York	9.802
Miami	9.7902096	Chicago	9.803
Los Angeles	9.796	Rome	9.803
Denver	9.7961848	Seattle	9.8072544
Knoxville, TYS	9.7968816	Paris	9.809
Knoxville, UT	9.7969745	Vancouver BC	9.809
Buenos Aires	9.797	London	9.812
Sydney	9.797	Amsterdam	9.813
Tokyo	9.798	Oslo	9.819

The Effect of Air Resistance

Air can have a significant effect on a freefalling object depending on:

- **Size** – the greater the "cross section", the greater the air resistance
- **Shape** – the less streamlined, the greater the air resistance
- **Speed** – the greater the speed through the air, the greater the air resistance

The slower and denser the object, the less will be the effect of air resistance.

Modeling the Effect of Gravity

- As long as gravity is the only significant force acting on an object (disregarding air resistance or any other force) it will have an acceleration close to g.
- Unless other factors are significant any object anywhere on Earth or near its surface in a freefall condition will accelerate downward at approximately 9.80 m/s^2.
- This value is often used with the standard constant acceleration formulas to solve problems involving objects moving under the influence of gravity.