Homework

1. Estimate the speed of the planet mercury? Compare your speed to mach one, and the speed of light.

2. In a given time Δt which is short compared to the orbital period of the moon (27 days), the moon will fall a distance
$$\frac{1}{2} a_m \Delta t^2$$
towards the center of the earth, where a_m is the acceleration of the moon. a_m is analagous to the free fall acceleration $g = 10\,\mathrm{m/s^2}$ on earth. What is the ratio between $g = 10\,\mathrm{m/s^2}$ and a_m. How did Newton use this number to understand the distance dependence of the gravitational force?

3. At all moments in time the earth is falling towards the sun with an acceleration a_{ES}. How large is this acceleration in units of g (the acceleration of falling bodies on earth). Why don't we fall into the sun? Assume that the earth suddenly stopped moving. Then, assuming (unrealistically) that our acceleration towards the sun is constant thereafter, how long would it take us to reach the sun?

4. If a bullet is shot horizontally (by a person), estimate how far it travels before reaching the ground. To answer this question you will need to estimate the muzzle speed of a bullet and the height of a person[1].

5. A bullet is shot straight up – estimate its initial speed.

   (a) Sketch its velocity as a function of time. Label the time axis (*i.e.* the x-axis) in appropriate units. Label the y axis (veolocity) in appropriate units.

   (b) When does it reach the top of the arc? Indicate this point on your graph.

   (c) Use your graph to determine the average speed of the bullet on its way up.

   (d) How high up did the bullet travel?

[1] Oh well . . . Ok . . . , I'll help you out on the bullet question. . . A bullet is moved by exploding gasses, which move at the speed of sound in air (mach one). So perhaps a bullet moves at about 1/4 of mach one.