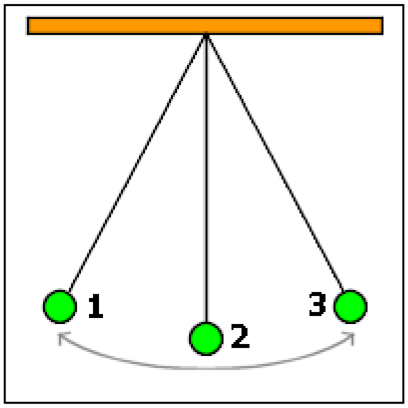
Measuring Gravity with a Pendulum!



A pendulum is a very simple toy, but you can actually use it to measure gravity! The beat of a pendulum called its period, P, depends on the length of the pendulum, L, and the acceleration of gravity, g ,according to:

$$P = 2\pi\sqrt{\frac{L}{g}}$$

If you measure P in seconds, and know the length of the pendulum, L, in meters, you can figure out how strong the acceleration of gravity is, g, in meters/sec^2. Let's see how this works for explorers working on different planets and moons in the solar system!

Problem 1 – A mars colonist wants to make a pendulum that has a beat of 4 seconds. If the acceleration of gravity on mars is 3.8 m/sec^2, how long will the pendulum have to be in meters?

Problem 2 - A pendulum clock on the moon has a length of 2 meters, and its period is carefully measured to be 7.00 seconds. What is the acceleration of gravity on the moon?

Problem 3 – On Earth, prospectors are looking for a deposit of iron ore beneath the ground. They decide to use the acceleration of gravity to find where the iron is located because the additional iron mass should change the acceleration of gravity. They use a carefully-made pendulum with a length of 2.00000 meters and measure the period of the swing as they walk around the area where they think the deposit is located. To the nearest millionth of a second, how much will the period change if the acceleration of gravity between two spots changes from 9.80000 meters/sec^2 to 9.80010 meters/sec^2? (use p = 3.14159)

Problem 1 – A mars colonist wants to make a pendulum that has a beat of 4 seconds. If the acceleration of gravity on mars is 3.8 m/sec^2, how long will the pendulum have to be in meters?

Answer: $4 = 2\pi (L/3.8)^{1/2}$ then $L = (16/4\pi^2)*3.8$ = **1.54 meters**.

Problem 2 - A pendulum clock on the moon has a length of 2 meters, and its period is carefully measured to be 7.00 seconds. What is the acceleration of gravity on the moon?

Answer: $7.00 = 2\pi (2/g)^{1/2}$ so $g = 8\pi^2/49$ so g = **1.61 meters/sec^2**.

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Answer: $P = 2\pi (2.00000/9.80000)^{1/2}$ = **2.838451 seconds**.
And $P2 = 2\pi (2.00000/9.80010)^{1/2}$ = **2.838437 seconds**

So the difference in period will be **0.000014 seconds or 14 microseconds.**

$$T = 2\pi\sqrt{\frac{L}{g}}\left(1 + \frac{1}{16}\theta_0^2 + \frac{11}{3072}\theta_0^4 + \cdots\right)$$

Where theta is the start angle from verticle.