Answer to Question #82537, Physics / Electromagnetism

Measure how high you can jump on Earth. From that you can calculate the kinetic energy you had when you started the jump. Use this kinetic energy and the general form of gravitational potential energy to determine how high you could jump on Mars.

Solution.

By the Law of conversation of energy, the kinetic energy I had when I started the jump on Earth is:

$$E = \frac{mv^2}{2} = mgh$$

where h is height of jumping, v is speed at the start of jumping.

Let $h = 1\ m, m = 90\ kg$

Then:

$$E = 90 \cdot 9.8 \cdot 1 = 882\ J$$

Using the general form of gravitational potential energy in case of Mars:

$$E = G\frac{Mm}{r} - G\frac{Mm}{r_1}$$

where G is gravitational constant, M is mass of Mars, R is radius of Mars, $h_1$is height of jumping on Mars, H is my height.

$$G = 6.67 \cdot 10^{-11}\ N \cdot m^2/kg^2$$

$$M = 6.42 \cdot 10^{23}\ kg$$

r_1 is the distance between centres of Mars and body at the height of jumping, r is the distance between centres of Mars and body at the start of jumping.

$$r_1 = R + h_1 + H/2$$

$$r = R + H/2$$

R is radius of Mars

$$R = 3389.5 \cdot 10^3\ m$$

Then:

$$E = G\frac{Mm}{R + H/2} - G\frac{Mm}{R + h_1 + H/2}$$

$$E = G\frac{Mmh_1}{(R + \frac{H}{2})(R + h_1 + H/2)}$$

Since $(h_1 + H/2)$ is much less then:

$$E = G\frac{Mmh_1}{R^2}$$

So, height of jumping on Mars:

$$h_1 = \frac{ER^2}{GMm}$$

Answer:

$$h_1 = \frac{882 \cdot (3389.5 \cdot 10^3)^2}{6.67 \cdot 10^{-11} \cdot 6.42 \cdot 10^{23} \cdot 90} = \frac{10133.042}{3853.926} = 2.63\ m$$