Answer on Question#51974 - Physics - Other

At what altitude above the earth's surface would the acceleration due to gravity be $g_h = 4.9\,\frac{\mathrm{m}}{\mathrm{s}^2}$? Assume the mean radius of the earth is $R_E = 6.4 \times 10^6$ meters and the acceleration due to gravity $g_0 = 9.8\,\frac{\mathrm{m}}{\mathrm{s}^2}$ on the surface of the earth.

Solution:

The acceleration due to gravity at some altitude H above the earth's surface is given by

$$g_H = \frac{GM_E}{(R_E + H)^2},$$

where M_E – is the mass of the earth, G – is the gravitational constant.

It is given that

$$g_h = \frac{GM_E}{(R_E + h)^2} = 4.9\,\frac{\mathrm{m}}{\mathrm{s}^2},$$

and that

$$g_0 = \frac{GM_E}{{R_E}^2} = 9.8\,\frac{\mathrm{m}}{\mathrm{s}^2}.$$

Dividing g_0 by g_h we obtain

$$\frac{g_0}{g_h} = \frac{(R_E + h)^2}{{R_E}^2} = \left(1 + \frac{h}{R_E}\right)^2$$

Therefore

$$h = R_E\left(\sqrt{\frac{g_0}{g_h}} - 1\right) = 6.4 \times 10^6\mathrm{m}\left(\sqrt{\frac{9.8\,\frac{\mathrm{m}}{\mathrm{s}^2}}{4.9\,\frac{\mathrm{m}}{\mathrm{s}^2}}} - 1\right) = 2.65 \times 10^6\mathrm{m}$$

Answer: $h = R_E\left(\sqrt{\frac{g_0}{g_h}} - 1\right) = 2.65 \times 10^6\mathrm{m}.$