At what altitude above the earth's surface would the acceleration due to gravity be 4.9 ms^{-2} ? Assume the mean radius of the earth is 6.4×10^6 metres and the acceleration due to gravity 9.8 ms^{-2} on the surface of the earth.

Solution.

On the Earth surface, the gravitational force, acting on the point-like constant mass object, is described by the following equation:

$$F(R_E) = G\frac{mM_E}{R_E^2},$$

where *G* is the is the gravitational constant, *m* is the mass of a man and *M* is the mass of the Earth. Dividing it to the mass *m*, we obtain

$$\frac{F(R_E)}{m} = g(R_E) = G\frac{M_E}{R_E^2}.$$

Gravitational accelerations at different altitudes are than connected in the following way:

$$g(R_E + h) = g(R_E)\frac{R_E^2}{(R_E + h)^2}.$$

Solving equation, we find the altitude *h*:

$$h = R\left(\sqrt{\frac{g(R_E)}{g(R_E + h)}} - 1\right),$$

$$h = 6.4 \times 10^6\text{m}\left(\sqrt{\frac{9.8\ \text{ms}^{-2}}{4.9\ \text{ms}^{-2}}} - 1\right) = 6.4 \times 10^6\text{m} \times 0.414 = 2.7 \times 10^6\text{m}.$$

Answer.

$h = 2.7 \times 10^6\text{m}$