# Increase of mass in the gravitational field


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As we know, force multiplied by distance equals energy:

E=F.d

**E** represents energy; **F** represents force and considers **d** as distance. Also the gravitational force between two masses is calculated by the following equation:

$$F = \frac{GMm}{r^2}$$

Where **G** equals to the global constant of gravity and **M** is the first mass (celestial substance) and **m** represents the second mass of a material and **r** is the distance between two centers. So gravitational potential energy obtain by following ways:

$$E = F \times d$$

$$d = r \Rightarrow E = F \times r \Rightarrow F = \frac{E}{r}$$

$$\frac{E}{r} = \frac{GMm}{r^2} \Rightarrow E = \frac{GMm}{r} = U$$

**U** represents gravitational potential energy that equals and equivalent to the corresponding mass and it will increase to the mass. Now we calculate the mass amount:

$$U = \frac{GMm_0}{r}$$

$$E = mc^2$$

$$E = U$$

$$\Delta m = \frac{E}{c^2} = \frac{U}{c^2} = \frac{\frac{GMm_0}{r}}{c^2} = \frac{GMm_0}{rc^2}$$

$$m = m_0 + \Delta m = m_0 + \frac{GMm_0}{rc^2}$$

$$m = \frac{m_0 rc^2 + GMm_0}{rc^2} = \frac{m_0\left(rc^2 + GM\right)}{rc^2}$$

$m_0$ is the initial mass of a material, **c** is the speed of light, **Δm** is increase in mass of a material in gravitational field and **m** is the final mass of a material in the gravitational field. Hence, we calculate 1kg mass of a material in the sun surface:

$$m = \frac{m_0\left(rc^2 + GM\right)}{rc^2} = \frac{1\times\left(6.96\times10^8\times9\times10^{16} + 6.672\times10^{-11}\times1.99\times10^{30}\right)}{6.96\times10^8\times9\times10^{16}} = 1.00000212$$