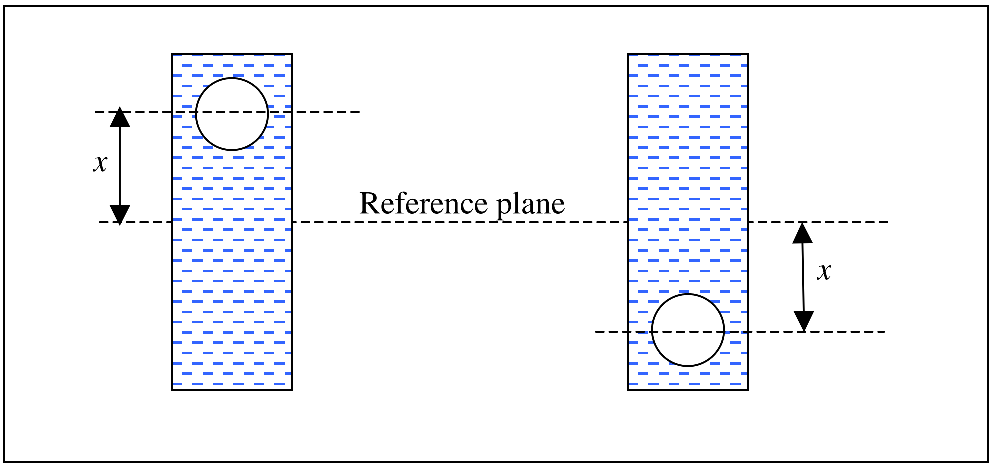
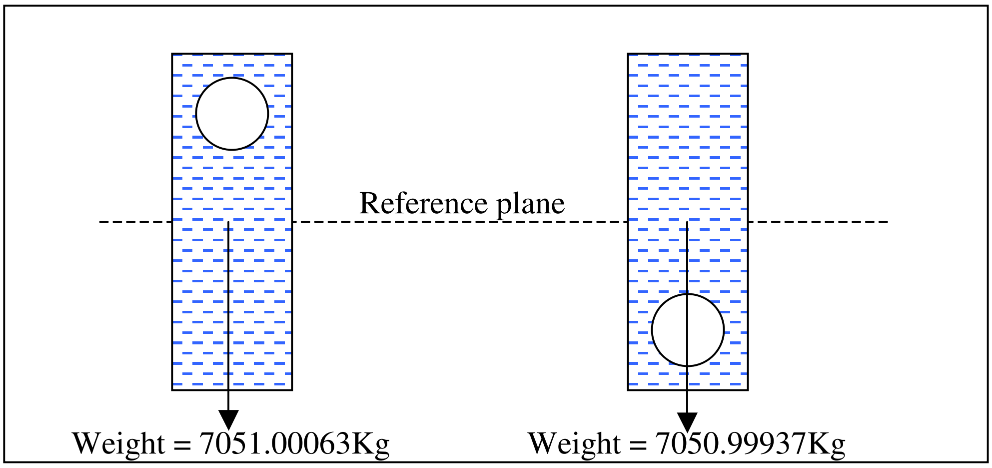
Proof for Tinman's Gravity Machine.

Here are the two situations for Tinman's system before launch and after return to earth.



We will take the reference plane as the geometric centre of the tubes. We will take the total mass of the tubes completely filled with water as *M*. We will take the mass of water needed to fill the spheres as m. Thus the actual mass is close to *M-m* but we also want to take account of the distance *x* of the spheres from the centre line. Gravity follows an inverse square law so we can write for the force on a tube completely filled with water as $F_M = \frac{KM}{R^2}$ where *K* is a constant and *R* is the distance from our reference plane to the centre of the earth. But the tube has an amount *m* missing and the force on that missing part of the LH tube would be $F_m = \frac{Km}{(R+x)^2}$. Thus the actual force F_{LH} on the tube is $F_{LH} = \frac{KM}{R^2} - \frac{Km}{(R+x)^2}$. This is very slightly different to the downward force on the normally assumed actual mass *M-m* because we assume that gravity is uniform within our laboratories, but it isn't. It's only a tiny tiny difference but when taken over the vast distances used by Tinman to get to outer space where gravity is reduced to one tenth it becomes significant. By the same argument the downward force F_{RH} on the RH tube is $F_{RH} = \frac{KM}{R^2} - \frac{Km}{(R-x)^2}$. These two slightly different forces are shown in the next figure as Kg weight, using Tinman's 7500Kg for *M* and 449Kg for *m*.



Now let's see what those slightly different weights mean when calculating the energy needed to raise them to outer space where gravity is one tenth. Clearly we expect the slightly greater weight to need slightly more energy, and this means that we cannot assume that the energy needed to reach outer space is exactly equal to the energy gained when falling back to earth.

Because of the inverse square law the distance from the earth's centre to get one tenth the gravity force is $\sqrt{10} \times R$ so the energy W_{LH} needed to raise the LH tube to that height is given by the definite integral

$$W_{LH} = \int_{R}^{R\sqrt{10}} \left[\frac{KM}{r^2} - \frac{Km}{(r+x)^2} \right] .dr \qquad (1)$$

By the same argument the energy W_{RH} needed to raise the RH tube to that height is given by

$$W_{RH} = \int_{R}^{R\sqrt{10}} \left[\frac{KM}{r^2} - \frac{Km}{(r-x)^2} \right] .dr \qquad (2)$$

The difference between (1) and (2) is

$$W_{DIFF} = \int_{R}^{R\sqrt{10}} \left[\frac{Km}{(r-x)^2} - \frac{Km}{(r+x)^2} \right] .dr \qquad (3)$$

which is independent of the mass M.
Solving the integral yields

$$W_{DIFF} = Km \left[\frac{1}{r-x} - \frac{1}{r+x} \right]_{R}^{R\sqrt{10}}$$

Taking to a common denominator

$$W_{DIFF} = Km \left[\frac{(r+x)-(r-x)}{(r-x)(r+x)} \right]_{R}^{R\sqrt{10}}$$

$$W_{DIFF} = Km \left[\frac{2x}{r^2 - x^2} \right]_{R}^{R\sqrt{10}}$$

Because $r >> x$ over the integration range we can use the very good approximation

$$W_{DIFF} \approx Km \left[\frac{2x}{r^2} \right]_{R}^{R\sqrt{10}}$$

Yielding

$$W_{DIFF} = \frac{2Kmx}{R^2} \left(\frac{1}{10} - 1 \right)$$

$$W_{DIFF} = \frac{-2Kmx}{R^2} \left(\frac{9}{10} \right)$$

But $\frac{K}{R^2}$ is earth's acceleration g and $2x$ is the distance h between the two spherical volumes.
Hence W_{DIFF} can be written as

$$W_{DIFF} = -\left(\frac{9}{10} \right) mgh$$

This is the energy expended in going to outer space and back again. There is also energy expended while in outer space in pulling the top sphere down against buoyancy which in the 1/10 gravity is $(1/10)mgh$. Total energy W_{EXP} expended is therefore

$$W_{EXP} = -mgh$$

where the minus sign represents expenditure. But we have not yet completed the cycle. We let the lower sphere rise under buoyancy force where we gain energy W_{GAIN}

$$W_{GAIN} = mgh$$

Thus after the buoyancy rise there is an energy balance, we have got back exactly the amount of energy we lost.

Tinman has since pointed out that when the hollow sphere rises under buoyancy an equivalent amount of water falls the same amount, and the energy associated with that rise has not been accounted for. However it can be shown that when that happens there is a change of potential energy of the system, and that change of potential energy accounts for the fall of that water. This change in potential energy is rarely considered because it cannot be put to practical use, it is the energy that would be gained if we had a mineshaft that reached to the centre of the earth where gravity is zero, and we let the mass fall down to that point. The formula for acceleration g down that mineshaft is

$$g = \frac{Kr}{R^3}$$

where r is the distance from the earth centre, R is the earth radius and K is that used above. The energy gained in falling from $r=R$ to $r=0$ is given by the definite integral

$$W = \int_0^R \frac{Kmr}{R^3} = \left[\frac{Kmr^2}{2R^3}\right]_0^R = \frac{Km}{2R}$$

where the m is the change of mass from 7050.99937Kg to 7051.00063Kg as described earlier. That calculates exactly as mgh. Thus the falling water of energy value mgh is exactly accounted for by the change in potential energy of the system.