Parallels between Gravitation and Electricity

1) Both are proportional to $1/r^2$
2) Force is directed along the line joining the objects
3) The Force is the product of the two sources (*mass for gravity, charge for electricity*)
4) Both are extremely long ranged
5) Sources affect only like particles (gravity – mass, electricity – charge)

Differences

Gravity	Electricity
always attractive	attractive for opposite charges
due to the mass of an object	repulsive for like charges
effects only objects with mass	source is the charge of an object
force is extremely weak	effects only objects with charge
	force is relatively strong

Ex. The Hydrogen Atom

What is the ratio in the magnitudes of the Gravitational and Electric forces between the proton and the electron in a hydrogen atom?

Constants
$k = 9 \times 10^9\ Nm^2/C^2$
$G = 6.67 \times 10^{-11}\ Nm^2/kg^2$

Separation Distance
$r = 5.3 \times 10^{-11}\ m$

Particle Attributes

$q_e = -1.6 \times 10^{-19}\ C$
$q_p = 1.6 \times 10^{-19}\ C$
$m_e = 9.11 \times 10^{-31}\ kg$
$m_p = 1.672 \times 10^{-27}\ kg$

** **Gravitation Force** between p and e^-:

$$F = -\frac{Gm_p m_e}{r^2}$$

$$F = -\frac{\left(6.67x10^{-11}\frac{Nm^2}{kg^2}\right)\left(1.672x10^{-27}kg\right)\left(9.11x10^{-31}kg\right)}{\left(5.3x10^{-11}m\right)^2}$$

$F_g = -3.6x10^{-47}\ N$ *Insanely Small* !! (- ➔ *attractive*)

** **Electric Force** between p and e^-:

$$F = \frac{kq_p q_e}{r^2}$$

$$F = \frac{\left(9x10^9\frac{Nm^2}{C^2}\right)\left(1.6x10^{-19}C\right)\left(-1.6x10^{-19}C\right)}{\left(5.3x10^{-11}m\right)^2}$$

$F_e = -8.2x10^{-8}\ N$ (- ➔ *attractive*)

Thus

$F_e / F_g \sim 10^{39}$ - *which means the Electric Force is 39 orders of magnitudes stronger than the Gravitational Force*