PHYSICS

$e = mc^2$

1. Einstein's first assumption of Relativity was that ____________ is relative.

2. Einstein's second assumption of Relativity was that the speed of light is ____________. (constant, infinite, relative)

3. Michelson & Morley measured the speed of ____________.

4. Newton would add 2 velocities as a simple addition. (True, False)

5. Finish this very common Physics equation: force = mass x ____________.

6. e = ½ mv squared is the formula for __________ energy. (kinetic, potential, heat)

7. When a body feels a force it gains ___________ energy. (kinetic, potential, heat)

8. According to Newton, in e = ½ mv squared if e increases, __________ stays constant.

9. According to Einstein, in e = ½ mv squared if e increases, so can ___________________ stays constant. (mass and velocity, mass, velocity)

10. What law states "Energy can neither be created nor destroyed"? (Law of Conservation of Energy, Law of Conservation of Heat, Law of Conservation of Matter)

11. In a Relativistic Universe, energy is conserved. (True, False)

12. Einstein insisted in his 1905 paper that mass and energy were ___________.

13. The average American uses about ___________ gallons of gasoline per year.

14. According to $e = mc^2$, 1 gram of matter, or an average peanut converts to ___________ quintillion ergs of energy – enough to equal 670,000 gallons of gas.

15. How many years could you drive on 1 gram of matter that is converted to pure energy? (1,155, 115.5, 11.55)

DERIVATIONS

In Newtonian Physics …

$$V = V_1 + V_2$$

In the Einsteinian Physics of Relativity…

$$V = \frac{V_1 + V_2}{1 + \frac{V_1 V_2}{c^2}}$$

So if the first velocity is the speed of light…

$$V = \frac{c + V_2}{1 + \frac{c V_2}{c^2}} = c + V_2 \left(\frac{c}{c + V_2} \right) = c$$

"a body cannot move faster than light"

Mass – Energy Equivalence

By Newton's Second Law of Motion… $f = ma$

In Newtonian Physics, if a increases, then f increases. But in Einsteinian Physics, if a increases, then f or m might increase.

Kinetic Energy is represented… $e = \frac{1}{2} m v^2$

In Newtonian Physics, if v increases, then e increases. But in Einsteinian Physics, if v increases, then e or m might increase.

By the reciprocal of the Fitzgerald ratio… $\frac{1}{\sqrt{1 - v^2/c^2}}$ or $\left(1 - \frac{v^2}{c^2}\right)^{-1/2}$

And by the Binomial Theorem (first worked out by Newton himself)… $1 + \frac{v^2}{2c^2}$

By the Lorentz mass relationship, where there is a mass in motion (m_1) and a mass at rest (m_0)…

$$m_1 = m_0\left(1 + v^2/2c^2\right)$$
$$= m_0 + m_0 v^2/2c^2$$

And for the resulting motion… $m_1 - m_0 = m$

$$m = m_0 v^2/2c^2 = \frac{1}{2} m_0 v^2/c^2$$

And since the definition of kinetic energy is… $e = \frac{1}{2} m v^2$

We therefore have… $m = e/c^2$ or $\mathbf{e = mc^2}$