Quiz 3; Phys 100 Name _____

$\gamma = 1/\sqrt{1 - s^2/c^2}$. $t = \gamma t_0$. $L = L_0/\gamma$. $E = mc^2$. $c = 3 \times 10^8$ m/s.

1. (3 points) Does the special theory of relativity allow you to go on a trip and return younger than you were when you left? Explain.

Answer: No. Relativistic time dilation means that on a trip where you travel close to the speed of light, time will pass more slowly for you, but it will pass nonetheless. You can't go backward in time.

2. (4 points) Velma observes her spaceship to be 100 m long and 10 m high. She passes Mort at $0.9c$. How long and how high is her spaceship as observed by Mort? (*Hint:* you don't need to perform a calculation. Just eliminate the obviously wrong answers.)

(a) 100 m, 10 m

(b) 229 m, 23 m

(c) 44 m, 4.4 m

(d) 44 m, 10 m. Lengths perpendicular to the direction of motion do not contract.

(e) 100 m, 23 m

3. (4 points) You give 90 J of kinetic energy to a 1 kg stone when you throw it. By how much do you increase its mass?

Answer:

$$m = \frac{E}{c^2} = \frac{90}{9 \times 10^{16}} = 10^{-15} \text{ kg}$$

In other words, a completely negligible amount.

4. (4 points) Neil deGrasse Tyson says that astrophysicists have looked for evidence that the speed of light in vacuum is not a constant, and failed to find any such evidence. What do astrophysicists do to see whether c varies across time or space?

(a) They weigh the luminiferous ether

(b) They measure the fine-structure constant

(c) They observe ordinary meter sticks very carefully

(d) They fire bullets from trains

(e) They take pictures of Jupiter's satellites

5. (4 points) Tyson explains how, because of $E = mc^2$, different types of particles can convert into other types. Why does he say the photons in the current microwave radiation background do not convert into anything else?

(a) Microwave photons don't have enough quarks in their ether bindings

(b) The annihilation of microwave photons would create supermassive black holes and a reverse big bang

(c) There is not enough antimatter in the universe for any more conversions of anything

(d) Only hadrons can convert into other particles, and photons are not hadrons.

(e) Microwave photons have low energy, smaller than the mass of anything they might convert to