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) While standing next to it, 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 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) A bike rider zips by you, going 3.0 m/s relative to you. Find out if the time dilation factor in this case is close to 1 or not, and tell me if this means you should observe any relativistic effects for such everyday speeds.

Answer: Since $s/c = 10^{-8}$, $\gamma = 1/\sqrt{1 - s^2/c^2} \approx 1$. This means that *no* relativistic effects will be noticeable to us; they will be way too small.

4. (4 points) If we were to greatly dim the laser beam going through a diffraction grating, so that we had about one photon per second going through, what would we observe?

(a) An extremely dim interference pattern, with side peaks only visible using expensive equipment

(b) Each photon randomly ending up somewhere on the interference pattern

(c) No interference pattern at all—very dim light will just go straight through

(d) Extremely dim light cannot get through, due to the de Broglie limitation effect

(e) The Einstein paradox, where the photons appear to travel faster than light, but without transmitting any information.

5. (4 points) In chapter 3 of *Astrophysics for People in a Hurry,* Tyson discusses the Cosmic Microwave Background (CMB). Why does he think it's so important—what information about the history of the universe does he expect to get from the CMB?

Answer: The CMB is strong evidence for the big bang scenario of the universe expanding, radiation being left over from the time that the universe becomes transparent, and the radiation cooling down as the universe expands. Variations in the CMB also tell us about how galaxies and other structures began to form.