

PHY 100S – THE MAGIC OF PHYSICS

Spring Term, 2013

HOMEWORK #4

DUE: By 11:00 AM, Friday, March 22, 2013 in the Drop Boxes

Late penalty = 5% per day (which also applies to weekend days) for a maximum of 7 days, after which homework will not be accepted. The final late due date is thus 11:00 AM, Friday, March 29 (note: the University is closed on March 29, so if you are submitting on this day, email a copy to your tutor by 11 AM).

DROP BOXES: The completed homework assignment should be submitted in the *Drop Box for your tutorial section*. There are six Drop Boxes – one for each tutorial section, clearly labelled. The Drop Boxes are located in the basement of the Burton tower of the McLennan Physics building.

TEXTBOOK: All questions are taken from the textbook, *Physics: Concepts and Connections, Fifth Edition*, by Art Hobson, Pearson Education (2010).

INSTRUCTIONS: (1) Make sure your name and student number, and the name of your tutor are on your submitted homework, preferably on all pages in case a page comes loose. Staple all pages together.
(2) Show all your reasoning and work legibly, and draw a box around the final answer where applicable.

MARKING: Marks will be given for reasoning, as well as for final answers. Each question is worth 2 marks. Total marks = 20.

QUESTIONS:

Chapter 10, Conceptual Exercises 38, 42, 44, 48

38. Velma, who is carrying a clock and a meter stick, passes Mort. Is it possible that Mort could observe length contraction of Velma's meter stick but observe no time dilation of her clock? If so, how?
42. Velma's spaceship has a rest-mass of 10,000 kg, and she measures its length to be 100 m. She moves past Mort at $0.8c$. According to Mort's measurements, what are the mass and the length of her spaceship?
44. A meter stick with a rest-mass of 1 kg moves past you. Your measurements show it to have a mass of 2 kg and a length of 1 m. What is the orientation of the stick, and how fast is it moving?

48. A red-hot chunk of coal is placed in a large air-filled container where it completely burns up. The container is not a thermal insulator, in other words, thermal energy passes through the container's walls. According to $E = mc^2$, does the total mass of the container and its contents change during the burning process? If so, does the mass increase or decrease?

Chapter 11, Conceptual Exercises 10, 14, 20, 24, 34, 42

10. A rifle barrel and a laser both point directly toward a target some distance away. General relativity says that the bullet and the light beam both experience the same downward acceleration during their horizontal travel, yet the bullet hits the target well below the laser beam. Explain.
14. The big bang created just three chemical elements. Why didn't it create any more?
20. Is there a place in the present-day universe that is the centre of the universe? Explain.
24. Imagine a huge triangle stretching across a large portion of the observable universe. Will the angles of this triangle add up to the usual 180° , or will they add up to more than, or less than, 180° ? Explain.
34. Since the universe is accelerating as it expands, is there any doubt among cosmologists that the fate of the universe is to expand forever? Explain.
42. How could the large-scale structure that we see in the universe today have originated from tiny quantum fluctuations?