

Name: _____

Date: _____



Cornell University
Prison Education Program

Conceptual Physics Homework Packet 5 Due: May 4th, 2018

Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page. If questions are taken from one of the textbooks, it will be indicated. A large portion of your grade will be calculated based on *how* you obtained an answer, so please **show your work** (including all diagrams and drawings if relevant).

If you prefer working on looseleaf paper, or have a large portion of your work on looseleaf, please be sure to hand that in along with this homework packet.

The content in this homework relates to material we covered in class 3 (kinematics) and class 4 (graphs). Note that you will need use material from class 2 (units). The related readings are:

1. *Light and Matter*, Chapter 23 (Sections 1)
2. *College Physics*, Chapter 28 (Sections 1 to 3)
3. *Light and Matter*, Chapter 27 (All Sections)

1. (2 points) Does motion affect the rate of a clock as measured by an observer moving with it? Does motion affect how an observer moving relative to a clock measures its rate?

From *College Physics*, Chapter 28 Question 4

2. (2 points) To whom does the elapsed time for a process seem to be longer, an observer moving relative to the process or an observer moving with the process? Which observer measures proper time?

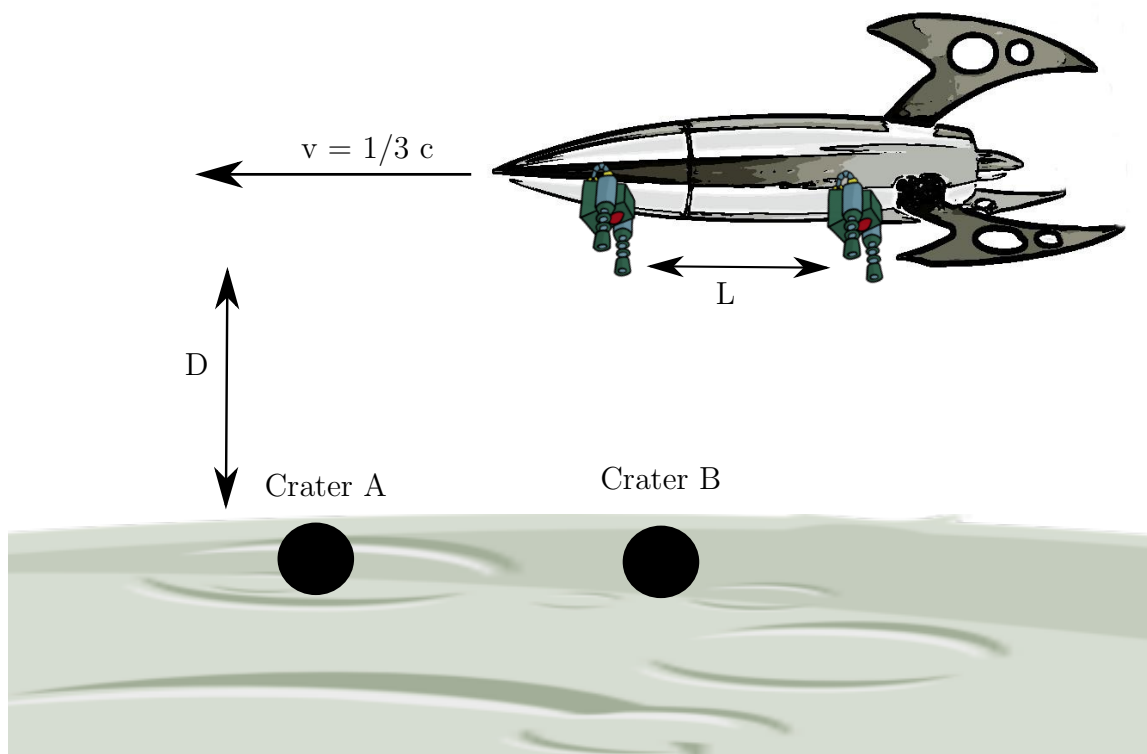
From *College Physics*, Chapter 28 Question 5

3. (2 points) A set of twins works in the Sears Tower, a very tall office building in Chicago. One works on the top floor and one works in the basement. Considering general relativity, which twin will age more slowly?

4. (2 points) Does your body's mass cause spacetime to curve around it? If not, why not? If so, and if light follows curved paths through spacetime, why can't you see directly behind a person standing in your line of sight?

5. (10 points) Signals are sent to and from satellites in orbit around Earth. If someone on Earth sends a radio signal up to one of these satellites,
- (a) Will the satellite perceive the signal to be red-shifted, blue-shifted, or the same as an observer on Earth?
 - (b) Will the satellite perceive the frequency to be larger, smaller or the same as an observer on Earth?
 - (c) Will the satellite perceive the wavelength to be longer, shorter or the same as an observer on Earth?
 - (d) Will the satellite perceive the energy of the incoming radio waves to be greater, smaller or the same as an observer on Earth?
 - (e) Will the satellite perceive the radio waves to be travelling faster, slower or at the same speed as observer on Earth?

6. (8 points) A species of space-faring aliens are travelling in a spaceship at $1/3$ the speed of light relative to a small uninhabited planet with no atmosphere. Their ship is equipped with two identical cannons that blast explosive devices straight down, creating craters to mine for various materials. The cannons on the ship are separated by a distance L , and the ship itself has a height H . As they pass by a planet, a distance D above the surface, the aliens simultaneously launch 2 explosive devices (in their reference frame), creating 2 large craters A and B. The diagram bellow (not drawn to scale) illustrates this situation.



- (a) To an alien standing on the planet, how far apart are the two cannons?
- A distance greater than L .
 - A distance L .
 - A distance less than L .
 - There is insufficient information to answer this question.
- (b) What would an alien standing on the planet measure the height of the ship to be?
- Greater than H .
 - Exactly H .
 - Less than H .
 - There is insufficient information to answer this question.
- (c) To an alien on the planet, how high up is the ship?
- A distance greater than D .
 - A distance equal to D .
 - A distance less than D .
 - There is insufficient information to answer this question.

- (d) To an alien on the ship, how high up are they flying?
- A. A distance greater than D .
 - B. A distance equal to D .
 - C. A distance less than D .
 - D. There is insufficient information to answer this question.
- (e) To an alien on the ship, what is the distance separating the craters A and B?
- A. Greater than L .
 - B. Exactly L .
 - C. Less than L .
 - D. There is insufficient information to answer this question.
- (f) To an alien on the planet, what is the distance separating the craters A and B?
- A. Greater than L .
 - B. Exactly L .
 - C. Less than L .
 - D. There is insufficient information to answer this question.
- (g) To an alien on the ship, in what order are craters A and B created?
- A. Crater A is created first, then crater B.
 - B. Crater B is created first, then crater A.
 - C. They are created simultaneously.
 - D. There is insufficient information to answer this question.
- (h) To an alien on the planet, in what order are craters A and B created?
- A. Crater A is created first, then crater B.
 - B. Crater B is created first, then crater A.
 - C. They are created simultaneously.
 - D. There is insufficient information to answer this question.