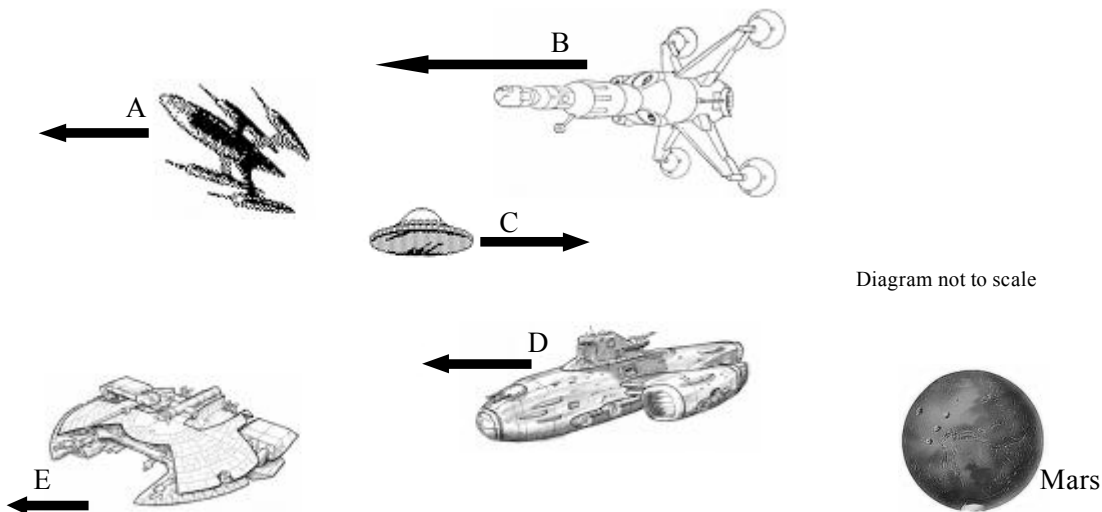


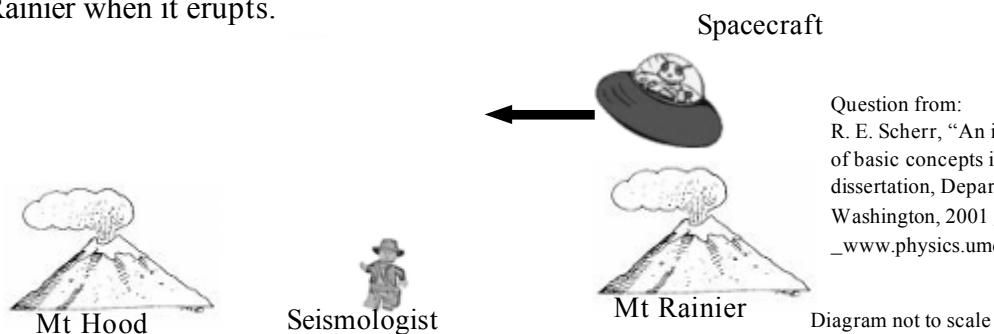
Relativity Concepts Pre-Test

1. Motion in the following set of spaceships is designated by arrows. The direction of the arrows indicates the direction of motion and the length of the arrow indicates the speed of the spaceship relative to an observer on Mars.



Select the largest group of ships from the following groups that share an inertial reference frame.

- A, B, D and E*
 - A, C and D*
 - A and D*
 - A, B, C, D and E*
2. Kim observes a clock two light seconds away. Kim is at rest relative to the clock. Which statement is correct about the time Kim observes?
- Kim's observed time is identical to the time displayed at the clock*
 - Kim's observed time is different to the time displayed at the clock but we cannot tell by how much*
 - Kim's observed time is 2 seconds behind the time displayed at the clock*
 - Kim's observed time is 2 seconds in advance of the time displayed at the clock*
3. Mt. Rainier and Mt. Hood, which are 300 km apart in their rest frame, suddenly erupt at the same time in the reference frame of a seismologist at rest in a laboratory midway between the volcanoes. A fast spacecraft flying with constant speed $v = 0.8c$ from Rainier towards Hood is directly over Mt. Rainier when it erupts.



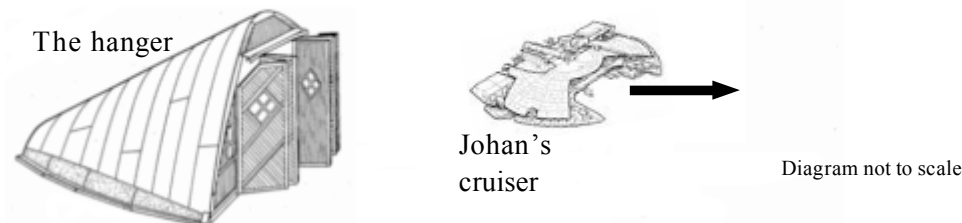
Question from:
R. E. Scherr, "An investigation of student understanding of basic concepts in special relativity," Ph.D. dissertation, Department of Physics, University of Washington, 2001 _unpublished_,
[_www.physics.umd.edu/perg/papers/scherr/index.html](http://www.physics.umd.edu/perg/papers/scherr/index.html)

The seismologist and the observer in the spacecraft are intelligent observers, i.e., they correct for signal travel time to determine the time of events in their reference frame. Each observer has synchronized clocks with all other observers in his or her reference frame.

Which of the following statements most accurately describes the timing of the eruptions?

- In both the seismologist's and the spacecraft's reference frame both volcanos erupt simultaneously.*
- In both the seismologist's and the spacecraft's reference frame Mt Rainier erupts before Mt Hood.*
- In the seismologist's reference frame the eruptions are simultaneous, while in the spacecraft's reference frame Mt Hood erupts before Mt Rainier.*
- In the spacecraft's reference frame the eruptions are simultaneous, while in the seismologist's reference frame Mt Hood erupts before Mt Rainier.*

4. Johan flies a 600m long space cruiser. Boris is standing in the 2Km long space hangar. Johan flies at $0.8c$ away from Boris, as shown in the diagram below.



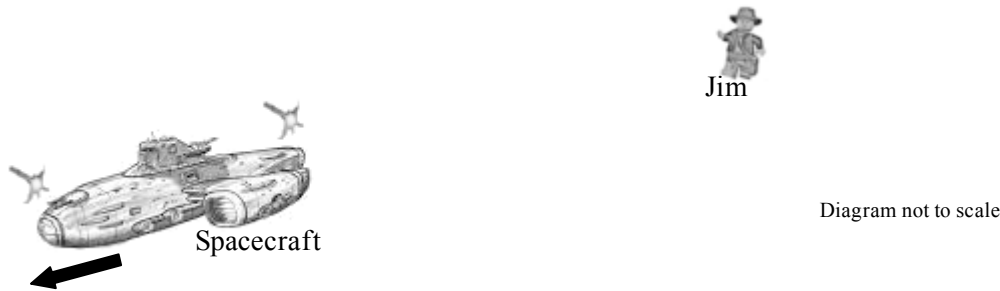
Which statement is correct about Boris and Johan's observations of each other?

- Johan's cruiser is only 360m long in Boris's reference frame, while the hangar is 2km long in Johan's reference frame.*
- Johan's cruiser is only 360m long in Boris's reference frame, while the hangar is 1.2km long in Johan's reference frame.*
- Johan's cruiser is 600m long in Boris's reference frame, while the hangar is 2km long in Johan's reference frame.*
- Johan's cruiser is 600m long in Boris's reference frame, while the hangar is 1.2km long in Johan's reference frame.*

5. Ulysses wants to verify time dilation. He has two very accurate synchronised atomic clocks; one is placed on a rocket heading into deep space at a speed of $0.6c$ while the other is kept on Earth. The time on the rocket is regularly signalled back to Earth. Once the delay in the signal reaching Earth is taken into account, which of the following is observed on Earth according to Special Relativity?
- Seconds on the rocket clock are longer than seconds on Earth.*
 - Seconds on Earth are longer than seconds on the rocket clock.*
 - Seconds on Earth are the same as seconds on the rocket clock.*
 - You cannot predict if there is change in clock times or the magnitude or direction of that change.*

Relativity Concepts Post-Test:

1. Jim observes a large spacecraft travelling at speed of $0.7c$ away from him. He calculates (taking into account signal delay) that the tail light and nose light of the craft flash once simultaneously in his reference frame.

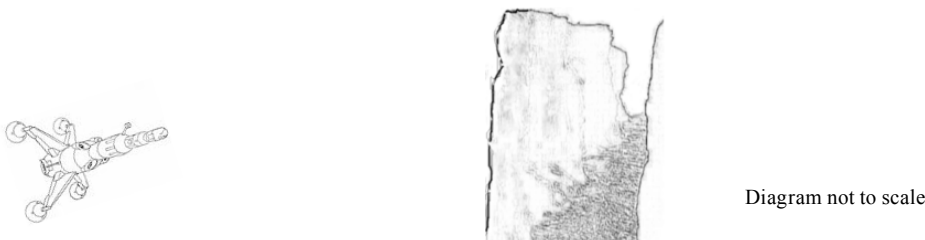


Which of the following is true regarding the lights in the Reference frame of the spacecraft?

- a. There is no way to be sure what is happening on the spacecraft.
 - b. The nose light flashes before the tail light
 - c. The lights flash simultaneously
 - d. The lights are on constantly
2. Beth sets her watch to match an interplanetary clock when she is close to it. Beth moves 5 light seconds away, ensuring time dilation does not affect her synchronised watch.

Select the statement that most accurately describes Beth's view from her new position of the time on her watch and the time on the interplanetary clock.

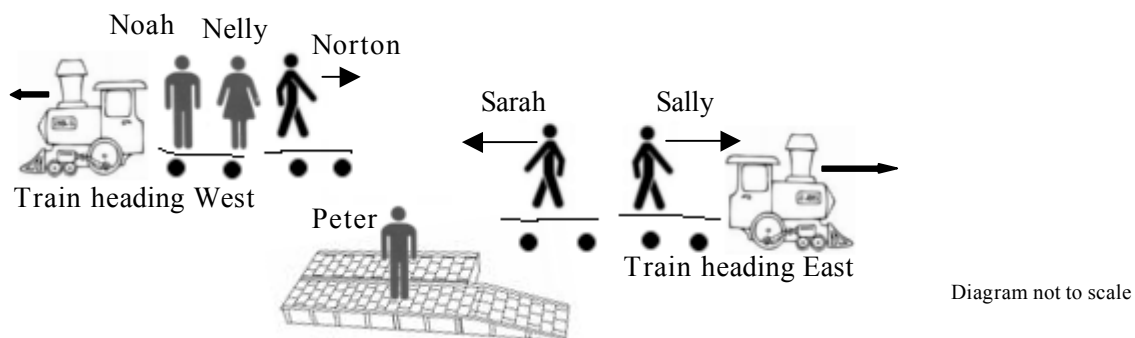
- a. The time on Beth's watch is 5 seconds ahead of the time observed on the interplanetary clock.
 - b. The time on Beth's watch is 5 seconds behind the time observed on the interplanetary clock.
 - c. The time on Beth's watch is the same as the time observed on the interplanetary clock.
 - d. The time on Beth's watch is 2.5 seconds ahead of the time observed on the interplanetary clock.
3. Terri is flying at a speed of $0.6c$ ($\gamma = 1.25$) towards a chasm she measured to be 4.5km long when at rest with regard to the chasm. Terri's craft is 4km long.



Which of the following is true from Terri's frame of reference?

- a. Terry's craft is 5km long and the front of Terri's craft leaves the chasm before the back enters.
- b. The chasm is now 3.6km long and the front of Terri's craft leaves the chasm before the back enters.
- c. Terry's craft is now 3.2km long and Terri's craft fits entirely in the chasm
- d. The chasm is now 5.625km and Terri's craft fits entirely in the chasm

4. Paul wants to verify time dilation – he has two very accurate synchronised atomic clocks C1 and C2, his friend Harry has access to military jets and flies 1 of his clocks (C1) around the world at high speed a couple of times. What statement is correct about the times on C1 and C2 at the end of this experiment?
- C1 and C2 are exactly synchronised.*
 - The time on C1 is ahead of the time on C2.*
 - The time on C2 is ahead of the time on C1.*
 - The clocks will read different times but it is impossible to predict which one will be ahead of the other.*
5. Consider a train that can move at a speed of $0.5c$ (1.5×10^8 m/s) to the right, as measured by you. I shine a pulse of light towards the back of the train (i.e. opposite the direction the train is moving). The speed of the pulse is $1.0c$ (3×10^8 m/s) in my reference frame. What is the velocity of the light pulse in your reference frame?
- $0.5c$ to your left
 - $0.5c$ to your right
 - $1c$ to your left
 - $1c$ to your right
 - $1.5c$ to your left
 - $1.5c$ to your right
6. Noah, Nelly and Norton are on a train travelling West at 10km/h relative to the station; Sally and Sarah are on a train travelling East at 20km/h relative to the station. Peter is standing still on the platform at the station. Noah and Nelly are standing while Norton walks to the back of the train (East) at 10km/hr relative to his train. Sally runs towards the front of her train (East) at 20km/hr while Sarah runs towards the back of her train (West) at 20km/hr .



Which of the following groups are stationary in a common inertial reference frame?

- Noah, Nelly and Norton
- Sally and Sarah
- Sally and Peter
- Norton, Sally and Peter
- Norton, Sarah and Peter
- Noah, Nelly and Peter
- Everyone