Mentoring week 10

Paul lea

Points of interest

- review minkowski diagrams

- look at [[SpecialRelatvityKinematicsReviewQuestions2023.pdf]]

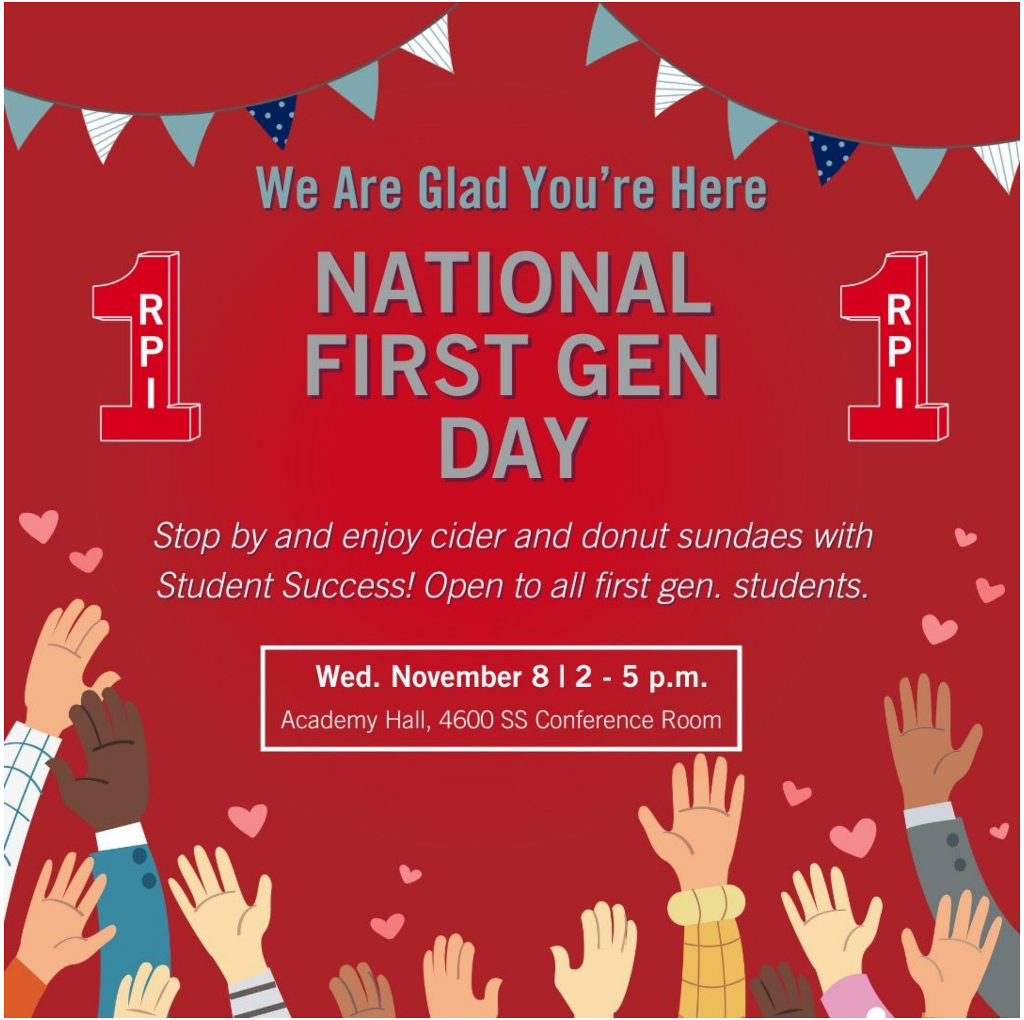
- finished relativistic kinematics

- going to do relativistic dynamics and energy and stuff after exam

- 1 minute essays

-hygine

-mac n cheese thing



We Are Glad You're Here
RPI
NATIONAL
FIRST GEN
DAY
RPI
Stop by and enjoy cider and donut sundaes with
Student Success! Open to all first gen. students.
Wed. November 8 | 2 - 5 p.m.
Academy Hall, 4600 SS Conference Room

FINISH THE SEMESTER STRONG

FYE PRESENTS:

FINAL EXAMS PREP & MANAGING TEST ANXIETY

SUNDAY, NOVEMBER 12
OR
WEDNESDAY, NOVEMBER 15

DCC 337 @ 6 PM

FIRST-YEAR SUCCESS WORKSHOPS

Finals. Just another exam, right? Not necessarily. Understand why you may have to study differently for finals.
Learn strategies for recognizing and managing test anxiety.

Helpful hints provided by students who have found success!

Rensselaer

MUELLER CENTER
CAMPUS RECREATION AND WELLNESS

Please join us for a

Thanksgiving Dinner

November 23 // 11:30-2pm

Location: McNeil Room

Hosted by the Mueller Center

Free for undergrad and grad students!

Contact Donna Sutton suttoa@rpi.edu with questions.

RSVP here:

MAC 'N CHEESE with AGD'S

SATURDAY NOVEMBER 11TH
5 - 9 PM

ALL PROFITS ARE GOING TO THE ALPHA GAMMA DELTA FOUNDATION FOR FIGHTING HUNGER.

PREORDER FORM AND MORE DETAILS TO COME SOON!

Mac and Cheese with AGD's

Charity	Date	Time
AGD Foundation: Fighting Hunger	11/11	5-9 pm

The Basic Bowl extra cheese, bread crumbs	$8
Literally Fire buffalo, hot cheetos	$8
The Broc 'N Roll extra cheese, bread crumbs, broccoli	$9
Feelin' Buff bread crumbs, buffalo, chicken	$10
The Smokehouse bread crumbs, barbecue, chicken	$10
Mac Attack extra cheese, bread crumbs, bacon	$10
The Triple C extra cheese, bread crumbs, chicken	$10
Make Your Own! pick your own combo of toppings	price will vary

Dine in or Deliver!!

teams

alexis

Kay

edith

luther

bryan

Luke

sam

Jovanny

ryan (will switch off)

1) A rocket is moving at 1/4 the speed of light relative to Earth. At the center of this rocket, a light suddenly flashes. To an observer at rest on Earth

A) the light will reach the front of the rocket at the same instant that it reaches the back of the rocket.

B) the light will reach the front of the rocket before it reaches the back of the rocket.

C) the light will reach the front of the rocket after it reaches the back of the rocket.

2) A rocket is moving at 1/4 the speed of light relative to Earth. At the center of this rocket, a light suddenly flashes. To an observer at rest in the rocket,

A) the light will reach the front of the rocket at the same instant that it reaches the back of the rocket.

B) the light will reach the front of the rocket before it reaches the back of the rocket.

C) the light will reach the front of the rocket after it reaches the back of the rocket.

3) An astronaut in an inertial reference frame measures a time interval Δt between her heartbeats. What will observers in all other inertial reference frames measure for the time interval between her heartbeats?

A) Δt B) more than Δt C) less than Δt

D) The answer depends on whether they are moving toward her or away from her.

1) A rocket is moving at 1/4 the speed of light relative to Earth. At the center of this rocket, a light suddenly flashes. To an observer at rest on Earth

A) the light will reach the front of the rocket at the same instant that it reaches the back of the rocket.

B) the light will reach the front of the rocket before it reaches the back of the rocket.

C) the light will reach the front of the rocket after it reaches the back of the rocket.

Answer: C This is the "rear clock ahead" effect and can be checked using Lorentz transformations.

2) A rocket is moving at 1/4 the speed of light relative to Earth. At the center of this rocket, a light suddenly flashes. To an observer at rest in the rocket,

A) the light will reach the front of the rocket at the same instant that it reaches the back of the rocket.

B) the light will reach the front of the rocket before it reaches the back of the rocket.

C) the light will reach the front of the rocket after it reaches the back of the rocket.

Answer: A

3) An astronaut in an inertial reference frame measures a time interval Δt between her heartbeats. What will observers in all other inertial reference frames measure for the time interval between her heartbeats?

A) Δt B) more than Δt C) less than Δt

D) The answer depends on whether they are moving toward her or away from her.

Answer: B Time dilation

4) You are a passenger on a spaceship. As the speed of the spaceship increases, you would observe that

A) the length of your spaceship is getting shorter.
B) the length of your spaceship is getting longer.
C) the length of your spaceship is not changing.

5) A star is moving towards the earth with a speed at 90% the speed of light. It emits light, which moves away from the star at the speed of light. Relative to us on earth, what is the speed of the light moving toward us from the star?

A) $0.90c$ B) c C) $1.1c$ D) $1.20c$ E) $1.9c$

6) Astronaut Mark Uri is space-traveling from planet X to planet Y at a speed of $0.65c$ relative to the planets, which are at rest relative to each other. When he is precisely halfway between the planets, a distance of 1.0 light-hour from each one as measured in the planet frame, nuclear devices are detonated on both planets. The explosions are simultaneous in Mark's frame. What is the difference in the time of arrival of the flashes from the explosions as observed by Mark?

A) 0 min B) 180 min C) 90 min
D) 360 min E) 113 min

4) You are a passenger on a spaceship. As the speed of the spaceship increases, you would observe that

A) the length of your spaceship is getting shorter.
B) the length of your spaceship is getting longer.
C) the length of your spaceship is not changing.
Answer: C You are in the proper frame of the ship.

5) A star is moving towards the earth with a speed at 90% the speed of light. It emits light, which moves away from the star at the speed of light. Relative to us on earth, what is the speed of the light moving toward us from the star?

A) $0.90c$ B) c C) $1.1c$ D) $1.20c$ E) $1.9c$
Answer: B Second postulate. Speed of light is the same in all frames.

6) Astronaut Mark Uri is space-traveling from planet X to planet Y at a speed of $0.65c$ relative to the planets, which are at rest relative to each other. When he is precisely halfway between the planets, a distance of 1.0 light-hour from each one as measured in the planet frame, nuclear devices are detonated on both planets. The explosions are simultaneous in Mark's frame. What is the difference in the time of arrival of the flashes from the explosions as observed by Mark?

A) 0 min B) 180 min C) 90 min
D) 360 min E) 113 min
Answer: A This is a trick question. You need to read the whole question before answering. I have highlighted the key words.

7) As measured in Earth's rest frame, a spaceship traveling at $0.964c$ takes 11.2 y to travel between planets. How long does the trip take as measured by someone on the spaceship?

A) 2.98 y B) 7.28 y C) 42.1 y D) 30.7 y

8) An astronaut on a spaceship moving at $0.927c$ says that the trip between two stationary stars took 7.49 y. How long does this journey take as measured by someone at rest relative to the two stars?

A) 20.0 y B) 2.81 y C) 4.05 y D) 22.1 y

9) An unstable particle is moving at a speed of 2.6×10^8 m/s relative to a laboratory. Its lifetime is measured by a stationary observer in the laboratory to be 4.7×10^{-6} seconds. What is the lifetime of the particle, measured in the rest frame of the particle? ($c = 3.00 \times 10^8$ m/s)

Answer: 2.3 μs

7) As measured in Earth's rest frame, a spaceship traveling at $0.964c$ takes 11.2 y to travel between planets. How long does the trip take as measured by someone on the spaceship?

A) 2.98 y B) 7.28 y C) 42.1 y D) 30.7 y

Answer: A The ship is in the proper frame for leaving and arriving, so it measures the proper time.

8) An astronaut on a spaceship moving at $0.927c$ says that the trip between two stationary stars took 7.49 y. How long does this journey take as measured by someone at rest relative to the two stars?

A) 20.0 y B) 2.81 y C) 4.05 y D) 22.1 y

Answer: A The ship is in the proper frame for leaving and arriving, so it measures the proper time.

9) An unstable particle is moving at a speed of 2.6×10^8 m/s relative to a laboratory. Its lifetime is measured by a stationary observer in the laboratory to be 4.7×10^{-6} seconds. What is the lifetime of the particle, measured in the rest frame of the particle? ($c = 3.00 \times 10^8$ m/s)

Answer: 2.3 μs $t_{lab} = \gamma t_{particle}$

10) A spaceship approaches the earth with a speed 0.50*c*. A passenger in the spaceship measures his heartbeat as 70 beats per minute. What is his heartbeat rate according to an observer that is at rest relative to the earth?

A) 69 beats per minute
B) 73 beats per minute
C) 65 beats per minute
D) 61 beats per minute
E) 80 beats per minute

Answer: D

11) Relative to the frame of the observer making the measurement, at what speed parallel to its length is the length of a meterstick 60 cm?

A) 0.80*c*
B) 0.60*c*
C) 0.50*c*
D) 0.70*c*
E) 0.90*c*

12) In their common rest frame, two stars are 90.0 light-years (ly) apart. If they are 12.0 ly apart as measured by the navigator in a spaceship traveling between them, how fast is the spaceship moving? Express your answer in terms of *c*.

A) 0.991*c*
B) 0.986*c*
C) 0.980*c*
D) 0.972*c*

10) A spaceship approaches the earth with a speed 0.50*c*. A passenger in the spaceship measures his heartbeat as 70 beats per minute. What is his heartbeat rate according to an observer that is at rest relative to the earth?

A) 69 beats per minute
B) 73 beats per minute
C) 65 beats per minute
D) 61 beats per minute
E) 80 beats per minute

Answer: D You need to convert beats per minute into time per beat and then use time dilation. Then convert back to beats per minute.

11) Relative to the frame of the observer making the measurement, at what speed parallel to its length is the length of a meterstick 60 cm?

A) 0.80*c*
B) 0.60*c*
C) 0.50*c*
D) 0.70*c*
E) 0.90*c*

Answer: A 1 meter=proper length, then use length contraction.

12) In their common rest frame, two stars are 90.0 light-years (ly) apart. If they are 12.0 ly apart as measured by the navigator in a spaceship traveling between them, how fast is the spaceship moving? Express your answer in terms of *c*.

A) 0.991*c*
B) 0.986*c*
C) 0.980*c*
D) 0.972*c*

Answer: A A light year is a unit of length. The proper length is 90 and $L_{ship} = L_{proper}/\gamma$

13) A particle in a 453 m-long linear particle accelerator is moving at $0.875c$. How long does the particle accelerator appear to the particle?

A) 219 m B) 589 m C) 104 m D) 936 m

14) Two space stations are at rest relative to each other and are 6.0×10^7 m apart, as measured by observers on the stations. A spaceship traveling from one station to the other at $0.90c$ relative to the stations passes both of them, one after the other. As measured by an observer in the spaceship, how long does it take to travel from one station to the other? ($c = 3.00 \times 10^8$ m/s)

A) 97 ms B) 220 ms C) 510 ms
D) 58 ms E) 39 ms Answer: A

15) A spacecraft is measured by an observer on the ground to have a length of 53 m as it flies toward the earth with a speed 1.7×10^8 m/s. The spacecraft then lands and its length is again measured by the observer on the ground, this time while the spacecraft is at rest on the launchpad. What result does he now get for the length?

13) A particle in a 453 m-long linear particle accelerator is moving at $0.875c$. How long does the particle accelerator appear to the particle?

A) 219 m B) 589 m C) 104 m D) 936 m

Answer: A 453=proper length, then use length contraction for other frames.

14) Two space stations are at rest relative to each other and are 6.0×10^7 m apart, as measured by observers on the stations. A spaceship traveling from one station to the other at $0.90c$ relative to the stations passes both of them, one after the other. As measured by an observer in the spaceship, how long does it take to travel from one station to the other? ($c = 3.00 \times 10^8$ m/s)

A) 97 ms B) 220 ms C) 510 ms

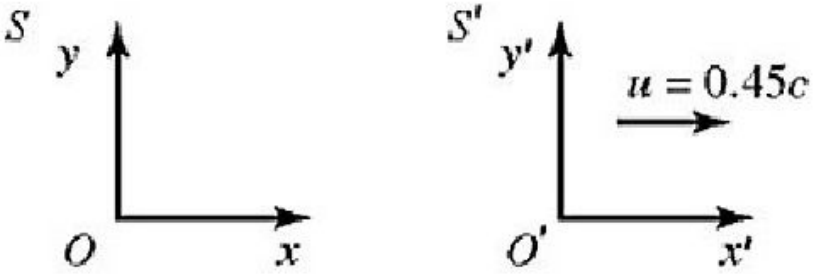
D) 58 ms E) 39 ms

Answer: A The spaceship sees a contracted distance of $L_{ship} = 6 \times 10^7/\gamma$.

15) A spacecraft is measured by an observer on the ground to have a length of 53 m as it flies toward the earth with a speed 1.7×10^8 m/s. The spacecraft then lands and its length is again measured by the observer on the ground, this time while the spacecraft is at rest on the launchpad. What result does he now get for the length?

Answer: 64 m Length contraction when the ship is moving relative to the observer.

16) System S' has a velocity $u = +0.45c$ relative to system S, as shown in the figure. The clocks of S and S' are synchronized at $t = t' = 0$ when the origins O and O' coincide. An event is observed in both systems. The event takes place at $x = 600$ m and at time $t = 1.9$ μs, as measured by an observer in S. What is the x'-coordinate of the event, measured by an observer in S'?

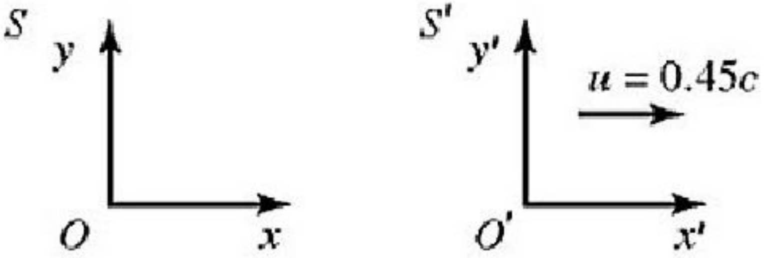


A) 380 m
B) 340 m
C) 360 m
D) 350 m
E) 310 m

17) In an "atom smasher," two particles collide head on at relativistic speeds. If the velocity of the first particle is $0.741c$ to the left, and the velocity of the second particle is $0.350c$ to the right (both of these speeds are measured in Earth's rest frame), how fast are the particles moving with respect to each other?

A) $0.866c$
B) $1.091c$
C) $0.883c$
D) $0.788c$

16) System S' has a velocity $u = +0.45c$ relative to system S, as shown in the figure. The clocks of S and S' are synchronized at $t = t' = 0$ when the origins O and O' coincide. An event is observed in both systems. The event takes place at $x = 600$ m and at time $t = 1.9$ μs, as measured by an observer in S. What is the x'-coordinate of the event, measured by an observer in S'?



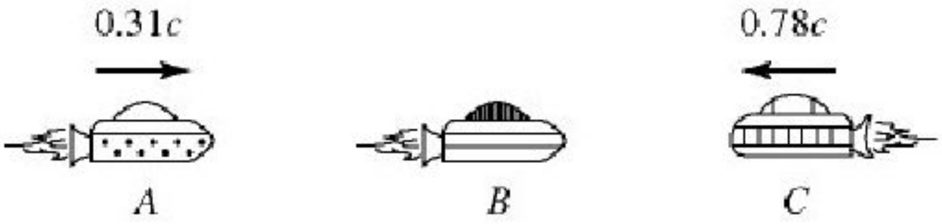
A) 380 m B) 340 m C) 360 m
D) 350 m E) 310 m
Answer: A Just use the straight Lorentz Transformations recognizing that the S' frame sees the S frame moving with a negative velocity. $x' = \gamma(x - vt)$.

17) In an "atom smasher," two particles collide head on at relativistic speeds. If the velocity of the first particle is $0.741c$ to the left, and the velocity of the second particle is $0.350c$ to the right (both of these speeds are measured in Earth's rest frame), how fast are the particles moving with respect to each other?
A) $0.866c$ B) $1.091c$ C) $0.883c$ D) $0.788c$
Answer: A Switch to the frame of the first particle. The observer is then moving at 0.741c to the left and the second particle is moving at 0.350c to the left in the observer's frame.

18) A spaceship approaching an asteroid at a speed of $0.60c$ launches a rocket forward with a speed of $0.40c$ relative to the spaceship. At what speed is the rocket approaching the asteroid as measured by an astronaut on the asteroid?

A) $0.81c$ B) $1.0c$ C) $0.76c$ D) $0.64c$ E) $0.96c$

19) Three spaceships A, B, and C are in motion, as shown in the figure. The commander on ship B observes ship C approaching with a relative velocity of $0.78c$. The commander also observes ship A, advancing in the rear, with a relative velocity of $0.31c$. What is the velocity of ship C, relative to an observer on ship A?



A) $0.88c$ B) $0.38c$ C) $1.4c$
D) $0.62c$ E) $1.1c$

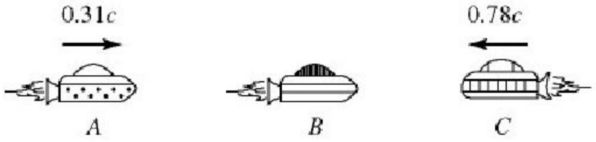
20) Two spaceships are approaching one another, each at a speed of $0.28c$ relative to a stationary observer on Earth. What speed does an observer on one spaceship record for the other approaching spaceship?

18) A spaceship approaching an asteroid at a speed of 0.60*c* launches a rocket forward with a speed of 0.40*c* relative to the spaceship. At what speed is the rocket approaching the asteroid as measured by an astronaut on the asteroid?

A) 0.81*c* B) 1.0*c* C) 0.76*c* D) 0.64*c* E) 0.96*c*

Answer: A Straightforward velocity addition.

19) Three spaceships *A*, *B*, and *C* are in motion, as shown in the figure. The commander on ship *B* observes ship *C* approaching with a relative velocity of 0.78*c*. The commander also observes ship *A*, advancing in the rear, with a relative velocity of 0.31*c*. What is the velocity of ship *C*, relative to an observer on ship *A*?



A) 0.88*c* B) 0.38*c* C) 1.4*c*
D) 0.62*c* E) 1.1*c*

Answer: A Switch to the frame of A, in which B is moving in the negative x direction at 0.31c and C is then moving in frame B in the negative x direction at 0.78c.

20) Two spaceships are approaching one another, each at a speed of 0.28*c* relative to a stationary observer on Earth. What speed does an observer on one spaceship record for the other approaching spaceship?

Answer: 0.52c Straightforward velocity addition.