McRoberts Secondary

Special Relativity Unit Test 2025-01-22

Personal Data

Family Name:

Given Name:

Signature:

checked

Registration Number

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9	☐	☐	☐	☐	☐	☐	☐	9

In this section **no** changes or modifications must be made!

Scrambling 0 0

Type: 020

Exam ID(Physics 12): 25012200001

Please mark the boxes carefully: ☒ Not marked: ☐ or ■

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Only clearly marked and positionally accurate crosses will be processed!

Answers 1 - 15

	a	b	c	d
1	☐	☐	☐	☐
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13	☐	☐	☐	☐
14	☐	☐	☐	☐
15	☐	☐	☐	☐
	a	b	c	d

Answers 16 - 20

	a	b	c	d
16	☐	☐	☐	☐
17	☐	☐	☐	☐
18	☐	☐	☐	☐
19	☐	☐	☐	☐
20	☐	☐	☐	☐
	a	b	c	d

1. Calculate the Lorentz factor when $v = 0.870c$.

    a. 1.78
    b. 1.53
    c. 2.03
    d. 2.89

2. If you were to travel to a star 59.0 light-years from Earth at a speed of $1.100 \times 10^8\ \mathrm{m/s}$, what would you measure this distance to be?

    a. $54.3\ \mathrm{ly}$
    b. $54.9\ \mathrm{ly}$
    c. $63.4\ \mathrm{ly}$
    d. $46.5\ \mathrm{ly}$

3. Why did Michelson and Morley orient light beams at right angles to each other?

    a. To obtain an interference pattern that would indicate how much the speed of light differs when moving in different directions.
    b. To observe the wave-particle duality of light.
    c. To observe the scattering of photons at 90 degrees that could be analyzed to see if light is an electromagnetic wave.
    d. To obtain a diffraction pattern that would indicate if the speed of light is constant in all frames of reference regardless of their motion.

4. Sitting in a stationary car, you observe a fast-moving train to be shorter than its rest length. An observer on the train observes your car to be

    a. shorter than its rest length
    b. longer than its rest length
    c. the same as its rest length
    d. not enough information to determine

5. A clock moving at $v = 0.810c$ passes your clock when both clocks read $t = 0$. When your clock reads $t = 49.0\ \mathrm{s}$, what does the moving clock read?

    a. $28.7\ \mathrm{s}$
    b. $83.6\ \mathrm{s}$
    c. $36.7\ \mathrm{s}$
    d. $4.2\ \mathrm{s}$

6. A rod passes by you at a speed of $0.380c$. You measure its length to be $64.0\ \mathrm{m}$. How long would it be at rest?

    a. $73.1\ \mathrm{m}$
    b. $119.7\ \mathrm{m}$
    c. $69.2\ \mathrm{m}$
    d. $59.2\ \mathrm{m}$

7. What was the purpose of the Michelson-Morley experiment?

    a. To measure the Earth's motion relative to the ether.
    b. To make a precise measurement of the speed of light.
    c. To establish that the Earth is the one true reference frame.
    d. To verify that light is an electromagnetic wave.

8. Which of the following is the correct expression for the Lorentz factor?
   a. $(1 + v^2/c^2)^{-1/2}$
   b. $(1 - v^2/c^2)^{1/2}$
   c. $(1 - v^2/c^2)^{-1/2}$
   d. $(1 + v^2/c^2)^{1/2}$
9. Length contraction occurs
   a. only when the object is not moving.
   b. only when the object is approaching the speed of light.
   c. perpendicular to the direction of motion (transverse lengths).
   d. parallel to the direction of motion (longitudinal lengths).
10. A car moving at $v = 0.661c$ turns on its headlights. In the car's reference frame, what distance does the light cover in 7.98×10^{-8} s?
    a. 213.0 m
    b. 23.9 m
    c. 65.9 m
    d. 179.0 m
11. Why was it once believed that light must travel through a medium called the *ether* and could not propagate across empty space?
    a. Light shows the phenomenon of diffraction and interference.
    b. Maxwell's theory of electromagnetism implies this.
    c. The speed of light is the maximum possible speed.
    d. All other known waves need a medium to travel through.
12. If Michelson and Morley had observed the interference pattern shift in their interferometer, what would that have indicated?
    a. The speed of light is boosted in the direction of Earth's motion.
    b. The speed of light is the same in all frames of reference.
    c. The speed of light changes upon reflection from a surface.
    d. The speed of light depends on the motion relative to the ether.
13. According to the postulates of special relativity, the speed of light in a vacuum
    a. is constant for all observers regardless of their motion.
    b. is constant only in the rest frame of the ether.
    c. depends on the speed of the observer.
    d. depends on the speed of the light source.
14. An astronaut goes on a long space voyage near the speed of light. When he returns home, how will his age compare to the age of his twin who stayed on Earth?
    a. This is a paradox in special relativity that does not have a clear answer.
    b. The astronaut will be younger than his twin because of time dilation.
    c. Both will be the same age because each can claim that it was the other who was moving.
    d. The astronaut will be older than his twin because of time dilation.

15. What best describes the Lorentz factor in the nonrelativistic limit?

    a. $\gamma \approx c$
    b. $\gamma \approx 0$
    c. $\gamma \to \infty$
    d. $\gamma \approx 1$

16. In your spaceship, you see an alien spaceship moving at $0.68c$. Considering the effects of time dilation and length contraction, the aliens would see your spaceship moving

    a. faster than $0.68c$
    b. at $0.68c$
    c. slower than $0.68c$
    d. not enough information to determine

17. Which statement accurately describes the relativity of simultaneity?

    a. Only events at the same location can be simultaneous.
    b. Events simultaneous in one frame may not be simultaneous in another.
    c. Simultaneity is absolute.
    d. All observers in inertial reference frames agree on which events are simultaneous.

18. Suppose you decide to travel to a star 60.0 light-years away in the reference frame of the Earth. How fast would you have to travel so that the distance would be only 50.0 light years?

    a. $0.438c$
    b. $0.553c$
    c. $0.794c$
    d. $0.646c$

19. A clock moving at $v = 0.370c$ passes your clock when both clocks read $t = 0$. When the moving clock reads $t = 52.0\,\text{s}$, what do the clocks in your frame read?

    a. $48.3\,\text{s}$
    b. $19.2\,\text{s}$
    c. $161.0\,\text{s}$
    d. $56.0\,\text{s}$

20. Time dilation means that

    a. time flies when you're having fun.
    b. moving clocks run faster than clocks at rest.
    c. moving clocks run slower than clocks at rest.
    d. moving clocks run at the same rate as clocks at rest.