



# McRoberts Secondary

Special Relativity Unit Test 2025-01-22



## Personal Data

Family Name:
Given Name:
Signature:
checked

## Registration Number

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7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7
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9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9

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

Scrambling

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Type

020

Exam ID(Physics 12)

25012200002

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

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15	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	a	b	c	d

## Answers 16 - 20

	a	b	c	d
16	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	a	b	c	d





1. 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.
2. A car moving at  $v = 0.186c$  turns on its headlights. In the car's reference frame, what distance does the light cover in  $7.68 \times 10^{-8} \text{ s}$ ?
  - a. 217.0 m
  - b. 23.0 m
  - c. 197.0 m
  - d. 214.0 m
3. 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.  $(1 - v^2/c^2)^{1/2}$
4. 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. All observers in inertial reference frames agree on which events are simultaneous.
  - d. Simultaneity is absolute.
5. Why did Michelson and Morley orient light beams at right angles to each other?
  - a. To obtain a diffraction pattern that would indicate if the speed of light is constant in all frames of reference regardless of their motion.
  - b. To observe the scattering of photons at 90 degrees that could be analyzed to see if light is an electromagnetic wave.
  - c. To obtain an interference pattern that would indicate how much the speed of light differs when moving in different directions.
  - d. To observe the wave-particle duality of light.
6. In your spaceship, you see an alien spaceship moving at  $0.26c$ . Considering the effects of time dilation and length contraction, the aliens would see your spaceship moving
  - a. faster than  $0.26c$
  - b. at  $0.26c$
  - c. slower than  $0.26c$
  - d. not enough information to determine
7. A clock moving at  $v = 0.580c$  passes your clock when both clocks read  $t = 0$ . When your clock reads  $t = 28.0 \text{ s}$ , what does the moving clock read?
  - a. 16.3 s
  - b. 11.2 s
  - c. 34.4 s
  - d. 22.8 s

8. What best describes the Lorentz factor in the nonrelativistic limit?
- $\gamma \approx 1$
  - $\gamma \rightarrow \infty$
  - $\gamma \approx 0$
  - $\gamma \approx c$
9. Calculate the Lorentz factor when  $v = 0.360c$ .
- 1.22
  - 1.07
  - 0.92
  - 0.79
10. A clock moving at  $v = 0.280c$  passes your clock when both clocks read  $t = 0$ . When the moving clock reads  $t = 14.0\text{ s}$ , what do the clocks in your frame read?
- 3.9 s
  - 22.4 s
  - 136.0 s
  - 14.6 s
11. Length contraction occurs
- only when the object is not moving.
  - perpendicular to the direction of motion (transverse lengths).
  - parallel to the direction of motion (longitudinal lengths).
  - only when the object is approaching the speed of light.
12. 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?
- Both will be the same age because each can claim that it was the other who was moving.
  - The astronaut will be older than his twin because of time dilation.
  - The astronaut will be younger than his twin because of time dilation.
  - This is a paradox in special relativity that does not have a clear answer.
13. If you were to travel to a star 90.0 light-years from Earth at a speed of  $2.000 \times 10^8\text{ m/s}$ , what would you measure this distance to be?
- 125.0 ly
  - 121.0 ly
  - 76.9 ly
  - 67.1 ly
14. If Michelson and Morley had observed the interference pattern shift in their interferometer, what would that have indicated?
- The speed of light is the same in all frames of reference.
  - The speed of light depends on the motion relative to the ether.
  - The speed of light changes upon reflection from a surface.
  - The speed of light is boosted in the direction of Earth's motion.

15. What was the purpose of the Michelson-Morley experiment?
- To measure the Earth's motion relative to the ether.
  - To make a precise measurement of the speed of light.
  - To establish that the Earth is the one true reference frame.
  - To verify that light is an electromagnetic wave.
16. 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
- shorter than its rest length
  - longer than its rest length
  - the same as its rest length
  - not enough information to determine
17. Why was it once believed that light must travel through a medium called the *ether* and could not propagate across empty space?
- All other known waves need a medium to travel through.
  - Light shows the phenomenon of diffraction and interference.
  - The speed of light is the maximum possible speed.
  - Maxwell's theory of electromagnetism implies this.
18. A rod passes by you at a speed of  $0.360c$ . You measure its length to be 96.0 m. How long would it be at rest?
- 189.5 m
  - 187.6 m
  - 89.6 m
  - 102.9 m
19. Suppose you decide to travel to a star 40.0 light-years away in the reference frame of the Earth. How fast would you have to travel so that the distance would be only 31.0 light years?
- $0.632c$
  - $0.657c$
  - $0.808c$
  - $0.317c$
20. According to the postulates of special relativity, the speed of light in a vacuum
- is constant for all observers regardless of their motion.
  - depends on the speed of the light source.
  - depends on the speed of the observer.
  - is constant only in the rest frame of the ether.