

Physics GRE Review Fall 2004

General Relativity Problems

Massachusetts Institute of Technology
Society of Physics Students
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Special Relativity Problem Set

The standard MIT relativity curriculum, either from 8.033 or 8.20, far exceeds the level of detail tested on the GRE. This problem set is intended to refresh the essential concepts you can expect to encounter on the Physics GRE.

1. Relativistic Coordinate Transformation

An event occurs in a moving frame S' at coordinates $(x', y', z', ct') = (3m, 1m, 0, 2m)$. S' moves at velocity $v = 0.8c$ in the x-direction with respect to a rest frame S . Find the coordinates of the event in S .

- (a) (7.66, 1, 0, 7.33)
- (b) (7.66, 1.66, 0, 7.33)
- (c) (5, 1, 0, 3.33)
- (d) (5, 1.66, 0, 3.33)
- (e) (3, 1.66, 0, 7.33)

2. Length Contraction

If a moving observer holds a rod of length $L = 1m$ at an angle of $\theta = 45^\circ$ from the x-axis, and is travelling at velocity $v = \sqrt{1/2}c$, find the length as measured by a stationary observer.

- (a) $\sqrt{3/4}m$
- (b) $\sqrt{5/8}m$
- (c) $\sqrt{1/2}m$
- (d) $\sqrt{3/2}m$
- (e) $\sqrt{5/2}m$

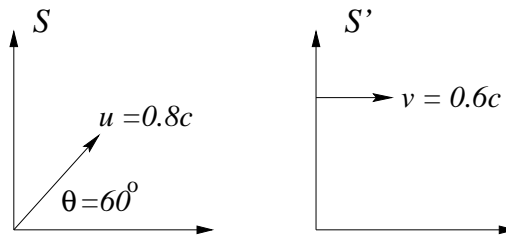
3. Time Dilation

If a moving observer sees a time of $t_0 = 3s$ elapse on his own watch and a stationary observer measures $t = 5s$ for the same time interval, find the relative velocity of the two observers.

- (a) $0.3c$
- (b) $0.4c$
- (c) $0.5c$
- (d) $0.6c$
- (e) $0.8c$

4. Relativistic Velocity Addition

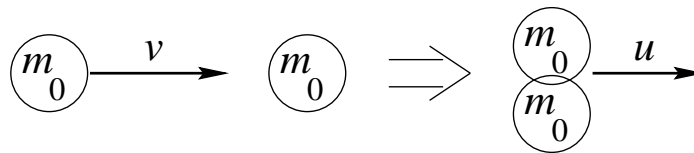
A particle in rest frame S moves at velocity $\vec{u} = (0.8c, 60^\circ)$. Find the particles velocity u' in frame S' which moves at a velocity $\vec{v} = v\hat{x}$ with respect to S .



- (a) $(0.721c, 106^\circ)$
- (b) $(0.589c, 110^\circ)$
- (c) $(0.640c, 60^\circ)$
- (d) $(0.775c, 110^\circ)$
- (e) $(0.775c, 70^\circ)$

5. Relativistic Collision

A particle with rest mass m_0 travels at a velocity $v \approx c$ with relativistic factor $\gamma_v = 100$ and collides with a second particle of mass m_0 . If the two particles stick together upon collision, find the factor γ_u for the velocity u with which the particles travel after the collision.



- (a) $\gamma_u = 20$
- (b) $\gamma_u = 30$
- (c) $\gamma_u = 50$
- (d) $\gamma_u = 80$
- (e) $\gamma_u = 100$