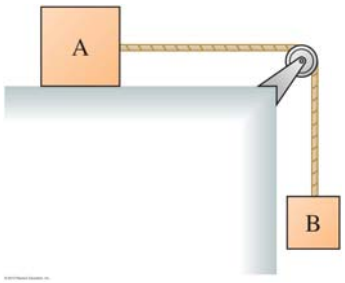
Name & Partners' Names:_____

7) A cosmic ray particle moving down toward Earth at constant speed decays 4.0 ms after it was produced as measured in the frame in which the particle is at rest. According to observers in the Earth frame, the particle traveled a distance of 3.0 lt · ms between its production and its decay.

a) Explain why you cannot divide 3.0 lt · ms by 4.0 ms to determine the speed of the particle as measured in the Earth frame.

b) Determine the speed of the particle in the Earth frame.

5) The figure shows box A (mass 6 kg) and box B (mass 2 kg) connected by a light-weight rope over an ideal, massless pulley. The boxes are released from rest.

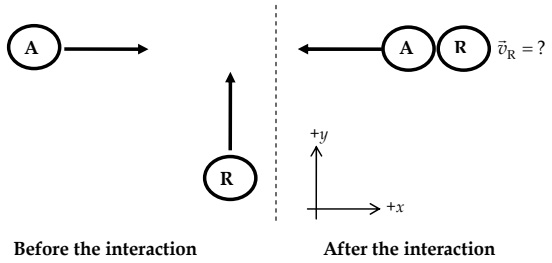


a) After box B has fallen 1.225 m, what is the speed of box A and box B? Neglect friction between box A and the table.

b) If the masses were switched so that box A were 2 kg and box B were 6 kg and released from rest, what can you say about A and B's speed after B had fallen 1.225 m, compared to part a)? Neglect friction between box A and the table.

c) Consider the original scenario. You make some measurements, and find that friction can't be neglected. When box B has fallen from rest a distance of 1.225 m, friction between box A and the table has transformed 8.01 J into non-mechanical forms (likely thermal energy). Determine the speed of box A and B after B has fallen from rest a distance of 1.225 m.

3) Astronauts Arlo and Rebeccca are on a collision course in outer space. Arlo (mass 45 kg) is moving in the $+x$ direction at 1.0 m/s. Rebecca (mass 60 kg) is moving in the $+y$ direction at 2.0 m/s. On colliding, the astronauts push off of each other in such a way that Arlo now moves to in the $-x$ direction, but still at 1.0 m/s. After the interaction, Rebecca is now moving with some unknown velocity $\vec{v}_R$. Determine Rebecca's speed and direction after the interaction.

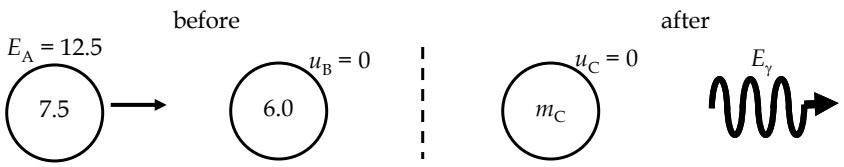


8) Amy is sitting in the very front of a train, while Penny is sitting in the very back of the train. According to Amy and Penny, the train is 1.875 lt · ms long. Sheldon is sitting on the tracks next to the train when it passes him by. Sheldon measures that the time between Amy passing him by and Penny passing him by is 2.5 ms. Amy and Penny measures that the time between Sheldon passing by them is 3.125 ms.

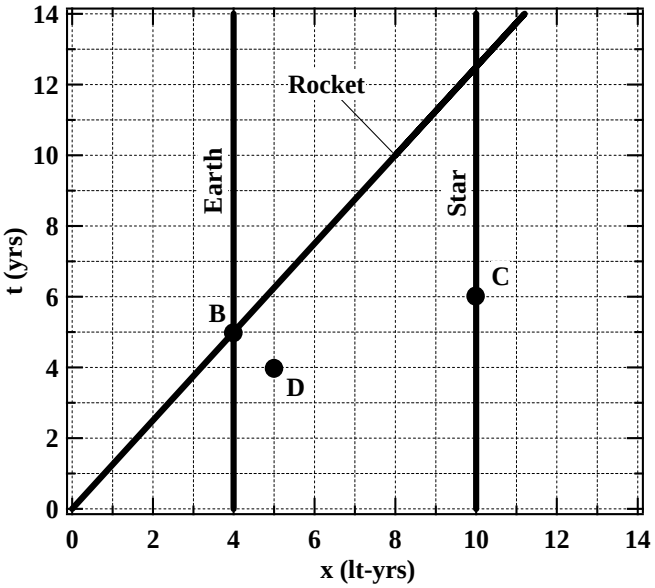
c) Determine the speed of the train, according to Sheldon, **in two different ways**.

d) Determine the length of the train, according to Sheldon, **in two different ways**.

11) Particle A (m = 7.5 GeV/c^2, E = 12.5 GeV) moves to the right and collides with stationary particle B (m = 6.0 GeV/c^2.) The result is stationary particle C of unknown mass m_C and a photon γ of unknown energy E_γ. Determine m_C.



9) The spacetime diagram shows the world lines of the Earth, a Star, and a Rocket, as well as several labeled events.



c) Which event(s) could cause which other event(s)? Which event(s) could not cause which other events(s)? Explain your reasoning.

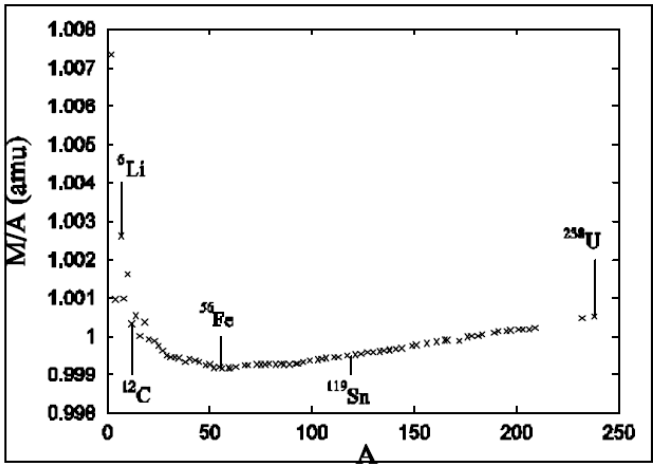
d) As measured by observers on a comet moving at constant speed with respect to the Earth (in the same direction as the Rocket), events C and D happen at the same time. Determine the speed of this comet with respect to the Earth.

a) Determine the speed of the Rocket, as measured by Earth observers.

b) Order events B, C, and D from earliest to latest in the ***Rocket's*** reference frame. Indicate any ties with an = sign.

10) The graph shows the average mass per nucleon (M/A) for various nucleon numbers (A). Consider the following choices:

mass is converted to kinetic energy	no energy conversions occur in this reaction
kinetic energy is converted to mass	not enough information to choose

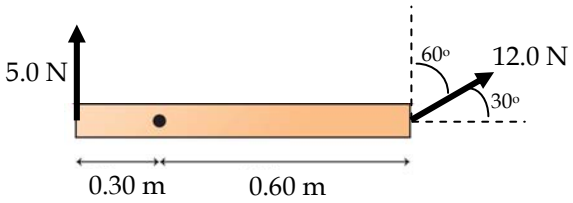


a) Two lithium nuclei (^{6}Li) combine to form a single carbon nucleus (^{12}C). What happens in this reaction? Explain your reasoning.

b) Two tin nuclei (^{119}Sn) combine to form a single uranium nucleus (^{238}U). What happens in this reaction? Explain your reasoning.

6b) In a scene from Fast and Furious XXX, observers on the ground observe the Rock in his rocket-car to be moving at a constant speed of 0.60*c* in a straight line, while Vin Diesel in his rocket-car is moving at a constant speed of 0.90*c* in the same direction. According to the Rock in his rocket-car, how fast is Vin Diesel going?

1) The figure is a bird's eye view; the only forces exerting torque are shown. The bar is free to pivot about the axis indicated by the dot. The moment of inertia of the bar about the axis indicated by the dot is 0.30 kg · m^2. Determine the magnitude of the angular acceleration of the bar.



2) Your friend stands on a horizontal platform that is free to rotate without friction. She holds a calculus textbook in each hand, with her arms resting along her sides. The combined moment of inertia of the two books, platform, and woman is 10 kg·m^2. You spin her so that her angular speed is 15 rad/s. She then holds her arms out away from her body, and her angular speed decreases to 6 rad/s. Determine the combined moment of inertia after she lifts her arms away from her body.