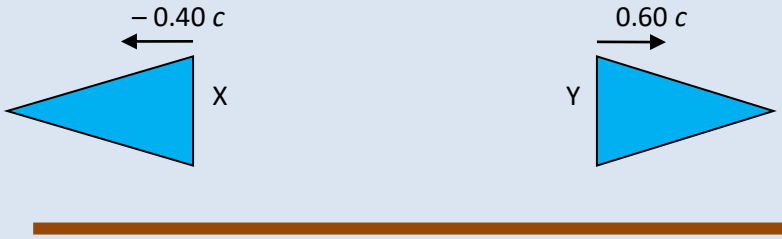
Quiz A6

Relativity

1. Two rockets, X and Y, move relative to the ground with velocities – 0.40c and +0.60 c.



What is the speed of X relative to Y?

A 0.20 c **B** 0.26 *c* **C** 0.81 *c* **D** *c*

2. An event E has coordinates (in light years) $(x=1, ct=0)$ in frame S. Frame S' moves past S with velocity 0.80c. When clocks in both frames show zero the origins of the two frames coincide. What are the coordinates of E in S' in light years?

	x'	ct'
A	$\frac{5}{3}$	0
B	$\frac{5}{3}$	$-\frac{4}{3}$
C	$\frac{3}{5}$	0
D	$\frac{3}{5}$	$-\frac{4}{3}$

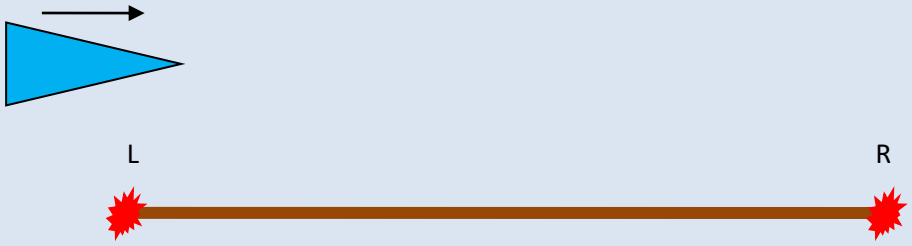
3. The gamma factor for a rocket is 2. What is the speed of the rocket?

A $\frac{1}{2}c$ **B** $\frac{\sqrt{3}}{4}c$ **C** $\frac{\sqrt{3}}{2}c$ **D** $\frac{2}{3}c$

4. A spacecraft leaves Earth with speed 0.80c ($\gamma = \frac{5}{3}$) on its way to a planet a distance of 24 ly according to Earth. When will the spacecraft arrive at the planet according to Earth and rocket observers?

	Earth observer	Rocket observer
A	30 years	18 years
B	30 years	30 years
C	18 years	18 years
D	18 years	30 years

5. A rocket is flying over a space station of proper length 900 m with a speed 0.80c ($\gamma = \frac{5}{3}$).



Two explosions take place at the same time according to space station clocks at the ends L and R of the space station. According to the rocket, what is the difference: time of the explosion at R minus that for L?

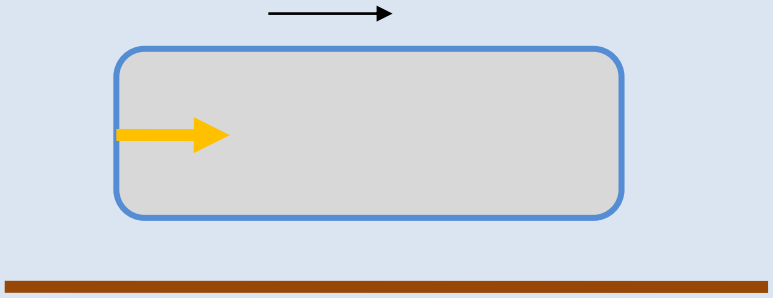
A 4.0×10^{-6} s

B -4.0×10^{-6} s

C 2.4×10^{-6} s

D -2.4×10^{-6} s

6. A beam of light is emitted from the left end of a box that moves with speed 0.60c ($\gamma = \frac{5}{4}$) relative to the ground. The proper length of the box is 300 m.



When will the beam of light arrive at the right end of the box according to box and ground observers?

	Box observer	Ground observer
A	2 μs	1 μs
B	2 μs	2 μs
C	1 μs	1 μs
D	1 μs	2 μs

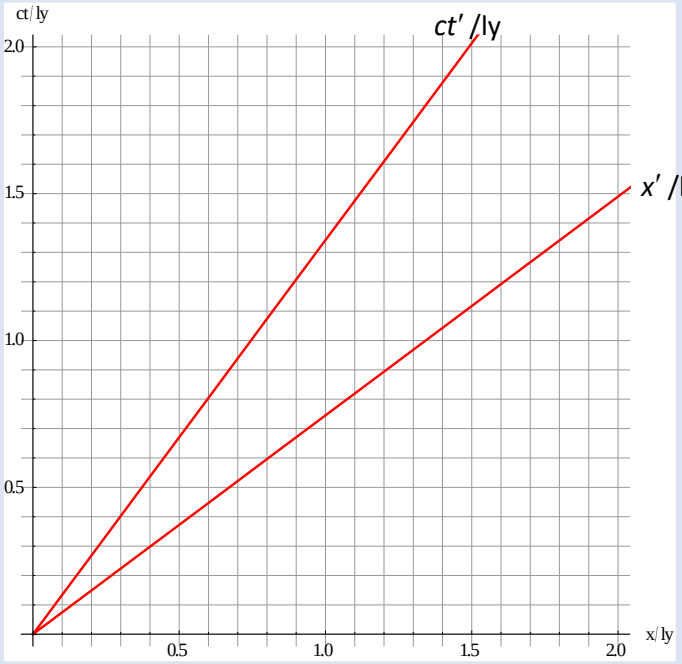
7. The half-life of a particle X is *T* when at rest. A freshly prepared beam of X particles moves in a lab. After travelling a distance *d* (measured in the lab) half the particles decay. The gamma factor for the particles is γ . Which is an expression for the speed of the particles in the beam relative to the lab?

A $\frac{d}{T}$ **B** $\frac{2d}{T}$ **C** $\frac{d}{\gamma T}$ **D** $\frac{\gamma d}{T}$

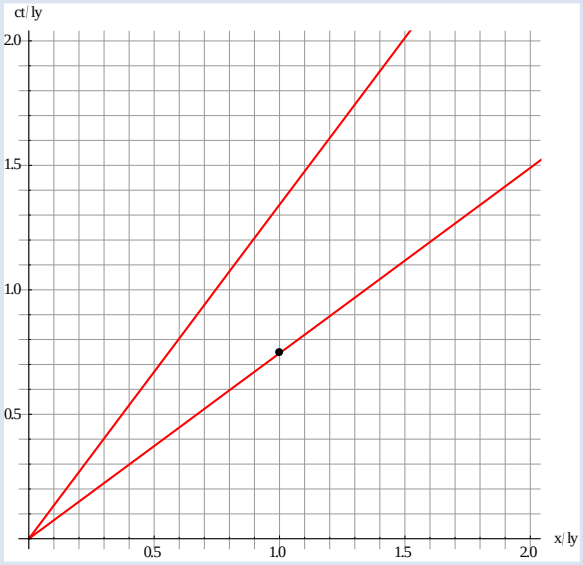
8. A space station and rocket have the same proper length *L*. The rocket moves past the space station. The gamma factor is γ.
What is the length of the space station measured by the rocket observers and what is the length of the rocket measured by the space station observers?

	Length of the space station measured by the rocket observers	**Length of the rocket measured by the space station observers**
A	$L\gamma$	$L\gamma$
B	$L\gamma$	$\frac{L}{\gamma}$
C	$\frac{L}{\gamma}$	$L\gamma$
D	$\frac{L}{\gamma}$	$\frac{L}{\gamma}$

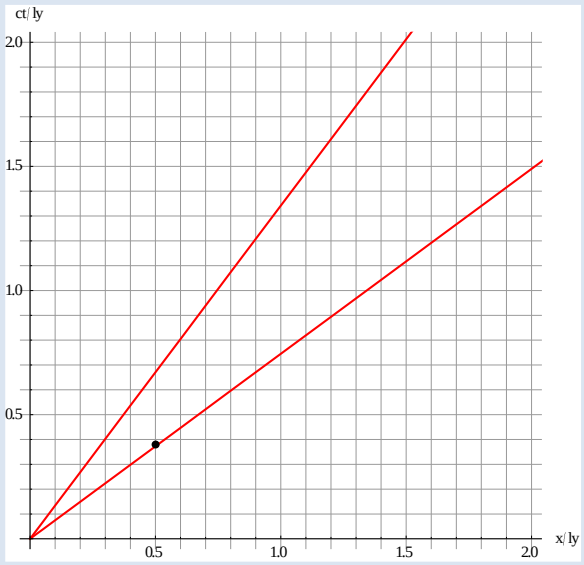
9. The diagram shows the space and time axes for a frame S and a frame S' that moves past S.



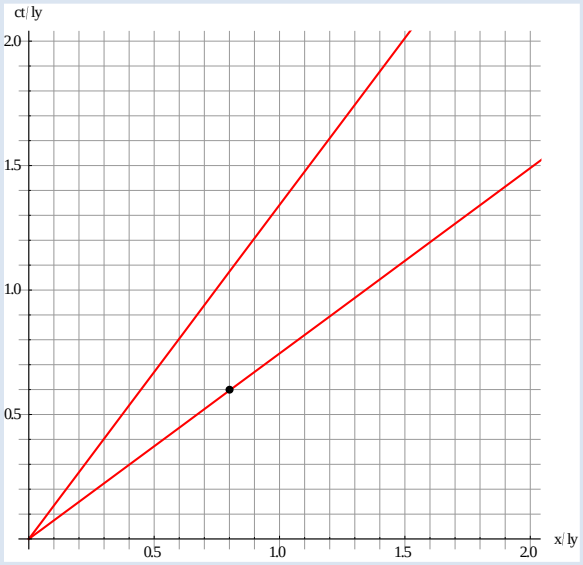
Which diagram correctly shows the position of the event whose coordinates (in light years) in S' are $(x' = 1, ct' = 0)$?


ct/ ly
2.0
1.5
1.0
0.5
0.5
1.0
1.5
2.0
x/ ly

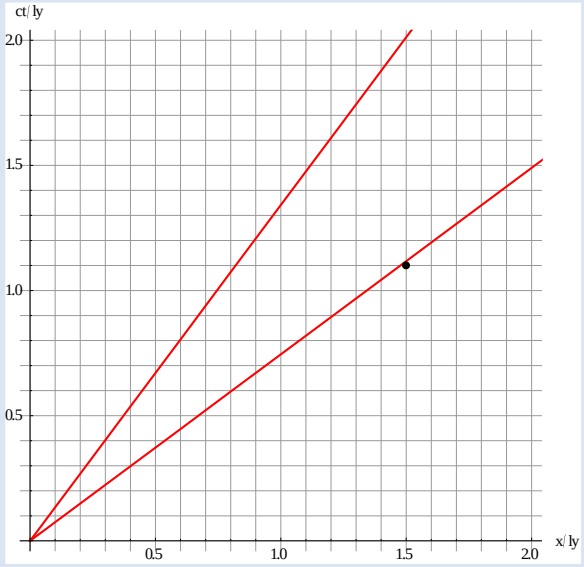
A


ct/ ly
2.0
1.5
1.0
0.5
0.5
1.0
1.5
2.0
x/ ly

B

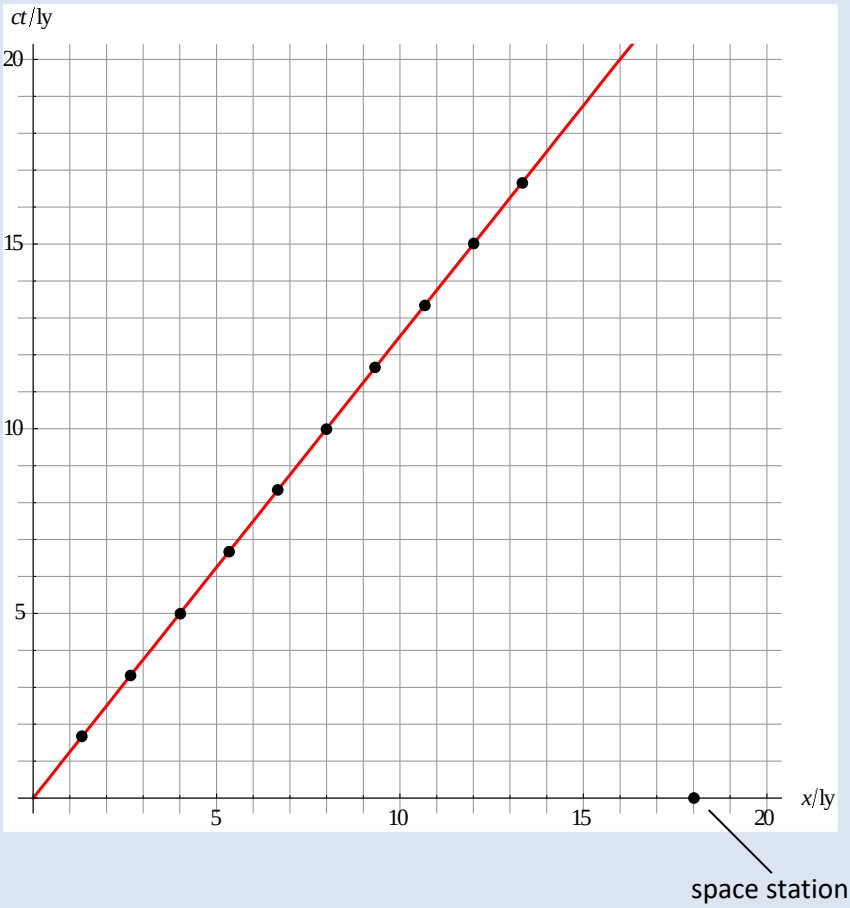

ct/ ly
2.0
1.5
1.0
0.5
0.5
1.0
1.5
2.0
x/ ly

C


ct/ ly
2.0
1.5
1.0
0.5
0.5
1.0
1.5
2.0
x/ ly

D

10. The diagram shows the spacetime axes of Earth's frame and the worldline of a rocket. When Earth and rocket clocks show zero, the rocket is at the origin of the Earth frame. The dots on the worldline are one light year apart by rocket clocks. At time zero a light signal is emitted from a space station at rest relative to Earth towards the rocket. The position of the space station at time zero is x = 18 ly in the Earth frame.



When does the light signal arrive at the rocket according to Earth and rocket observers?

	Earth observers /years	**Rocket observers /years**
A	10	10
B	10	6.0
C	18	10
D	18	6.0

Quiz A6 Answers	
1	C
2	B
3	C
4	A
5	B
6	D
7	C
8	D
9	D
10	B