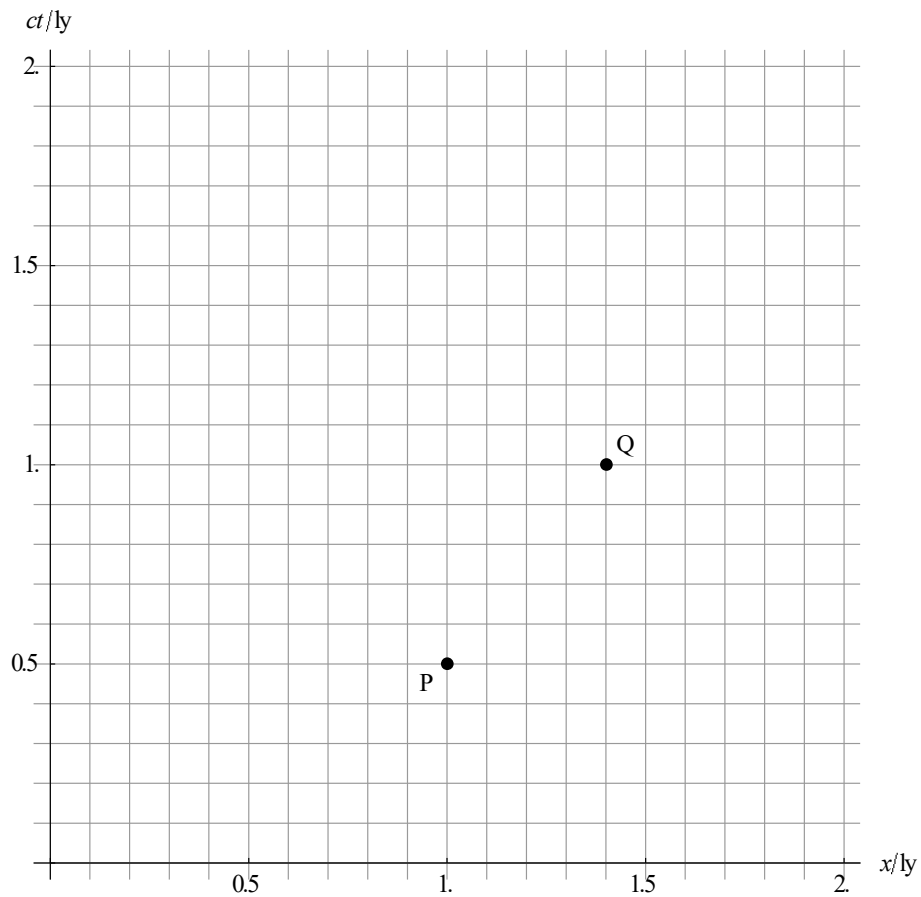


Teacher notes

Topic A

The spacetime diagram shows two events P and Q in an inertial frame S.



- Explain why there is **no** reference frame in which P and Q occur at the same time.
- Determine the speed relative to S, of another reference frame in which P and Q occur at the same point.

Answers

(a) This can be answered by a neat application of the spacetime interval:

The PQ spacetime interval is $(\Delta s)^2 = 0.50^2 - 0.40^2 > 0$. In a frame where P and Q are simultaneous $(\Delta s)^2 = 0 - (\Delta x)^2 < 0$. This is impossible since the spacetime interval has the same value in all frames.

More conventional answers would be: For events P and Q to occur at the same time, line PQ must be parallel to primed space axis. This means speed of frame is

$$\frac{v}{c} = \frac{0.50}{0.40} \Rightarrow v = 1.25c \text{ which is impossible.}$$

Using Lorentz transformations another answer is:

$$c\Delta t' = 0 = \gamma(c\Delta t - \frac{v}{c}\Delta x). \text{ So, } \frac{v}{c} = \frac{c\Delta t}{\Delta x} = \frac{0.50}{0.40} = 1.25 \text{ which is impossible.}$$

(b) The primed time axis must be parallel to the line PQ. Speed is $\frac{v}{c} = \frac{0.40}{0.50} \Rightarrow v = 0.80c$.

OR

$$\Delta x' = 0 = \gamma(\Delta x - v\Delta t). \text{ Speed is } v = \frac{\Delta x}{\Delta t} = \frac{0.40}{\frac{0.50}{c}} = 0.80c.$$