

PHYSICS 200 MIDTERM #1

October 5, 2007

Questions 1-8: Multiple choice/short answer - 1 point each

Question 9: Show your work - 7 points total

Name:

Student Number:

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\begin{aligned} x' &= \gamma(x - vt) & x &= \gamma(x' + vt') \\ t' &= \gamma\left(t - \frac{v}{c^2}x\right) & t &= \gamma\left(t' + \frac{v}{c^2}x'\right) \end{aligned}$$

$$u' = \frac{u - v}{1 - \frac{uv}{c^2}}$$

$$\Delta T = \frac{v^2}{c^2} \frac{L_1 + L_2}{c}$$

$$e^{i\pi} = -1$$

$$\vec{p} = \gamma m \vec{v}$$

$$f' = f \gamma \left[1 - \cos\theta \frac{v}{c} \right]$$

$$I = (\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2 - (\Delta t)^2 \cdot c^2$$

$$d\tau = dt \sqrt{1 - \frac{v^2}{c^2}}$$

$$E = mc^2$$

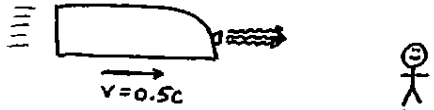
$$1 \text{ light year} = c \times 1 \text{ year}$$

$$-\frac{\hbar^2}{2m} \frac{\partial^2 \psi}{\partial x^2} + V\psi = i\hbar \frac{\partial \psi}{\partial t}$$

$$c \approx 3 \times 10^8 \text{ m/s}$$

POSSIBLY USEFUL FORMULAE

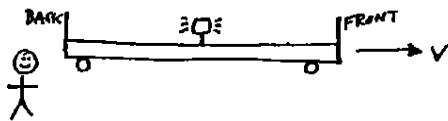
1



A train moving at $0.5c$ emits light (at speed c in the train's frame) from its front headlight. What speed does a fixed observer beside the track measure for the light?

Answer:

2

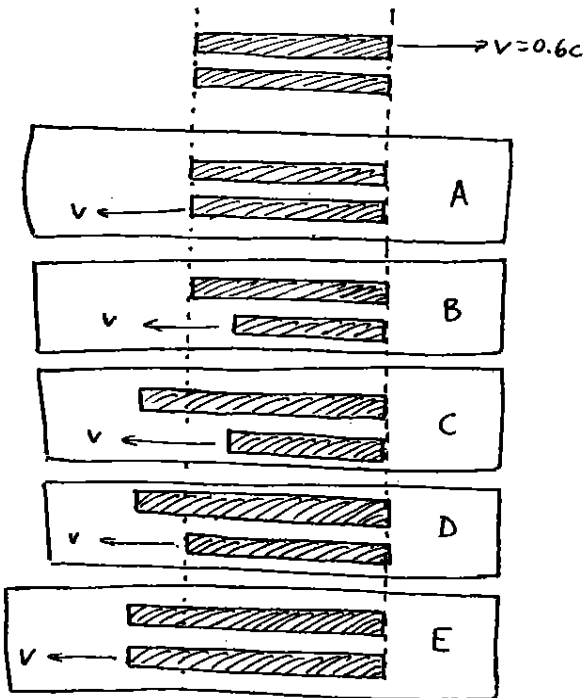


A flash of light is emitted from the center of a moving train. According to a fixed observer near the track, the light

- reaches the back of the train
- a) at the same time as
 - b) before
 - c) after
- the light reaches the front of the train

Answer:

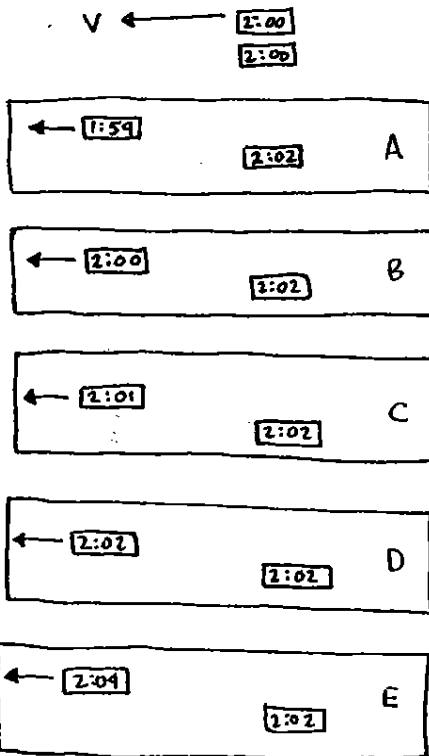
3



The top picture shows two rods, as observed in the frame of the lower rod. Which of the remaining pictures represents an observation of the same rods in the frame of the upper rod?

Answer:

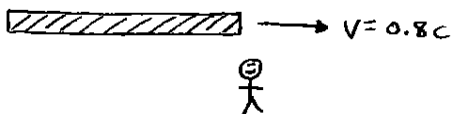
④



Two identical clocks are set to the same time as one passes the other at high velocity (as shown in the top figure). Which of the other figures represents a possible observation of the clocks at some later time in the frame of the fixed clock. (Assume the readings on the clocks are exact).

Answer:

⑤



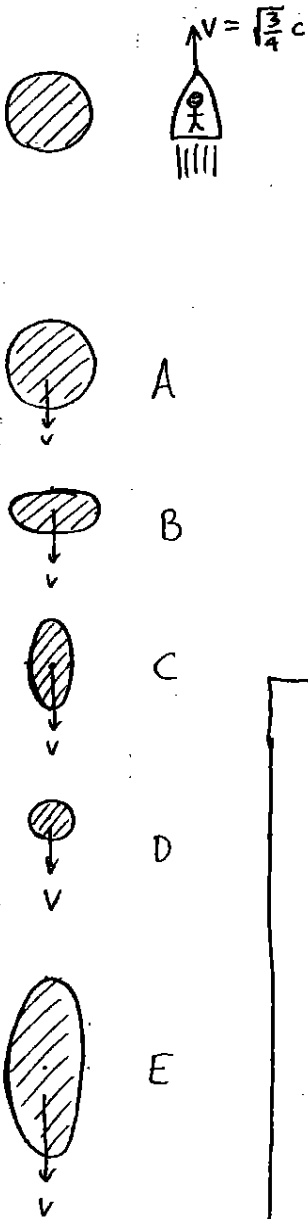
A meter stick travels at $0.8c$ relative to some fixed observer. How long does the observer measure

for the time it takes the stick to pass?

- A) $\frac{1m}{c}$
- B) $\frac{0.8m}{c}$
- C) $\frac{0.6m}{c}$
- D) $\frac{1.25m}{c}$
- E) $\frac{0.75m}{c}$

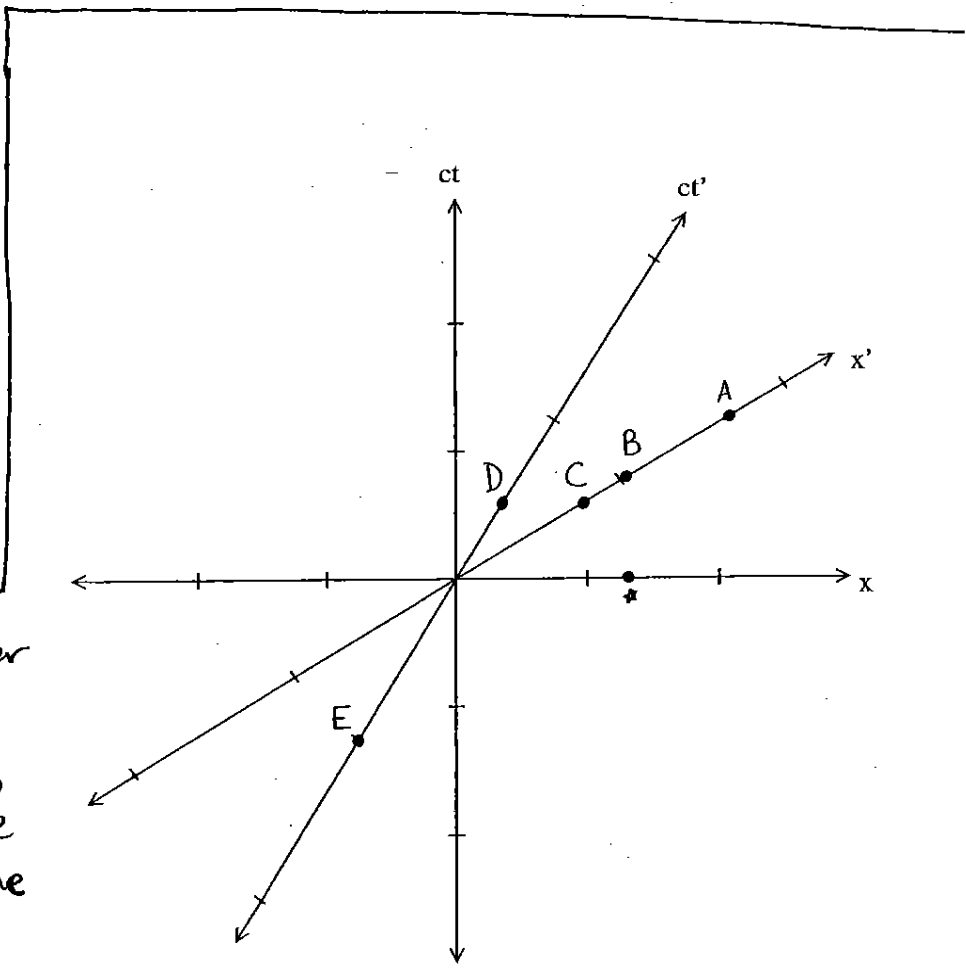
Answer:

6



Which of the diagrams below best represent the shape of the shaded object in the top picture, as observed by the person in the rocket in the top picture.

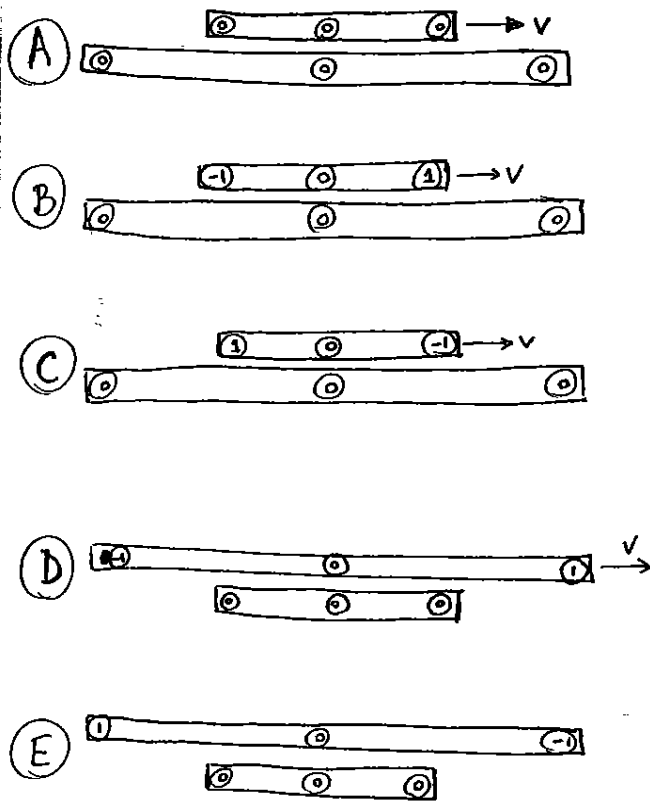
Answer:



7 According to an observer in the frame using x' and t' coordinates, which event is at the same location as the event marked $*$?

Answer:

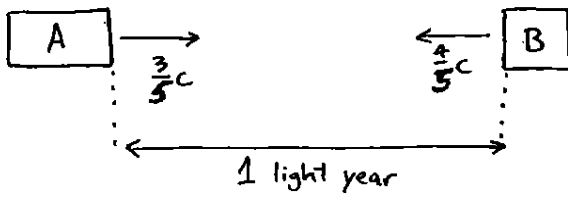
8



Two identical meter sticks, each with synchronized clocks at the ends and in the middle, pass each other at $v = \sqrt{\frac{3}{4}}c$. Which picture represents a possible observation of the system at some instant in the frame of the lower meter stick. Numbers in the circles represent the clock readings (in some units).

Answer:

9



Two ships approach each other at high velocity, as shown. The ships are initially 1 light year apart.

- a) What is the speed of ship B as measured by ship A?
(2 points)

- b) Assuming the clock on ship A reads $t'=0$ in the picture above, what does the clock read when the two ships meet?
(3 points)

c) How far away does A observe B to be when A's clock reads $t'=0$?
(2 points)