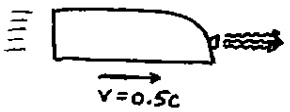
(1)



$\gamma = \sqrt{\frac{3}{4}}$

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?

a) 1.5c b) γc c) c d) $\frac{c}{\gamma}$ e) 0.5c

Answer:

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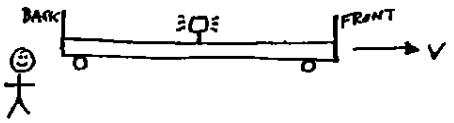
(2)



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:

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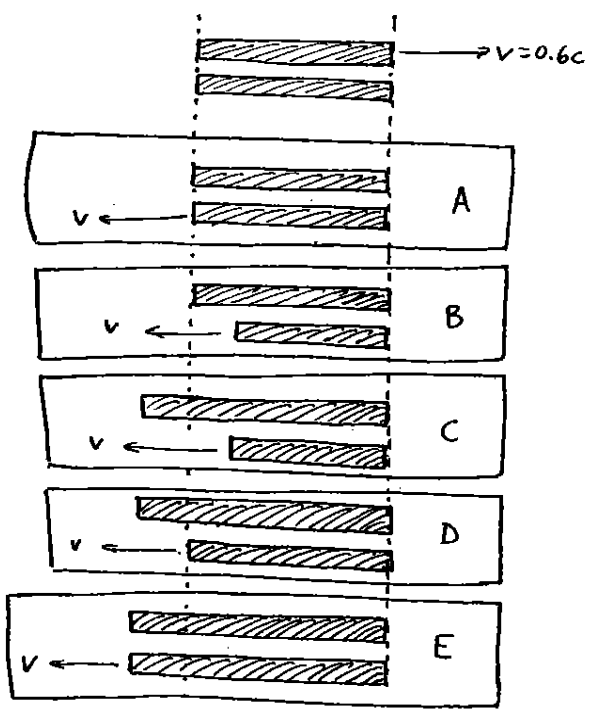
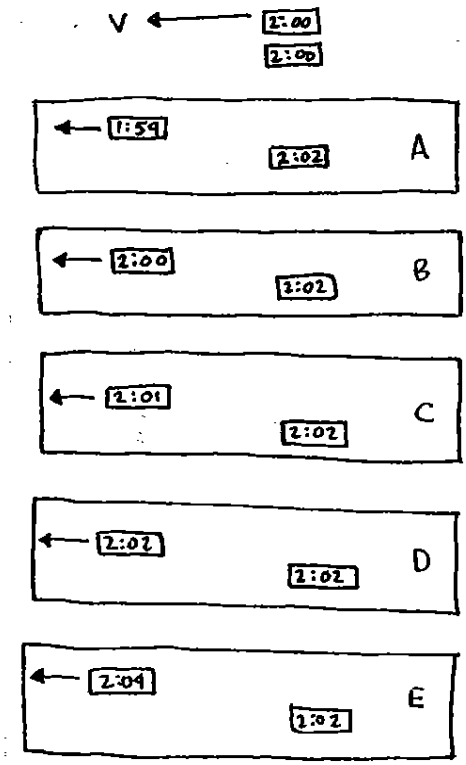
(3)



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:

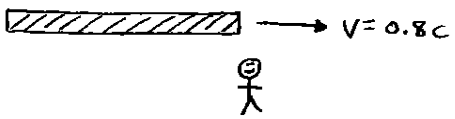
(4)



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) $\frac{0.8m}{c}$

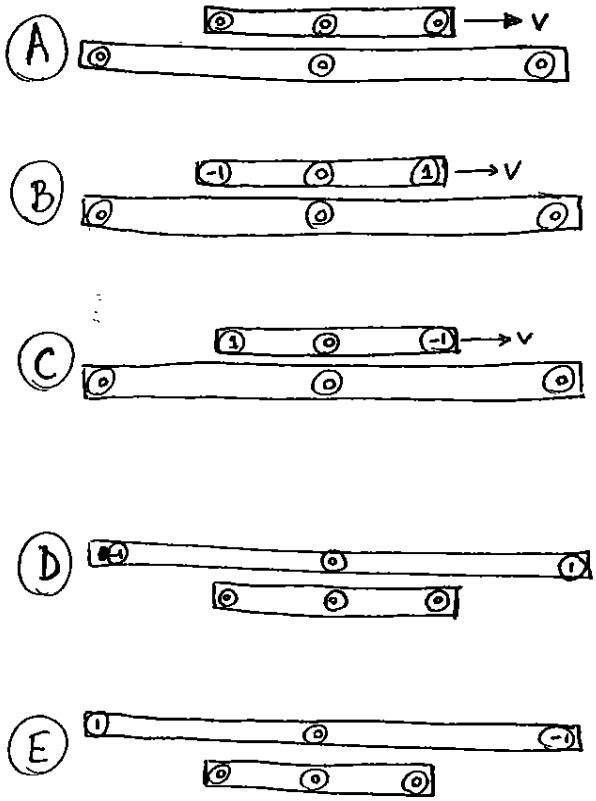
C) $\frac{0.6m}{c}$

D) $\frac{1.25m}{c}$

E) $\frac{0.75m}{c}$

Answer:

6



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:

7) The picture at the right represents an observation of an object moving at $v = \sqrt{\frac{3}{4}}c$. Which of the following pictures best represents the actual shape of the object (in its own frame).

A) 

B) 

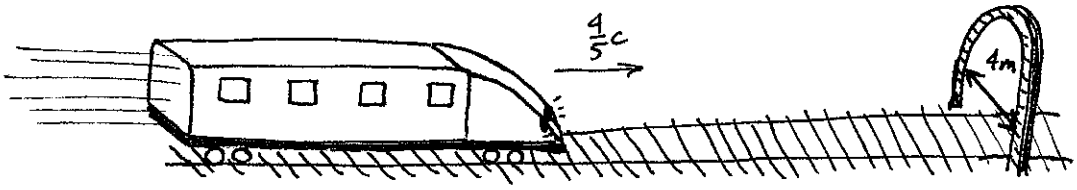
C) 

D) 

E) 

8) An unstable particle has an average lifetime of 10^{-8} seconds in its rest frame. A beam of these particles is produced with speed 4/5c. How far on average do the particles travel before decaying?

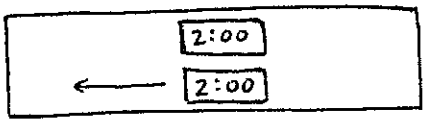
A) 1.44 m
B) 2.4 m
C) 3 m
D) 4 m



Problem 9

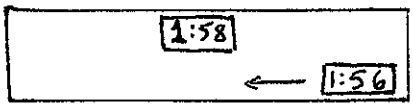
A train is 5m wide in its own frame of reference. If the train travels at velocity 4/5c towards an archway that is 4m wide (in the frame of the track), then:

A) the train will fit through the archway.
B) the train will not fit through the archway.
C) observers in the frame of reference of the track will see the train fit through the archway, but observers on the train will not
D) people on the train will observe it to fit through the archway, but observers on the track will find that it does not fit.

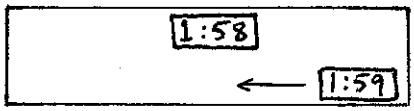


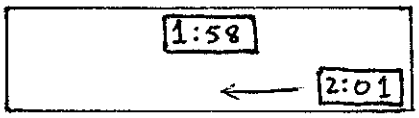
Problem 10

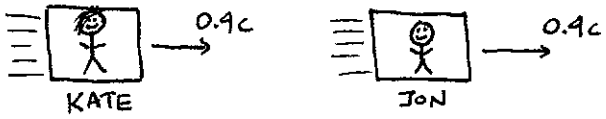
The picture above shows two clocks moving at a large relative velocity. Which of the pictures below represents a possible observation of the clocks at some earlier time (assume the readings on the clocks are exact)?

A)


B)


C)


D)




Problem 11

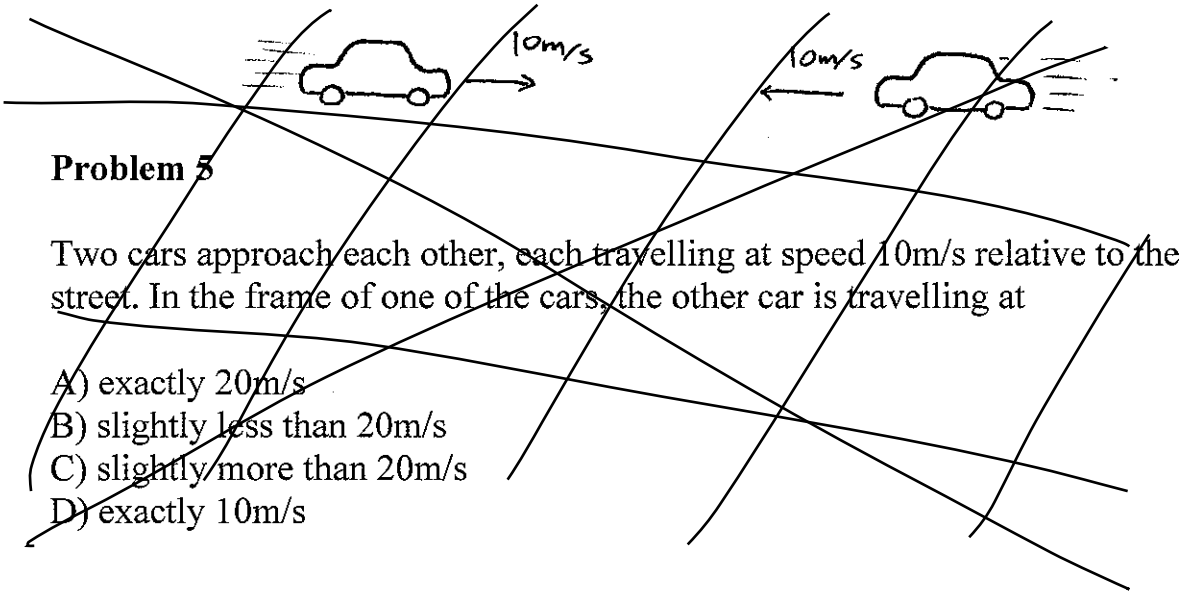
Jon and Kate are both traveling at velocity 0.4c in the positive x direction, with Jon 1km ahead of Kate. In Kate's frame of reference two firecrackers separated by 3 km along the x direction explode simultaneously. In Jon's frame, the firecracker at a larger value of x explodes

A) before the other firecracker.
B) after the other firecracker.
C) at the same time as the other firecracker.

Problem #12

On her 50th birthday, Oprah leaves Earth traveling at 3/5c towards a planet 3 light years away. When she reaches the planet, she immediately returns to Earth at the same speed. How old is Oprah when she arrives back on Earth?

A) 56 years old
B) 56.4 years old
C) 58 years old
D) 60 years old
E) 62.5 years old



Problem 5

Two cars approach each other, each travelling at speed 10m/s relative to the street. In the frame of one of the cars, the other car is travelling at

A) exactly 20m/s
B) slightly less than 20m/s
C) slightly more than 20m/s
D) exactly 10m/s

Problem 13

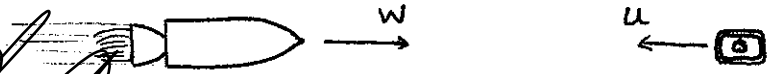
The Canada Line train is traveling at 0.5c. Lights at the front and the back of the train turn on simultaneously in the frame of the train. In the frame of the track, the lights at the front of the train turn on

A) at the same time as the lights at the back of the train
B) before the lights at the back of the train
C) after the lights at the back of the train
D) before or after, depending on where the observer is located on the track.

Problem 7

An electron is fired from a particle accelerator and hits a target 1km away. For the events where the electron is fired and where it hits the target, the invariant (spacetime) interval I is

A) positive
B) zero
C) negative
D) Not enough information to determine the answer.



Problem 8

A rocket and an iPhone approach each other, at speeds w and u as shown. In the frame of the picture, the iPhone rings at $x=L$ and $t=T$. In the frame of the rocket, the phone rings at position $x' = \gamma (L - v T)$, where v is equal to

A) w
B) $w + u$
C) $(w + u)/(1 + uw/c^2)$
D) $-(w + u)/(1 + uw/c^2)$
E) $-u$

Assume that origin of coordinates in the rocket's frame ($x'=t'=0$) agrees with the origin of coordinates in the frame of the picture ($x=t=0$).