a) Biker travels 5 m of space in 11 m of time

$$v = \frac{5\,m}{11\,m} = 0.455\,c \qquad \gamma = 1.123$$

b) $t_A - t_B = 0$ according to Bob

c) Bob measures $A = (-11, -9)$ $B = (2, -9)$

To compute Biker's location of each event, use Lorentz transformation – note one small complication

$$A: \quad x' = \gamma(x - vt) = 1.123\left(-11 - (0.455)(-9)\right)$$
$$= -7.76$$
$$t' = \gamma\left(t - \frac{vx}{c^2}\right) = 1.123\left(-9 - \frac{(0.455)(-11)}{1^2}\right)$$
$$= -4.49$$

But Biker's clock is offset from Jane + Bob's clock by +5.

$$\rightarrow t' = -4.49 + 5 = 0.51$$

We can likewise compute location of event B acc. to Biker.

$$B: \quad x' = \gamma(x - vt) = 1.123\left(2 - (0.455)(-9)\right)$$
$$= 6.83$$
$$t' = 5 + \gamma\left(t - \frac{vx}{c^2}\right) = 5 + 1.123\left(-9 - \frac{(0.455)(2)}{1^2}\right)$$
$$= -6.12$$

Thus we find the interval in time between A and B acc. to Biker is

$$\Delta t' = t'_A - t'_B = 0.51 - (-6.12) = \boxed{6.63 \text{ sec}}$$

As a check, compute the STI for each observer.

Bob: $STI = \sqrt{(t_A - t_B)^2 - (x_A - x_B)^2}$

$= \sqrt{(0)^2 - (-13)^2} = \underline{13i\ m}$

Biker: $STI = \sqrt{(t'_A - t'_B)^2 - (x'_A - x'_B)^2}$

$= \sqrt{(6.63)^2 - (-7.76 - 6.83)^2} = \underline{13i\ m}$

Yes, same STI. Note that it is imaginary, so no message can pass between events (A) and (B).

d) time interval acc. to Jane: $t_C - t_B = 9\ m$

e) Once again, use Lorentz trans for Biker:

$C: \quad x' = \gamma(x - vt) = 1.123(2 - (0.455)(0))$

$= 2.25\ m$

$t' = 5 + \gamma\left(t - \frac{vx}{c^2}\right) = 5 + 1.123\left(0 - \frac{(0.455)(2)}{1^2}\right)$

$= 3.98\ m$

$\rightarrow$ Biker $(t'_C - t'_B) = 3.98 - (-6.12) = \boxed{10.1\ m}$

f) Biker flashes light at point (F), beam travels to Bob and reaches him at

$F: (-11, 2)$

We need to use geometry and algebra to determine the location of event (F).

Equation of flash of light: $t = -x - 9$

Equation of Biker: $x = \frac{5}{11}t + 2$

Intersection when these are equal

$$x = \frac{5}{11}(-x-9) + 2$$

$$x = -\frac{5}{11}x - \frac{45}{11} + 2$$

$$\frac{16}{11}x = -\frac{45}{11} + \frac{22}{11}$$

$$16x = -45 + 22$$

$$\Rightarrow x = \frac{-23}{16} = -1.44$$

$$t = -\left(\frac{-23}{16}\right) - 9 = \frac{-121}{16} = -7.56$$

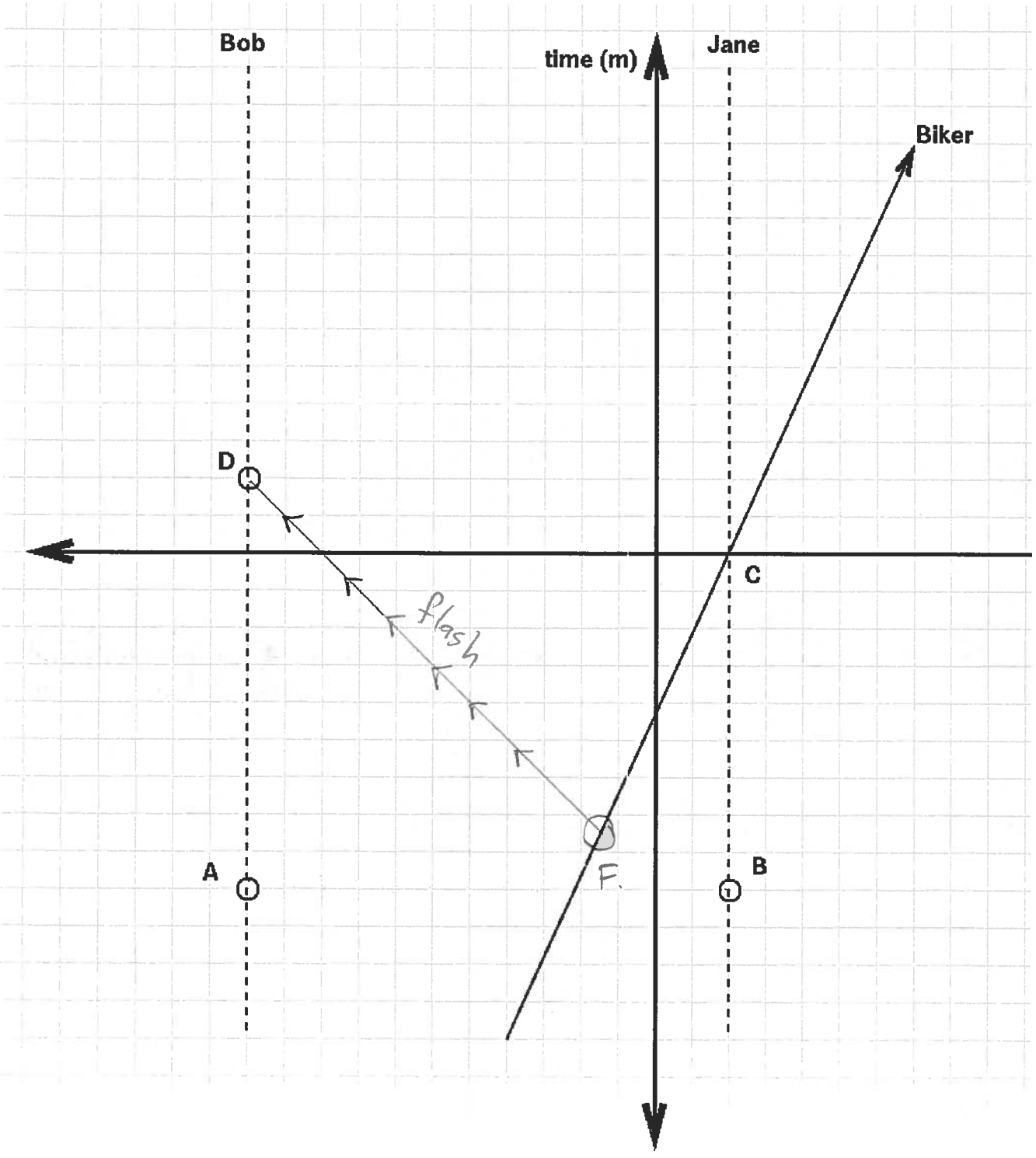
(F) $= (-1.44, -7.56)$

↖ time acc. to Bob

g) So time of flash acc. to Biker is

$$t' = 5 + \gamma\left(t - \frac{vx}{c^2}\right) = 5 + 1.123\left(-7.56 - \frac{(0.455)(-1.4}{1^2}\right.$$

$$= \underline{\underline{-2.76 \text{ m}}}$$


Bob
time (m)
Jane
Biker
D
C
flash
A
F
B