Higher Physics
Our Dynamic Universe
Check Test 5: Solutions

1. E
2. C
3. C
4. A
5. B
6. C
7. B
8. B
9. D
10. A

11 (a). $1st\ student: \quad v = 0.83 + 1.20 = 2.03\ ms^{-1}\ relative\ to\ building$ (1)

$2nd\ student: \quad v = 1.80\ ms^{-1}\ relative\ to\ building$

$Therefore: \quad speed\ of\ 1st\ student = 2.03 - 1.80 = 0.23\ ms^{-1}\ relative\ to\ 2nd\ student$ (1)

(b). (i). $3 \times 10^8\ ms^{-1}$ (1)

The speed of light is the same for all observers/all inertial frames of reference. (1)

(ii). $l' = l\sqrt{1 - \left(\frac{v}{c}\right)^2}$ (1)

$= 71 \times \sqrt{1 - \left(\frac{0.80c}{c}\right)^2}$ (1)

$= 42.6\ m$ (1)

(iii). Correct - From the perspective of the stationary observer, clocks will run slower due to time Dilation. (1)

OR

Incorrect - From the perspective of students on board the plane, they are in the same frame of reference as the clock so measure the proper time, t.

OR

Not possible to say - Frame of reference has not been defined.

12 (a). $d = vt$ (1)

$= 0.995 \times (3 \times 10^8) \times (2.2 \times 10^{-6})$ (1)

$= 660\ m$

12 (b). $$t' = \frac{t}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$ (1)

$$= \frac{2.2 \times 10^{-6}}{\sqrt{1-\left(\frac{0.995c}{c}\right)^2}}$$ (1)

$$= 2.2 \times 10^{-5}\ s$$ (1)

(c). For an observer on Earth's frame of reference, the mean lifetime of the muon is much greater. (1)

OR

The distance in the muon's frame of reference is shorter.

13 (a). The apparent decrease in length of an object moving relative to an observer. (1)

(b). $$\gamma = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$

$$= \frac{1}{\sqrt{1-(0.80)^2}}$$ (1)

$$= 1.67$$ (1)

(c). $$l' = l\sqrt{1-\left(\frac{v}{c}\right)^2}$$

$$l' = \frac{l}{\gamma}$$ (1)

(d). For an object moving with a velocity much less than c, v/c is very small causing the Lorentz factor to be approximately 1. (1)

If γ=1, l'=l so the contracted length is equal to the proper length of the object, meaning there is a neglibile change in length observed. (1)