7.
$$t = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$60.0 \text{ years} = \frac{15.0 \text{ years}}{\sqrt{1-\frac{v^2}{(3.00\times10^8 \text{ m/s})^2}}}$$

$$\sqrt{1-\frac{v^2}{(3.00\times10^8 \text{ m/s})^2}} = \frac{15.0 \text{ years}}{60.0 \text{ years}}$$

$$1-\frac{v^2}{(3.00\times10^8 \text{ m/s})^2} = \left(\frac{15.0 \text{ years}}{60.0 \text{ years}}\right)^2$$

$$\frac{v^2}{(3.00\times10^8 \text{ m/s})^2} = 1-\left(\frac{15.0 \text{ years}}{60.0 \text{ years}}\right)^2 = 0.938$$

$$v = \sqrt{(0.938)(3.00\times10^8 \text{ m/s})^2} = 2.90\times10^8 \text{ m/s}$$

8. She should give 2.5 h according to the space bus clock. Not only does the space bus clock show down, but biological clocks (you) slow down at the same rate. If you travel at a high speed through space, you are not aware that there is anything different. Writing an exam for 2.5 h on the space bus will seem the same to you as writing the same exam in your class room. However, if the principal looks in by means of a video camera, he would think you were given extra time.

$$t = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{2.50}{\sqrt{1-(0.96)^2}} = 8.9 \text{ h}$$

The principal would think that you had 8.9 h to write a 2.5 h exam.

Lesson 2–Length Contraction

1.
$$L = L_0\sqrt{1-\frac{v^2}{c^2}} = (35.0 \text{ m})\sqrt{1-\frac{(2.55\times10^8 \text{ m/s})^2}{(3.00\times10^8 \text{ m/s})^2}} = 18.4 \text{ m}$$

2.
$$L = L_0\sqrt{1-\frac{v^2}{c^2}}$$

$$L_0 = \frac{L}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{80.0 \text{ m}}{\sqrt{1-(0.900)^2}} = 184 \text{ m}$$

3.
$$L = L_0\sqrt{1-\frac{v^2}{c^2}}$$

$$2.85 \text{ light years} = (6.25 \text{ light years})\sqrt{1-\frac{v^2}{(3.00\times10^8 \text{ m/s})^2}}$$

Note: We do not need to convert light years.

$$\frac{2.85 \text{ light years}}{6.25 \text{ light years}} = \sqrt{1-\frac{v^2}{(3.00\times10^8 \text{ m/s})^2}}$$

$$(0.456)^2 = 1-\frac{v^2}{(3.00\times10^8 \text{ m/s})^2}$$

$$\frac{v^2}{(3.00\times10^8 \text{ m/s})^2} = 1-(0.456)^2$$

$$v = \sqrt{(0.792)(3.00\times10^8 \text{ m/s})^2} = 2.67\times10^8 \text{ m/s}$$

4.
$$L = L_0\sqrt{1-\frac{v^2}{c^2}} = (90.0 \text{ m})\sqrt{1-(0.800)^2} = 54.0 \text{ m}$$

NOTE: Height does not change. It is only the dimension parallel to the direction of travel that changes.

5.
$$L = L_0\sqrt{1-\frac{v^2}{c^2}} = (1.20 \text{ km})\sqrt{1-\frac{(3.10\times10^8 \text{ m/s})^2}{(3.00\times10^8 \text{ m/s})^2}}$$

You will soon discover that the mathematics is impossible to do as we cannot find the square root of a negative value. According to Einstein's special theory of relativity, nothing can travel faster than light (3.00×10^8 m/s). The salesman was not telling the truth.