

**Physics 30 - Lesson 39H**  
**Special Relativity**

1)  $v = 2.4 \times 10^8 \text{ m/s}$   
 $t = 2.0 \times 10^{-8} \text{ s}$   
 $t_o = ?$

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

$$t_o = t \sqrt{1 - \frac{v^2}{c^2}} \quad \checkmark$$

$$t_o = 2.0 \times 10^{-8} \text{ s} \sqrt{1 - \frac{(2.4 \times 10^8 \text{ m/s})^2}{(3.0 \times 10^8 \text{ m/s})^2}} \quad \checkmark$$

$$t_o = 1.2 \times 10^{-8} \text{ s} \quad \checkmark$$

2)  $t = 3.5 \times 10^{-8} \text{ s}$   
 $t_o = 2.6 \times 10^{-8} \text{ s}$

/4

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

$$1 - \frac{v^2}{c^2} = \left(\frac{t_o}{t}\right)^2 \quad \checkmark$$

$$1 - \left(\frac{t_o}{t}\right)^2 = \frac{v^2}{c^2}$$

$$\sqrt{\left(1 - \left(\frac{t_o}{t}\right)^2\right)} c^2 = v \quad \checkmark$$

$$v = \sqrt{\left(1 - \left(\frac{2.6 \times 10^8 \text{ s}}{3.5 \times 10^8 \text{ s}}\right)^2\right)} (3.0 \times 10^9)^2 \quad \checkmark$$

$$v = 2.00 \times 10^8 \text{ m/s} \quad \checkmark$$

3)  $L = 90 \text{ m}$   
 $L_o = ?$   
 $v = 0.80c$

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$$L = L_o \sqrt{1 - \frac{v^2}{c^2}} \quad \checkmark$$

$$L_o = \frac{L}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{90 \text{ m}}{\sqrt{1 - \frac{(0.8c)^2}{(1.0c)^2}}} = 150 \text{ m} \quad \checkmark$$

4) A)  $v = \frac{d}{t}$

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B)  $t = \frac{t_o}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \checkmark$

$$t = \frac{d}{v} = \frac{20.1 \text{ y}}{0.95c} = 21.05 \text{ years} \quad \checkmark$$

$$t_o = 21.05 \sqrt{1 - \frac{(0.95c)^2}{(1.0c)^2}} \quad \checkmark$$

$$t_o = 21.05(0.31) = 6.75 \text{ years} \quad \checkmark$$

5)  $u = ?$   
 /3  $m_o = 1.67 \times 10^{-27} \text{ kg}$   
 $v = 0.6c$

$$m = \frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1.67 \times 10^{-27} \text{ kg}}{\sqrt{1 - \frac{(0.6)^2}{(1.0)^2}}}$$

$$m = 2.09 \times 10^{-27} \text{ kg}$$

6)  $m = 4$   
 $m_o = 1$   
 /4  $v = ?$

$$1 - \frac{v^2}{c^2} = \left(\frac{m_o}{m}\right)^2$$

$$1 - \left(\frac{m_o}{m}\right)^2 = \frac{v^2}{c^2}$$

$$v = \sqrt{\left(1 - \left(\frac{m_o}{m}\right)^2\right)} c^2$$

$$v = \sqrt{\left(1 - \left(\frac{1}{4}\right)^2\right)} (1.0c)$$

$$v = 0.968c$$

7)  $E = m_o c^2$   
 /3  $E = (9.11 \times 10^{-31} \text{ kg})(3.0 \times 10^8 \text{ m/s})^2$   
 $E = 8.20 \times 10^{-14} \text{ J}$

8)  $E_k = ?$   
 $v = 2.7 \times 10^8 \text{ m/s}$   
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$$m = \frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1.67 \times 10^{-27} \text{ kg}}{\sqrt{1 - \frac{(0.9)^2}{(1.0)^2}}}$$

$$m = 3.83 \times 10^{-27} \text{ kg}$$

$$E_k = (m - m_o)c^2$$

$$E_k = (3.83 \times 10^{-27} \text{ kg} - 1.67 \times 10^{-27} \text{ kg})(3.0 \times 10^8 \text{ m/s})^2$$

$$E_k = 1.95 \times 10^{-10} \text{ J}$$

9)  $E = ?$   
 /4

$$m = \frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}} = m = \frac{1.67 \times 10^{-27} \text{ kg}}{\sqrt{1 - \frac{(0.7)^2}{(1.0)^2}}} = 2.34 \times 10^{-27} \text{ kg}$$

$$E = m_o c^2 = (2.34 \times 10^{-27} \text{ kg})(3.0 \times 10^8 \text{ m/s})^2$$

$$E = 2.10 \times 10^{-10} \text{ J}$$

10)  $P = \frac{E}{t} = \frac{9.0 \times 10^{13} \text{ J}}{0.1 \times 10^{-6} \text{ s}} = 9.0 \times 10^{20} \text{ W}$   
 /5  $m = (0.001)(1 \text{ kg})$   
 $m = 0.001 \text{ kg}$

$$E = mc^2$$

$$E = (0.001 \text{ kg})(3.0 \times 10^8 \text{ m/s})^2$$

$$E = 9.0 \times 10^{13} \text{ J}$$