

**PHYSICS 6
 HOUR EXAM 1
 SPRING 2003**

SOLUTIONS

I. 1d, 2c, 3b, 4e, 5d, 6c,7c, 8e.

II. a. accelerates

b. distance it falls = $(1/2) g t^2 = (1/2) \times (9.8 \text{ m/s}^2) \times (5 \text{ s})^2 = 4.9 \times 25 \text{ m} = 120 \text{ m}$

c. Ball takes 5 sec, whether thrown horizontally or not, since vertical (which accelerates) and horizontal (no acceleration) are independent.

d. Since horizontal motion is at constant 10 m/s, horizontal distance in 5 sec will be $10 \text{ m/s} \times 5 \text{ s} = 50 \text{ m}$

III.

a. Proper time is the given 9×10^{-11} sec. In lab, which moves at $0.8c$ relative to Kaon, time will be longer (dilated) by factor $1/\sqrt{1 - (0.8)^2} = 1/\sqrt{1 - 0.64} = 1/\sqrt{0.36} = 1/0.6 = 5/3 = 1.67$

So $t = 1.67 \times 9 \times 10^{-11} \text{ s} = 1.5 \times 10^{-10} \text{ s}$

b. In that time, traveling at $0.8c$, the Kaon will cover

$$0.8 \times (3.0 \times 10^8 \text{ m/s}) \times (1.5 \times 10^{-10} \text{ s}) \\ = 3.6 \times 10^{-2} \text{ m} = 3.6 \text{ cm.}$$

c. Velocity addition with $u' = 0.75c$, the pion's velocity in the Kaon rest frame, and $V = 0.8c$, the velocity of the Kaon rest frame relative to the lab.

$$u = \frac{u' + V}{1 + \frac{u'V}{c^2}} = \frac{0.75c + 0.8c}{1 + 0.75 \times 0.8} = \frac{1.55c}{1.60} = 0.97c$$

d. $E = m_0 c^2 = 8.85 \times 10^{-28} \text{ Kg} \times (3.0 \times 10^8 \text{ m/s})^2 = 7.97 \times 10^{-11} \text{ J}$
 or $7.97 \times 10^{-11} \text{ J} / (1.60 \times 10^{-19} \text{ J/eV}) = 4.98 \times 10^8 \text{ eV} = 498 \text{ MeV.}$