SOLUTIONS

$x' = \gamma(x - Vt)$

$ct' = \gamma(ct - \frac{Vx}{c})$

$\gamma = \dfrac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$

$f = f_0\sqrt{\frac{1-v/c}{1+v/c}}$

$\Delta s = \sqrt{c^2t^2 - x^2}$

$v_{o/a} = \dfrac{v_{o/b} + v_{b/a}}{1 + \frac{v_{o/b}v_{b/a}}{c^2}}$

$\vec{P} = (\gamma mc, \gamma m v_x, ..)$ $\quad F_x = F_x'$ $\quad F_y = F_y'/\gamma$

h=4.14x10^{-15} eVs $\quad$ c=3x10^8 m/s

Physics 262 Fall 2010 Exam 5 **LAST NAME FIRST NAME** **Use backs for scratch**

1] A mass of m (rest mass) moving at 0.943c collides and sticks to an initially stationary mass 4m. What is the final speed of the stuck-together lump (to the nearest c/10?) $\gamma_i = 3$

A] 0
B] 0.1 c
C] 0.2 c
D] 0.3 c
E] 0.4 c
F] 0.5 c
G] 0.6 c
H] 0.7 c
I] 0.8 c
J] 0.9 c

$P_i = (\gamma_i mc, \gamma_i m v_i) + (4mc, 0) = (7mc, 2.83mc) = P_f$ $\quad v_f = \frac{2.83}{7}c = 0.4c$

2] The final lump is hotter (the kinetic energy "lost" in an inelastic collision goes into heat.) What is the rest mass of the hot lump (choose the closest answer)? $\gamma_f = 1.091$ $\quad P_f = (\gamma_f M_f c, \gamma_f m_f v_f)$ so

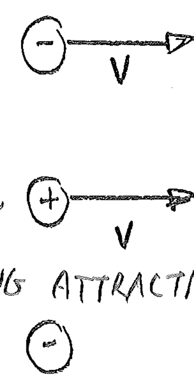
A] 4m
B] 5m
C] 6m
D] 7m
E] 8m
F] 9m
G] 10m
H] 11m
I] 12m
J] 13m

$M_f = 6.42m$

3] Consider three charges as shown; the negative charges (at the instant shown) are equally far from the positive charge, perpendicular to v. Consider the electromagnetic forces exerted by the positive charge on each negative charge (i.e. ignore the forces the negative charges exert on each other.) Which of the following statements is true in this reference frame:

A] The magnitude of the electric force from the positive charge on each negative charge is the same
B] The magnitude of the electric force on the upper charge is smaller than on the lower charge (but still nonzero)
C] The magnitude of the electric force on the lower charge is larger than on the upper charge (but still nonzero)
D] The electric force on the upper charge is zero; the electric force on the lower charge is nonzero.
E] The electric force on the lower charge is zero; the electric force on the upper charge is nonzero.
F] The electric force on either charge (caused by the + charge) is zero.
G] No statement is true

4] Which of the statements above is true in the reference frame of the + charge? $\boxed{A}$



5] In the frame shown, the total electromagnetic force on each negative charge (from the + charge) :
A] is the same for both – charges
B] is larger for the the top charge
C] is larger for the bottom charge → TOP CHARGE ALSO HAS MAGNETIC FORCE, OPPOSING ATTRACTION

6] In the frame of the + charge, which of the statements in 5 is true?

All F is electrical, so SAME force. $\boxed{A}$

7] A wire in the lab carries a current of electrons with a linear charge density of $4\text{x}10^7$ e/m, each moving at 0.01 c. The wire is overall electrically neutral (in the lab.) In the rest frame of the electrons, their charge density is

A] $< 4\text{x}10^7$ e/m They are contracted INTO the lab frame.
B] $= 4\text{x}10^7$ e/m
C] $> 4\text{x}10^7$ e/m

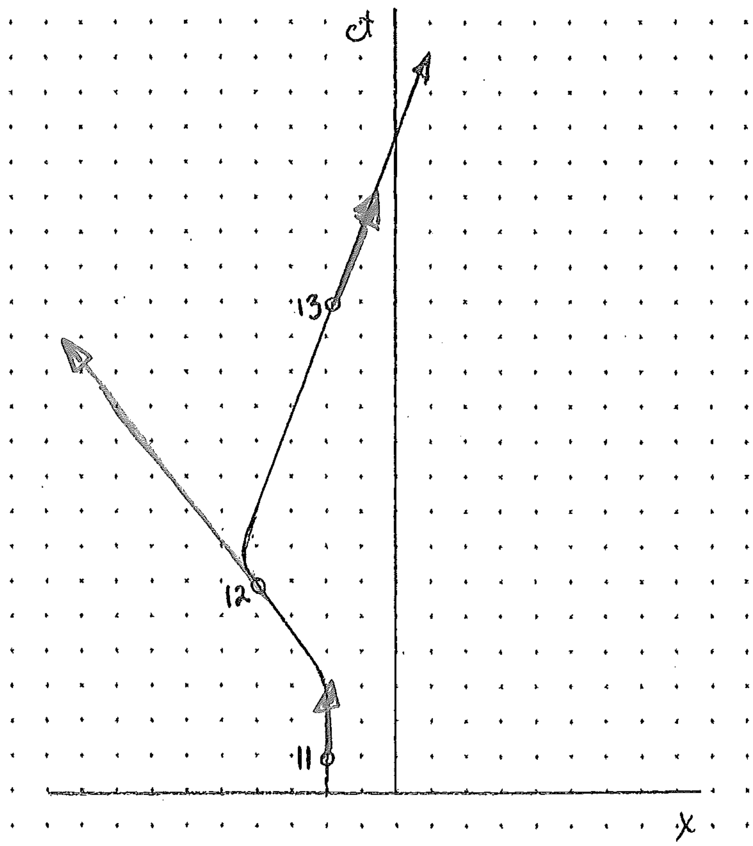
8] An electron moves near the wire, in the same direction as the electrons in the wire and at the same speed. The force on the electron:
A] is zero from $qV \times B$ or from Relativity.
B] is directed toward the wire
C] is directed away from the wire
D] is toward the wire in the lab frame, but away from the wire in the electron rest frame
E] is away from the wire in the lab frame, but toward the wire in the electron rest frame

9&10] What is the **net** charge density of the wire, in charges per meter, as seen by this electron?

(You will probably want to use the Taylor expansion $\gamma = 1 + \frac{1}{2}\frac{v^2}{c^2}$ for small v/c. Don't forget the + nucleii!)

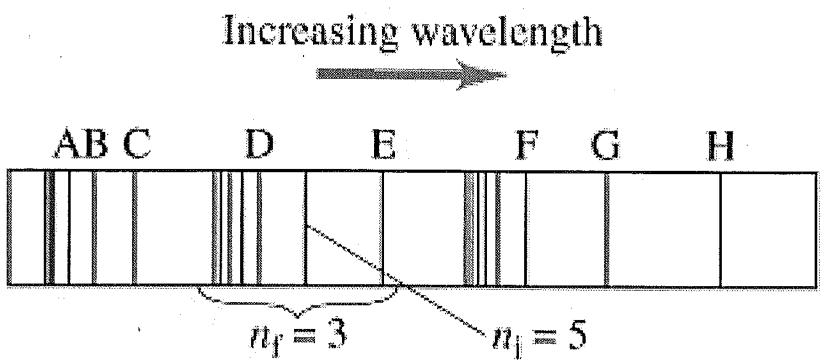
$\lambda = 2 \cdot \frac{1}{2}\frac{v^2}{c^2}\lambda_0 = 4000\ e/m.$

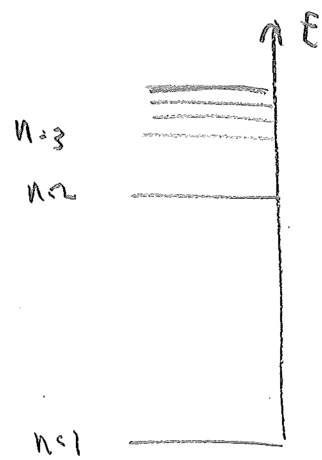
11,12,13] Sketch energy-momentum 4-vectors on the worldline shown, at the points indicated.



14&15] Light shines on a metal with a work function of 2.6 eV. What is the longest wavelength that can eject an electron (in nm?) $E = \frac{hc}{\lambda}$ $\lambda = \frac{hc}{E} = 4.78 \times 10^{-7}$ m $= 478$ nm.

16] If the intensity of light (at a wavelength that can emit electrons) is increased:
A] the rate at which electrons are emitted will increase
B] the kinetic energy of the emitted electrons will increase
C] both will increase
D] neither will increase





17] The spectrum of hydrogen is shown. Which letter corresponds to the transition from n_i=6 to n_f=4?
Lower energy, longer λ $\boxed{G}$

18] The ionization energy of hydrogen is 13.6 eV. What is the energy, to the nearest 1/10th of an eV, of the photon emitted? Enter 9 for anything 0.9 eV or larger.

$\left(\frac{1}{4^2} - \frac{1}{6^2}\right) \cdot 13.6 \text{ eV} = 0.47 \text{ eV}.$