AUB	PHYSICS 212	June 13, 1997
Physics Department	FINAL EXAM	Time 2H

N.B. Write your name and ID number on the top of your booklet.

1)- 20 points

An observer S is standing on a platform of length $D_o = 65$ m on a space station. A rocket R passes at a speed $v = 0.80c$ moving parallel to the edge of the platform. The observer S notes that the front and back of the rocket simultaneously line up with the ends of the platform at a particular instant (fig. A)

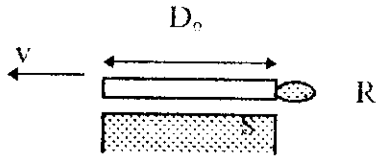

Fig A

a) According to S, what is the time necessary for the rocket to pass a particular point on the platform?
b) What is the rest length L_o of the rocket?
c) According to an observer S' on the rocket, what is the length D of the platform?
d) According to S', how long does it take for observer S to pass the entire length of the rocket ?
e) According to S, the ends of the rocket simultaneously line up with the ends of the platform . Are these events simultaneous to S'?

2)- 20 points

A certain accelerator produces a beam of neutral kaons ($m_K c^2 = 498$ MeV) with kinetic energy 325 MeV. Consider a kaon that decays in flight into two pions ($m_\pi c^2 = 140$ MeV). Find the kinetic energy of each pion in the special case in which the pions travel parallel or antiparallel to the direction of the kaon beam.

3)- 20 points

The discovery of the antiproton $\bar{p}$ took place in 1956 at Berkeley through the following reaction: $p + p \rightarrow p + p + p + \bar{p}$, in which accelerated protons were incident on a target of protons at rest in the laboratory. When the product particles in the laboratory frame S move together as if they were a single unit, find

a) the magnitude v' of the velocity of either reacting proton in the center-of- masse reference frame S',
b) the velocity v of the incident protons in the laboratory frame.

4)- 20 points

What is the wavelength of the least energetic photon in the Balmer spectrum?
What is the wavelength of the series limit for the Balmer series? $R = 1.097 \times 10^{7}$ m^{-1}.

5)- 20 points

X rays with λ =100 pm are scattered from a carbon target. The scattered radiation is viewed at 90° to the incident beam.

a) What is the Compton shift $\Delta\lambda$?

b) What kinetic energy is imparted to the recoiling electron?

6)- 15 points

a) For n=4, what is the largest allowed value of ℓ ?

b) What is the magnitude of the corresponding angular momentum ?

c) How many different components on the z axis may this angular momentum vector have?

d) What is the magnitude of the largest projected component ?

e) What is the smallest angle that the angular momentum vector can make with the z-axis?

7)- 30 points

The wave function for the ground state of the hydrogen atom is given by

$$\psi(r) = \frac{1}{\sqrt{\pi a_o^3}} e^{-r/a_o} \quad , \quad \text{in which } a_o \text{ is the Bohr radius.}$$

a) Show that the probability that an electron lies within a sphere of radius r is given by: $P = 1 - e^{-2x}(1 + 2x + 2x^2)$, in which $x = r/a_o$.

b) Evaluate the probability that the electron, in the ground state, will be found between the spheres $r = a_o$ and $r = 2a_o$.

8)- 15 points

The nuclide ^{120}Sn ($Z = 50$) has a filled proton shell, 50 being one of the magic nucleon numbers . The nuclide ^{121}Sb ($Z = 51$) has an extra proton outside this shell. According to the shell concept, this extra proton should be easier or harder to remove than a proton from the filled shell. (1u =931.5 MeV)

Nuclide	Z	N	Atomic Mass(u)
^{121}Sb	50+1	70	120.903821
^{120}Sn	50	70	119.902199
^{119}In	50-1	70	118.905819

9)- 30 points

The Ω^- baryon has $S = -3$. K^+ and K^o have $S = 1$. Ξ^o and Ξ^- have $S = -2$.

While Σ^+ , Σ^o , Σ^- , Λ^o all have $S = -1$. All non strange particles such as p , n, pions and η, η' have $S = 0$. Each baryon is assigned a baryon number $B = +1$.

a) It is desired to produce the Ω^- using a beam of K^- incident on protons. What other particles are produced in this reaction? (Use the three conservation laws for B, S and Q).

b) How might the Ω^- decay ? (knowing that the product particles can be Λ^o , Ξ^o , K^- and π^-).

10)- 10 points

Analyze this process in terms of its quark content (u, d, and s).

$\Sigma^- \rightarrow n + \pi^-$

Use data given in problem number 8 with the following table:

quark	charge (unit e)	Baryon number	strangeness
u	2/3	+1/3	0
d	-1/3	+1/3	0
s	-1/3	+1/3	-1