



AUB Physics Department

Final Exam

Physics 212

June 20, 1995

Name: _____

Useful information:

$k = 9 \times 10^9 \text{ J.m/C}$ $e = 1.6 \times 10^{-19} \text{ C}$ $m_e = 0.511 \text{ MeV}/c^2$ $\mu_B = 5.79 \cdot 10^{-5} \text{ eV/T}$

$hc = 12400 \text{ eV.Å}$ $\hbar = 6.58 \times 10^{-16} \text{ eV.s}$ $e/m_e = 1.759 \times 10^{11} \text{ C/kg}$

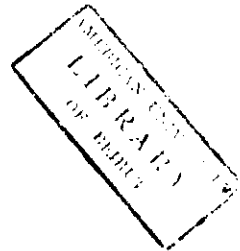
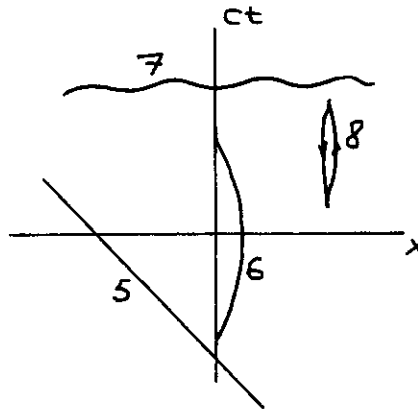
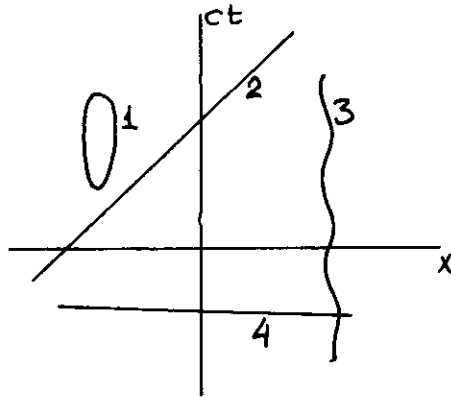
$m_n = 1.008666 \text{ u}$ $m_p = 1.007277 \text{ u}$ $1 \text{ u} = 931.5 \text{ MeV}/c^2$

Boltzmann constant $k = 1.38 \cdot 10^{-23} \text{ J/K}$.

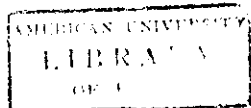
Some lighter elements: ${}^1\text{H}$, ${}^2\text{He}$, ${}^3\text{Li}$, ${}^4\text{Be}$, ${}^5\text{B}$, ${}^6\text{C}$, ${}^7\text{N}$, ${}^8\text{O}$, ${}^9\text{F}$

Part A.

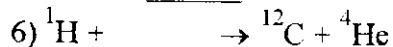
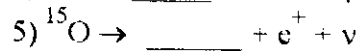
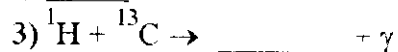
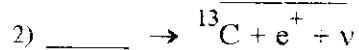
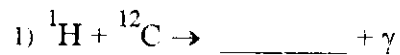
- 4 1. The following space-time diagrams show several examples of world lines. Indicate on the diagrams, which of the lines
- belong to massive particles
 - belong to massless particles
 - violate the principle of causality or the postulates of the special relativity theory



- 4 2. Mark the incorrect statement
- The characteristic X-ray lines of an element have wavelengths that are inversely proportional to the voltage across the X-ray tube
 - If the voltage across an X-ray tube is increased, the short wavelength cutoff λ_{\min} of the continuous X-ray spectrum decreases
 - A characteristic X-ray line cannot have wavelength shorter than the cutoff limit λ_{\min} of the continuous spectrum
 - Continuous X-ray spectrum will be produced by any charged body subjected to a rapid acceleration or deceleration
 - both a) and d)



- 15 VI. The principal source of energy in older stars is the carbon cycle. This cycle involves six reactions, which are partially given below:



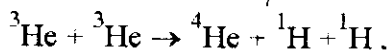
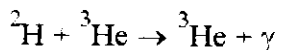
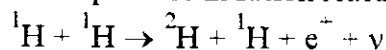
A. Fill in the blanks in these reactions.

B. Indicate which reactions involve weak interaction

C. Carbon cycle requires higher temperatures than the proton-proton cycle in the sun.

Roughly, how much higher would you expect the required temperature to be as compared to the temperature needed for the p-p cycle?

In order to estimate the temperature, answer the following questions first: What is the role of temperature in fusion reactions? In the proton-proton cycle,



it is the last reaction that is most temperature sensitive. Why?

Which is the most temperature-sensitive reaction in the carbon cycle?

- 4 3. Consider the electronic states in a hydrogen atom. Mark the incorrect statement (if any)
- a) There are 2 degenerate states with the same energy in the level with the principal quantum number $n=1$.
 - b) An electron in an s -state ($l=0$) will not interact with the external magnetic field
 - c) The average kinetic energy of the electron in the ground state is 13.6 eV
 - d) In the $2p$ state, the z -component of the orbital angular momentum can have three different values

- 4 4. It follows from the uncertainty principle that
- a) each particle must have an antiparticle
 - b) even at absolute zero atoms in a crystalline lattice have to vibrate with the amplitude of at least kT/h
 - c) the values of quantum numbers n and l for an electron in the hydrogen atom cannot be specified with arbitrary precision
 - d) electron in the hydrogen atom cannot move along elliptical trajectories
 - e) none of the above

Part B

- 14 I. A particle of unknown mass M decays into two particles of masses $m_1 = 0.5 \text{ GeV}/c^2$ and $m_2 = 1.0 \text{ GeV}/c^2$ whose momenta are measured to be $p_1 = 2.0 \text{ GeV}/c$, directed along the Y -axis, and $p_2 = 1.5 \text{ GeV}/c$ directed along the X -axis
Find the mass of the unknown particle and its speed.

- 10 II. A group of π -mesons is observed traveling at a speed $0.8c$ with respect to the laboratory. If the proper half-life of π -mesons is 18 ns, and there were initially 32000 of them, how many will be left after they have traveled 36 m according to the stationary observer?