Final Exam Physics 342 Fall 2005 December 14, 2005

Printed Name: _____ ID Number: _____

Signature:_____

1. What is the probability of decay per second of a nucleus with a half-life of 4 hours?

2. Find the maximum kinetic energy of the electrons emitted in the negative beta decay of ^{11}Be.

	Z	A	Atomic Mass
Li	3	8	8.022486
Be	4	10	10.013534
Be	4	11	11.021658
B	5	10	10.012937
B	5	11	11.009306
C	6	10	10.016853
C	6	11	11.011433

3. Answer each of the following with the appropriate letter:

A for Fission B for Fusion C for Both D for Neither

_____ Several products of the reaction are highly radioactive.

_____ Energy release can be as large as several MeV per reacting nucleon.

_____ It is usually necessary to overcome a Coulomb barrier for the reaction to occur.

_____ Nuclear reaction is usually induced by the capture of a neutron.

_____ Reacting nuclei come from commonly available chemical elements.

_____ Electrical power could be generated by boiling water using heat obtained from kinetic energy of nuclei and nucleons produced in the reaction.

_____ It is presently being used to generate power in the United States.

_____ Neutrons produced could produce reactor fuel.

_____ Care must be taken not to produce a chain reaction.

_____ Isotope separation is usually needed to produce fuel.

4. Classify the following materials by the appropriate number as:

(1) Conductor
(2) Insulator
(3) Semiconductor
(4) Conductor and insulator.
(5) Conductor and semiconductor.
(6) Insulator and semiconductor.
(7) Conductor, insulator, and semiconductor.
(8) None of these.

___. Filled valence band, empty conduction band, energy gap = 8 eV.

__. Filled valence band, empty conduction band, energy gap = 1 eV.

__. Half-filled valence band, empty conduction band, energy gap = 1 eV.

__. The Fermi energy is located in the gap between the valence and conduction bands.

__. The electrical resistance decreases significantly as the temperature is lowered.

__. The electrical resistance is large at low temperature.

5. Answer the numbered questions with the following lettered choices:

A. General relativity
B. Slow process
C. Rapid process
D. White dwarf
E. Neutron star
F. Black hole

____ A binary pulsar is evidence for it.

____ Light can't escape from it.

____ Nuclide production in supernovas.

____ Supported by precession of perihelion.

____ Production of some stable nuclides are shielded by short-lived isotopes.

____ A probable ending for our sun.

____ Mass of object is inside Schwarzschild radius.

6. Calculate the binding energy of a donor impurity caused when $^{31}_{15}\mathrm{P}$ is inserted into a lattice of $^{28}_{16}\mathrm{Si}$. The dielectric constant of Si is 12. Assume electron mass.

7. Given that the Fermi energy is 56.27 MeV for a neutron star with one solar mass, what is the Fermi energy of a star of 1.5 solar masses?

8. The early universe was radiation dominated, our present is matter dominated. At what temperature was this conversion possible?

9. At what velocity is the classical value of the kinetic energy off by 1%?

10. If we define $\Delta p = \sqrt{(p^2)_{av} - (p_{av})^2}$ what is its value for a particle of mass m in a one-dimensional box of length L?

11. Assume that the nucleons in a nucleus obey Fermi statistics. Find the Fermi energy of the neutrons and protons in $^{40}_{20}Ca$.

12. A π^+ at rest decays to a $\mu^+ + \nu_\mu$ if the rest energy of a π^+ is 140 MeV and that of the μ^+ is 105.7 MeV, what is the energy of the ν_μ ?