Nuclear Energy and Special Relativity (pg. 1)

Questions 1-2 deal with nuclear fission for which the following reaction is a good example.

$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{138}_{56}Ba + {}^{95}_{36}Kr$ + neutrons + released energy

1. The total number of free neutrons in the products of this reaction is

(A) 2
(B) 3
(C) 4
(D) 5
(E) 6

2. Which of the following statements is always true for neutron-induced fission reactions involving $^{235}_{92}U$?

I. The end products always include Ba and Kr.
II. The rest mass of the end products is less than that of $^{235}_{92}U + {}^{1}_{0}n$.
III. The total number of nucleons (protons plus neutrons) in the end products is less than that in $^{235}_{92}U + {}^{1}_{0}n$.

(A) II only
(B) III only
(C) I and II only
(D) I and III only
(E) I, II, and III

3. When ^{10}B is bombarded by neutrons, a neutron can be absorbed and an alpha particle (^{4}He) emitted. If the ^{10}B target is stationary, the kinetic energy of the reaction products is equal to the

(A) kinetic energy of the incident neutron
(B) total energy of the incident neutron
(C) energy equivalent of the mass decrease in the reaction
(D) energy equivalent of the mass decrease in the reaction, minus the kinetic energy of the incident neutron
(E) energy equivalent of the mass decrease in the reaction, plus the kinetic energy of the incident neutron

4. At noon a radioactive sample decays at a rate of 4.000 counts per minute. At 12:30 P.M. the decay rate has decreased to 2.000 counts per minute. The predicted decay rate at 1:30 P.M. is

(A) 0 counts per minute
(B) 500 counts per minute
(C) 667 counts per minute
(D) 1.000 counts per minute
(E) 1.333 counts per minute

5. Quantities that are conserved in all nuclear reactions include which of the following?

I. Electric charge
II. Number of nuclei
III. Number of protons

(A) I only
(B) II only
(C) I and III only
(D) II and III only
(E) I, II, and III

6. A negative beta particle and a gamma ray are emitted during the radioactive decay of a nucleus of $^{214}_{82}Pb$. Which of the following is the resulting nucleus?

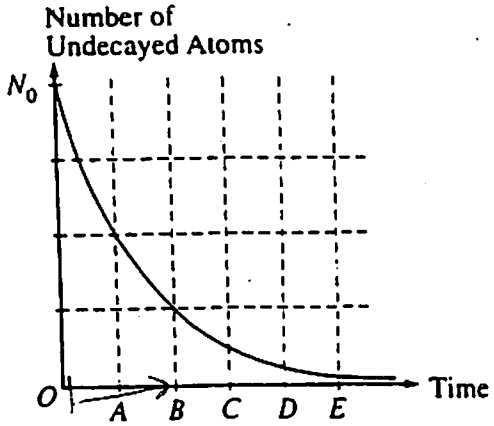
(A) $^{210}_{80}Hg$

(B) $^{214}_{81}Tl$

(C) $^{213}_{83}Bi$

(D) $^{214}_{83}Bi$

(E) $^{218}_{84}Po$



7. The graph above shows the decay of a sample of carbon 14 that initially contained N_0 atoms. Which of the lettered points on the time axis could represent the half-life of carbon 14 ?

(A) *A*
(B) *B*
(C) *C*
(D) *D*
(E) *E*

The nuclide $^{214}_{82}Pb$ emits an electron and becomes nuclide X. Which of the following gives the mass number and atomic number of nuclide X ?

	Mass Number	Atomic Number
(A)	210	80
(B)	210	81
(C)	213	83
(D)	214	81
(E)	214	83

A 50,000 W radio station transmits waves of wavelength 4 m. Which of the following is the best estimate of the number of photons it emits per second?

(A) 10^{8}
(B) 10^{22}
(C) 10^{30}
(D) 10^{40}
(E) 10^{56}

Cobalt 60 is a radioactive source with a half-life of about 5 years. After how many years will the activity of a new sample of cobalt 60 be decreased to 1/8 its original value?

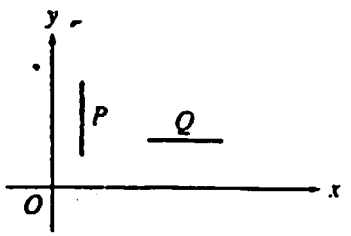
(A) 2.5 years
(B) 5 years
(C) 10 years
(D) 15 years
(E) It depends on the original amount of cobalt 60.

A muon, with a lifetime of 2×10^{-6} second in its frame of reference, is created in the upper atmosphere with a velocity of $0.998c$ toward the Earth. The lifetime of the muon, as measured by an observer on the Earth, is most nearly

(A) 3×10^{-2} s
(B) 3×10^{-3} s
(C) 3×10^{-4} s
(D) 3×10^{-5} s
(E) 3×10^{-6} s

The operator of a space station observes a space vehicle approaching at a constant speed v. The operator sends a light signal at speed c toward the space vehicle. The speed of the light signal relative to the space vehicle is

(A) $c + v$
(B) $c - v$
(C) c
(D) $v/\sqrt{1 - v^2/c^2}$
(E) $c\sqrt{1 - v^2/c^2}$



Rods P and Q are at rest in an inertial reference frame and oriented as shown above. Both rods have length L in this reference frame. A person moves at a relativistic speed in the $+x$ direction. Which of the following would be the lengths, as compared to L, observed for these rods by the person?

	P	Q
(A)	Less than L	Less than L
(B)	Less than L	L
(C)	Less than L	Greater than L
(D)	L	Less than L
(E)	L	L