Name _____ Date _____

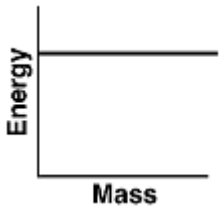
Honors Physics Modern WS #3H

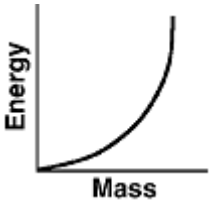
Period _____ Mrs. Nadworny

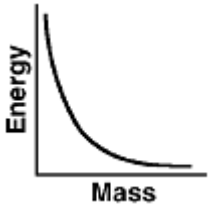
Mass – Energy Relationship

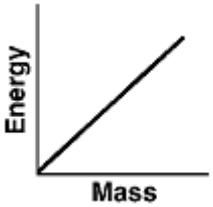
Directions: Read online textbook pages 896 – 901. Solve the following problems using the GUESS method and proper significant figures. Be sure to show ALL work.

1. Which graph best represents the relationship between energy and mass when matter is converted into energy?

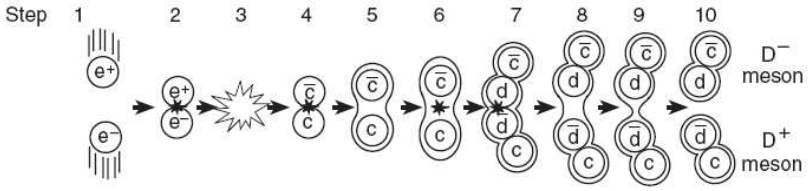
(A) 

(B) 

(C) 

(D) 

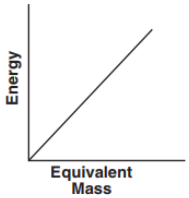
2. The diagram below represents the sequence of events (steps 1 through 10) resulting in the production of a D– meson and a D+ meson. An electron and a positron (antielectron) collide (step 1), annihilate each other (step 2), and become energy (step 3). This energy produces an anticharm quark and a charm quark (step 4), which then split apart (steps 5 through 7). As they split, a down quark and an antidown quark are formed, leading to the final production of a D– meson and a D+ meson (steps 8 through 10).



Which statement best describes the changes that occur in this sequence of events?

(A) Isolated quarks are being formed from baryons.
(B) Hadrons are being converted into leptons.
(C) Matter is converted into energy and then energy is converted into matter.
(D) Energy is converted into matter and then matter is converted into energy.

3. The graph below represents the relationship between energy and the equivalent mass from which it can be converted.



The slope of this graph represents

(A) c (B) g (C) g^2 (D) c^2

4. The energy equivalent of the rest mass of an electron is

(A) 2.73×10^{-22} J (B) 8.20×10^{-14} J (C) 1.50×10^{-10} J (D) 1.44×10^{-2} J

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5. When 2.0×10^{-16} kilogram of matter is converted into energy, how much energy is released?
   (A) 1.8×10^{-1} J (B) 6.0×10^{-32} J (C) 1.8×10^{1} J (D) 6.0×10^{-8} J

6. What is the total energy released when 9.11×10^{-31} kilogram of mass is converted into energy?
   (A) 2.73×10^{-22} J (B) 9.11×10^{-31} J (C) 8.20×10^{-14} J (D) 1.01×10^{-47} J

7. In a process called pair production, an energetic gamma ray is converted into an electron and a positron. It is not possible for a gamma ray to be converted into two electrons because
   (A) charge must be conserved
   (B) momentum must be conserved
   (C) Mass-energy must be conserved
   (D) Baryon number must be conserved

8. During the process of fusion in the Sun, four protons will combine with two electrons, which creates a lot of energy, some neutrinos and photons. Calculate the amount of energy contained in the initial protons and electrons.

9. When a certain amount of matter is converted into energy, it creates 7.16×10^{13} joules. Calculate how much matter it was.

10. If a proton were to combine with an antiproton (antiparticle with same mass, but opposite charge), they would annihilate each other in a process called Pair Annihilation.
    a. Calculate the amount of energy that would be released by this annihilation.

    b. Convert this energy into electronvolts.

11. A normal water bottle holds approximately 0.495 kilograms of water. If the entire bottle of water were converted into energy, how much would it create?

Answers in size order: 3.01×10^{-10}, 6.01×10^{-10}, 7.96×10^{-4}, 1.88×10^{9}, 4.46×10^{16}