Name: _____ Period: _____

Modern-Mass Energy Equivalence

1. If a deuterium nucleus has a mass of 1.53×10^{-3} universal mass units less than its components, this mass represents an energy of
   1. 1.38 MeV
   2. 1.42 MeV
   3. 1.53 MeV
   4. 3.16 MeV

2. The energy equivalent of 5.0×10^{-3} kilogram is
   1. 8.0×10^{5} J
   2. 1.5×10^{6} J
   3. 4.5×10^{14} J
   4. 3.0×10^{19} J

3. How much energy, in megaelectronvolts, is produced when 0.250 universal mass unit of matter is completely converted into energy?

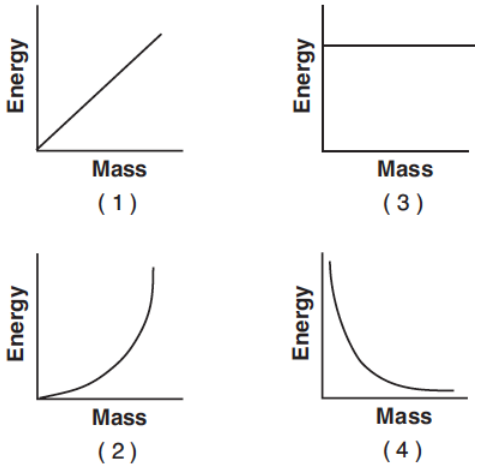
4. The energy equivalent of the rest mass of an electron is approximately
   1. 5.1×10^{5} J
   2. 8.2×10^{-14} J
   3. 2.7×10^{-22} J
   4. 8.5×10^{-28} J

5. The energy produced by the complete conversion of 2.0×10^{-5} kilogram of mass into energy is
   1. 1.8 TJ
   2. 6.0 GJ
   3. 1.8 MJ
   4. 6.0 kJ

6. What is the minimum total energy released when an electron and its antiparticle (positron) annihilate each other?
   1. 1.64×10^{-13} J
   2. 8.20×10^{-14} J
   3. 5.47×10^{-22} J
   4. 2.73×10^{-22} J

7. The energy required to separate the 3 protons and 4 neutrons in the nucleus of a lithium atom is 39.3 megaelectronvolts. Determine the mass equivalent of this energy, in universal mass units.

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



9. The total conversion of 1.00 kilograms of the Sun's mass into energy yields
   1. 9.31×10^{2} MeV
   2. 8.38×10^{19} MeV
   3. 3.00×10^{8} J
   4. 9.00×10^{16} J

10. What total mass must be converted into energy to produce a gamma photon with an energy of 1.03×10^{-13} joule?
    1. 1.14×10^{-30} kg
    2. 3.43×10^{-22} kg
    3. 3.09×10^{-5} kg
    4. 8.75×10^{29} kg

11. A tritium nucleus is formed by combining two neutrons and a proton. The mass of this nucleus is 9.106×10^{-3} universal mass unit less than the combined mass of the particles from which it is formed. Approximately how much energy is released when this nucleus is formed?
    1. 8.48×10^{-2} MeV
    2. 2.73 MeV
    3. 8.48 MeV
    4. 273 MeV

12. After a uranium nucleus emits an alpha particle, the total mass of the new nucleus and the alpha particle is less than the mass of the original uranium nucleus. Explain what happens to the missing mass.

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Modern-Mass Energy Equivalence

Base your answers to questions 13 and 14 on the information and data table below.

In the first nuclear reaction using a particle accelerator, accelerated protons bombarded lithium atoms, producing alpha particles and energy. The energy resulted from the conversion of mass into energy. The reaction can be written as shown below.

$$ {}_{1}^{1}H + {}_{3}^{7}Li \rightarrow {}_{2}^{4}He + {}_{2}^{4}He + energy $$

Data Table

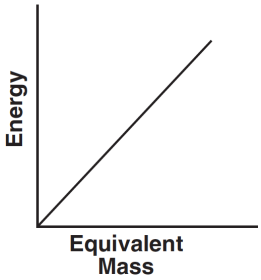
Particle	Symbol	Mass (u)
proton	${}_{1}^{1}H$	1.007 83
lithium atom	${}_{3}^{7}Li$	7.016 00
alpha particle	${}_{2}^{4}He$	4.002 60

13. Determine the difference between the total mass of a proton plus a lithium atom, ${}_{1}^{1}H + {}_{3}^{7}Li$, and the total mass of two alpha particles, ${}_{2}^{4}He + {}_{2}^{4}He$, in universal mass units.

14. Determine the energy in megaelectronvolts produced in the reaction of a proton with a lithium atom.

15. If a proton were to combine with an antiproton, they would annihilate each other and become energy. Calculate the amount of energy that would be released by this annihilation. [Show all work, including the equation and substitution with units.]

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



The slope of this graph represents

1. c
2. c^2
3. g
4. g^2

17. What is the total energy released when 9.11×10^{-31} kilogram of mass is converted into energy?
    1. 2.73×10^{-22} J
    2. 8.20×10^{-14} J
    3. 9.11×10^{-31} J
    4. 1.01×10^{-47} J

18. Calculate the energy equivalent in joules of the mass of a proton. [Show all work, including the equation and substitution with units.]