Name______________________________ Pd________

Is Your Mass Defective?

Isotope/ Species	Rest Mass
e	0.00055 u
n	1.0087 u
H-1	1.00783 u
H-2	2.0141 u
H-3	3.01604 u
He-4	4.0026 u
Li-7	7.016 u
Nb-93	92.906 u
Ba-138	137.905 u
U-235	235.0439 u

1. How much energy is released during the reaction: $^{1}_{1}H + ^{7}_{3}Li \rightarrow 2\,^{4}_{2}He$

$1.00783 + 7.016 \rightarrow 2(4.0026)$

$8.02383 \rightarrow 8.0052 \qquad \Delta m = 0.01863u$

$E=mc^2 = 0.01863(931) = 17.34$ MeV

2. How much energy is released by each reaction of the following variety: $^{3}_{1}H + ^{2}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$
(One of the most promising fusion reactions!)

$3.01604 + 2.0141 \rightarrow 4.0026 + 1.0087$

$5.03014 \rightarrow 5.0113 \qquad \Delta m = 0.01863u$

$E=mc^2 = 0.01863(931) = 17.54$ MeV

$$^{1}_{0}n + ^{235}_{92}U \rightarrow ^{138}_{56}Ba + ^{93}_{43}Nb + 5\,^{1}_{0}n + 5\,^{0}_{-1}e$$

$1.0087 + 235.0439 \rightarrow 137.905 + 92.906 + 5(1.0087) + 5(0.00055)$

3. The above reaction shows the spontaneous fission decay of uranium into two daughter nuclei, 5 neutrons, and 5 beta particles. How much energy would be released when 1 atom on uranium is struck by one slow neutron? How much energy from 1 kg of uranium is possible?

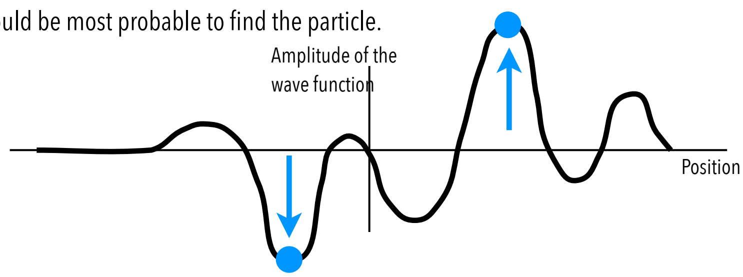
$236.0526 \rightarrow 235.8573 \qquad \Delta m = 0.19535u$

$E=mc^2 = 0.19535(931) = 181.87$ MeV

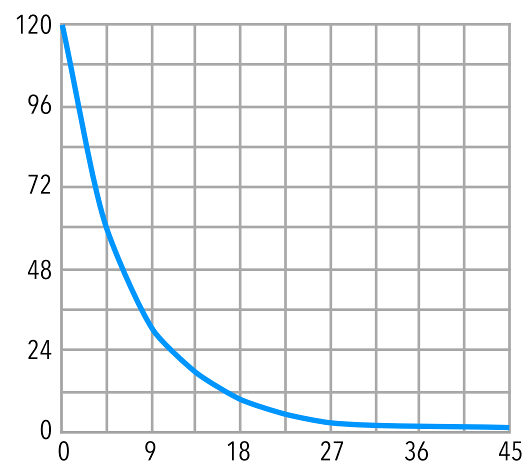
$1000\text{ g} \cdot 1\text{mol}/235.0439\text{ g} \cdot 6.022\cdot10^{23}\text{ atoms/mol} = 2.562\cdot10^{24}$ atoms

$(2.562\cdot10^{24}\text{ atoms})(181.97\text{ MeV/atom}) = 4.66\cdot10^{26}\text{ MeV} = 7.47\cdot10^{13}$ J

4. deBroglie said that every particle behaves like a wave and vice-versa. Schrödinger said that every wave/particle has a wave function which shows the probability of the particle/wave being versus particular locations. Below is a graph of a wave function. Choose the **TWO** locations where it would be most probable to find the particle.



5. You have a sample of 120 grams of pure Ca-47 that undergoes β⁻ decay. Calcium-47 has a half life of 4.5 days. Draw a graph showing the grams of Ca-47 remaining as a function of time (Don't forget to label your axes). How much Ca-47 would be left after 63 days? What does the Ca-47 become? How much energy is released with every decay if the energy of the ejected neutrino is negligible?



$63/4.5 = 14$ halflives

$(\tfrac{1}{2})^{14} = 6.1\cdot10^{-5}$ times the 120 g = 0.0073 g of Ca–47

Ca–47 → β^- + ***Sc-47***

$46.955 \rightarrow 0.00055 + 46.952 \qquad \Delta m = 0.00245u$

$E=mc^2 = 0.00245(931) = 2.28$ MeV