Name: Ku... Date: _______

Honors Physical Science

$E=mc^2$

E = energy released   m = mass changed into energy in kg   c = speed of light

$1g = 6.022 \times 10^{23}$ amu   1 kg = 1000 g   1 amu = 1u

1. What is the energy generated when the change in mass in a nuclear reaction =1g?
Step 1 convert mass into kg – 1g *(1kg/1000g) = 0.001kg
Step 2 insert variables into the equation $E = mc^2$ → $E = (.001)(3\times10^8 m/s)^2$

E = [crossed out] kgm^2/s^2 $= 9\times10^{13}$ J

Step 3: Convert to Joules using 1 kgm^2/s^2 = 1 J

2. Calculate the mass defect and the corresponding energy released during this fission reaction.

$^{236}_{92}U \rightarrow ^{88}_{36}Kr + ^{144}_{56}Ba + 4^{1}_{0}n$

(236.04556u)   [(87.91445u) + (143.92284u) +(4*1.00867u)] = 235.87197 u

Mass Defect = (sum of mass of products) – (sum of mass of reactants)

Mass defect = 235.87197 − 236.04556 = −0.17359

Convert to kg = −0.17359 amu * (1g/6.022 x 10^{23}amu) * (1kg/1000g) = -2.883×10^{-28}

$E=mc^2 = (2.883E^{-28})(3\times10^8)^2 = 2.59\times10^{-11}$ J

3. Calculate the mass defect and the corresponding energy released during this fusion reaction.

$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$

(2.0140u)   (3.0161u)   (4.0026u)   (1.0087u)

Mass = products − reactants

$= (4.0026 + 1.0087) - (3.0161 + 2.0140) = -0.0188$ amu

$-0.0188 \times \frac{1g}{6.022\times10^{23} amu} \times \frac{1kg}{1000g} = 3.1219\times10^{-29}$ kg $\times (3E^8)^2 = 2.81\times10^{-12}$ J

4. Calculate the mass defect and the corresponding energy released during this fusion reaction.

$^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{1}He + ^{1}_{1}H$

(2.0140u)   (2.0140u)   (3.0161u)   (1.0078u)

Mass = products − reactants $= (3.0161 + 1.0078) - (2.0140 + 2.0140) = -0.0041$

$0.0041 amu \times \frac{1g}{6.022\times10^{23} amu} \times \frac{1kg}{1000g} = (6.81\times10^{-30} kg)\times(3\times10^8)^2 = 6.13\times10^{-13}$ J

5. Calculate the mass defect and the corresponding energy released during this fusion reaction, use table with handout to determine the mass of each isotope.

$3\ {}^{4}_{2}He \rightarrow {}^{12}_{6}C$

3X (4.0026u) (12.000u)

mass defect = (12.000) − (3x 4.0026) = −0.0078amu

$\frac{0.0078\,amu}{} \cdot \frac{1g}{6.022\times10^{23}\,amu} \cdot \frac{1Kg}{1000g} = 1.295\times10^{-29}\,Kg$

$E = mc^2 = (1.295\times10^{-29}\,Kg)(3\times10^{8}\,m/s)^2 = 1.17\times10^{-12}\,J$

6. Calculate the mass defect and the corresponding energy released during the following reaction, use table with handout to determine the mass of each isotope.

${}^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$

(226.0254u) (222.01757u) (4.0026u)

mass defect = products − reactants
= (222.01757+4.0026) − 226.0254
= −0.00523

$\frac{0.00523\,amu}{} \cdot \frac{1g}{6.022\times10^{23}\,amu} \cdot \frac{1Kg}{1000g} = 8.68\times10^{-30}\,Kg$

$E = mc^2 = (8.68\times10^{-30})(3\times10^{8})^2 = 7.816\times10^{-13}\,J$

7. Calculate the mass defect and the corresponding energy released during the following reaction, use table with handout to determine the mass of each isotope.

${}^{230}_{90}Th \rightarrow {}^{226}_{88}Ra + {}^{4}_{2}He$

(230.03313u) (226.0254u) (4.0026u)

mass defect = products − reactants
(4.0026 +226.0254) − (230.03313) = 0.00513amu

$\frac{0.00513\,amu}{} \cdot \frac{1g}{6.022\times10^{23}\,amu} \cdot \frac{1Kg}{1000g} = 8.52\times10^{-30}\,Kg$

$E = mc^2 = (8.52\times10^{-30})(3\times10^{8})^2 = 5.11\times10^{-21}\,J$

8. Calculate the mass defect and the corresponding energy released during the following reaction, use table with handout to determine the mass of each isotope.

${}^{239}_{94}Pu \rightarrow {}^{4}_{2}He + {}^{235}_{92}U$

(239.0521634u) (4.0026u) (235.043923u)

mass defect = products − reactants
= (4.0026+235.043923) − (239.052163)
= −0.0056404amu

$\frac{0.0056404\,amu}{} \cdot \frac{1g}{6.022\times10^{23}\,amu} \cdot \frac{1Kg}{1000g} = 9.37\times10^{-30}\,Kg$

$E = mc^2 = (9.37\times10^{-30}\,Kg)(3\times10^{8}\,m/s)^2 = 8.43\times10^{-13}\,J$