IB PHYSICS

Name: ________________________________

Period: ________ Date: ___________________

DEVIL PHYSICS

BADDEST CLASS ON CAMPUS

TSOKOS READING ACTIVITY

Section 7-2 (5 Points)

1. Essential Idea: Energy can be released in nuclear decays and reactions as a result of the relationship between mass and energy.
2. Nature Of Science: Patterns, trends and discrepancies: Graphs of binding energy per nucleon and of neutron number versus proton number reveal unmistakable patterns. This allows scientists to make predictions of isotope characteristics based on these graphs.
3. Theory Of Knowledge:
   a. The acceptance that mass and energy are equivalent was a major paradigm shift in physics.
   b. How have other paradigm shifts changed the direction of science?
   c. Have there been similar paradigm shifts in other areas of knowledge?
4. Understandings:
   a. The unified atomic mass unit
   b. Mass defect and nuclear binding energy
   c. Nuclear fission and nuclear fusion
5. Applications And Skills:
   a. Solving problems involving mass defect and binding energy
   b. Solving problems involving the energy released in radioactive decay, nuclear fission and nuclear fusion
   c. Sketching and interpreting the general shape of the curve of average binding energy per nucleon against nucleon number
6. Guidance:
   a. Students must be able to calculate changes in terms of mass or binding energy
   b. Binding energy may be defined in terms of energy required to completely separate the nucleons or the energy released when a nucleus is formed from its nucleons
7. Data Booklet Reference:
   a. $\Delta E = \Delta m \cdot c^2$
8. Utilization:
   a. Our understanding of the energetics of the nucleus has led to ways to produce electricity from nuclei but also to the development of very destructive weapons
   b. The chemistry of nuclear reactions (see Chemistry option sub-topics C.3 and C.7)
9. Aims:

a. Aim 5: some of the issues raised by the use of nuclear power transcend national boundaries and require the collaboration of scientists from many different nations

b. Aim 8: the development of nuclear power and nuclear weapons raises very serious moral and ethical questions: who should be allowed to possess nuclear power and nuclear weapons and who should make these decisions? There also serious environmental issues associated with the nuclear waste of nuclear power plants.

10. Read section 7-2, pgs 285-293, in your textbook.

11. Answer the following questions:

a. What are *unified atomic mass units* (*atomic mass units*) and what is the value of one of them? ______

____

b. What is the mass of electrons, protons, and neutrons in both kilograms and unified mass units?

	Kilograms	Unified Mass Units
Electron		
Protons		
Neutrons		

c. What is *mass defect*? ____

____

d. What is the equation for finding the mass defect? ______________________________

____

e. How can you account for the difference? ____________________________________

____

____

f. What is binding energy? ____

____

____

g. What is the equation for binding energy? ____________________________________

h. How can you compute (roughly) the work needed to remove one nucleon? ______________

____

____

i. How does binding energy relate to nuclear stability? ____________________________

____

j. How much energy, in both Joules and electronvolts, is contained in one unified mass unit? ________

____

k. What is the dividing point on the average binding energy per nucleon vesus nucleon number chart?

____

l. What is the approximate binding energy per nucleon for most nuclei? ____________________

m. Why is the binding energy per nucleon roughly the same for large nuclei (A > 20)? ____________

____

____

n. How can you determine if energy will be released in a reaction/decay or if energy must be added to make a reaction/decay occur? ______________________________________

____

____

____

____

o. When a decay occurs, what form of energy is released? ______________________________

p. What is the guiding principle with respect to energy in a decay such as ${}^{226}_{88}\text{Ra} \rightarrow {}^{222}_{86}\text{Rn} + {}^{4}_{2}\alpha$? _____

____

q. Using Einstein's formula of $E=mc^2$, we find that there is more energy on the left side of the arrow than on the right. Where did the extra energy go? ______________________________

____

r. For a decay to occur, what relationship must exist between the mass of the decaying nucleus and the decay products? ____

____

s. In spite of your answer in 'n.' above, a nuclear reaction can occur if the total mass on the left side of the arrow is less than that on the right side. What is the prerequisite for this to occur? __________

____

____

t. The amount of kinetic energy needed for the reaction in 'q.' above must be greater than the mass difference. How come? ____

____

____

u. Name the two types of energy-producing nuclear reactions? __________________________

v. What is nuclear fission? ____

____

w. What is one possible fission reaction for U-235? ____

____

x. Your reaction above required a neutron to get it started, but once the reaction occurred, it released three neutrons. What do you suppose those neutrons are going to do and what is it called? ________

____

y. What is one of the requirements for ‘x.’ and ’y.’ above to get started and what is it called? ________

____

____

z. Nuclear reactors must control the rate of reaction. What would happen if rate of reaction is too fast?

____

aa. What is nuclear fusion? ____

____

bb. What is an equation for a hydrogen fusion reaction? ______________________________________

cc. What would the energy released by fusion of a kilogram of deuterium ($^{2}_{1}H$) be comparable to? _____

____

dd. In terms of separation and temperature, what is required for this type of fusion to take place and why is it required (this is an important exam tip)? ____

____

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____

____

ee. The temperature needed causes the fusion material to turn into plasma. Plasma melts everything it comes in contact with. So how can you contain it? ____

____

ff. How important is it for tokamak engineers to understand the right hand rule? ___________________

gg. In terms of nuclear fission and fusion, why is ^{62}Ni important? __________________________________

____

____

____

12. Answers may be typed or neatly printed. Drawings may be freehand, but try to make use of the ‘Shapes’ or ‘Insert Clipart” functions of MS Word. If you submit this assignment electronically, the filename must be in the following format, “LastnameFirstinitialPerXReadActX-X”.