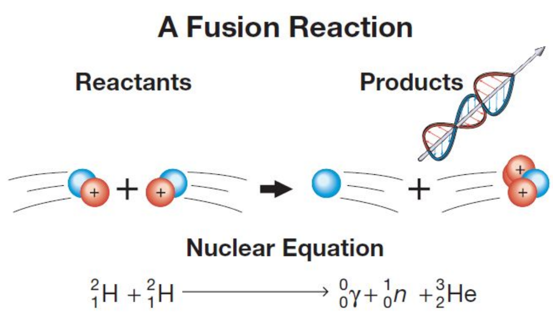
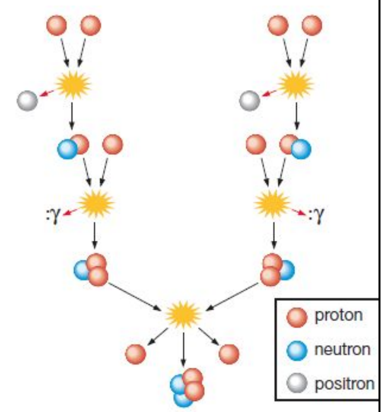
Science 30	Unit D: Energy and the Environment
Lesson 11 - Nuclear Fusion	84 mins

Nuclear Waste

- There is no long term plan to dispose of the spent fuel bundles from a nuclear power plant
- This ionizing waste needed careful consideration… even if it’s only small amounts.
	- What is done is:
	    - First stored under water, for a few years to allow any unspent fuel to be used up,
	    - Then put in concrete canisters for the foreseeable future...

Nuclear Fusion

nuclear fusion: a process in which two smaller nuclei join to form a larger nucleus, with the simultaneous release of energy.  	Solar Fusion Reactions hydrogen to deuterium: $^{1}_{1}H + ^{1}_{1}H \rightarrow ^{0}_{+1}e + ^{2}_{1}H$ deuterium to helium-3: $^{2}_{1}H + ^{1}_{1}H \rightarrow ^{0}_{0}\gamma + ^{3}_{2}He$ helium-3 to helium-4: $^{3}_{2}He + ^{3}_{2}He \rightarrow 2^{1}_{1}H + ^{4}_{2}He$	

Controlling the Fusion Reaction

- Needs an EXTREME amount of heat and energy to START - Needs an EXTREME amount of fuel to continue - Temperatures needed to start on earth are too high for the energy out to outweigh the energy in	- Development into “cold” fusion is a hot topic. If we would be able to achieve a type of fusion at temperatures never to temperatures in a furnace or fire we could have an extremely reliable source of energy.

Science 30 - Lesson 47 - Unit D - Nuclear Fusion

Name: ____________________

Use the following information to answer the next question

Nuclide	Mass (10^{-3} kg/mol)
bromine-91, $^{91}_{35}Br$	90.916 27
lanthanum-142, $^{142}_{57}La$	141.899 71
strontium-94, $^{94}_{38}Sr$	93.915 29
xenon-140, $^{140}_{54}Xe$	139.918 43

1) Calculate the change in mass and corresponding energy change per mole of uranium-235 in the nuclear reactions given. Use masses given in the Science Data Booklet and those provided in the above table.

a) $^{235}_{92}U + \, ^{1}_{0}n \rightarrow 2^{1}_{0}n + \, ^{94}_{38}Sr + \, ^{140}_{54}Xe$

b) $^{235}_{92}U + \, ^{1}_{0}n \rightarrow 3^{1}_{0}n + \, ^{91}_{35}Br + \, ^{142}_{57}La$

2) Calculate the change in mass that would correspond to a release of 2.0 x 10^{14} J of energy.

3) For each fusion reaction given, complete the equation and identify the unknown product, $^{A}_{Z}X$

$^{2}_{1}H + \, ^{3}_{1}H \rightarrow \, ^{1}_{0}n + \, ^{A}_{Z}X$

$^{14}_{7}N + \, ^{1}_{1}H \rightarrow \, ^{0}_{0}\gamma + \, ^{A}_{Z}X$

4) Calculate the energy change for each reaction in question 3. Determine whether the fusion reaction results in a release of energy. Support your answer.

5) Describe the conditions necessary for fusion to occur. Describe the challenges in attempting to create a fusion reactor that can sustain these conditions.

6) Is nuclear energy from the fission of uranium a renewable or non-renewable energy source? Provide a reason for your answer.

7) A possible reaction for fusion power involves a fusion between helium-3 and deuterium nuclei. The products of the reaction are helium-4 and a proton.
   a) Present the process described as a balanced nuclear equation.
   b) Calculate the change in mass and the corresponding energy change for the fusion between helium-3 and deuterium nuclei.