Nuclear Fission and Fusion Assignment NAME_____

1. Given the following masses:

$$^{235}_{92}\mathrm{U} = 3.9017\times10^{-25}\ \mathrm{kg}$$
$$^{138}_{56}\mathrm{Ba} = 2.28922\times10^{-25}\ \mathrm{kg}$$
$$^{95}_{36}\mathrm{Kr} = 1.57534\times10^{-25}\ \mathrm{kg}$$

Calculate the energy (in J and MeV) released per the following fission reaction:

$$^{1}_{0}\mathrm{n} + {}^{235}_{92}\mathrm{U} \rightarrow {}^{138}_{56}\mathrm{Ba} + {}^{95}_{36}\mathrm{Kr} + 3\,{}^{1}_{0}\mathrm{n}$$

/3

2. Compare the approximate amounts of energy released in chemical, fission and fusion reactions. /1

3. Explain fission in terms of short-range nuclear-attractive forces and long-range coulomb-repulsive forces.

/2

4.

(a) State why neutrons have to be slowed down in order to produce fission in ^{235}U /1

(b) Explain why the most effective moderators have atoms of low mass and low absorption of neutrons /2

(c) State why the nuclei produced by fission reactions are likely to have an excess of neutrons /1

(d) State why fission products are hazardous and difficult to process /1

(e) State why it is generally not possible to attain a continuous chain reaction using naturally occurring uranium unless it is enriched with ^{235}U /1

5.

(a) Draw and label a basic diagram showing the following components of a water-moderated reactor: core, fuel rods, moderator, control rods, heat exchanger, and shielding.

/4

(b) Describe the function of each of the following components of a water-moderated fission power reactor: fuel rods, moderator, control rods, heat exchanger, safety rods, and shielding.

/6

(c) Explain starting, normal operation and stopping of a nuclear reactor in terms of chain reactions.

/3

(d) Explain briefly why the delayed emission of neutrons allows the chain reaction in a nuclear power reactor to be controlled. /1

(e) Discuss the advantages and disadvantages of nuclear fission over fossil fuel power stations.

/3

6. Given that deuterium has a mass of 3.344×10^{-27} kg and helium-3 has a mass of 5.008×10^{-27}, calculate the energy (in J and MeV) released in the fusion reaction $^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{3}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$.

/3

7. State the main energy conversion process in suns and stars and describe the conditions that favour this kind of reaction. /2

8. Discuss the advantages and disadvantages of nuclear fusion over nuclear fission as a source of power.

/3

TOTAL /37