

**Physics 173, Physics of Sustainable Energy**  
**Homework 12**  
**Due: 1pm, Tues Dec 12th, 2023**

Please upload your answers at the Canvas website as a PDF file. You can easily convert JPEG photos to PDF using online tools. When doing so, please ensure that in the PDF your photos are in the proper orientation.

**Regular questions**

When you write out your response, please circle or underline the final answer to each part of the question. This will make it clearly visible to the grader. Remember to give justification for all your answers, and whenever the answer is a number always show the units, e.g. “200 J”, “0.5 kg”.

1. Please supply your evaluation of the course at `evals.wustl.edu`. **{4 points}**
2. Appraisal of nuclear power as an energy source.
  - (a) Describe two important advantages of using nuclear reactors to generate electricity, compared to using solar power.
  - (b) Describe two important disadvantages of using nuclear reactors to generate electricity, compared to using solar power.
  - (c) Roughly how much Uranium-235 (in kilograms) would be consumed to provide one year's supply of electrical energy for a city of about a million houses?

**{6 points}**

**Multiple choice questions**

**{2 points each}**

Each question has one correct answer, unless the question specifies otherwise. You do not have to show your working, but it may help the grader. You may look up online any quantities that are needed but not supplied in the question or in lecture materials. If you hand-write your answers please use capital letters.

1. When an atom of  $^{19}\text{O}$  undergoes beta decay what does it turn in to?  
(A) a different isotope of oxygen      (B) nitrogen      (C) fluorine      (D) sulfur
2. Which of the following is *not* part of the electromagnetic spectrum?  
(A) radio waves      (B) microwaves      (C) beta rays      (D) gamma rays
3. Fission fragments are  
(A) uranium nuclei that do not undergo fission  
(B) nuclei of atomic mass around 100 that are produced by fission of a larger nucleus  
(C) nuclei of atomic mass 238 or larger that were created by fusion in supernovas  
(D) neutrons that are produced in a fission process

4. When a  $^{235}\text{U}$  undergoes fission, estimate how fast the resultant fission fragments are traveling.  
(A)  $10^{14}$  m/s      (B) 100,000 m/s      (C) 1000 m/s      (D) 10 million m/s
5. The definition of “fissile” is: any material in which  
(A) the nuclei undergo spontaneous fission  
(B) energy can be produced by both fission and fusion of the nuclei  
(C) a self-sustaining chain of fission events can occur  
(D) neutrons are slowed down by collisions with nuclei
6. The role of the moderator in a nuclear reactor is  
(A) to absorb neutrons, which decreases the fission rate  
(B) to slow down the neutrons, which increases the fission rate  
(C) to emit neutrons, which increases the fission rate  
(D) to slow down the neutrons, which decreases the fission rate
7. A conventional nuclear reactor cannot explode like a nuclear weapon because  
(A) the total amount of uranium in a reactor is much smaller than in a weapon  
(B) the reactor does not contain fissile material  
(C) when it gets very hot the chain reaction slows down  
(D) the accumulation of fission fragments suppresses further fission
8. The no-threshold linear hypothesis is  
(A) mainly used for predicting acute radiation sickness  
(B) widely used even though it may have large errors  
(C) reliable to within 30% for doses below 0.1 Sv  
(D) not applicable to doses of gamma radiation
9. After the Fukushima meltdown, residents of Tokyo (pop. 10 million) each received an average extra radiation dose of 0.004 mSv. According to the linear hypothesis, how many extra cancers were caused by this?  
(A) 1 or 2      (B) about 1500      (C) about 40,000      (D) about 200
10. The city of Ramsar in Iran has a high level of background radiation, around 100 mSv/year. According to the linear hypothesis, what would be the resultant increase in the lifetime cancer risk for inhabitants of Ramsar?  
(A) +2%      (B) less than 1%      (C) +30%      (D) +10%