Instructions: This test has the same format as before. For problems in the longer answer section, show your work; your work will be checked as well as your answer. For short answer questions, pick the best answer for the multiple-choice questions.

DECLARATION: ______________________ is the topic of my (term paper, short oral presentation, lab project) (choose one). This topic (has, has not) been approved.

1. (2) REVIEW QUESTION: If a 12,000 ft lb of work are done by a motor in 80.0 sec, the power of the motor in hp is ___. Note: 1 hp = 550 ft lb/s.

2. (4) REVIEW QUESTION: For the following two length measurements indicate the precision and number of significant figures for each, add them, and multiply them using the rules strictly. (Include units.)

<table>
<thead>
<tr>
<th>Precision</th>
<th>No. of significant figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 7.34 m</td>
<td>_________________________</td>
</tr>
<tr>
<td>b) 382.1 m</td>
<td>_________________________</td>
</tr>
<tr>
<td>c) sum of 7.34 m + 382.1 m equals</td>
<td>________</td>
</tr>
<tr>
<td>d) produce of 7.34 m m times 382.1 m equals</td>
<td>________</td>
</tr>
</tbody>
</table>

3. (2) REVIEW QUESTION: Suppose 5.0 million BTU's are added to water to produce steam in a coal-fired power plant and only 1.5 million BTU's of work are done. The first law efficiency of the power plant is __ % and __ BTU's must be rejected to the cold reservoir.

4. (1) In a neutral atom the number of electrons is equal to the number of ___ in the ___.

5. (1) Two nuclei having the same number of protons but a different number of neutrons are called ___ of each other.

6. (4) The number of protons in the nucleus $^{90}$Sr is __, while the number of neutrons is __. The number of electrons in each of the shells is __, __, __, __, __, and __.

7. (2) If 10,000 $^{24}$Na nuclei are found in a sample, how many remain after 32 minutes if the half life is 8 minutes?

8. (2) List 2 ways that a radioactive substance may enter the body.

9. (4) Of the three types of nuclear radiation,

   (a) the type that was later found to be a Helium nucleus.
   (b) the type that is not charged at all is __
   (c) the type that was later found to be an electron is __
   (d) the type that carries the most energy __.
10. (2) When radioactive Calcium is injected into the intestinal tract, the rat's body transports a radioactive atom in the body the same as it does if that atom were stable. Why? ____________________________

11. (3) Three stages, for the conversion of U.S. Energy to Nuclear Power, were initially devised in the “Atoms For Peace” program. Here, the 1st stage was ____, the 2nd stage was ____, and the 3rd stage was ____.

12. (2) The purpose of the water in the light water reactor is two-fold: it ____ and it ____.

13. (1) The bad part about a nuclear reactor is that it could explode such as an atomic bomb. (True, False)

14. (2) The fuel required for a breeder reactor is ____ and ____.

15. (2) Of the approximately 100 nuclear power plants in operation in the United States today, about 70 of them are ____ variety while the remainder of them are of the ____ variety.

16. (1) Define "neutron moderation." ________________________________

17. (1) Which of the following has the larger R-value?
   (a) 1 in of softwood; (b) 2 in of hardwood; (c) 1 in of STYROFOAM;
   (d) single pane glass; (e) 1 in of stone; (f) double pane glass

18. (1) A storm window (namely two panes of glass) has an R-value of about ____.

19. (2) On a winter day when the inside temperature is 75°F and the outside temperature is 10°F, the energy lost through a 3.0 ft by 5.0 ft single pane window with total R-value of 1.00 is ____ BTU per hour.

20. (1) An emergency shut down procedure of a nuclear reactor is a process which is called ____.

21. (2) REVIEW QUESTION: A type of coal that is found in the North Dakota that only has a BTU content of 6000 BTU/lb is called _____. This BTU content is so low that it does not make economic sense to ship the coal by train. Instead, what is done? ____________.

22. (2) Radiation damage to human tissue is measured in units of ____; for one year, the average radiation damage per person occurring from nature itself is approximately ____.

23. (2) Two of three known fissionable isotopes which would be available for nuclear power plants (or even nuclear bombs) are ____ and ____.

24 (1) What country has gone all out with regard to nuclear power and also the “breeder reactor.”

25 (1) Nuclear fusion results from (a) a neutron moving slowly striking a $^{235}\text{U}$ nucleus (b) a neutron moving slowly striking a $^{239}\text{Pu}$ nucleus (c) the forcing of two light hydrogen isotopes to combine or “fuse” together (d) the forcing of two light helium isotopes to combine or “fuse” together.

26. (1) Energy is given off by our sun by (a) nuclear fission (b) nuclear fusion (c) both nuclear fission and nuclear fusion (d) neither nuclear fission nor nuclear fusion
27. (3) The three general methods of heat transfer are ___ , ___ , and ___ .

B. Longer Answer Questions

1. (4) (a) What is meant by the “envelope” of a house and (b) why is good venting of a roof important?

2. (4) List and discuss three advantages of nuclear power in the United States. Contrast that with three disadvantages.

3. (4) Explain how energy is obtained from nuclear fission by drawing a diagram of a neutron moving slowly that strikes a $^{235}\text{U}$ nucleus. Be sure to include and identify all products of this fission event.

4. (4) What happened at Chernobyl. What kind of a reactor was this and how does it vary from the commercial reactors in the United States? List a method that people could protect themselves from the radioactive iodine that was included in the radioactive cloud that continued to move over Scandinavia and E. Europe.
5. (6) Draw, as best you can, and explain the operation of a boiling water reactor. Be sure to include in your diagram the fuel rods, control rods, turbine and generator, the condenser, and all pumps. Also point out (a) where heat is added, (b) where work is done, (c) where heat is removed from the water, and (d) write down an expression for the First Law of Thermodynamics and for finding the “first-law efficiency” for the boiling water reactor. (Please use the back of this paper, if necessary.)

6. (4) REVIEW QUESTION: Briefly discuss three of the four equivalent statements of the Second Law of Thermodynamics as discussed in class.

7. (4) Draw, using a series of diagrams, and explain what happens in a "chain reaction" event.

8. (4) Define and discuss Carbon 14 and carbon dating
9. (14) TEXT QUESTIONS: Define and discuss from the viewpoint of the text the following.

(2) critical mass

(2) Manhattan Project

(2) moderator

(2) generation-III reactor design

(2) dry-cast storage

(2) gamma ray

(2) Inertial Confinement