Instructions: This test has the same format as before. Part A consists of short answer questions where you are to pick the best word, phrase, or choice of answers which best answers or, in some cases, defines the statement. Part B consists of longer answer questions. Make your answer clear and concise. If you need more room turn over the test paper and continue on the back but please indicate "over" on front. For problems it is the procedure that will be checked, not only the answer, so please try to make it clear. Important note: if a problem is stated so that the precision digit is underlined, be sure to include the rules for precision and significant figures in your calculation. So for this, the second energy test of the term, Good Luck! (Total points: 101; a bonus point is included.)

DECLARATION: I ELECT TO DO A (LAB PROJECT, TERM PAPER, OR SHORT ORAL PRESENTATION). PLEASE CIRCLE ONE OF THE ABOVE. IF YOU HAVE AN IDEA FOR A TITLE PLEASE WRITE IN HERE:

A. Short Answer Questions

1. (5) REVIEW QUESTION PLUS: Choose from the physical quantities which we have discussed - length, area, volume, time, mass, force, speed, acceleration, work, energy, power - to identify the following quantities taken from problems. (Note: In some blanks two quantities should be supplied.)
   - a) 573 m²
   - b) 47.3 BTU
   - c) 39.2 joules
   - d) 29,700 ft lb
   - e) 84.9 joules/s
   - f) 4,490 ft lb/s
   - g) 7.91 lb
   - h) 29.3 slugs
   - i) 10 calories
   - j) 27 ft/sec
   - k) 39.7 ft/sec²
   - l) 5.73 m²
   - m) 37.5 KWH
   - n) 9840 KWH/sec
   - o) 80 Newtons

2. (2) A device for removing fly-ash from the stacks of coal-fired power plants is called ___.

3. (2) A device used for removing sulfur from the stacks of a coal-fired power plant is called ___.

4. (2) The colorless, odorless gas given off in the burning of coal is called ___, and is believed responsible for possibly producing a global warming of the earth by a process called ___.

5. (2) As a general rule, the coal lower in sulfur but also lower in BTU content is found where?

6. (2) Coal is mainly formed by?

7. (2) In what region of the country is most of the U.S. coal found? (a) Appalachian Mountains; (b) Eastern Interior Basin; (c) Northern Rocky Mountains; (d) Southern Rocky Mountains; (e) Alaska or (f) Hawaii.

8. (2) In the strip mining of coal, land reclamation is required to what extent?

9. (2) Two problems that still remain after land reclamation are what?

10. (2) List two uses for number 6 oil.

11. (2) Suppose 8 million BTU/s are added to water to produce steam in a coal-fired power plant and 2.5 million BTU/s of work are done. The first law efficiency of the power plant is __% and __ BTU/s must be rejected to the coal reservoir.

12. (2) Oil and natural gas are both believed to be formed by ___.

13. (3) The atom $^{90}$Sr has got _?_ protons in the nucleus, _?_ neutrons in the nucleus, and _?_, _?_, and _?_ electrons in the first, second, and third shells respectively.

14. (2) REVIEW QUESTION: A box measures 2.0 m by 1.0 m by 3.0 m. The volume is _?_ m$^3$, or the volume is _?_ cm$^3$.

15. (2) REVIEW QUESTION: If the rate of growth of coal usage is a mere 2 per cent per year, the doubling time is _?_.

16. (2) A 62 kg woman running at 3.0 m/s has a kinetic energy of _?_ (Include units!)

17. (2) Hamline will typically use _?_ for heating in the boiler plant. Occasionally during a cold winter day, Hamline will be removed from the above source of heat by XCEL energy and instead be forced to use _?_.

18. (2) REVIEW QUESTION: The energy of elevation is a physical quantity called _?_ energy.

19. (4) For the following measurements, indicate the precision and the number of significant figures. Carry out operations using strictly the rules for precision and significant figures.

<table>
<thead>
<tr>
<th>Precision</th>
<th>No. of significant figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) 509 cm</td>
<td></td>
</tr>
<tr>
<td>(b) 903.5 cm</td>
<td></td>
</tr>
<tr>
<td>(c) (a) x (b) =</td>
<td></td>
</tr>
<tr>
<td>(d) (a) - (b) =</td>
<td></td>
</tr>
<tr>
<td>(e) (a) + (b) =</td>
<td></td>
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</tbody>
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20. (2) In the strip mining of coal, reclamation laws of most states require the coal companies to _?_. But then, how is it determined that the land has indeed been "adequately" reclaimed?

21. (2) Why is topsoil so important to coal companies in the strip mining of coal?

22. (2) The peak in the United States oil production occurred in the early 1970s. The peak in the remaining non-OPEC world oil production is expected to peak in about _?_ years while the peak in the OPEC world oil production is expected to peak in about _?_ years.

B. Longer Answer Questions

1. (3) Briefly discuss what a refinery does with crude oil and the uses for its products where you include grades 1 through 5. (Grade #6 is included in question 10 above.) Be as specific as you can.
2. REVIEW QUESTION. Suppose a 120 lb person climbs 50 steps, a total distance of 27.5 ft high, in 40.2 sec.
   (a)(1) Where does the energy come from that allows the person to climb the steps?
   (b)(1) What is the increase in the Gravitational Potential Energy (GPE) of person?
   (c)(1) Calculate the work done by the person in climbing the steps.
   (d)(2) Calculate the power done by the person in climbing the steps (in hp). NOTE: 1 hp = 550 ft lb/sec.

3. (3) Suppose there are thirty 40 watt light bulbs that are operated for a 24.0 hour period of time. If electricity costs 7.35 cent per KWH find the cost of operating all 30 light bulbs for that period of time.

4. (4) Start with a diagram of 50 ft of peat under extreme pressure from above and below. List the various names, thicknesses and BTU content of the grades of coal which can be formed from this initial thickness of peat.

5. (4) State the First Law of Thermodynamics. Use a typical model for a coal-burning power plant for your explanation. Also state the First Law Efficiency.

6. On the back of this page, draw a diagram of a typical coal-fired electrical power plant. Indicate as best you can the boiler where the coal is burned, the turbine, the stack (2). Note where heat is added, where work is done, and where heat is removed (1). Write down an expression for the first law efficiency for this coal plant (1). Note the name of and positioning of the device used to remove sulfur from the coal (1).
7. (5) Define both "mouth-fed" power plants and "unit trains" and discuss the conditions whereby each would be most economically viable.

8. (4) List three of the many "equivalent" statements of the Second Law of Thermodynamics, and also include a statement of the "Second Law Efficiency." Is the Second Law Efficiency usually a greater percentage or is it a smaller percentage than the First Law Efficiency?

9. (4) TEXT SHORT ESSAY QUESTION. Discuss from the viewpoint of the text "tar sands."

10. TEXT QUESTIONS: Define or briefly discuss from the viewpoint of the text the following:

   (2) enhanced recovery
   
   (2) Kerogen
   
   (2) Carnot Efficiency
   
   (2) cogeneration
   
   (2) compression stroke
   
   (2) Radioactivity
   
   (2) Manhatten Project