A. Short Answer Questions

1.5 (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.)

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VOLUME: a) 573 m³

WORK OR ENERGY: b) 47.3 BTU
c) 39.2 joules
d) 29,700 ft lb
e) 84.9 joules/s

POWER: f) 4,490 ft lb/s
g) 7.91 lb
h) 29.3 slugs
i) 5.73 m²
j) 27 ft/sec

ACCELERATION: k) 39.7 ft/sec²

- ELECTROSTATIC PRECIPITATOR
- SCRUBBER
- CARBON DIOXIDE (CO₂)

2. (2) A device for removing fly-ash (particulate) 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 ___.

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 9.0 million BTU's are added to water to produce steam in a coal-fired power plant and 3.5 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 ___.

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Pressure in Sandy Regions of the World
13. (2) Which is lighter, #1 oil, #3 oil, or #6 oil?

14. (2) In the strip mining of coal, what is the "drag line?"

15. (2) The Law of "Conservation of Energy" is used in describing which of the Laws of Thermodynamics? Choose from (a) the first (b) the second (c) the third or (d) the zeroth Law of Thermodynamics.

16. (2) The coal deposits of North Dakota mainly are of the grade called: ___.

17. (2) The term applied to a power plant (or any) energy source whereby two products are supplied at once is called ___.

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>To the nearest unit of  ±1cm</td>
<td>3</td>
</tr>
<tr>
<td>(b) 903.5 cm</td>
<td></td>
</tr>
<tr>
<td>To the nearest unit of  ±0.1cm</td>
<td>4</td>
</tr>
<tr>
<td>(c) 509 cm × 903.5 cm</td>
<td></td>
</tr>
<tr>
<td>= 460 000 cm²</td>
<td></td>
</tr>
<tr>
<td>(d) 509 cm - 903.5 cm</td>
<td></td>
</tr>
<tr>
<td>= -395 cm</td>
<td></td>
</tr>
</tbody>
</table>

20. (2) The amount of heat required to raise the temperature of 2.7 kg of water from 27.0°C to 35.8°C is ___.

21. (2) Find the kinetic energy of a 85 kg person who running at 8.0 m/s.

22. (2) The amount of radioactivity given off by a coal plant is (less than, about equal to, more than) the amount of radioactivity given off by a "properly acting" nuclear power plant. (Choose one.)

B. Longer Answer Questions

1. (4) Briefly discuss what a refinery does with crude oil and discuss 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.

   Grade 1: Kerosene
   Grade 2: Gasoline (or Diesel)
   Grade 3: Plastic, Medicine, Clothing
   Grade 4: Fertilizer
2. (3) Suppose there are thirty 40 watt light bulbs that are operated for a 24.0 hour period of time. If electricity costs 9.053 cent per KWH find the cost of operating all 30 light bulbs for that period of time.

\[
\text{Power} = 30 \times 40 \text{W} = 1200 \text{W} = 1.2 \text{ KW} \\
\text{Time} = 24.0 \text{H} \\
\text{Energy} = \text{Power} \times \text{Time} = 29 \text{KWH} \\
\text{Cost} = \left(9.053 \frac{\text{c}}{\text{KWH}}\right) (29 \text{KWH}) = 260.4 = \$260.4
\]

3. REVIEW QUESTION. Suppose a 160 lb person climbs 50 steps, a total distance of 27.5 ft high, in 40.5 sec.

(a)(1) Where does the energy come from that allows the person to climb the steps?

\[\text{From the Food the person ate, but ultimately from the Sun.}\]

(b)(1) What is the increase in the Gravitational Potential Energy (GPE) of person?

\[\text{GPE = Weight x Height} = (60 \text{lbs})(27.5 \text{ft}) = 4400 \text{ft-lb}\]

(c)(1) Calculate the work done by the person in climbing the steps.

\[\text{Work} = \text{Increase in GPE} = 4400 \text{ft-lb}\]

(d)(2) Calculate the power done by the person in climbing the steps (in hp). NOTE: 1 hp = 550 ft lb/sec.

\[\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{4400 \text{ft-lb}}{40.5 \text{s}} = 109 \text{ ft-lb/s} \]

\[\text{HP} = \left(\frac{109 \text{ ft-lb/s}}{550 \text{ ft-lb/s}}\right) = 0.200 \text{ HP}\]

4. (4) Start with a diagram of 80 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.

\[
\text{Energy cannot be created nor destroyed, or better, for any system the sum of all forms of energy must add up to a constant! Here } Q_{in} = W + Q_{c} \\
1st \text{ Law Eff} = \frac{W}{Q_{in}} \times 100\%
\]
6. (4) Define both "mouth-fed" power plants and "unit trains" and discuss the conditions whereby each would be most economically viable.

**MOUTH-FED POWER PLANTS - BTU CONTENT IS MINIMAL AND IT'S MORE ECONOMICAL TO BURN COAL ON SITE & SHIP ELECTRICITY VIA HIGH VOLTAGE POWER LINES.**

If BTU content is high (subbituminous, bituminous, or anthracite) it does pay to ship the coal via unit trains (100 coal cars per train, 100,000 lbs of coal per coal car, 2 unit trains per day).

7. (3) List three of the many "equivalent" statements of the Second Law of Thermodynamics.

1. It is impossible; perpetual motion machine will never be built. 2. Heat flows from hot to cold (⇒ Heat death of universe)
2. Entropy (entropy) for any isolated system increases (⇒ All systems the same)
3. Depreciation exists for any economic cycle but be accounted for.

8. Draw a diagram and explain the operation of a typical coal-fired electrical power plant. Indicate as best you can the boiler where the coal is burned, the stack, the boiler, the turbine and generator, the "condenser", and all pumps (5). Also, note where heat is added, where work is done, and where heat is removed (1).
9. TEXT SHORT ESSAY QUESTION. Discuss from the viewpoint of the text "Shale Oil.

(4) Gross Domestic Product (GDP). In your discussion be sure to mention which countries enjoy the
greatest GDP with a minimal expenditure of energy per capita. Also mention which countries use the
greatest energy per capita.

The GDP is the sum of all goods & services
produced by a country. The GDP divided by the
population is a measure of standard of living.
Countries with greatest GDP are Switzerland, Japan, New Zealand
having small energy capita. The country with greatest energy is U.S.

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

(2) power

Is a measure of the rate of doing
work (or energy)

(2) British Thermal Unit (BTU)

Is the amount of heat energy to
raise the temperature of 1 lb. of water 1°F.

(2) fuel cell

Is like a battery whose electricity is
produced by a continuous supply of
energy containing chemicals external to
the fuel cell

(2) entropy

Is a measure of the amount of
disorder & from the 2nd law of thermodynamics, either increases for any system
or at best remains the same.

(2) latent heat

Is that energy (heat) that must be
supplied to a substance without a change
in temperature.

(2) cap and trade

Is a way to prevent the increase in
production of carbon (or sulphur) by placing an
upper limit on production. Industry can cut back on carbon production and sell allowances to other
companies to produce carbon back to the cap.

(2) regenerative braking

The kinetic energy of motion
of a car is converted to electricity rather than
being wasted as heat. (used in hybrid which use
both gasoline and electrical motors.)