Physics 1110  Final Exam  Name____________________
Energy, Environment, and 150 Points  Wednesday, May 17, 2017
the Economy, Jerry Artz 7:45 – 9:45 AM, RSC 011  Campus mail #______________

Instructions: The test has the same format as before. For problems, show your work. For underlined measurements in the problems, use correct precision and significant figures in your calculation. And as usual, if you do not have enough room, just turn over the page but write “over” so that I know. Thanks! And, if you
would like your final returned through campus mail, include your mail box # above. Good Luck!

Equations & conversions factors:
\[
\frac{Q}{t} = \frac{\text{Area} \times (T_H - T_C)}{R_i} \quad E.F. = \frac{\text{NetHeat}}{\text{HeatedArea} \times DD} \quad DT = \frac{70}{P}
\]
\[
\frac{Q}{t} = \left(\frac{\text{air change}}{H}\right) \times (\text{Volume}) \times (0.018 \frac{\text{Btu}}{\text{ft}^3 \cdot \text{F}^0}) \times (T_H - T_C) \quad \text{Power} = \frac{\text{Work(or Energy)}}{\text{time}}
\]
\[
KE = \frac{1}{2} mv^2 \quad DD = 65 - T_{ave} \quad T_{ave} = \frac{T_{high} + T_{low}}{2} \quad |HP| = 550 \frac{\text{ft} \cdot \text{lb}}{s} \quad Q = mc\Delta T
\]

Boiling point of H2O = 212 °F; the Freezing point of H2O = 32 °F; \( t_f = \frac{9}{5} t_c + 32 \) \( t_c = \frac{5}{9} (t_f - 32) \)

Metric: Heat added = mass \times \text{specific heat} \times \text{temperature change} \hspace{1cm} \text{(Know the units here!)}

English: Heat added = weight \times \text{specific heat} \times \text{temperature change} \hspace{1cm} \text{(Know the units here!)}

Increase in GPE = weight \times \text{height} \hspace{1cm} \text{(Know the units here!)}

Work (or Energy) = Power \times \text{time} \hspace{1cm} \text{(If it helps: KWH = KW \times H)}

\[
1st\text{LawEff} = \frac{W}{Q_H} \times 100\% \quad 2nd\text{LawEff} = \frac{\text{Minimum Energy required to accomplish a task}}{\text{Energy content of fuel used to accomplish that task}} \times 100\%
\]

A. Short Answer Questions

1. (1) The prefix "Mega" as applied to Megawatts (MW) means ___.

2. (1) From the physical quantities which we have discussed, a measure of the capacity to do work is called ___.

3. (1) The time that it takes for usage of a resource to double when acted upon by exponential growth is called the ___.

4. (1) A 73 kg man running at 2.23 m/s has a kinetic energy of ___.

5. (1) The amount of heat necessary to raise the temperature of 4.5 kg of water from 45 degrees C to 98 degrees C is ___. (Recall the "specific heat" for water is 1.00 kilocalories/kg C°.)

6. (1) If 1.6 km = 1 mile, a distance of 66 mi equals ___ km.

7. (2) A box measuring 2.2 ft by 3.3 ft by 1.55 ft contains ___ ft³ or ___ in³.

8. (1) From the physical quantities which we have discussed, a measure of the rate of doing work (or energy) is ___.

9. (1) If the doubling time of bacteria in a bottle were 5 min and the bottle was completely full at 12 noon, at what time would the bottle be 1/8th full?

10. (2) A wall measures 5.7 m by 7.8 m. The area of the wall is ___ m² or it is also ___ cm².

11. (1) Write the following in scientific notation 93,000,000 miles
12. (1) Write the following in ordinary notation: $7.26 \times 10^{-2}$ m

13. (1) A person exerts a force of 27 N in pushing a box a distance of 50 cm. The work done by the 27 N force is ___. (Include units with your answer.)

14. (1) A form of energy which is often referred to as the "energy of elevation" is called ___. energy.

15. (1) A device for removing particulate matter from the stacks of coal-fired power plants is called ___.

16. (1) The amount of heat required to raise the temperature of 25 lb of water from 72.5 °F to 95.2 °F is ___. (Include units.)

17. (1) A form of energy which is often referred to as the "energy of motion" is called ___. energy.

18. (5) 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 KWH  
b) 47.3 slugs  
c) 39.2 N  
d) 29,700 W  
e) 84.9 ft/s

f) 4,490 J/s (Joule/second)  
g) 7.91 lb  
h) 29.3 ft²  
i) 5.73 m³  
j) 27 ft lb/s

19. (1) In the strip mining of coal, reclamation laws of most states require the coal companies to ___.

20. (1) Number 6 oil is (a) thin and light; (b) thick and heavy; (c) thick and light; (d) thin and heavy.

21. (2) Suppose, in a particular period of time, that 12.0 million BTU's are added to water to produce steam in a coal-fired power plant and 4.0 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.

22. (2) The typical power output of a utility-operated nuclear generator is closest to ___ while the power output from the coal-fired power plant is closest to ___. Choose from (a) 1 MW (b) 10 MW (c) 100 MW (d) 1,000 MW (e) 10,000 MW (f) 100,000 MW (g) 1 kW

23. (2) In a neutral atom, the number of electrons is equal to the number of ___ in the ___.

24. (4) Of the three major types of nuclear radiation decay-products (i.e., alpha particles, beta particles, & gamma rays):

(a) The type that carries a positive charge is ___.

(b) The type that carries a negative charge & can be stopped by a piece of Aluminum foil is ___.

(c) The type that was later found to be a high energy electron is ___.

(d) The type that cannot be stopped by any thickness less than 6 inches of lead is ___.

25. (1) List 2 of the three ways discussed in class that a radioactive substance may enter the body.
26. (1) An emergency shut down procedure of a nuclear reactor is a process which is called ___ and the average nuclear power plant in the US averages how many ___ per year.

27. (1) Which of the following is characteristic of a radioactive nucleus: (a) A radioactive nucleus is unstable and wishes to decay (b) There are three principal modes of decay: alpha, beta, and gamma radiation (c) It is the decay products of a radioactive nucleus that does damage in human tissue. (d) all of the above are correct (e) none of the above are correct.

28. (1) Nuclear fusion results from (a) the joining of two light nuclei such as two heavy isotopes of hydrogen (b) the splitting of a heavy nucleus by a neutron (c) the solar energy striking the earth (d) the geothermal energy from the earth cooling down (e) the splitting of a heavy nucleus by an electron.

29. (1) Nuclear fission results from (a) the joining of two light nuclei such as two heavy isotopes of hydrogen (b) the splitting of a heavy nucleus by a neutron (c) the solar energy striking the earth (d) the geothermal energy from the earth cooling down (e) the splitting of a heavy nucleus by an electron.

30. (1) By which method does the sun produce energy; is it nuclear fission or nuclear fusion?

31. (6) (Please fill in the blanks) One of the fissionable isotopes found in High-Level Nuclear Waste is Cesium 137—namely, 137Cs. For this nucleus, the atomic number is ____ and the mass number is ____. The number of protons in the nucleus is ____, the number of neutrons in the nucleus is ____, and the total number of electrons in all the shells is ____. Of these electrons, there are ___ in the first (innermost) shell, ___ in the second shell, ___ in the third shell, ___ in the fourth shell, ___ in the fifth shell, ___ in the sixth shell, and ___ in the seventh outermost shell.

32. (2) Ozone has two sides to its character in that at surface altitudes it hurts us because it ___, while at very high altitudes it helps us because it ___.

33. (1) A temperature inversion occurs whenever (a) temperature decreases with altitude or (b) temperature increases with altitude or (c) temperature is constant as altitude increases. (Choose one)

34. (2) A colorless, tasteless gas that is given off by incomplete combustion in automobiles and that is toxic at high concentrations is called ___. This gas can be mostly removed by a pollution control device called a ___ that can be inserted in the exhaust system of our automobiles.

35. (3) On Jan. 1, 2017, the high temperature was 22 deg F and the low temperature was 8 deg F. On Jan. 2, 2017, the high temperature was 10 deg F and the low temperature was -20 deg F. The number of degree days on Jan. 1 was ____, the number of degree days on Jan. 2 was ____, and the contribution for both days was ___.

36. (2) A general type of heat transfer which refers to heat carried by the actual motion of a fluid (water or air) is called ___. This heat transfer as applied to a home where heat is lost out through the cracks and other openings of a house is called ___.

37. (2) A general type of heat transfer which refers to energy emitted by a hot object in the form of electromagnetic rays is called ___. This heat gain resulting from sunlight shining in through the windows of a home is called ___.

38. (1) A general type of heat transfer which refers to heat passing through a substance without a change in shape of the object is called ___.

39. (1) Which is best: a low evaluating factor or a high evaluating factor?

40. (1) An outdoor temperature at 77 °C on the Celcius scale is equal to ___ on the Fahrenheit scale.
41. (1) Heavy materials like concrete, masonry, and water have a high _2_ in that they store a lot of heat and allow temperatures inside the house to remain in a comfortable temperature range.

42. (1) A toxic form of alcohol is called _2_ and is made from _2_.

43. (1) A form of alcohol which is used in alcoholic beverages is called _2_ and is made from _2_.

44. (1) At our local Holiday filling station down the street, E85 is a mixture of 85% of _2_, and 15% of _2_.

45. (2) The fraction of sunlight that is immediately reflected by the earth is called the _2_.
   Currently for the earth, this fraction is about (a) 10% (b) 20% (c) 30% (d) 55%

46. (2) The difference in temperature between the freezing point temperature and the boiling point temperature in Fahrenheit degrees is _2_, while the difference between the freezing point temperature and the boiling point temperature in Celsius is _2_.

47. (1) Of the three types of heat transfer, select all those that are proportional to the fourth power of the Kelvin absolute temperature. Choose from (a) Conduction (b) Convection (c) Radiation

48. (1) Of the three types of heat transfer, select all those that are proportional to the difference in temperature. Choose from (a) Conduction (b) Convection (c) Radiation

49. (1) The albedo is (a) the percentage of sunlight absorbed by the earth (b) the percentage of sunlight reflected by the earth (c) the percentage of infrared energy absorbed by the earth (d) the percentage of infrared energy reflected by the earth.

50. (2) Our atmosphere currently consists of 21% _2_ and 78% _2_. (Order is important here!)

51. (2) Our earth heats up and gives off radiation energy called _2_ radiation which consists of
   (a) high energy, small wavelength (b) high energy, large wavelength (c) low energy, small wavelength (d) low energy, large wavelength

52. (2) From our NASA link, the preindustrial concentration of CO₂ is closest to _2_ and the current concentration of CO₂ is closest to _2_.
   (a) 280 ppm (b) 320 ppm (c) 360 ppm (d) 400 ppm (e) 280 ppb (f) 320 ppb (g) 360 ppb (h) 400 ppb (i) 440 ppb

53. (1) Of all the greenhouse gases, the one that has the most effect at absorbing the earth’s heat energy and not allowing it to escape is (a) CH₄ (b) CO₂ (c) NOX (d) SOX (f) H₂O vapor (g) halocarbons

54. (1) Among the most dramatic changes scientists have measured is the shrinking of summer time Arctic sea ice, which, since 1979, has shrunk (a) 5%  (b) 10%  (c) 20%  (d) 40%

55. (1) The 1991 eruption of Mt. Pinatubo in the Philippines caused the global temperature to (increase, decrease) (Choose one.) because of _2_.

56. (1) From the short oral presentations Thursday, which of the following was NOT presented: (a) small scale (at home) composting  (b) septic tanks installation using anaerobic bacteria (c) large scale (commercial) composting  (d) aerobic bacteria and their importance
57. (1) From the short oral presentations Thursday, one of the real problems that exist with composting is that methane gas is released which is a major greenhouse gas (true, false)

58. (1) In the presentation last Thursday, one possible solution to our climate concerns and exponential growth philosophy is redefining prosperity and moving toward a no-growth economy. (true, false)

B. Longer Answer Questions

1. (4) Convert 8.2 km/h to inches/s
   (Show your work as a series of conversion factors; you do not need to multiply the factors out to get full credit.)

   **NOTE:**
   - 5280 ft = 1 mile
   - 2.54 cm = 1 in
   - 12 in = 1 ft
   - 1.6 km = 1 mile
   - 60 s = 1 min
   - 60 min = 1

2. (6) Suppose a 90 lb person climbs to a platform 10 ft above the pool and dives into a pool of water below. Fill in the GPE (relative to the pool), Kinetic Energy, and Total Energy for the following elevations:

<table>
<thead>
<tr>
<th>Height</th>
<th>Gravitational Potential Energy (GPE)</th>
<th>Kinetic Energy (KE)</th>
<th>Total Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) 10 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) 8 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) 3 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) 0 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
   (e) When the diver goes into the water, where did all the energy go? _________________

3. Please refer to the diagram for the *thermodynamic model* for a typical power plant:
   (a) (2) Identify the hot temperature reservoir $T_H$ and the cold temperature reservoir as $T_C$ and use arrows to draw in heat added $Q_H$, Work done $W$, and heat removed $Q_C$.
   (b) (1) Use $Q_H$, $W$, and $Q_C$ to provide a description of the 1st Law of Thermodynamics
   (c) For a specific coal-burning power plant,
      (i) (1) What does the top rectangle represent? ____________________________
      (ii) (1) What does the bottom rectangle represent? _________________________
      (iii) (1) What is included within the circle? _______________________________
      (iv) (2) Use these specifics to describe the operation of a typical coal-burning power plant:

4. (3) (a) (1) What happened at Chernobyl. (b) (1) What kind of a reactor was this? (c) (1) 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. (2) What happens when a neutron moving slowly strikes a \(^{235}\text{U}\) nucleus? (Explain and draw a diagram.)

6. (4) List four of the many consequences listed in class or in the NASA link of global warming.

7. (4) List and briefly discuss four specific examples of a passive heating system.

8. (3) Contrast and compare the effect of greenhouse gases in our atmosphere versus the effect of stratospheric ozone.
8. (3) LAB QUESTION: How much does it cost to operate a 2,500 W air-conditioner for 24.0 continuous hours if electricity costs 9.75 cents per KWH?

9. LAB QUESTION: A strange wooden house was constructed with one south-facing window (R-Value 2.0) and 6.0 inch thick hardwood having an R-value of 1.00 per inch. (The R-Value of the air films may be neglected.) The house was placed in the backyard on stilts with the 6.0 inch hardwood placed on the floor, ceiling, and all four walls. The structure measured 7.0 ft by 9.0 ft for the floor (and ceiling) and the walls are 8.0 ft high. The south-facing wall plus window measures 7.0 ft by 8.0 ft and the window measures 3.0 ft by 5.0 ft. Assume that the specific heat of air is 0.018 BTU/ft³ DD. If the structure was maintained at an inside temperature of 75 deg F and the outside temperature at 25 deg F for the entire day, and there were 1.4 air changes per hour, determine:

(a)(3) The heat lost by conduction for the day.

(b)(1) The heat lost by infiltration for the day.

(c)(1) The heat gained from insolation (solar gain) for the day.

(d)(2) The evaluating factor for the structure.

10. (4) LAB QUESTION: If the initial temperature of 300 g unknown metal is 80.0 deg C, calculate its specific heat if, upon insertion, it causes the temperature of water and calorimeter to rise from 18.0 deg C to 22.0 deg C. The mass of that water is 500 g (specific heat: 1.00 cal/g C deg) and the mass of the calorimeter is 100 g (specific heat: 0.100 cal/g C deg). Neglect heat loss to atmosphere.
12. TEXT QUESTIONS: Define and briefly discuss:

(2) The second law of thermodynamics (please discuss but also include at least one equivalent statement here in your description)

(2) entropy

(2) NOX and SOX

(2) kerogen

(2) inertial confinement

(2) energy payback time

(2) inverter

(2) Ice-albedo feedback (be sure to mention if this is a positive or a negative feedback)