

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_\_ / 144

**Wind Power Test (2016-2017)**

## Statistics &amp; Basic Information (7 pts)

1. What percent of the world's energy is generated by steam turbines driving rotary generators?  
\_\_\_\_\_ (1 pt)
2. How does the sun's heat lead to the production of energy? (2 pts)
3. \_\_\_\_\_ states in the U.S. produce over 5% of their energy through the use of wind energy. (1 pt)
4. List two disadvantages of using wind power. (2 pts)
5. Wind power differs from the production of energy by coal in that it does not utilize the process of \_\_\_\_\_, leading it to be less polluting to the atmosphere. (1 pt)

## Energy Storage (26 pts)

6. Flywheel energy storage systems take in energy in the form of \_\_\_\_\_ energy and store it as \_\_\_\_\_ energy. (1 pt each)
7. The amount of energy that can be stored by the mass in flywheel energy storage systems is proportional to the object's \_\_\_\_\_ times the square of its \_\_\_\_\_. (1 pt each)
8. In an electrochemical cell, the anode is where (reduction/oxidation) occurs, and the cathode is where (reduction/oxidation) occurs. (1 pt, no partial credit)
9. The anode (donates/accepts) electrons from the circuit, and is connected to the (positive/negative) terminal of the battery. (1 pt, no partial credit)
10. What is the major factor reducing the lifespan of primary cells? Explain how this process works. (3 pts)

11. The Leclanché cell was invented and patented in \_\_\_\_\_ and contains a conducting solution of \_\_\_\_\_, a cathode of \_\_\_\_\_, and anode of \_\_\_\_\_. (1 pt each)
12. The crowfoot cell uses a \_\_\_\_\_ anode, a \_\_\_\_\_ cathode, a \_\_\_\_\_ anode solution, and a \_\_\_\_\_ cathode solution. (1 pt each)
13. Secondary cells are also commonly known as \_\_\_\_\_ batteries. (1 pt)
14. The oldest type of secondary cell is the \_\_\_\_\_ cell, which produces \_\_\_\_\_ and \_\_\_\_\_ gases if overcharged. (1 pt each)
15. Describe the differences between a wet cell and a dry cell. (2 pt) Which came first? (1 pt) Give an example of commercial usage for each type. (2 pt)

Wind Turbine Design (20 pts)

16. Is the wind turbine in the picture a horizontal/vertical axis turbine? What type is it?  
\_\_\_\_\_ (2 pt)
17. Name one advantage and disadvantage for each HAWT and VAWT designs (four factors in total). (4 pts)



18. Do HAWTs or VAWTs have higher efficiency? Why? (3 pts)
19. What type of vertical axis wind turbine is able to easily start at low wind speeds?  
\_\_\_\_\_ (1 pt)
20. What is a giromill? (2 pts)

21. True or False: VAWTs need a yaw control mechanism. (1 pt)
22. Types of wind farms: (3 pts)
1. \_\_\_\_\_: within 30 km of the shoreline
  2. \_\_\_\_\_: within 3 km of the shoreline or 10 km offshore
  3. \_\_\_\_\_: more than 10 km from land
23. List an advantage and a disadvantage of offshore wind farms (2 pts)

24. What does Betz's law state? (2 pts, no partial)

Energy Sources & Alternative Energy (21 pts)

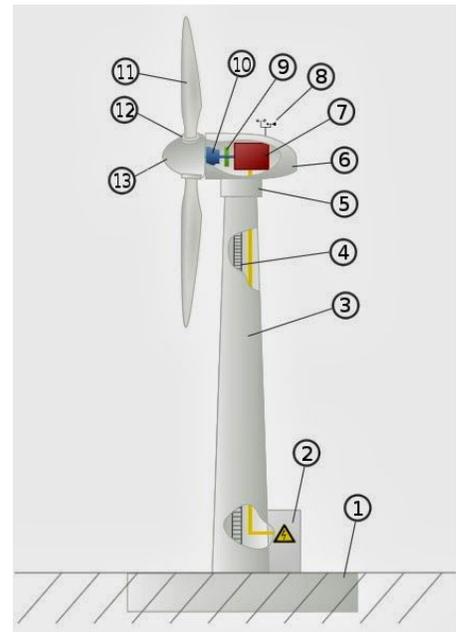
25. The three R's of conserving energy, listed from highest to lowest preference, are \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_. (2 pts, no partial credit)
26. What is the top coal producing US state? \_\_\_\_\_ (1 pt)
27. The US has around \_\_\_\_ generators and \_\_\_\_ operational power plants. (2 pts)
1. 8000, 2000
  2. 20000, 8000
  3. 2000, 800
  4. 10000, 6000
28. OTEC stands for \_\_\_\_\_. (1 pt)
29. The basic closed-cycle OTEC plant is as follows: warm seawater goes through a(an) \_\_\_\_\_ and vaporizes the liquid \_\_\_\_\_. The vapor passes through a \_\_\_\_\_ that turns a generator. (3 pts)
30. Where was the first OTEC plant inaugurated? \_\_\_\_\_ (2 pts)
31. The amount of hydroelectric energy produced is depended on the \_\_\_\_\_ and \_\_\_\_\_ . (2 pts)

32. Which country is the largest producer of hydroelectric power? \_\_\_\_\_ (1 pt) Which country is the second largest producer of hydroelectric power? \_\_\_\_\_ (1 pt)
33. Geothermal power plants use \_\_\_\_\_ from reservoirs below the earth's surface to produce electricity. (1 pt)
34. The three types of geothermal power plants are \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. (3 pts)
35. The largest group of geothermal power plants in the world is at the \_\_\_\_\_, located in the state of \_\_\_\_\_. (2 pts)

Labeling (24 pts)

36. Identify the parts indicated in the diagram and describe the function of each (1 pt for each ID, 2 pts for each function):

- 1.
2. Skip #2.
- 3.
4. Skip #4.
- 5.
6. Skip #6.
- 7.
8. Skip #8.
- 9.
- 10.
- 11.
12. Skip #12.
- 13.



Energy Transmission and Distribution (12 pts)

37. From the point of view of a generator of electrical power, the most desirable power factor for loads is \_\_\_\_\_. (2 pts, no partial)

38. Why is such a power factor desirable? (4 pts)

39. The longest HVDC power link is in the country of \_\_\_\_\_. (2 pts, no partial)

40. Indicate all of the following are disadvantages of monopolar HVDC systems using earth return: (0.5 pt for each correct indication or lack thereof, max 2 pts)

1. Corrosion
2. Higher costs
3. Magnetic anomalies
4. It requires synchronization between the grids being connected

41. List two advantages of HVDC systems (1 pt for each):

42. Compared to conventional 2-wire distribution systems, SWER lines carry a (higher/lower) voltage. (1 pt)

Calculations (34 pts)

43. Calculate the power converted from the wind into rotational energy by a wind turbine given the following data: blade length = 50 m, wind speed = 11 m/s, air density =  $1.23 \text{ kg/m}^3$ , power coefficient = 0.4. Show your work. (4 pts)

