

Wind Power

Huntley Invitational

04 Feb 2017

School Name _____

School Number _____

Participant Name(s) _____

Written Test Score _____

Overall Rank _____

Instructions:

- **All multiple choice, matching, and calculation final answers must be on the bubble sheet.**
- **All written answers will be placed on the test.**
- **Please check the bubble sheet to ensure your team name is accurate and the ID is your Team Number.**
- **Test pages may be torn apart to split work between team members.**
- **The answer sheet you are using allows for multiple bubbles to be filled in and graded. This is important for two question types on this exam.**
 - o Questions that state "Select all that apply" may or may not require the filling in of multiple bubbles to earn credit.
 - o If the question has an "ab" answer choice, please bubble in both letters on your scantron to select that answer.

Multiple Choice (Every question is worth 1 point)

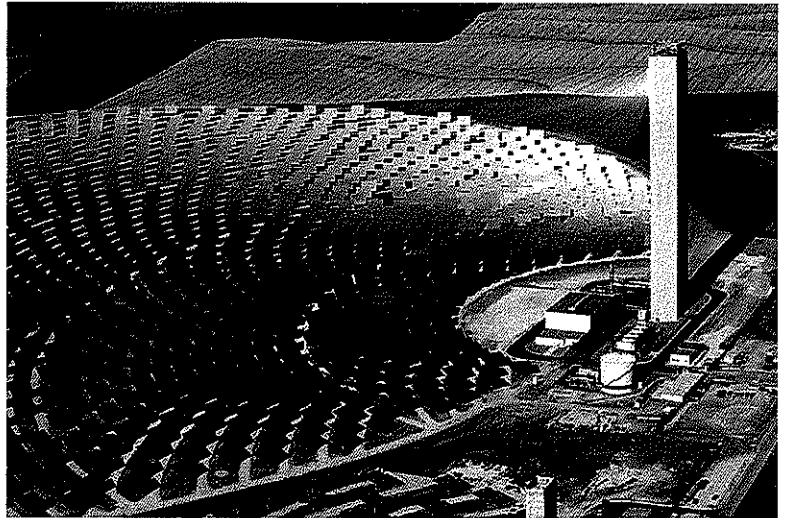
1. What type of windmill is shown in the picture to the right?
- a. Tower mill
 - b. Smock mill
 - c. Post
 - d. Vertical axis



2. The first windmills were built to
- I. Generate Electricity
 - II. Pump Water
 - III. Grind Grain
- a. I only
 - b. I and II only
 - c. II and III only
 - d. I and III only
 - e. I, II, and III

3. The first windmills were created in _____ and had a _____ axis.
- a. Denmark; horizontal
 - b. Denmark; vertical
 - c. Persia; horizontal
 - d. Persia; vertical
 - e. None of the above

4. What is the name of the type of power generating system shown in the picture to the right?
- a. Photovoltaic Cells (PV)
 - b. Vertical Axis Wind Turbines
 - c. Concentrator Photovoltaics (CPV)
 - d. Concentrated Solar Power (CSP)



5. What type of energy source would most likely use a pressurized water reactor (PWR)?
- a. Nuclear
 - b. Wind
 - c. Coal
 - d. Natural gas
 - e. Hydro

6. Which of the following energy sources would not use combustion to power a generator? Select all that apply.

a. Nuclear b. Wind c. Coal d. Natural Gas e. Hydro

7. Which energy source is reliant on gravity to create the conditions necessary for energy generation?

a. Nuclear b. Wind c. Coal d. Natural Gas e. Hydro

8. Gas turbine engines are most suitable for which of the following types of power generation?

a. Nuclear b. Wind c. Coal d. Natural Gas e. Solar

9. Which of the following statements is true with regards to lithium ion batteries?
- I. Have a longer lifespan than alkaline batteries
 - II. Are not as toxic as alkaline batteries
 - III. Perform better at colder temperatures compared to alkaline batteries
- a. I only
 - b. I and II only
 - c. II and III only
 - d. I and III only
 - e. I, II, and III
10. A simple battery consists of an anode and a cathode separated by an electrolyte solution. Which of the descriptions below best describes what is happening when a battery is being discharged?
- a. Electrons flow into the anode due to a reduction reaction and out of the cathode due to an oxidation reaction.
 - b. Electrons flow out of the anode due to an oxidation reaction and into the cathode due to a reduction reaction.
 - c. Electrons flow out of the anode due to a reduction reaction and into the cathode due to an oxidation reaction.
 - d. Electrons flow into the anode due to an oxidation reaction and out of the cathode due to a reduction reaction.
11. What form of energy storage uses large caverns left behind by mining?
- a. Flywheel
 - b. Hydrogen
 - c. Compressed Air
 - d. Pumped Storage
 - e. Vehicle-2-grid
12. Which of the following is an advantage of vertical axis wind turbines? Select all that apply.
- a. Automatically faces the wind
 - b. Heavy machinery can be located close to the ground
 - c. Lightweight
 - d. Higher efficiency than horizontal axis wind turbine

Matching (Every question worth 1 point)

Match these terms to the correct form of power transmission

- a. AC b. DC c. Both d. Neither

13. Majority of transmission lines in the United States transmit this
14. More efficient form to transmit electricity over long distances
15. The preferred transmission form of Nikola Tesla
16. Has no transmission loss along power lines

Calculations (Every Question is worth 2 points)

17. A wind turbine is found to be generating 12.5 kW of power at the same time the wind speed was measured at 3.2 m/s. Two hours later the wind speed is found to have increased to 12.8 m/s. What Quantity of power listed below would be closest to the expected output of this turbine at this wind speed?

- A) 50 kW B) 100 kW C) 150 kW D) 200 kW E) 400 kW F) 800 kW

18. A GE 1.5 MW wind turbine has three blades that are each 116 feet long. If this turbine is spinning at 15 rpm's at what speed in metes/sec are the tips of the blades moving?
- a) 32 m/s b)55 m/s c) 125 m/s d) 180 m/s e) 420 m/s ab) 730 m/s

The following passage should be used for questions 19-21

A wind farm supplies 25 MW of power to a town that is located 45 miles away. This power is sent over a 100 kV line with a resistance of 0.13 Ω /mile.

19. What is the current flowing in the line?
- a) 70 Amps b) 250 Amps c) 740 Amps d) 1125 Amps e) 2070 Amps ab) 17100 Amps
20. How much power is lost during transmission?
- a) 81 kW b) 80 kW c) 370 kW d) 1.2 MW e) 3.2 MW ab) 58 MW
21. What percent of power is lost?
- a) 0.32 % b) 0.72 % c) 1.5 % d) 4.8 % e) 13 % ab) 100%
22. Most utility companies around the world charge for energy by SI unit of energy the Joule. For some reason utility companies in the United States charge by the kilowatt-hour. How many Joules are in a kilowatt-hour?
- a) 0.60 MJ b) 1.2 MJ c) 3.6 MJ d) 4.8 MJ e) 6.4 MJ ab) 9.6 MJ

23. How much power can we expect from a wind turbine located at sea level if the wind speed is currently measured to be 25 miles per hour and the air temperature is 15°C.

Some potentially useful and possibly useless data.

- Length of one turbine blade = 142 feet
- One inch = 2.54 cm
- Density of dry air at sea level and 15°C 0.0765 lb/ft³
- 1kW =1000 Watts
- 1 hour = 3600 seconds
- At this wind speed this turbine is capable of capturing 37% of the wind energy.
- One kg of water weighs 2.2 pounds
- $E = mc^2$
- 1 MW = 1,000,000 watts

- a. 117 kW b. 700 kW c. 1.3 MW d. 1.9 MW e. 3.9 MW ab. 14 MW

Written Response

24. Who built the first large-size wind turbine for electricity generation in Cleveland, Ohio in 1888? (1 pt)

25. What is the difference between a wind mill and a wind turbine? (2 pt)

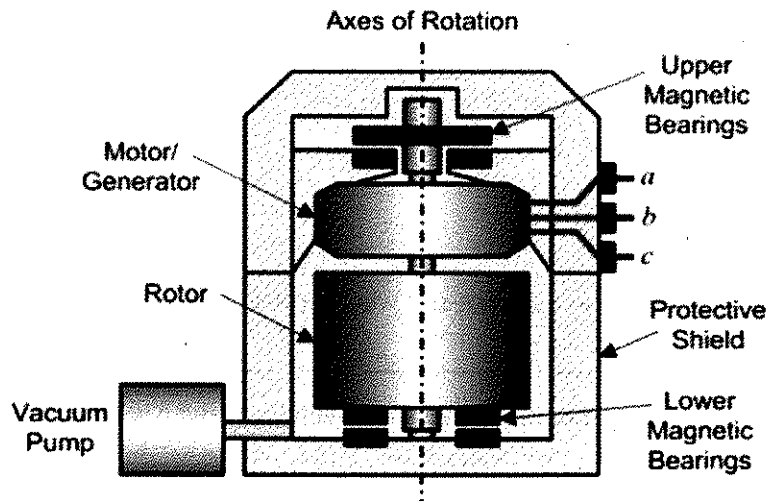
26. What does NIMBY stand for? How does it apply to wind energy? (2 pt)

27. Define pumped storage and its connection to wind energy. (3 pts)

28. Powerwall is a battery system being manufactured by what company? (1 pt)

29. What is being shown in the diagram to the right? (1 pt)

30. What is the benefit of increasing the elevation of the wind turbine? (1 pts)



31. What is corona loss (aka corona discharge)? (2 pts)

32. What form of current is impacted most by the "skin effect"? What impact does this have on transmission? (2 pts)

33. What is the name of the wind turbine design shown to the right? (1 pt)

