Science Olympiad Fairfax Invitational **Score:**_____

School Name: KEY **Team Members Names:**_____

Team Number:_____ _____

Choose the best answer and write it in the space provided: (1 point each)

A 1. The original source of the electrical power produced by a wind generator is

A. the Sun's radiated energy.
B. the gravitational energy of the Sun and the Moon.
C. nuclear energy stored within atoms in the Earth's atmosphere.
D. the Earth's internal energy.

D 2. Of these renewable energy sources which one does not depend directly on radiant energy from the Sun?

A. biomass B. wind C. solar D. geothermal

D 3. A wind turbine produces a power P when the wind speed is v. Assuming that the efficiency of the turbine is constant, the best estimate for the power produced when the wind speed becomes $2v$ is

A. $2P$. B. $4P$. C. $6P$. D. $8P$.

C 4. A wind generator produces 5.0 kW of power for a wind speed of 6.0 m/s. The best estimate for the power produced for a wind speed of 12.0 m/s is

A. 10 kW. B. 25 kW. C. 40 kW. D. 125 kW.

C 5. What is the typical cut-out speed of a modern wind turbine?

A. 3 m/s B. 12 m/s C. 25 m/s D. 40 m/s

B 6. The optimal blade chord is a function of

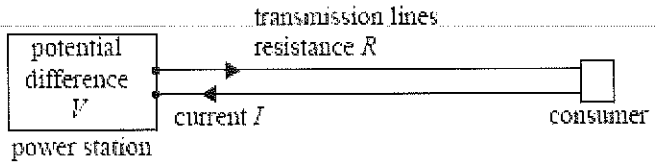
A. rated power B. radius C. wake losses D. hub height

C 7. The rms voltages across the primary and secondary coils in an ideal transformer are V_p and V_s respectively. The currents in the primary and secondary coils are I_p and I_s respectively.

Which **one** of the following statements is always true?

A. $V_s = V_p$ B. $I_s = I_p$ C. $V_s I_s = V_p I_p$ D. $\frac{V_s}{V_p} = \frac{I_s}{I_p}$.

C 8. A power station generates electrical energy at a potential difference V and current I. The resistance of the transmission lines between the power station and the consumer is R.



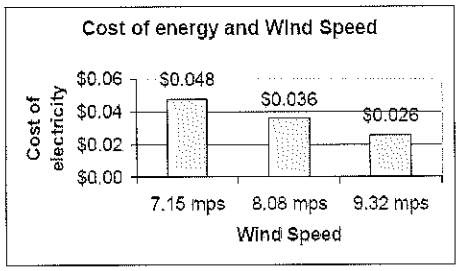
The power lost in the transmission lines is

A. 0. B. $\frac{V^2}{R}$. C. RI^2. D. VI.

C 9. Wind turbines are normally mounted100 feet or more above the ground. This is done in order to:

A. allow room for plants and trees to grow beneath them.
B. reduce noise for people who live and work nearby.
C. take advantage of faster, less turbulent winds.
D. reduce the number of birds that might be killed by the blades.

C 10. Based on the graph of "Cost of energy and Wind Speed" what can you determine about wind energy costs?



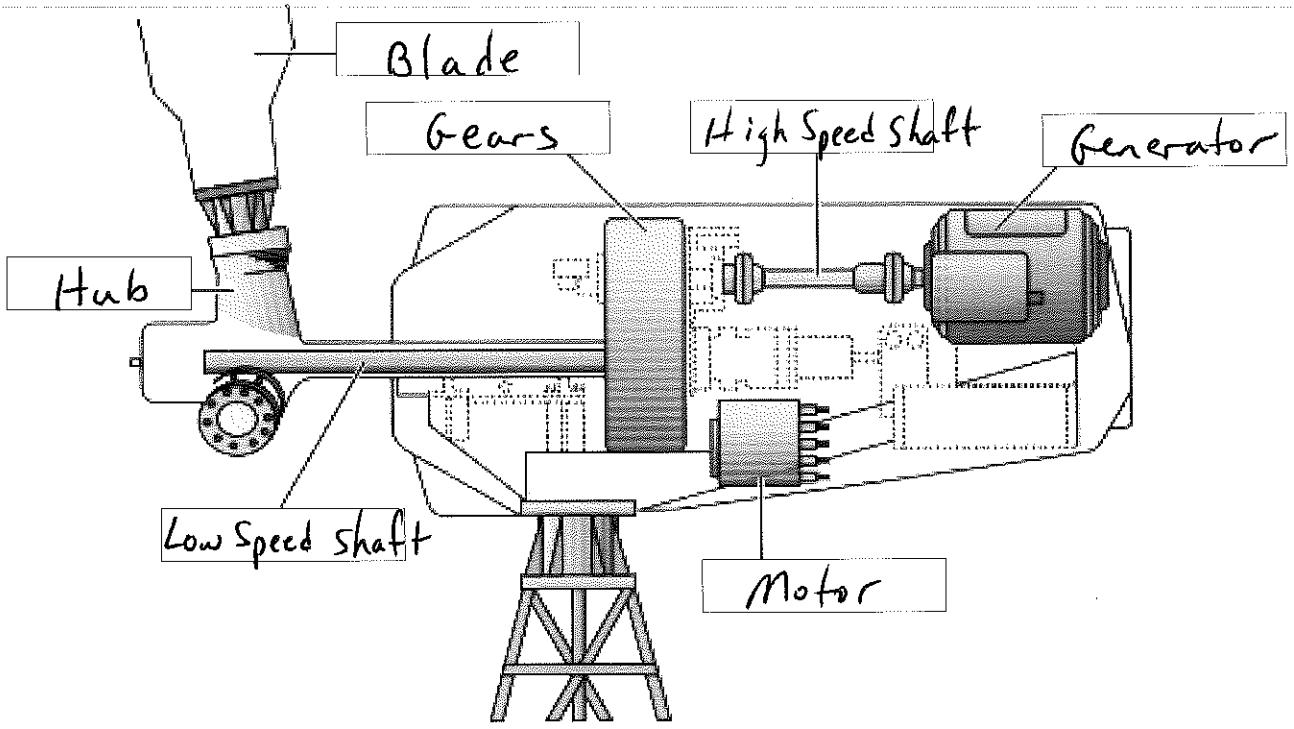
The three examples above are for costs per kilowatt-hour for a 51 MW wind farm at three different average wind speeds expressed in meters per second. Cost figures include the current wind production tax credit.
Source: http://www.awea.org/pubs/factsheets/EconomicsOfWind-Feb2005.pdf

A. The cost of energy from wind increases as wind speed increases.
B. There is no relationship between wind speed and wind energy cost.
C. The cost of energy from wind increases as wind speed decreases.
D. The cost of energy from wind decreases as wind speed decreases.

11. Identify the two basic types of wind turbine fan blade design in use today in the United States

1. HAWT 2. VAWT

12. Identify the parts of the wind turbine below. Write in the boxes provided



C 13. The principal advantage of ac power over dc power is that

A. less energy is dissipated during transmission.
B. ac voltage oscillates while dc voltage does not.
C. ac voltage can be transformed via conventional transformers.
D. ac circuits multiply power more easily.
E. ac circuits are safer.

A 14. A step-up transformer has a ratio of 1 to 10. Neglecting slight losses, if 100 W of power go into the primary coil, the power coming from the secondary coil is

A. 1 W. B. 10 W. C. 100 W. D. 1000 W. E. none of these

C 15. High voltages are used for the transmission of electric power over long distances because

A. high voltages can be stepped down to any required value.

B. larger currents can be used.

C. power losses during transmission are minimized.

D. transformers have a high efficiency.

C 16. Energy from biomass is obtained by

A. burning the biomass to convert its chemical energy into heat
B. processing the biomass to obtain gases like methane or fuels such as ethanol that can be burned turning their chemical energy into heat
C. both and b
D. neither a or b

D 17. Hydro-electric power is produced primarily in the western U.S. This is because this type of renewable energy depends on

A. low flat areas subject to flash flooding to power the turbines
B. mountainous regions with substantial rain and snow
C. deep valleys that can be used to store mountain runoff behind dams
D. both c and b are correct

D 18. Geothermal energy is different from both solar and wind because it

A. is substantially less expensive than either of them
B. can be efficiently generated anywhere in the U.S.
C. is much more expensive than either of them.
D. is the only one of the three that can generated 24 hours a day, 365 days a year

C 19. California, Nevada, Utah and Hawaii are the only states with geothermal power plants. The best explanation for this is that these states are

A. all in the western portion of the U.S.
B. all adjacent to the Pacific Ocean
C. all are located near major plate boundaries where volcanoes and earthquakes are prevalent
D. none of the above

C 20. In addition to using geothermal energy for hydrothermal steam production to power turbine driven generators, geothermal energy can also be used in geothermal heat pumps for home heating. Which of the following best explains how this is accomplished?

A. The Earth's crust heats up in summer and then gradually loses this energy in the winter. the heat pump takes advantage of this phenomenon to heat and cool the home.

B. The Earth's crust maintains a relatively constant temperature of between 10-15°C. This allows the heat pump to efficiently transfer energy and heat or cool the home.

C. These systems require drilling deep into the Earth's crust to use the high temperatures found there to heat the homes. Cooling is not possible.

D. These systems require drilling deep into the Earth's crust to use the low temperatures found there to cool the homes. Heating is not possible.

Free Response Questions. Write your answers in the spaces provided neatly.

1. HAWT (Horizontal Axis Wind Turbine) and VAWT (Vertical Axis Wind Turbine) designs have advantages and disadvantages over each other. For each of the reasons below mark if it is an advantage for a HAWT or an advantage for a VAWT:

Reason	HAWT advantage	VAWT advantage
Less strain on the axle, reduces maintenance		✓
Easy maintenance because rotor housing is near ground		✓
Wind direction does not matter		✓
Has a higher efficiency because the blades don't rotate into the wind (so don't drag)	✓	
Can be installed in locations where taller structures are prohibited or are undesirable		✓
Higher installations increase the available wind energy	✓	

2. Based on the information below, which two bulk energy storage technologies would you consider best if you wanted a low cost, short term, electrical energy storage?

1. Flywheel 2. Super - Capacitors

Technology	Location	Output	Efficiency (%)	Initial investment cost (USD/kW)	Primary application
PSH	Supply	electricity	50 - 85	500 – 4,600	long-term storage
UTES	Supply	thermal	50 - 90	3,400 – 4,500	long-term storage
CAES	Supply	electricity	27 - 70	500 - 1 500	long-term storage
Pit storage	Supply	thermal	50 - 90	100 – 300	medium
Molten salts	Supply	thermal	40 - 93	400-700	high-temperature applications
Batteries	Supply, demand	electricity	75 - 95	300 – 3,500	distributed/ offgrid storage, short-term storage
Thermo-chemical	Supply, demand	thermal	80 ~ 99	1,000 – 3,000	low, medium, and high temperature applications
Chemical – hydrogen storage	Supply, demand	electrical	22 - 50	500- 750	long-term storage
Flywheels	T&D	electricity	90 - 95	130 – 500	short-term storage
Super-capacitors	T&D	electricity	90 - 95	130 – 515	short-term storage
Solid media storage	Demand	thermal	50 - 90	500 – 3000	medium temperature applications
Ice storage	Demand	thermal	75 - 90	6,000 – 15,000	low temperature applications

3. Suppose you worked for a utility company that wanted to install several wind turbines in a suburban neighborhood.

Name two factors that might make locals regard wind power negatively.

1. Noise
2. Appearance

What two things can be done to increase local acceptance of wind turbines?

1. Education
2. Lower energy costs

Describe 2 situations in which a small wind turbine would be preferable over a large wind turbine?

1. Urban Setting
2. Areas with lower wind speeds