

Point or No Point: FRQ #1 - Design an Experiment

For each response written below, decide if the answer earns a point or not. There are no half points.

A homeowner in the Northern Hemisphere is considering installing photovoltaic (PV) panels on the roof of the home to help provide electricity for the home. The homeowner has read conflicting reports on which compass direction the panels should face to maximize the amount of electricity (in kWh) that the panels can produce.

- a. The homeowner plans to design an experiment to determine the direction of the panels for maximal electricity production

i. **Identify** the independent variable in the experiment.

1. The compass direction of where the solar panel is facing.	____/1
2. The independent variable is the compass direction the PV panels are facing.	____/1
3. The independent variable of the experiment will be the sun or amount of light measured.	____/1
4. Which compass direction the panels should face.	____/1

ii. **Identify** the dependent variable in the experiment.

1. The amount of electricity produced in kWh.	____/1
2. Which panel provides maximal electricity production.	____/1
3. The dependent variable is the amount of energy (in kWh) the panel can produce.	____/1
4. The dependent variable is the position or direction of the panels that will change.	____/1

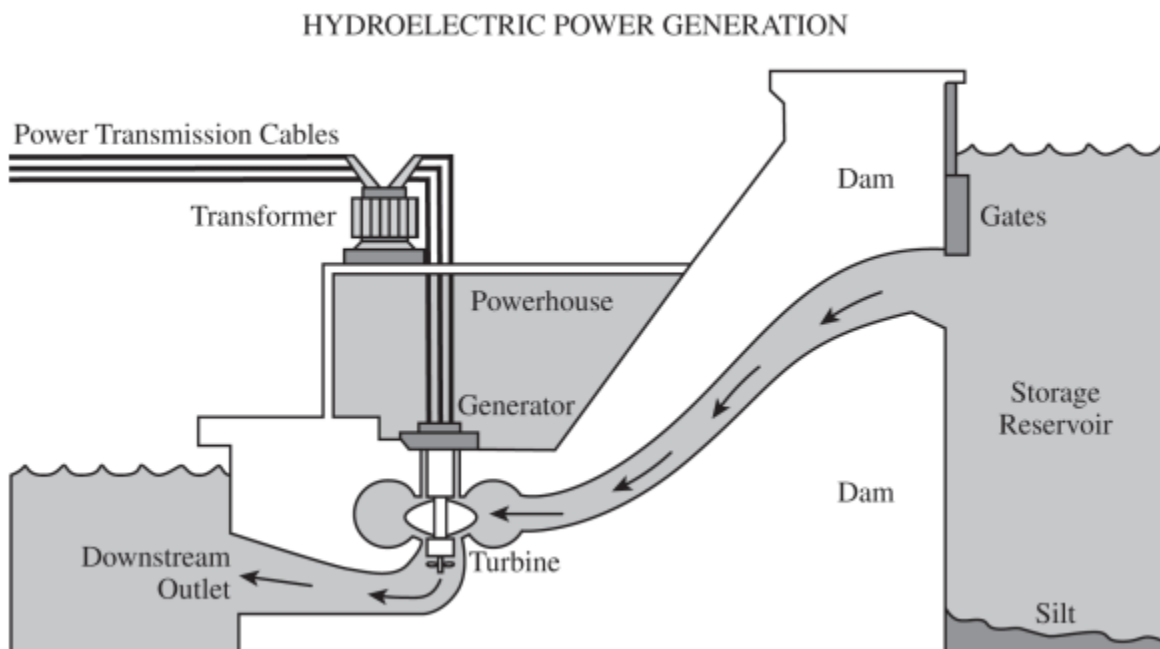
iii. **Identify** a reasonable hypothesis for the experiment.

1. If the panels face either east or west, then the amount of electricity generated will increase because the sun rises and sets in those directions.	____/1
2. It doesn't matter which direction the panels are pointed towards.	____/1
3. If the PV panels were installed on the roof in the Northern hemisphere, the greatest amount of electricity will be produced when facing south.	____/1
4. A reasonable hypothesis for this experiment would be that the panels will be able to produce the most amount of electricity when facing the direction the sun rises from which would be the east.	____/1

iv. **Describe** one variable that was not discussed that could affect the results of the study.

1. If the area has a lot of precipitation, resulting in blockage from the sun, this will decrease the amount of sunlight, therefore decreasing the amount of electricity produced, no matter what direction the PV panels are facing.	____/1
2. One variable that could change the results of the study that was not discussed was the weather and how it can affect the amount of exposure the solar panels have to light.	____/1
3. The season that the study occurred during, like if it was winter or summer.	____/1
4. One variable that isn't discussed is the amount of condensation and precipitation in the area. This can affect the results because clouds block sunlight so areas with more clouds would generate less electricity.	____/1

b. The diagram below shows another way of generating electricity using a renewable resource. The arrows indicate the flow of water.



i. **Identify** the location shown in the diagram where the kinetic energy of the water is transformed into mechanical energy.

1. Kinetic energy turns into mechanical energy at the generator.	____/1
2. The turbine.	____/1
3. Kinetic energy turns into mechanical energy in the turbine section of the generator.	____/1
4. The turbine is the location of the hydroelectric dam where water's kinetic energy turns into mechanical energy.	____/1

- ii. **Explain** why the water in the storage reservoir has potential energy that is useful in hydroelectric power generation.

1. The stored water is important to power generation because it not only will later be used and changed to kinetic energy but it pushes the function/use of the generator.	____/1
2. The water in the storage reservoir contains a lot of water being contained at a higher altitude than where the turbine is. As gravity pulls down, the energy in the water goes from potential to kinetic, increasing the rate at which electricity is generated.	____/1
3. The water stored in the reservoir has potential energy because the water from there creates kinetic energy and then that kinetic energy is turned into mechanical energy.	____/1
4. Water flows from the storage reservoir, past the turbine, and out the downstream outlet. The water flows that way because the reservoir is built at a higher level, so water will flow. This leads to the generation of electrical energy in the generator.	____/1

- iii. **Explain** how coupling hydroelectric power with solar or wind power is an advantage to providing a constant source of electricity to a community.

1. By coupling hydroelectric energy with wind and solar you can keep constant energy because there isn't always wind and sun to make energy, so the hydroelectric power can make energy when solar or wind can't.	____/1
2. Both solar and wind are renewable energy sources and can provide cheaper energy than hydroelectric (because dams are very expensive), so they can be constantly used for people who don't make a lot of money.	____/1
3. Hydroelectric power combined with wind power benefits a community by ensuring constant usable energy production in the cause of one resource becoming sparse.	____/1
4. Even if there is a lack of sun due to clouds, or a lack of wind in the troposphere, the water located in the reservoir is constant therefore the community is able to rely on many renewable energy sources to provide electricity.	____/1

- iv. **Explain** how a hydroelectric power system, like the one depicted, may be negatively affected by climate change.

1. These power systems can be negatively affected by climate change through the depletion of water in areas with dams due to increased temperatures and therefore more precipitation.	____/1
2. As Earth's climate becomes warmer, more ice may melt, which adds more water to rivers. This could lead to more energy being produced.	____/1
3. Climate change may increase surface temperatures, leading to evaporation of water in the storage reservoir. The hydroelectric power system no longer had the potential energy it needs to produce electricity.	____/1
4. Hydroelectric power will be negatively affected by climate change if the water gets too cold and freezes.	____/1

- c. Over time, reservoirs that form behind dams can undergo changes.

- i. **Identify** one advantage, other than the generation of hydroelectric power, of the formation of a reservoir behind a hydroelectric dam.

1. Recreational facilities may be used for activities, allowing for social entertainment in communities.	____/1
2. The development of a reservoir behind a dam could be beneficial as it will protect the dam from possible environmental dangers such as strong winds, debris, and pollution.	____/1
3. The reservoir is where water is cleaned and filtered to be put back into the environment.	____/1
4. The water in the reservoir can be used by humans for fracking. It can also be used to water crops and gardens.	____/1

- ii. **Explain** the effect of increased silt in the reservoir on the hydroelectric power system.

1. If more silt were to build up in the reservoir, not as much water would be able to be stored, which would ultimately impact the amount of energy that can be produced. Less storage means less energy production.	____/1
2. The increase in silt has led to the increase in weathering of the dam, slowing breaking off small pieces that may damage the dam's structure.	____/1
3. Increased silt in the reservoir could lead to challenges as silt erodes easily and could be caught in the turbines that are needed to produce energy as well as increase pollution.	____/1
4. Silt can either get stuck in the turbine and stop it from functioning or it can block the dam gate.	____/1

RUBRIC

AI: Identify the independent variable

1. Point
2. Point
3. No point
4. Point

Aii: Identify the dependent variable

1. Point
2. No point - Not the panel
3. Point
4. No point - That is IV

Aiii: Identify a reasonable hypothesis for the experiment.

1. Point
2. No point - No mention of electricity being produced
3. Point
4. Point

Aiv: Describe one variable that was not discussed that could affect results of the study.

1. Point
2. No point - Not specific enough and not impact to results of study
3. No point - Not specific enough and not impact to results of study
4. Point

Bi: Identify location of energy transformation

1. No point
2. Point
3. Point
4. Point

Bii: Explain why water in storage reservoir has potential energy...

1. No point - not answering question/explaining why
2. Point
3. No point - not answering question/explaining why
4. Point

Biii: Explain how coupling hydroelectric power with solar or wind power is an advantage...

1. Point
2. No point - Just wrong / Not answering question
3. No point - "becoming sparse" not necessarily accurate and cannot sub for intermittent
4. Point

Biv: Explain how a hydroelectric power system may be negatively affected by climate change.

1. No point - Answer negates itself
2. Point
3. Point
4. No point - No necessarily wrong but no tie in to specifics

Ci: Identify one advantage of the formation of a reservoir behind a hydroelectric dam.

1. Point
2. No point - Not accurate
3. No point - Not accurate
4. No point likely - Second answer cannot be counted

Cii: Explain the effect of increased silt in the reservoir on the hydroelectric power system.

1. Point
2. No point - Did not discuss turbine damage
3. No point - Did not discuss turbine damage
4. No point - Did not discuss turbine damage