Mini-Test 2

Passage II

Solar panels are assemblies of connected photovoltaic cells that harness solar energy to produce electricity. Photovoltaic cells can produce electricity from a range of light frequencies at varying efficiencies; however, current solar panel technology is incapable of capturing the entire solar range. Scientists have determined that illuminating photovoltaic cells with monochromatic light enables higher efficiency, but they have yet to develop the technology necessary to split light into its various wavelength ranges to make use of this higher efficiency.

Experiment 1

Photovoltaic cells show a decrease in efficiency at increased temperatures. A group of scientists wanted to determine which frequency range of light might produce the best efficiency in photovoltaic cells and how temperature might affect this efficiency. The results of their experiment are given in Table 1.

Table 1

Temp. (°C)	Photovoltaic cell efficiency (%)		
	Frequency Range 1	Frequency Range 2	Frequency Range 3
25	20.2%	20.0%	20.4%
26	19.7%	19.7%	19.7%
27	19.2%	19.4%	19.0%
28	18.7%	19.1%	18.3%
29	18.2%	18.8%	17.6%

Experiment 2

With mathematical models, the same group of scientists attempted to project the efficiencies of photovoltaic cells coupled with techniques that allowed for the splitting of wavelength ranges. They projected uniform increases in efficiencies for all frequency ranges, but they noted the continued decrease in efficiency at increased temperatures. The theoretical results of their models are given in Table 2.

Table 2

Temp. (°C)	Theoretical photovoltaic cell efficiency w/ wavelength splitting (%)		
	Frequency Range 1	Frequency Range 2	Frequency Range 3
25	47.2%	45.0%	50.4%
26	46.1%	44.3%	48.6%
27	45.0%	43.6%	46.8%
28	43.9%	42.9%	45.0%
29	42.8%	42.2%	43.2%

6. Do the results from Experiment 1 support the claim that photovoltaic cells capturing different frequency ranges function at varying efficiencies with changes in temperature?

- **F.** Yes, because as temperature increases, so does efficiency.
- **G.** Yes, because as temperature increases, efficiency decreases.
- **H.** No, because there is no uniform change in efficiency as related to temperature.
- **J.** No, because all photovoltaic cells function at the same efficiency regardless of frequency.

7. Based on the results from Experiment 1, photovoltaic cells capturing which frequency range of light would function best in environments that keep the cell temperatures at roughly 29°C?

- **A.** Frequency 1
- **B.** Frequency 2
- **C.** Frequency 3
- **D.** All frequency ranges will function the same.

8. Based on the results from Experiment 1, photovoltaic cells capturing which frequency range of light would function best in environments that keep the cell temperatures at roughly 26°C?

F. Frequency Range 1
G. Frequency Range 2
H. Frequency Range 3
J. The cells would function the same with all three frequency ranges.

9. One of the scientists suggests that he can build a cooling system for the theoretical photovoltaic cells in Experiment 2 that will lower their temperature by 1°C and result in the same efficiency change observed in the experiment, but minus 1.0%. The theoretical photovoltaic cells capturing which frequency ranges, if any, would achieve a net benefit from this cooling system?

A. Frequency Ranges 1 and 2
B. Frequency Ranges 1 and 3
C. Frequency Ranges 2 and 3
D. None of the theoretical photovoltaic cells would benefit.

10. In Experiment 1, which of the following variables is held constant?

F. The temperature of the environment
G. The amount of sunlight shone on the photovoltaic cells
H. The photovoltaic cells used
J. The frequency range of light captured by the photovoltaic cells

11. Suppose the scientists note the temperature sensitivity of the photovoltaic cells in both experiments, defining sensitivity as the amount of change in efficiency as temperature increases. Which of the following best describes the changes in efficiency and temperature sensitivity of the photovoltaic cells in Experiment 1 to the theoretical photovoltaic cells with wavelength splitting in Experiment 2?

A. Efficiency increases from Experiment 1 to Experiment 2, and sensitivity to temperature increases from Experiment 1 to Experiment 2.
B. Efficiency increases from Experiment 1 to Experiment 2, but sensitivity to temperature decreases from Experiment 1 to Experiment 2.
C. Efficiency decreases from Experiment 1 to Experiment 2, and sensitivity to temperature decreases from Experiment 1 to Experiment 2.
D. Efficiency decreases from Experiment 1 to Experiment 2, but sensitivity to temperature increases from Experiment 1 to Experiment 2.

END OF MINI-TEST TWO

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