Past-paper walk-through

Solar Radiation and Earth's Seasons ▪ 4.7

eXercise

Questions in this set

- 2022 Set 1 Q3

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 3

2022 Set 1 ▪ Q3

Increasing global urbanization causes associated problems such as the formation of urban heat islands.

(a) Describe how urbanization leads to the formation of urban heat islands.

Question 3

2022 Set 1 ▪ Q3

Increasing global urbanization causes associated problems such as the formation of urban heat islands.

(b)(i) Urban heat islands have been linked to a variety of environmental problems. **Propose** a reasonable solution that could help lower the temperature increases caused by urban heat islands.

(b)(ii) Justify the solution proposed in part (b)(i) by providing one additional benefit other than reducing temperatures in urban heat islands.

Question 3

2022 Set 1 ▪ Q3

Increasing global urbanization causes associated problems such as the formation of urban heat islands.

(c)(i) Urban areas are increasingly using solar energy to generate electricity for residences and businesses. As a result of improved technology, the efficiency of solar panels has changed over time. In 1992 a solar cell had a maximum efficiency of 15.9%. In 2017 a solar cell prototype capable of 44.5% efficiency was produced. **Calculate** the percent change in efficiency from the 1992 cell to the 2017 cell. **Show** your work.

(c)(ii) The average home in the United States uses 12,900 kWh of electricity per year. The local power company is raising the cost of purchasing electricity from $0.11 per kWh to 0.13 per kWh. Assuming a home uses the average kWh of electricity in one year, **calculate** the change in electricity cost for one year for the homeowner. **Show** your work.

Question 3

(c)(iii) The roof of a typical house in the United States receives a total of four hours of sunlight per day that can be converted by solar panels into electricity. A house has 30 solar panels on its roof, and each panel generates a maximum output of 300 watts. **Calculate** how many kWh can be produced by the system at maximum output in one calendar year. **Show** your work.

Question 3

2022 Set 1 ▪ Q3

Increasing global urbanization causes associated problems such as the formation of urban heat islands.

(d) Explain why the Northern Hemisphere receives more solar energy from the Sun between June and August than the Southern Hemisphere receives between June and August.

Solution 3

(a)

Mark scheme

- Urbanization forms heat islands because: urban buildings block wind currents, raising local temperatures; urban materials/structures (roads, sidewalks, buildings) absorb and hold heat; urban areas have fewer trees, so less shade/transpiration raises temperatures; or urban areas have many vehicles/air conditioners/machinery producing waste heat.

Solution 3

(b)(i)

Mark scheme

- A reasonable solution to lower urban heat island temperatures: plant green roofs/vegetation/increase green space; use cool/reflective/lighter-colored roofing and surfaces; increase the efficiency of waste-heat-producing systems (vehicles, air conditioners); or decrease the use of such systems.

Solution 3

(b)(ii) Mark scheme

- Justification must give one additional benefit (besides reducing temperature) matched to the proposed (b)(i) solution — e.g. green roofs/vegetation: provide food crops, create wildlife habitat, slow/capture stormwater runoff, insulate buildings (lower heating/cooling costs), give aesthetic/recreational value, or filter/remove air pollution and carbon. Cool/reflective surfaces: reflect solar energy or reduce energy consumption, lowering cooling costs. Increased efficiency of waste-heat systems: decreases CO2 production (reduces climate change) or reduces energy costs. Decreased use of such systems: decreases CO2 production, decreases vehicle-related air pollution, or reduces energy costs.

Solution 3

(c)(i)

Mark scheme

- Percent change = ((44.5% - 15.9%)/15.9%) x 100, equivalently (44.5/15.9 - 1) x 100 179.9% (accept 180%). 1 point for the correct setup (must include multiplying by 100); 1 point for the correct final value (179.9% or 180%).

Solution 3

(c)(ii)

Mark scheme

- Change in cost = 12,900 kWh x $(0.13-0.11)$/kWh, equivalently (12,900 kWh x $0.13/kWh$) $-$ $(12,900 kWh x 0.11/$kWh) $= 1,677-1,419 =$ $258 increase for the year. 1 point for the correct setup (must include units); 1 point for the correct fi$

Solution 3

(c)(iii)

Mark scheme

- kWh produced = 30 panels x 300 watts/panel x (1 kW/1,000 watts) x 4 hours/day x 365 days/year = 13,140 kWh per year at maximum output. 1 point for the correct setup; 1 point for the correct final value (13,140 kWh per year).

Solution 3

(d)

Mark scheme

- During June through August the Northern Hemisphere is tilted toward the Sun, so it receives more direct solar energy per unit area than the Southern Hemisphere does during the same months; the Northern Hemisphere also has more hours of daylight/sunlight during this period.