

Past-paper walk-through

Energy Conservation ■ 6.13

eXercise

Questions in this set

- 2025 Set 1 Q3
- 2023 Set 1 Q3
- 2018 Q1
- 2014 Q1

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

2025 Set 1 ■ Q3

Respond to parts A, B, C, D, E, F, and G.

(a) One major environmental problem is air pollution. Air pollution can come from natural or anthropogenic sources. Motor vehicles can be a source of particulate matter (PM) and other pollutants.

Identify an anthropogenic source of particulate matter, other than from motor vehicles.

Question 3

2025 Set 1 ■ Q3

Respond to parts A, B, C, D, E, F, and G.

(b) One way to reduce pollutants associated with motor vehicles is to use a vapor recovery nozzle. Describe one way a vapor recovery nozzle is used to reduce atmospheric pollution.

Question 3

2025 Set 1 ■ Q3

Respond to parts A, B, C, D, E, F, and G.

(c) Acid rain is another air pollutant linked to motor vehicles. Over the past few years, there has been an increase in the number of people working from home, so fewer people are commuting to work in their personal vehicles.

Explain how a decrease in the number of people commuting to work in their personal vehicles could lead to a reduction in acid rain.

Question 3

2025 Set 1 ■ Q3

Respond to parts A, B, C, D, E, F, and G.

(d) The average gas mileage for a small gasoline-powered sport utility vehicle (SUV) is 22 miles per gallon (mpg) in the city. The average gas mileage for a small hybrid SUV is 36 mpg in the city. One commuter sells their gasoline-powered SUV and replaces it with a hybrid SUV.

Calculate the percent change in gas mileage between the gasoline-powered SUV and the hybrid SUV based on the data provided. Show your work.

Question 3

2025 Set 1 ■ Q3

Respond to parts A, B, C, D, E, F, and G.

(e) Both the gasoline-powered SUV and the hybrid SUV have 14-gallon gas tanks. As stated in part D, the average gas mileage for a small gasoline-powered sport utility vehicle (SUV) is 22 miles per gallon (mpg) in the city. The average gas mileage for a small hybrid SUV is 36 mpg in the city.

Calculate how many more miles the owner can drive in the hybrid SUV in the city than they could have driven in the gasoline-powered SUV. Show your work.

Question 3

2025 Set 1 ■ Q3

Respond to parts A, B, C, D, E, F, and G.

(f) In addition to vehicles, buildings such as schools often have high energy consumption. The primary sources of energy use in many buildings are heating, cooling, and lighting.

Propose a realistic solution that schools could implement to decrease energy use for heating and cooling, other than a reduction in the amount of time the school building is occupied.

Question 3

2025 Set 1 ■ Q3

Respond to parts A, B, C, D, E, F, and G.

(g) The school plans to upgrade its lighting to save money and reduce both its electricity use and its ecological footprint. The sustainability committee proposes that the school reduce its electricity use by switching to energy-efficient light-emitting diode (LED) bulbs. The school building uses 2.8×10^4 bulbs. The LED bulbs would each use 0.0085 kilowatts per hour. Each bulb would be used for an average of 2,340 hours per year.

Calculate the energy use in the school building in kilowatts per year using LED light bulbs. Show your work.

Solution 3

(a)

Mark scheme

- An anthropogenic source of particulate matter other than motor vehicles: coal/fossil fuel combustion; industrial exhaust; construction/demolition; waste incineration; mining; burning of biomass; anthropogenically caused wildfires; unpaved roads; or agricultural fields.

Solution 3

(b)

Mark scheme

- A vapor recovery nozzle reduces atmospheric pollution by preventing fumes/vapors from escaping into the atmosphere while gassing/fueling a motor vehicle.

Solution 3

(c)

Mark scheme

- A decrease in personal-vehicle commuting reduces acid rain because it results in lower nitrogen oxide/sulfur oxide emissions from cars, which leads to less nitric acid/sulfuric acid forming in the atmosphere.

Solution 3

(d)

Mark scheme

- Calculate percent change in gas mileage from 22 mpg (gasoline SUV) to 36 mpg (hybrid SUV). Setup (1 pt): $\% \text{ change} = (36 \text{ mpg} - 22 \text{ mpg}) / 22 \text{ mpg} \times 100$. Calculation (1 pt): $(36-22)/22 \times 100 = 14/22 \times 100 \approx 63.6\%$ increase (accept 63.6, 64%, or 64).

Solution 3

(e)

Mark scheme

- Calculate the extra miles drivable in the hybrid SUV vs. the gasoline SUV, both with 14-gallon tanks (36 mpg vs. 22 mpg). Setup (1 pt): $(14 \text{ gal} \times 36 \text{ mpg}) - (14 \text{ gal} \times 22 \text{ mpg})$, i.e., $14 \times (36 - 22)$. Calculation (1 pt): $14 \times 36 - 14 \times 22 = 504 - 308 = 196$ more miles (accept ~ 200).

Solution 3

(f)

Mark scheme

- A realistic school solution to decrease heating/cooling energy use (other than reducing occupied time): implement green building design features; open windows to reduce air-conditioning use; use energy-efficient heating and cooling equipment; adjust the thermostat to reduce heating/cooling use; or install conservation landscaping.

Solution 3

(g)

Mark scheme

- Calculate the school's annual LED lighting energy use: 2.8×10^4 bulbs, each using 0.0085 kW, used 2,340 hours/year. Setup (1 pt): $(2.8 \times 10^4 \text{ bulbs}) \times 0.0085 \text{ kW} \times 2,340 \text{ hours}$. Calculation (1 pt): $28,000 \times 0.0085 \times 2,340 = 556,920 \text{ kWh/year}$ (accept $\sim 5.6 \times 10^5$ or $5.6\text{E}5$; kWh/year or kW/year units both accepted).

Question 3

2023 Set 1 ■ Q3

3. Crude oil is extracted, transported, and refined for various uses by humans.
- (a) **Describe** one environmental impact on marine ecosystems associated with extraction or transportation of crude oil.
 - (b) **Identify** an atmospheric pollutant released during the combustion of refined oil products.
 - (c) **Propose** a solution an individual can use to reduce their reliance on refined oil products for transportation.
 - (d) **Justify** the solution proposed in part (c) by providing a benefit to human health.

Other natural resources, such as gold and silver, are also extracted. These resources can be used to make components for the electronics humans use. One metric ton of gold ore contains 5.0 grams of gold.

- (e) A deposit is estimated to contain 260 million metric tons of gold ore. **Calculate** the number of grams of gold that could be extracted from the deposit. **Show** your work.

Question 3

- (f) Assuming the price of gold is \$62.56 per gram, **calculate** the value of the gold that could be recovered from 1,000 metric tons of gold ore in the deposit. **Show** your work.
- (g) A typical cell phone contains 0.034 grams of gold. **Calculate** how many metric tons of gold ore would need to be mined to extract enough gold to manufacture 100,000 cell phones. **Show** your work.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

STOP

END OF EXAM

Solution 3

(a)

Mark scheme

- Any one environmental impact: marine life is harmed/killed by being coated/suffocated by oil from spills; animals are harmed/killed by ingesting spilled oil; oil slicks from spills can block sunlight from entering water and inhibit photosynthesis; oil that washes up on beaches/in marshes/in estuaries damages habitat; noise pollution disrupts marine animals' ability to communicate/mate/eat/evade prey; or CO₂ from combustion of fuels in boats/equipment is absorbed by the ocean and contributes to ocean acidification.

Solution 3

(b)

Mark scheme

- Any one atmospheric pollutant: carbon dioxide (CO_2); nitrogen oxides (NO_x , NO , NO_2 , N_2O); sulfur oxides (SO_x , SO_2 , SO_3); particulate matter (PM); carbon monoxide (CO); or volatile organic compounds (VOCs).

Solution 3

(c)

Mark scheme

- Any one solution: ride a bike/scooter/skateboard or walk instead of driving; replace a gasoline/diesel powered car with a hybrid or electric vehicle; replace a gasoline/diesel powered car with one that utilizes alternative fuel (biodiesel, ethanol, hydrogen); buy/drive a more fuel-efficient vehicle; work from home/telecommute to reduce miles driven; choose housing close to employment to reduce miles driven; take public transportation instead of driving; carpool instead of driving alone; or combine trips to reduce miles driven.

Solution 3

(d)

Mark scheme

- Fewer air pollutants (particulates, NO_x, VOCs, smog) from the proposed solution lead to lower rates of respiratory illness/problems (such as asthma, COPD, lung cancer), lower rates of cardiovascular illness (such as heart attacks), and less eye irritation. If the solution proposed in (c) was active transport (biking/walking/scootering), an additional acceptable justification is improved health/decreased risk of disease/cardiovascular illness from more physical activity/exercise.

Solution 3

(e)

Mark scheme

- Setup (1 point): $260 \times 10^6 \text{ metric tons} \times \frac{5 \text{ grams}}{1 \text{ metric ton}}$ (equivalently $5 \times 260,000,000$).
Calculation (1 point): $260,000,000 \times 5 = 1,300,000,000 \text{ grams of gold (i.e. } 1.3 \times 10^9 \text{ g)}$. Award 1 point for the correct dimensional setup and 1 point for the correct final numeric answer ($1,300,000,000 \text{ g}$ or $1.3 \times 10^9 \text{ g}$).

Solution 3

(f)

Mark scheme

- Setup (1 point): $\frac{\$62.56}{1 \text{ gram}} \times 1,000 \text{ metric tons} \times \frac{5 \text{ grams}}{1 \text{ metric ton}}$ (equivalently $1,000 \times 5 \times \$62.56$). Calculation (1 point): $1,000 \times 5 \times 62.56 = 312,800$, so the gold recovered from 1,000 metric tons of ore is worth \$312,800. Award 1 point for the correct setup and 1 point for the correct final numeric answer (\$312,800).

Solution 3

(g) Mark scheme

- Setup (1 point): $\frac{0.034 \text{ grams}}{1 \text{ cell phone}} \times \frac{1 \text{ metric ton}}{5 \text{ grams}} \times 100,000 \text{ cell phones}$ (equivalently $\frac{0.034 \times 100,000}{5}$). Calculation (1 point): $\frac{0.034 \times 100,000}{5} = \frac{3,400}{5} = 680$ metric tons of gold ore. Award 1 point for the correct setup and 1 point for the correct final numeric answer (680 metric tons).

Question 1

2018 ■ Q1

Read the following article from the *Fremont Daily Times* and answer the questions that follow.

[Newspaper article, masthead “Fremont Daily Times”, dated May 1, 2018, headline “GREEN IS THE NEW SCHOOL COLOR AT FREMONT HIGH SCHOOL!”]

A group of students from Fremont High School addressed the city council last night and proposed that one of the existing buildings at Fremont High School, which was built in 1970, be renovated to take advantage of recent advances in green technology. Currently the heat for the school is provided by fossil fuel combustion. The students said that the redesigned building would reduce the school’s carbon footprint, which is a measure of the amount of carbon dioxide and other carbon compounds released by various human activities. Incorporating specific features that conserve energy and utilize renewable energy sources can help reduce the carbon footprint.

Question 1

Councilperson Gail Fassler praised the idea, saying that the project could conserve local water resources, reduce the need for consuming new resources, and act as a “shining beacon” of sustainability for the greater Fremont community. Fassler suggested the project could even incorporate a living green roof as an additional sustainable feature. The council approved the initial site planning request and urged students to report back when the project was under way.

(a)(i) Define carbon footprint.

(a)(ii) Identify one way the school’s heating system is likely adding to the school’s carbon footprint.

(a)(iii) Describe one realistic way to reduce the contribution of the heating system to the school’s carbon footprint.

(b) Identify TWO environmental benefits of a living green roof, such as that suggested by Councilperson Fassler.

Question 1

- (c)** Describe TWO practices the cafeteria's food service could use to decrease the environmental impacts of Fremont High School.
- (d)** Discuss TWO benefits of using native plants for landscaping at Fremont High School.
- (e)** During the renovation, the carpeting must be replaced. Discuss one environmental benefit of using flooring made of plant material, such as cork or bamboo, instead of carpet made of synthetic fibers.

Fremont Daily Times

May 1, 2018

GREEN IS THE NEW SCHOOL COLOR AT FREMONT HIGH SCHOOL!

A group of students from Fremont High School addressed the city council last night and proposed that one of the existing buildings at Fremont High School, which was built in 1970, be renovated to take advantage of recent advances in green technology. Currently the heat for the school is provided by fossil fuel combustion. The students said that the redesigned building would reduce the school's carbon footprint, which is a measure of the amount of carbon dioxide and other carbon compounds released by various human activities. Incorporating specific features that conserve energy and utilize

renewable energy sources can help reduce the carbon footprint.

Councilperson Gail Fassler praised the idea, saying that the project could conserve local water resources, reduce the need for consuming new resources, and act as a “shining beacon” of sustainability for the greater Fremont community. Fassler suggested the project could even incorporate a living green roof as an additional sustainable feature. The council approved the initial site planning request and urged students to report back when the project was under way.

Solution 1

(a)(i)

Mark scheme

- 1 point for a correct definition of carbon footprint. Carbon footprint = the amount of carbon dioxide and/or other carbon compounds released to the environment by a product, process, or activity (a measurement of the amount of carbon released by human activities).

Solution 1

(a)(ii)

Mark scheme

- 1 point for correctly identifying a way the heating system adds to the carbon footprint. Accept: the burning/combustion of fossil fuels releases carbon dioxide; OR incomplete combustion of fossil fuels releases carbon monoxide.

Solution 1

(a)(iii)

Mark scheme

- 1 point for a correct description of a realistic way to reduce the heating system's contribution. Accept any one of: switch to renewables (solar, wind) or a more efficient fossil fuel (natural gas, propane) or a provider using nuclear energy; decrease the thermostat/program it to lower energy use at certain times; purchase carbon-offset credits through environmental agencies; increase insulation or other efficiency/design methods (green roof, double-paned glass, south-facing windows for passive solar heating, change air filters, etc.).

Solution 1

(b)

Mark scheme

- 2 points, 1 point per correct identification of an environmental benefit of a green roof (up to 2). Accept any two of: insulation/reduced fossil fuel use for heating and/or cooling; habitat for wildlife/plants, increases biodiversity; area to grow crops/local food production; reduction in urban heat islands; photosynthesis/carbon capture/CO₂ storage/oxygen release; stormwater treatment/runoff reduction; filters particulates, VOCs, O₃ from air.

Solution 1

(c) Mark scheme

- 2 points, 1 point per correct description of a practice that decreases the school's environmental impact (up to 2). Accept any two of: offer more vegetarian options/serve fewer animal products; use locally sourced food to reduce transportation; grow food at school; compost food waste; donate leftover food; use energy-friendly practices (LED lighting, more cold-cut sandwiches) to reduce energy use; purchase bulk packaged items; use recyclable containers/avoid disposable straws-trays; install a water fountain/stop selling single-serving bottled water; use reusable take-out containers/offer credit for reuse; allow students to choose appropriate portions to reduce food waste; purchase organic foods to reduce pesticide use; use gray water to irrigate landscaping.

Solution 1

(d)

Mark scheme

- 2 points, 1 point per correct discussion of a benefit of native plants (up to 2). Accept any two of: native plants need less pesticide/fertilizer/irrigation water because they are adapted to the local environment; increase biodiversity by providing native habitat; support native food webs/food production; reduce land available for invasive species to establish/spread; save the school money by needing less water/fertilizer/pesticide/upkeep.

Solution 1

(e) Mark scheme

- 1 point for a correct discussion of a benefit of plant-based flooring (e.g. cork, bamboo) over synthetic carpet. Accept any one of: plant-based material is more easily compostable/biodegradable/reusable, unlike carpet; it comes from a renewable resource, making it more sustainable than carpet; it is a carbon sink/reservoir (growing the plant material removes CO₂ from the atmosphere), unlike carpet; it requires fewer fossil fuels/toxic chemicals to produce than synthetic carpet fibers; it produces fewer indoor pollutants (off-gassed VOCs/toxins) than carpet; it harbors fewer pathogenic vectors/diseases/allergens (fleas, ticks, dust mites, mold spores) than carpet; when cultivated it provides habitat for native species.

Question 1

2014 ■ Q1

Read the article below and answer the questions that follow.

[Newspaper clipping] The Fremont Plaindealer — May 1, 2013

Last night the county council discussed a motion to support the construction of a new nuclear power plant on the Fremont River to address the rising demand for electrical power in Fremont County. Councilperson Pamela Kull spoke in support of the plant, remarking that “nuclear power plants produce no dangerous solid waste” and “using nuclear power avoids the release of greenhouse gases.” Councilperson Chinh Serach said that Dr. Kull’s remarks were incorrect and then introduced a different motion to provide funding to help Fremont homeowners and businesses reduce electricity use. He stated that such steps could make building the nuclear plant unnecessary.

(a)(i) State whether you agree or disagree with each of the following remarks made by Dr. Kull. For each remark, provide one justification for your position.

Question 1

“Nuclear power plants produce no dangerous solid waste.”

(a)(ii) State whether you agree or disagree with each of the following remarks made by Dr. Kull. For each remark, provide one justification for your position.

“Using nuclear power avoids the release of greenhouse gases.”

The Fremont Plaindealer

May 1, 2013

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greenhouse gases.”

Councilperson Chinh Serach said that Dr. Kull’s remarks were incorrect and then introduced a different motion to provide funding to help Fremont homeowners and businesses reduce electricity use. He stated that such steps could make building the nuclear plant unnecessary.

Question 1

2014 ■ Q1

Read the article below and answer the questions that follow.

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Question 1

(b) If the plan for a nuclear power plant in Fremont is approved, it will take several years for the plant to be built. Describe TWO environmental problems that could result from the construction of the plant (i.e., prior to operation).

Question 1

2014 ■ Q1

Read the article below and answer the questions that follow.

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(c)(i) Suppose that the nuclear power plant is constructed on the Fremont River site.

Question 1

Identify the most likely pollution threat that the plant will pose to the Fremont River as a result of the plant's normal daily operation.

(c)(ii) Discuss one potential ecological consequence of the pollution threat that you identified in part (i).

(c)(iii) Identify a system often used in nuclear power plants to reduce the pollution you identified in part (i).

Question 1

2014 ■ Q1

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(d) Describe TWO specific steps that Fremont residents and/or businesses could take to reduce the use of electricity.

Question 1

2014 ■ Q1

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Question 1

(e) Identify a specific nuclear power plant at which a major accident has occurred. Explain one environmental consequence (other than effects on human health) of a nuclear power plant accident.