Past-paper walk-through

Nuclear Power ▪ 6.6

eXercise

Questions in this set

- 2026 Q2
- 2024 Set 1 Q3
- 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 2

2026 ▪ Q2

The following information applies to parts A, B, C, D, E, F, and G.
The following graph shows the number of quadrillion British thermal units (BTUs) that were consumed in the United States using five different energy sources from 1950 to 2020.

Energy Consumption by Source in the United States, 1950-2020

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Question 2

- Petroleum (thick dotted): starts around 14 in 1950, rises steadily to a peak near 38 around 1978, dips to about 30 around 1983, rises again with fluctuations to a peak near 40 around 2005, declines to about 34 around 2012, rises slightly then drops sharply to about 33 by 2020.
- Natural gas (dashed): starts around 6 in 1950, rises to about 22 by 1970, dips slightly through the 1970s-80s to about 18, rises again through the 1990s-2000s to about 23 around 2000-2010, then rises sharply after 2010 to about 32 by 2020.
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- Nuclear (thick solid): near 0 from 1950 to about 1970, rises steadily from the 1970s to about 8 by 2000, continues rising slightly to about 8-9 through 2010-2020.
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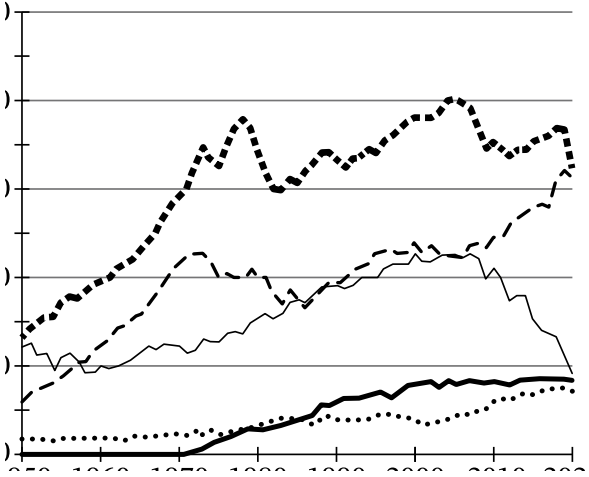
The following information applies to parts H and I.
Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

2. Respond to parts A, B, C, D, E, F, G, H, and I, and all subparts.

(a) Identify one renewable energy source that is used to generate electricity.

Question 2



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2026 ▪ Q2

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Question 2

The following information applies to parts H and I.
Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

2. Respond to parts A, B, C, D, E, F, G, H, and I, and all subparts.

(b) Based on the data in the graph, **identify** the energy source that had the highest consumption in 2010.

Question 2

2026 ▪ Q2

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Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

2. Respond to parts A, B, C, D, E, F, G, H, and I, and all subparts.

(c) Based on the data in the graph, **describe** the pattern in the energy consumption from coal in the United States from 1960 to 2020.

Question 2

2026 ▪ Q2

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The following information applies to parts H and I.
Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

2. Respond to parts A, B, C, D, E, F, G, H, and I, and all subparts.

(d) Based on the data in the graph and your knowledge of energy consumption, **explain** one likely reason why the use of coal for energy changed between 2010 and 2020.

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2. Respond to parts A, B, C, D, E, F, G, H, and I, and all subparts.

(e) Explain how fossil fuels are used to generate electricity.

Question 2

2026 ▪ Q2

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2. Respond to parts A, B, C, D, E, F, G, H, and I, and all subparts.

(f) In addition to fossil fuels, nuclear power can be used to generate electricity.
Identify one negative impact associated with nuclear energy.

Question 2

2026 ▪ Q2

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2. Respond to parts A, B, C, D, E, F, G, H, and I, and all subparts.

(g) Fossil fuel combustion leads to ocean warming. **Describe** one environmental problem other than coral bleaching that is associated with warming oceans.

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2. Respond to parts A, B, C, D, E, F, G, H, and I, and all subparts.

(h) Explain how an increase in nutrients, such as nitrates and phosphates, can negatively affect an aquatic ecosystem.

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2. Respond to parts A, B, C, D, E, F, G, H, and I, and all subparts.

(ii) Propose a realistic solution that would reduce nutrient pollution of waterways, while still allowing cultivation of crops.

(iii) Justify the solution proposed in part I (i) by explaining one potential advantage other than reducing nutrient runoff.

Question 3

2024 Set 1 ▪ Q3

Earth's climate has changed over time by the addition of greenhouse gasses to the atmosphere. One approach to mitigate climate change is the use of nuclear power, rather than coal-burning power plants, for electricity generation.

(a) Identify a fuel used in a nuclear power plant.

Question 3

2024 Set 1 ▪ Q3

Earth's climate has changed over time by the addition of greenhouse gasses to the atmosphere. One approach to mitigate climate change is the use of nuclear power, rather than coal-burning power plants, for electricity generation.

(b) Describe a negative environmental impact on nearby bodies of water that is caused by using water for cooling in nuclear power plants.

Question 3

2024 Set 1 ▪ Q3

Earth's climate has changed over time by the addition of greenhouse gasses to the atmosphere. One approach to mitigate climate change is the use of nuclear power, rather than coal-burning power plants, for electricity generation.

(c) In 2021, 4.1×10^{12} kilowatt hours (kWh) of commercial electricity was generated in the United States. Nuclear power accounted for 18.9

Another approach to reduce greenhouse gas emissions is to switch from coal-burning power plants to natural gas power plants.

Question 3

2024 Set 1 ▪ Q3

Earth's climate has changed over time by the addition of greenhouse gasses to the atmosphere. One approach to mitigate climate change is the use of nuclear power, rather than coal-burning power plants, for electricity generation.

(d) In addition to reducing greenhouse gas emissions, **describe** how switching from coal-burning power plants to natural gas power plants will improve air quality.

Researchers have proposed large-scale tree planting as a solution to reduce the effects of fossil fuel combustion on global climate change.

Question 3

2024 Set 1 ▪ Q3

Earth's climate has changed over time by the addition of greenhouse gasses to the atmosphere. One approach to mitigate climate change is the use of nuclear power, rather than coal-burning power plants, for electricity generation.

(e) Justify the proposed solution by explaining an additional advantage, other than the reduction of atmospheric greenhouse gases.

Question 3

2024 Set 1 ▪ Q3

Earth's climate has changed over time by the addition of greenhouse gasses to the atmosphere. One approach to mitigate climate change is the use of nuclear power, rather than coal-burning power plants, for electricity generation.

(f) 7.4×10^7 cubic meters of natural gas were extracted from a large deposit in 2020. An average of 4.76 kWh of electricity can be generated from each cubic meter of natural gas combusted. In 2020, an average home consumed 10,715 kWh of electricity. **Calculate** how many homes could have been provided with electricity by natural gas extracted from the large deposit in 2020. **Show** your work.

Question 3

2024 Set 1 ▪ Q3

Earth's climate has changed over time by the addition of greenhouse gasses to the atmosphere. One approach to mitigate climate change is the use of nuclear power, rather than coal-burning power plants, for electricity generation.

(g) In 2021, 8.99×10^{11} kWh of electricity was generated through the combustion of coal. One kilogram of carbon dioxide is produced per kWh of electricity generated by combusting coal, while 0.42 kilograms of carbon dioxide is produced by combusting natural gas. **Calculate** how much less carbon dioxide would have been produced in 2021 if all coal-burning power plants were replaced with natural gas-burning power plants. **Show** your work.

Solution 3

(a)

Mark scheme

- A fuel used in a nuclear power plant: Uranium (U-235) or Plutonium.

Solution 3

(b)

Mark scheme

- Using water for cooling in nuclear power plants causes thermal pollution: discharged water raises the temperature of nearby bodies of water outside organisms' range of tolerance and/or decreases dissolved oxygen; organisms can also be wounded or killed at the water intake; and water loss through evaporation can decrease stream flow/volume.

Solution 3

(c)

Mark scheme

- Calculate electricity generated by nuclear power in the US in 2021 (2 points: 1 for setup, 1 for the answer). Setup: (4.1×10^12 kWh) × 18.9% = (4.1×10^12) × 0.189. Calculation: 4.1×10^12 × 0.189 = 7.749×10^11 kWh 774,900,000,000 kWh (accept 7.75×10^11 or 7.7×10^11 kWh).

Solution 3

(d)

Mark scheme

- Switching from coal-burning to natural gas power plants improves air quality because burning natural gas produces less NOx, SOx, ash, particulates, toxic metals, and smog compared to burning coal.

Solution 3

(e)

Mark scheme

- An additional advantage of large-scale tree planting beyond reducing atmospheric greenhouse gases: provides forest habitat/increases biodiversity/diversifies niches; creates jobs (planting, recreation, wood harvesting); creates a more aesthetically pleasing environment/enhances cultural ecosystem services; decreases soil loss/erosion/sedimentation in waterways; provides shade/decreases ambient temperature; or slows water runoff/reduces flooding.

Solution 3

(f)

Mark scheme

- Calculate how many homes could be powered by the natural gas extracted (2 points: 1 for setup, 1 for the answer). Setup: (7.4×10^7 m^3) × (4.76 kWh / 1 m^3) × (1 home / 10,715 kWh). Calculation: 7.4×10^7 × 4.76 / 10,715 32,874 homes (accept 32,873 or 33,000).

Solution 3

(g)

Mark scheme

- Calculate how much less CO2 would be produced if all coal plants were replaced by natural gas plants in 2021 (2 points: 1 for setup, 1 for the answer). Setup: difference in emission rate $\times$ total kWh from coal = (1.0 kg CO2/kWh $-$ 0.42 kg CO2/kWh) $\times$ (8.99$\times$10^11 kWh); equivalently compute CO2 from coal (8.99$\times$10^11 kWh $\times$ 1.0 kg/kWh = 8.99$\times$10^11 kg) minus CO2 if that electricity were from natural gas (8.99$\times$10^11 kWh $\times$ 0.42 kg/kWh = 3.776$\times$10^11 kg). Calculation: 0.58 $\times$ 8.99$\times$10^11 = 5.2142$\times$10^11 kg 521 billion kg (accept 521,420,000,000 kg, 5.21$\times$10^11 kg, or 5.2$\times$10^11 kg).

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."

Question 1

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."

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Question 1

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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

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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

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.

(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.