# Past-paper walk-through

## Distribution of Natural Energy Resources ▪ 6.4

eXercise

# Questions in this set

- 2026 Q2
- 2019 Q2
- 2018 Q2

# 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.

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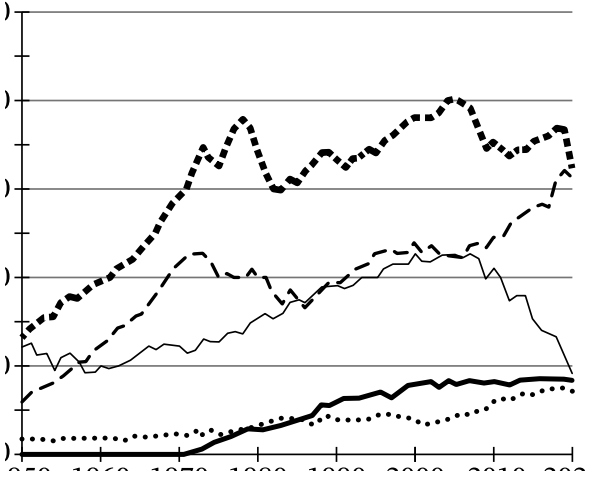
The following information applies to parts H and I.
Researchers studied an aquatic ecosystem near an area of land that had been converted to agricultural use. They reported an increase in nutrients, such as nitrates and phosphates, in the water.

**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

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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.

**(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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**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.

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2026 ▪ Q2

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**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.

# 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.

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

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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.

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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.

# 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.

**(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 2

2019 ▪ Q2

As conventional sources of crude oil are depleted, unconventional sources such as oil sands (also known as tar sands) are being utilized. Oils sands contain bitumen, which can be processed into a synthetic crude oil. A region of boreal forest in Alberta, Canada, that covers a deposit of oil sands will be cut and removed during the process of bitumen extraction. It is estimated that the deposit contains 73 billion barrels of recoverable bitumen. The rate of extraction from the deposit will be approximately 1 million barrels of bitumen per day.

**(a)** Identify one ecological benefit, other than providing habitat, that is provided by forests.

**(b)** Identify one economic benefit that is provided by forests.

# Question 2

**(c)** Describe TWO environmental consequences, other than those related to the loss of boreal forest habitat, that result from the extraction of bitumen or the transportation of synthetic oil to customers.
**(d)** Assuming the above extraction rate, calculate how many days will be needed to extract the recoverable volume of bitumen from the oil sands.
**(e)** Calculate how many years will be needed to fully extract the recoverable volume of bitumen from the oil sands.
**(f)** Monthly production of synthetic crude oil is 30 million barrels. Producing one barrel of synthetic crude oil uses two barrels of heated freshwater. Calculate the number of barrels of freshwater needed each year to supply this demand.

# Solution 2

**(a)**

**Mark scheme**

- One ecological benefit, other than providing habitat, provided by forests, e.g.: absorb carbon dioxide/produce oxygen (gas exchange); maintain ecological and/or species diversity; provide food for organisms; moderate/regulate (local) climate; purify/filter water or air; reduce soil erosion; absorb/store/regulate water; help maintain stream temperature/stream flow; aid in nutrient cycling; aid in soil formation. Full credit for any one valid benefit.

# Solution 2

**(b)**

**Mark scheme**

- One economic benefit provided by forests, e.g.: source of forest products (timber, medicine, nuts, crops such as shade-grown coffee, etc.); tourism; jobs in recreation/tourism/forestry; reduction in air pollutants, which can reduce health care costs or improve crop yields. Full credit for any one valid benefit.

# Solution 2

## (c) Mark scheme

- Describe TWO environmental consequences, other than those related to loss of boreal forest habitat, that result from bitumen extraction or transport of synthetic oil, 1 point per correct distinct consequence (max 2), e.g.: release of greenhouse gases/air pollutants such as $NO_x$ from fossil fuel combustion powering equipment/transportation/oil processing; release of air pollutants ($NO_x$, $SO_x$, or particulates) during mining operations or oil processing; storage and disposal of large amounts of solid/liquid mining waste, which can be toxic to organisms; pollution of surface water and/or groundwater from oil spills/leaks during transport; sediment pollution in surface water and/or groundwater from strip mining; disturbance from pipelines, such as habitat fragmentation or disruption of

## Solution 2

migratory routes; noise pollution from use of machinery during processing or transport; diversion/use of water from surface water and/or groundwater for processing oil.

# Solution 2

**(d)**

**Mark scheme**

- Setup: $7.3 \times 10^{10}$ barrels of bitumen $\times \dfrac{1 \text{ day}}{1.0 \times 10^{6} \text{ barrels of bitumen}} = 7.3 \times 10^{4}$ days $= 73{,}000$ days. 1 point for the correct dimensional-analysis setup, 1 point for the correct numeric answer (73,000 days). Units are not required in the final answer.

# Solution 2

**(e)**

**Mark scheme**

- Setup: $7.3 \times 10^4$ days $\times \dfrac{1 \text{ year}}{365 \text{ days}} = 2 \times 10^2$ years $= 200$ years. 1 point for correct setup, 1 point for the correct answer (200 years). An incorrect numeric answer carried over from part (d), if used correctly here, can still earn both points. Units are not required.

# Solution 2

## (f) Mark scheme

- Setup: $\frac{3 \times 10^7 \text{ barrels of synthetic oil}}{1 \text{ month}} \times \frac{2 \text{ barrels of fresh water}}{1 \text{ barrel of synthetic oil}} \times \frac{12 \text{ months}}{1 \text{ year}} = 7.2 \times 10^8$ barrels of fresh water $= 720{,}000{,}000$ barrels of fresh water per year. 1 point for correct setup, 1 point for the correct numeric answer. Units are not required.

# Question 2

2018 ▪ Q2

2. An offshore wind farm project using turbines to generate electricity is to be built along the Atlantic coast of the United States. It will be located about 13 km from the coast in water with an average depth of 10 m.

   (a) **Describe** one environmental benefit associated with an offshore wind project.

   (b) **Identify** and **describe** one potential economic effect of an offshore wind project.

   (c) **Describe** one additional way, other than wind power, that oceans can provide renewable energy for the generation of electricity.

   The project will consist of 200 wind turbines, each with a capacity of 4 megawatts (MW). Each turbine costs $1.2 million to build. Electrical demand in the area to be served by the project is expected to be $2.0 \times 10^6$ MWh per year.

   (d) **Calculate** how much electricity (in MWh) the wind project needs to generate per year in order to provide 80% of the annual electrical demand in the service area. Show all work.

   (e) Customers in the service area pay $0.20/kWh for electricity. **Calculate** how much revenue will be produced if the wind turbines provide 80% of the annual electrical demand in the service area. Show all work.

# Question 2

(f) Assuming all turbines are operating, **calculate** how many hours the wind turbines must operate to provide 80% of the annual electrical demand in the service area. Show all work.

# Solution 2

## (a) Mark scheme

- 1 point for a correct description of an environmental benefit of an offshore wind project. Accept any one of: reduced environmental damage from decreased reliance on fossil fuels (less habitat/ecosystem destruction from mining/drilling; less air/soil/water pollution from transporting fuels; less air pollution/greenhouse gases from combustion); reduced environmental damage from decreased reliance on nuclear power (no risk of radioactive release from accidents; no hazardous/radioactive waste to store; less uranium ore exploration/extraction/processing); increased aquatic habitat/artificial reefs for barnacles, sponges, other invertebrates, fish.

# Solution 2

**(b) Mark scheme**

- 2 points: 1 for identifying a potential economic effect of the offshore wind project, 1 for describing that effect (the description point cannot be earned without a correct identification). Example identify/describe pairs: Job creation (+) — jobs created in construction, operation, maintenance; Additional income (+) — municipalities receive more tax revenue, or the wind company profits long-run; Decreased electricity costs (+) — lower production costs reduce consumer electricity rates; Less reliance on foreign energy resources (+) — reduced fuel-transport costs; High initial construction/maintenance costs (–) — local taxes/fees rise to cover construction costs, parts/personnel must be transported offshore; Decreased property value (–) — coastal property values fall due to

## Solution 2

unfavorable aesthetics; Loss of income (–) — turbines hurt tourism/fishing/whale-watching aesthetics, disrupt local fishing, or reduce fossil-fuel company revenue; Job loss (–) — jobs lost in traditional energy sectors (coal, nuclear); Subsidies cost (–) — state subsidies for construction/transmission lines increase (may be recovered via taxes). Any one matched identify+describe pair earns both points.

# Solution 2

**(c)**

**Mark scheme**

- 1 point for a correct description of an ocean energy source other than wind. Accept any one of: use of tidal movement/currents to turn turbines; a device designed to capture energy from wave motion; harnessing the solar energy absorbed by oceans/using the natural thermal gradient in tropical and temperate oceans (Ocean Thermal Energy Conversion, OTEC); harvesting algae and converting it to biofuel.

# Solution 2

**(d)**

**Mark scheme**

- 2 points: 1 for the correct setup, 1 for the correct final answer. Setup: (0.80) $\times$ (2.0 $\times$ 10^6 MWh) = electricity the wind project must generate. Answer: 1.6 $\times$ 10^6 MWh.

# Solution 2

**(e)**

**Mark scheme**

- 2 points: 1 for the correct setup, 1 for the correct final answer. Setup: 1.6 $\times$ 10^6 MWh $\times$ $(0.20/kWh)\times(1\times10^3 kWh/1MWh) = 1.6\times10^6\times200$ =3.2 $\times$ 10^8. Answer: $320,000,000$(=320 million).

# Solution 2

**(f)**

**Mark scheme**

- 2 points: 1 for the correct setup, 1 for the correct final answer. Setup: 1.6 $\times$ 10^6 MWh $\div$ (200 turbines $\times$ 4 MW/turbine) = 1.6$\times$10^6 MWh $\div$ 800 MW. Answer: 2 $\times$ 10^3 hr = 2,000 hours.