

Past-paper walk-through

Human Population Dynamics ■ 3.8

eXercise

Questions in this set

- 2025 Set 2 Q3
- 2022 Set 2 Q3
- 2017 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

2025 Set 2 ■ Q3

The local government of a newly built town has contracted with an electrical company to provide energy to the town. The company generates electricity primarily through the burning of coal and has built a new power plant for the town. A nearby deposit of coal was discovered close to the surface. To access the coal, the company decides to remove the overburden and vegetation over the deposit.

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

(a) Identify a type of surface mining the company could use to access the coal.

Question 3

2025 Set 2 ■ Q3

The local government of a newly built town has contracted with an electrical company to provide energy to the town. The company generates electricity primarily through the burning of coal and has built a new power plant for the town. A nearby deposit of coal was discovered close to the surface. To access the coal, the company decides to remove the overburden and vegetation over the deposit.

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

(b) Describe an environmental problem associated with surface mining.

Question 3

2025 Set 2 ■ Q3

The local government of a newly built town has contracted with an electrical company to provide energy to the town. The company generates electricity primarily through the burning of coal and has built a new power plant for the town. A nearby deposit of coal was discovered close to the surface. To access the coal, the company decides to remove the overburden and vegetation over the deposit.

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

(c) The town is located downwind of the new coal-burning power plant.

Describe an environmental problem the town could experience as a result of the electricity generation at the coal-burning power plant.

Question 3

2025 Set 2 ■ Q3

The local government of a newly built town has contracted with an electrical company to provide energy to the town. The company generates electricity primarily through the burning of coal and has built a new power plant for the town. A nearby deposit of coal was discovered close to the surface. To access the coal, the company decides to remove the overburden and vegetation over the deposit.

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

(d) The local government is concerned about the environmental consequences of using coal to generate electricity for the town.

Propose a realistic solution the local government could enact that would reduce the negative environmental consequences of using coal to generate electricity.

Question 3

2025 Set 2 ■ Q3

The local government of a newly built town has contracted with an electrical company to provide energy to the town. The company generates electricity primarily through the burning of coal and has built a new power plant for the town. A nearby deposit of coal was discovered close to the surface. To access the coal, the company decides to remove the overburden and vegetation over the deposit.

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

(e) Burning one pound of coal produces an average of 0.88 kilowatt-hours (kWh) of electricity. An average household in the United States uses 1.064×10^4 kWh of electricity each year.

****Calculate**** how many pounds of coal would need to be burned to generate enough electricity to power a town with 11,000 houses for a year. ****Show**** your work.

Question 3

2025 Set 2 ■ Q3

The local government of a newly built town has contracted with an electrical company to provide energy to the town. The company generates electricity primarily through the burning of coal and has built a new power plant for the town. A nearby deposit of coal was discovered close to the surface. To access the coal, the company decides to remove the overburden and vegetation over the deposit.

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

(f) Researchers are concerned about the impact of noise pollution on songbirds in a forest near the power plant. Since the power plant was installed, bird species richness has declined from 7.5 species per hectare to 6.0 species per hectare.

Calculate the percent change in bird species per hectare since the power plant was installed. **Show** your work.

Question 3

2025 Set 2 ■ Q3

The local government of a newly built town has contracted with an electrical company to provide energy to the town. The company generates electricity primarily through the burning of coal and has built a new power plant for the town. A nearby deposit of coal was discovered close to the surface. To access the coal, the company decides to remove the overburden and vegetation over the deposit.

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

(g) The town has been growing since it was built and had a growth rate of 5.38% in 2022, with a population of 26,250.

Assuming that the growth rate remains constant, **calculate** the year in which the population will reach 52,500. **Show** your work.

Solution 3

(a)

Mark scheme

- A type of surface mining the company could use to access the coal: strip mining, open pit mining, or mountaintop removal. 1 point for naming any one valid surface-mining type.

Solution 3

(b)

Mark scheme

- An environmental problem associated with surface mining: removal of vegetation/soil/rock causes loss/destruction of habitat (and resulting loss of biodiversity); removal of vegetation can increase erosion rates; surface mining can contaminate groundwater/surface water/waterways via runoff of sediments/pollutants; removal of vegetation/soil/bedrock/parent material can release dust particles/methane; or high energy/fossil fuel consumption to operate equipment leads to air pollution. 1 point for any one valid problem.

Solution 3

(c)

Mark scheme

- An environmental problem the downwind town could experience from the power plant's electricity generation: release of air pollutants/toxic metals/particulates/ NO_x / SO_x could lower air quality and cause respiratory problems; release of sulfur dioxides/nitrogen oxides could cause acid rain; or greenhouse gas emissions (carbon dioxide/methane/water vapor) could alter precipitation/climate/weather/temperature patterns. 1 point for any one valid problem.

Solution 3

(d)

Mark scheme

- A realistic solution the local government could enact: require/incentivize the plant to install scrubbers/electrostatic precipitators; incentivize the use of alternative energy sources/energy-efficient appliances; or incentivize green building design/conservation landscaping/planting trees as carbon sinks. 1 point for any one valid, realistic solution.

Solution 3

(e) Mark scheme

- Setup (1 point): pounds of coal needed = (11,000 houses $\times$ 10,640 kWh per house) / 0.88 kWh per lb of coal, i.e. $\frac{11,000 \times 10,640}{0.88}$, using the given household usage of 1.064×10^4 kWh/year and the given 0.88 kWh generated per pound of coal burned. Calculation (1 point): approximately 133,000,000 lb of coal (i.e. 1.33×10^8 lb). Award 1 point for the correct setup (total kWh needed for the town divided by kWh generated per lb of coal) and 1 point for the correct final numeric value (accept equivalent or reasonably rounded answers).

Solution 3

(f)

Mark scheme

- Setup (1 point): percent change = $(6.0 \text{ species/ha} - 7.5 \text{ species/ha}) / 7.5 \text{ species/ha} \times 100$, i.e. $\frac{6.0 - 7.5}{7.5} \times 100$. Calculation (1 point): -20

Solution 3

(g)

Mark scheme

- Setup (1 point): since the target population of 52,500 is double the 2022 population of 26,250, use the Rule of 70 to estimate doubling time and add it to the starting year: $\left(\frac{70}{5.38}\right) + 2022$. Calculation (1 point): 2035 (doubling time of about 13 years added to 2022). Award 1 point for the correct setup (70 divided by the percent growth rate, plus the starting year) and 1 point for the correct final year (accept 2035 or a value from a reasonably equivalent growth calculation).

Question 3

2022 Set 2 ■ Q3

North Carolina is one of the fastest-growing states by population in the United States, with most growth concentrated in major cities like Charlotte. Increased population leads to increased demands for resources such as power and water.

The majority of electrical energy in North Carolina is produced during the combustion of coal.

(a) Identify one negative human health effect linked to the exposure to pollutants resulting from the combustion of coal.

Question 3

2022 Set 2 ■ Q3

North Carolina is one of the fastest-growing states by population in the United States, with most growth concentrated in major cities like Charlotte. Increased population leads to increased demands for resources such as power and water.

The majority of electrical energy in North Carolina is produced during the combustion of coal.

(b)(i) Coal ash, the powdery, solid substance that remains after coal combustion, presents a variety of potential environmental issues. Disposal of toxic coal ash is a growing concern in the state. Coal ash can be mixed with water and disposed of in large, unlined pits or as dry ash in landfills.

Describe an environmental problem associated with coal ash waste disposal.

(b)(ii) A proposed solution is to dispose of North Carolina's coal ash in clay-lined pits.

Justify this solution by providing one advantage of using clay soil.

Question 3

2022 Set 2 ■ Q3

North Carolina is one of the fastest-growing states by population in the United States, with most growth concentrated in major cities like Charlotte. Increased population leads to increased demands for resources such as power and water.

The majority of electrical energy in North Carolina is produced during the combustion of coal.

(c)(i) The population of Charlotte, North Carolina, has grown over the last few decades. The table shows the increase in the population size of Charlotte from 2013 to 2019.

Population of Charlotte, North Carolina, 2013–2019

Year	Population
2013	757,278
2014	774,807
2015	792,137
2016	808,834
2017	826,060
2018	841,611
2019	857,425

Question 3

Calculate the percent change in Charlotte's population from 2013 to 2019. **Show** your work.

(c)(ii) Based on Charlotte's 2019 growth rate of 1.88%, **calculate** the year when the population of Charlotte will double, assuming the growth rate stays the same. **Show** your work.

(c)(iii) The average Charlotte resident uses 90 gallons of water per day. **Calculate** the gallons of water used by the population of Charlotte in the year 2018. **Show** your work.

Question 3

2022 Set 2 ■ Q3

North Carolina is one of the fastest-growing states by population in the United States, with most growth concentrated in major cities like Charlotte. Increased population leads to increased demands for resources such as power and water.

The majority of electrical energy in North Carolina is produced during the combustion of coal.

(d) Drought periods are becoming more frequent in North Carolina, causing water resources to become more scarce. **Describe** one realistic action that citizens could take to reduce domestic outdoor water use.

Solution 3

(a)

Mark scheme

- Any one negative human health effect linked to pollutant exposure from coal combustion: lung/respiratory disease (asthma, COPD, bronchitis, lung cancer); neurological damage; birth defects; heart disease; eye irritation/respiratory irritation/headaches.

Solution 3

(b)(i)

Mark scheme

- Any one environmental problem associated with coal ash waste disposal: leaching from landfills/clay-lined pits; overflowing of coal ash into bodies of water; leaking and contamination of groundwater, soil, or nearby bodies of water; coal ash washing into bodies of water during severe weather events; dry ash blowing/carrying into nearby bodies of water, increasing turbidity/decreasing photosynthesis.

Solution 3

(b)(ii)

Mark scheme

- Clay is less permeable than unlined pits and can prevent the leaching of coal ash into soil/groundwater.

Solution 3

(c)(i)

Mark scheme

- Percent change = $[(857,425 \text{ people} - 757,278 \text{ people}) / 757,278 \text{ people}] \times 100$, equivalently $[(857,425/757,278) - 1] \times 100$. One point for this correct setup; one point for the correct result: $\approx 13\%$ (13.22%, or 13.224602%).

(c)(ii)

Mark scheme

- Doubling time = $70 / \text{growth rate}(\%) = 70 / 1.88 \approx 37$ years. One point for this correct setup. Adding 37 years to 2019 gives the doubling year: one point for the correct result, 2056.

Solution 3

(c)(iii)

Mark scheme

- Gallons used in 2018 = 90 gallons/person/day $\times$ 841,611 people $\times$ 365 days.
One point for this correct setup. One point for the correct result:
27,646,921,350 gallons (accept 2.76×10^{10} , 2.8×10^{10} , or 3×10^{10} gallons).

Solution 3

(d)

Mark scheme

- Any one realistic action to reduce domestic outdoor water use: plant drought-resistant species/use artificial landscaping/xeriscaping to reduce irrigation needs; eliminate/reduce nonessential water use such as washing cars or power washing; reduce sprinkler/irrigation use by monitoring soil/weather conditions or reducing frequency; collect rainwater or greywater for irrigation; water plants/lawn before sunrise/after sunset to limit evaporation; switch to drip irrigation to limit evaporation.

Question 3

2017 ■ Q3

Haiti shares a border with the Dominican Republic on the Caribbean island of Hispaniola.

(a)(i) The border between the two countries can be seen using satellite images because of the severe deforestation in Haiti.

Provide one reason why deforestation commonly occurs in a less developed country such as Haiti.

(a)(ii) Describe one realistic strategy to reduce deforestation in a less developed country.

DEMOGRAPHIC DATA FOR HAITI

Measure	1995	2015
Fertility rate (number of children per woman)	5.2	2.7
Life expectancy (years)	55	64
Infant mortality (deaths per 1,000)	85	48

Question 3

2017 ■ Q3

Haiti shares a border with the Dominican Republic on the Caribbean island of Hispaniola.

(b) Deforestation can affect water quality. Identify one change that can occur in the water quality of streams within a watershed that has been deforested. Explain how deforestation can lead to this change.

Question 3

2017 ■ Q3

Haiti shares a border with the Dominican Republic on the Caribbean island of Hispaniola.

(c) Identify TWO environmental benefits, other than those related to water quality, of maintaining forest ecosystems.

The table below contains demographic data for Haiti in 1995 and 2015.

DEMOGRAPHIC DATA FOR HAITI

Measure	1995	2015
Fertility rate (number of children per woman)	5.2	2.7
Life expectancy (years)	55	64
Infant mortality (deaths per 1,000)	85	48

Question 3

2017 ■ Q3

Haiti shares a border with the Dominican Republic on the Caribbean island of Hispaniola.

(d) Identify and discuss one factor in a less developed country that could contribute significantly to a change in life expectancy, similar to what occurred in Haiti from 1995 to 2015.

Question 3

2017 ■ Q3

Haiti shares a border with the Dominican Republic on the Caribbean island of Hispaniola.

(e) Identify and discuss one economic or cultural factor in a less developed country that could contribute significantly to a change in the fertility rate, similar to what occurred in Haiti from 1995 to 2015.