Cambridge AS & A Level · Geography 9696 · Notes

Population AS

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What you need to know

By the end of this topic you should be able to:

1. **Define and use the rates of natural change**: birth rate, death rate, natural increase rate, fertility rate and infant mortality rate, and calculate them.
2. **Explain the factors that affect fertility and mortality**: social, economic, environmental and political.
3. **Interpret age/sex structure diagrams** (population pyramids): read values, describe and compare shapes, and say what they mean.
4. **Describe population structure**: by age, by gender, and by dependency, including how to calculate and use the **dependency ratio**.
5. **Explain how birth rates and death rates change over time.**
6. **Critically appreciate the demographic transition model (DTM)**, Stages 1–5: what it shows, where it works and where it does not.
7. **Explain the issues of youthful and ageing populations** for people and governments.
8. **Link population and development**: how infant mortality rate and life expectancy change over time as countries develop.
9. **Explain the concept of food security**, and the causes and consequences of food shortages.
10. **Explain the roles of technology and innovation in developing food production**, and the role of **constraints** (such as war and climatic hazards) in sustaining a population.
11. **Explain the concept of carrying capacity.**
12. **Critically evaluate the concept of optimum population**, including overpopulation and underpopulation.
13. **Use a case study of one country's population policy on natural increase**, showing the difficulties it faced, and evaluate its attempts both to change the natural increase rate and to manage the results of population change.

It is examined in Paper 2: a compulsory 10-mark data question (Question 1) and an optional 30-mark structured question (Question 4).

Understand it

Measuring population change

A population changes in only two ways: through **natural change** (births minus deaths) and through **migration** (people moving in minus people moving out). Rates let us compare countries of different sizes, because they are given **per 1000 people per year**.

Rate	What it measures
Crude birth rate (CBR)	Live births in a year per 1000 people in the population
Crude death rate (CDR)	Deaths in a year per 1000 people in the population
Natural increase rate (NIR)	Birth rate minus death rate, per 1000 (or divide by 10 for a percentage)
Infant mortality rate (IMR)	Deaths of babies under 1 year old in a year per 1000 live births in that year
Fertility rate	How many children women have: per 1000 women of childbearing age (general fertility rate), or per woman over her lifetime (total fertility rate)

A worked example. A country of 30.0 million people has 870 000 births and 240 000 deaths in a year, and 60 000 more people leave than arrive.

- CBR $= \dfrac{870\,000}{30\,000\,000} \times 1000 = 29.0$ per 1000; CDR $= \dfrac{240\,000}{30\,000\,000} \times 1000 = 8.0$ per 1000.
- Natural increase $= 29.0 - 8.0 = 21.0$ per 1000, which is **2.1%** a year.
- Net migration $= \dfrac{-60\,000}{30\,000\,000} \times 1000 = -2.0$ per 1000, so the **population growth rate** is $21.0 - 2.0 = 19.0$ per 1000, or **1.9%**.

The word "crude" means the rate is worked out over the **whole** population, whatever its ages. A country with many old people can have a high crude death rate even when its health care is excellent, simply because old people die; a youthful country can have a low crude death rate although its health care is poor. That is why the IMR and life expectancy are better measures of health.

If natural increase is negative (more deaths than births), it is called **natural decrease**. When a rate is given as a percentage, the **number** added is the population times the rate: a population of 50.0 million growing at 1.8% gains $50.0 \times 0.018 = 0.9$ million people. That 0.9 million is the growth; the new total is 50.9 million.

Fertility

Birth rate counts births against **everyone**, men and children included. Fertility rates count births against the **women who could have them**, so they are the better measure of how many children families have.

- **General fertility rate (GFR)**: live births in a year per 1000 women of childbearing age (15–44 or 15–49). If the country above has 7.25 million women aged 15–49, its GFR is $\frac{870\,000}{7\,250\,000} \times 1000 = 120.0$.
- **Total fertility rate (TFR)**: the average number of children a woman would have over her lifetime if she had children at each age at the rate women of that age have them now. A TFR of 2.0 means two children per woman, roughly.
- **Replacement-level fertility** is a TFR of about **2.1**. Each couple must have two children to replace themselves, plus a little more because slightly more boys than girls are born (about 105 to 100) and because some girls die before they can have children. Where child deaths are common, replacement level is higher.

TFR is far higher in many LICs than in HICs: Niger, with a TFR of over 6, has one of the highest in the world, whereas Japan's was 1.20 in 2023 and South Korea's has fallen below 1.

Factors affecting fertility

High fertility happens where children are an asset and family planning is hard to get; low fertility where children are expensive and women have choices. Explain **how** each factor changes the number of children, not just that it does.

Factor	Raises fertility	Lowers fertility
Social	Early marriage; tradition or religion valuing large families or sons; low status and little education of women; high infant mortality, so parents have more children so that some survive	Education of girls, which delays marriage and childbearing and gives women careers; women's rights and emancipation; easy access to contraception and family planning; falling infant mortality
Economic	Children work on farms or bring in income; children are the only old-age security where there are no pensions	Children are costly to raise (housing, childcare, education) and laws stop child labour; women in paid work delay or limit children; recession and job insecurity; anti-natal fines or rewards
Environmental	Rural farming areas where labour is needed	Crowded, expensive cities; poor health of mothers through malnutrition or disease can lower fertility too
Political	Pro-natal policies (child benefits, tax breaks, paid parental leave, as in France and Singapore since 1987)	Anti-natal policies (China's one-child policy from 1979–1980; Singapore's "Stop at Two" in the 1970s)

A developed chain, the kind mark schemes reward: "When more girls stay in school, they marry later and start work, so they have fewer years of childbearing and more reason to delay children, so the fertility rate falls."

Factors affecting mortality

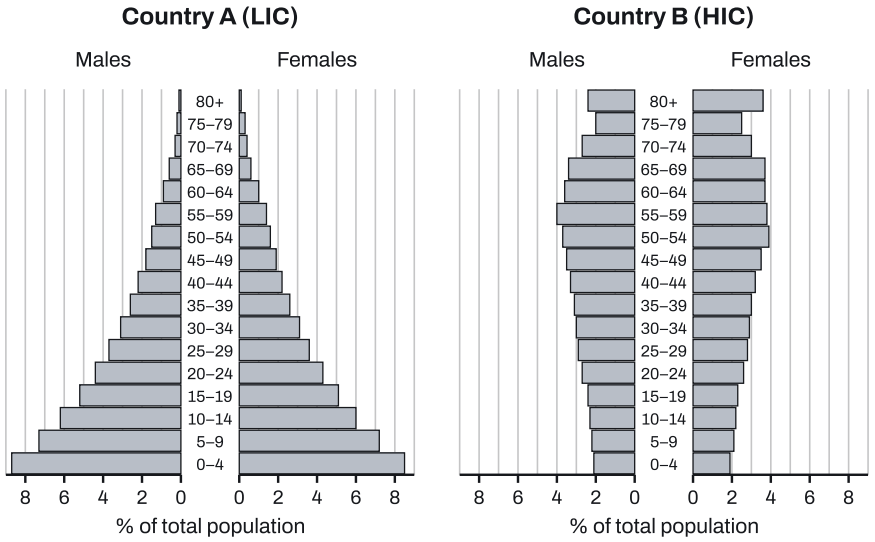
Factor	Raises mortality	Lowers mortality
Social	Little health care, few doctors, no vaccination; poor housing; low education about hygiene	Hospitals, doctors and midwives; vaccination; education about health; better housing
Economic	Poverty: poor diet and malnutrition; dangerous jobs (mining, fishing)	Higher incomes buy better food, housing and care; money for clean water and sewers
Environmental	Disease linked to environment (malaria where mosquitoes breed); dirty water (cholera, diarrhoea); air pollution (respiratory disease); drought and famine; floods and cyclones	Clean water and sanitation; draining breeding grounds; mosquito nets; flood defences
Political	War and conflict; corruption diverting health money	Stable government; public health programmes; aid

Infant mortality is a sensitive measure of development, because babies die of causes that money, health care and education can prevent: diarrhoea from dirty water, malnutrition, malaria, pneumonia, problems at birth. It falls with **clean water and sanitation**, **vaccination**, **care before and after birth** (antenatal and postnatal clinics, trained midwives, incubators for premature babies), **better diet** for mothers and babies, **education of mothers** (who then space births and know how to treat illness), mosquito nets, and peace. The world's IMR fell from about 65 per 1000 live births in 1990 to about 28 in 2022 (UNICEF), a fall of 57%.

Life expectancy (the average number of years a newborn can expect to live) rose worldwide from about 46 years in 1950 to 72.8 in 2019, before dipping to about 71 in 2021 during COVID-19. Women live longer than men almost everywhere, partly for biological reasons and partly because men are more likely to do dangerous jobs (mining, fishing, heavy industry), to smoke and drink heavily, and to die in accidents and wars.

Age/sex structure diagrams

An **age/sex structure diagram** (population pyramid) shows the percentage of the population in each age group (usually 5-year bands), males on the left and females on the right. Its shape is the record of past births, deaths and migration.



From the figure	Country A	Country B
Aged 0–14 (%)	43.9	12.8
Aged 15–64 (%)	53.5	63.9
Aged 65 and over (%)	2.6	23.3
Aged 80 and over (%)	0.2	6.0

How to read a pyramid:

- **The base** shows recent births. A wide base (Country A) means a high birth rate; a narrow base (Country B) means a low birth rate. A base narrower than the bars above it means births are falling.
- **How fast it narrows** shows death rates and life expectancy. Country A's bars shrink quickly with age (many people die before old age: low life expectancy); Country B's stay wide into old age (high life expectancy).
- **The top** shows the elderly. A wide top (23.3% aged 65 and over in B) is an **ageing** population; a narrow top (2.6% in A) is a **youthful** one.
- **Bulges and notches** record events: a baby boom (Europe and the USA after 1945), a war or famine (a notch in men of military age), emigration of young adults (a notch at 20–39) or immigration of workers (a bulge, often of men).
- **The two sides** show the **gender balance**.

Shapes: a **triangle** or concave pyramid (wide base, narrow top: Stage 2, youthful, LIC); a **bell** or straight-sided pyramid (Stage 4, stable); a **barrel** or inverted pyramid (narrow base, wide middle and top: Stage 5, ageing, HIC such as Japan or Italy). For a "compare the shape" question, describe the outline, not the bar values.

Gender balance. About 105 boys are born for every 100 girls, so young age groups have slightly more males. In HICs, **women outnumber men in old age**, increasingly so with age (in Country B, 3.6% females against 2.4% males aged 80 and over), because women live longer: a biological advantage, plus men's more

dangerous jobs, more smoking and drinking, more accidents, and past wars. Some countries are unbalanced at other ages:

- **More males**: where parents prefer sons and sex-selective abortion has been used, as in China, where the sex ratio at birth rose to about 120 boys per 100 girls in the 2000s, and parts of India; and where male migrant workers arrive, as in Qatar and the United Arab Emirates, where more than two-thirds of the population is male.
- **More females**: where young men emigrate for work, leaving women, children and the elderly, as in rural areas of Nepal and Lesotho; and in countries such as Russia, where men's life expectancy is far below women's.

Problems of gender imbalance (social problems, and effects on the birth rate):

- **A surplus of young men**: in China, tens of millions more men than women are of marrying age, so many men, especially poor rural men, cannot find a wife. Fewer marriages mean **fewer births**, which adds to the falling birth rate. The shortage of brides has been linked to the trafficking of women from neighbouring countries, and large numbers of single young men are thought to raise the risk of crime and unrest. Parents of sons spend more on housing and bride prices to make them attractive partners.
- **Male migrant workers**: in Qatar and the United Arab Emirates, most workers are men without their families, living in labour camps. Few of them can marry or have children there, so they add almost nothing to the birth rate; their families at home live apart for years; and the imbalance can bring social tension and segregation.
- **Areas left with women, children and the elderly**: where men emigrate (rural Nepal), women run farms and households alone, fewer children are born while couples live apart, and the dependency ratio of the village rises.
- **Elderly widows**: in HICs, many more women than men live into their 80s, so many elderly women live alone. They need more care, home help and housing for single people, and they are more likely to be poor, because women often earned less and have smaller pensions, as in Japan and the UK.

Dependency and the dependency ratio

The **dependency ratio** compares the people who are not of working age (the **dependants**: children aged 0–14 and elderly people aged 65 and over) with those of working age (15–64), who are assumed to support them:

$$\text{dependency ratio} = \frac{\%\text{ aged 0–14} + \%\text{ aged 65 and over}}{\%\text{ aged 15–64}} \times 100$$

It gives the number of dependants per 100 people of working age.

- Country A: $\frac{43.9 + 2.6}{53.5} \times 100 = 86.9$. Nearly all its dependants are **children** (young dependency).
- Country B: $\frac{12.8 + 23.3}{63.9} \times 100 = 56.5$. Most of its dependants are **elderly** (old-age dependency).

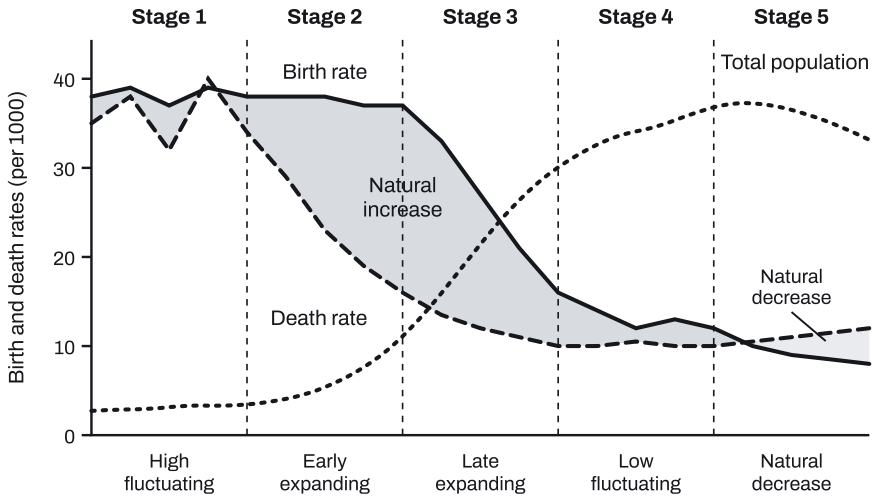
So the **structure** decides the ratio: a youthful population has a high ratio of young dependants, an ageing one a high ratio of elderly dependants, and a country with a large middle-aged bulge (many workers, few children and few elderly) has a **low** ratio, as China did around 2010. Two countries can have similar ratios with very different problems: one needs schools and jobs, the other pensions and care homes.

Why the ratio is only an indicator (it assumes everyone aged 15–64 works and nobody else does):

- children work, as child labour on farms or in workshops, in many LICs;
- elderly people keep working past 65, where there are no pensions or families to support them, or by choice;
- many 15–64-year-olds do not work: students in higher education, the unemployed, the sick and disabled, carers, and people who retire early;
- part-time, seasonal and informal work is not counted;
- retirement ages differ between countries and between men and women;
- births, deaths and migrants may not all be registered (refugees, unregistered children);
- it varies **within** a country: rural areas often have high ratios, because young adults have moved to the cities, leaving children and the elderly, and some elderly people retire to the countryside or coast; cities, with an inflow of young workers, have low ratios.

Changes in birth and death rates over time: the demographic transition model

The **demographic transition model (DTM)** shows how birth rates, death rates and total population changed in today's HICs as they developed, in five stages. It was based on the history of north-west Europe and North America; Stage 5 was added later, once some European countries had fewer births than deaths.



Stage 1: high fluctuating. Birth and death rates are both high (about 35–40 per 1000). Birth rates are high because there is no birth control, children work and are old-age security, and many die young. Death rates are high and fluctuate with famine, epidemics and war, sometimes rising above the birth rate. The population is small and grows little. No country is in Stage 1 today; only a few isolated groups, such as some in the Amazon rainforest, come close.

Stage 2: early expanding. The death rate **falls steeply** (here from about 34 to 16 per 1000) because of better food supply, clean water and sewers, vaccination and medical care. The birth rate **stays high** (about 37–38), because attitudes to family size change slowly and more children now survive. The gap between them is at its **widest**, so the population grows **rapidly**. Niger and Afghanistan are close to this stage.

Stage 3: late expanding. The birth rate **falls** (here from 37 to 16 per 1000) as children become costly rather than useful, infant mortality falls so families need fewer births, contraception spreads, and women are educated and go out to work. The death rate keeps falling, more slowly (16 to 10). The population still grows, but more slowly. Kenya and India are examples.

Stage 4: low fluctuating. Both rates are **low** (birth rate about 12–14, death rate about 10). The birth rate fluctuates with the economy and fashion (the post-war baby boom), and the population grows slowly or levels off. The UK, USA and Brazil are examples.

Stage 5: natural decrease. The birth rate falls **below** the death rate (here 8 against 12 per 1000). Fertility is well below replacement, and the death rate **rises slightly** because so many people are old. Without immigration, the population falls. Japan, where deaths have outnumbered births since the mid-2000s and the population has fallen since its peak of about 128 million in 2008, and Italy are examples; China, where deaths have outnumbered births since 2022, has just joined them.

The dependency ratio through the stages. In Stages 1 and 2 it is high, almost all from children. In Stage 3, as birth rates fall, the large cohorts born in Stage 2 reach working age, so the ratio **falls**: this is the **demographic dividend**, a chance for fast economic growth if there are jobs (as in East Asia from the 1970s). In Stages 4 and 5 it **rises again**, now from the elderly.

A critical appreciation of the DTM, needed for "how useful" questions:

Strengths	Limits
Simple, easy to understand: one diagram links birth rate, death rate and growth	**Eurocentric**: based on north-west Europe's history, and assumes every country will follow the same economic and social changes
Universal: every country can be placed in a stage and compared	**LICs and MICs differ**: death rates fell much faster after 1950, because medicines and vaccines were imported rather than invented, and birth rates started higher than in 19th-century Europe, so growth was faster
Shows the link between development and population change, a starting point for planning schools, jobs or pensions	**Ignores migration**, which changes many populations more than births and deaths (immigration keeps the UK's population rising; emigration shrinks Romania's)
The timescales are flexible, so it fits fast and slow transitions	**Gives no timings**: it cannot predict how long a country stays in a stage, or when it will move on
Has been revised: Stage 5 was added when it was observed	**Leaves out government policy**: China's birth rate fell faster than the model expects because of policy; pro-natal policies can raise births

Strengths	Limits
	Ignores sudden events: HIV/AIDS raised death rates in southern Africa in the 1990s, and wars and pandemics push countries "back" a stage
	Culture and religion can keep birth rates high long after death rates fall (parts of the Middle East), so the link between the two rates can be challenged

Judgement: the DTM describes the past of today's HICs well and is useful for comparison, but it is a poor **predictor** for LICs and MICs, because their transitions happen at different speeds, under different conditions, with migration and governments playing a large part.

Youthful and ageing populations

A **youthful population** has a large proportion of children (often over 40% aged under 15) and few elderly; it comes from a high birth rate and falling death rate (DTM Stages 2–3). Niger's median age is about 15. An **ageing population** has a rising proportion of elderly people (over about 20% aged 65 and over) and few children; it comes from **falling fertility** and **rising life expectancy**, and also from the emigration of young adults or the arrival of retired people. In Japan, about 29% of the population was 65 or over in 2023.

	Youthful population	Ageing population
Economic issues	Spending on schools, child health and childcare; too few jobs for the young, so youth unemployment and under-employment; a small tax base	Spending on pensions, health and social care; a shrinking workforce and tax base, so higher taxes on fewer workers; labour shortages and slower growth; wage rises
Social issues	Overcrowded schools and clinics; housing shortages and informal settlements; pressure on food and water	Demand for care homes, carers and specialist health care; loneliness; school closures; the strain on families who care for elderly relatives
Political issues	Unrest if young people have no jobs or prospects; the need for anti-natal policies	Older voters outnumber younger ones, making change to pensions hard; pressure to allow immigration, which may be unpopular
Future	**Population momentum**: even if fertility falls, the large young cohort will have many children, so growth continues for decades; but there is a potential demographic dividend	The problems get worse as the working population shrinks further; natural decrease
Positives	A large future workforce and market, which can attract foreign companies	Elderly people provide childcare, volunteer and spend savings (the "grey pound"); less crime; they drive less

How governments manage them: for a youthful population, anti-natal policies, education (especially of girls), family planning, job creation and vocational training; for an ageing population, raising the retirement age, encouraging private pensions and saving, pro-natal policies, immigration of young workers, encouraging older people to keep working, and automation and robots in care (as in Japan).

Keep the issues in the right category: pension costs are mainly **economic**, the need for carers and the isolation of the elderly **social**.

Population and development

As countries develop, **infant mortality falls and life expectancy rises**, because economic growth brings:

- **health care**: more doctors, clinics and hospitals, vaccination programmes and antenatal care, paid for by higher tax revenue;
- **clean water and sanitation**, which cut diarrhoea and cholera, the main killers of babies in poor areas;
- **better diet**, as incomes rise and food production improves, so mothers and babies are better nourished;
- **education**, especially of women, who learn about hygiene, nutrition and spacing births;
- **better housing and transport**, which let people reach clinics and food.

But development does not explain everything, which matters in "how far" essays:

- **Social and political choices**: some places reach low IMR and high life expectancy at modest incomes by spending on public health and women's education, such as Kerala in India, whose IMR is far below India's average, and Cuba, whose life expectancy is close to the USA's.
- **Uneven development**: within a country, rural and poor or indigenous groups may not share the gains, so national averages hide gaps; urban areas usually have better access to services.
- **Wealth can harm health**: in HICs, diets high in fat and sugar and less exercise raise heart disease and type 2 diabetes; the USA spends the most on health care per person, yet its life expectancy is lower than most other HICs'.
- **Other shocks**: HIV/AIDS cut life expectancy in southern Africa in the 1990s and 2000s; war (Syria, Yemen, Sudan) raises death rates whatever a country's earlier development; pandemics such as COVID-19 lowered life expectancy worldwide in 2020–2021.
- **Culture and environment**: malaria in tropical areas, or traditions about child care and the value of girls.

Falling death rates also **change birth rates**: once families are confident their children will survive, they need fewer births, so the birth rate falls, but only after a **time lag**, because social customs change slowly. This lag is why population grows so fast in DTM Stage 2.

Food security and food shortages

Food security exists when everyone, at all times, can get enough safe, nutritious food to meet their dietary needs for an active and healthy life. It has four parts:

- **availability**: enough food is produced or imported;

- **access**: people can afford it and reach it;
- **utilisation**: the food is safe and nutritious and people can use it (clean water, cooking, health);
- **stability**: supply and access stay steady through the year and through shocks.

A **food shortage** happens when supply falls below what a population needs. About 700–750 million people were undernourished in 2023 (FAO estimates), most in sub-Saharan Africa and South Asia.

Causes of food shortages:

- **Environmental**: drought (the Horn of Africa, 2020–2023); floods (Pakistan, 2022); pests and disease (the desert locust swarms that hit East Africa in 2019–2021, the worst in Kenya for 70 years); soil erosion, desertification and salinisation; climate change bringing hotter, less reliable seasons.
- **Economic**: poverty, so people cannot afford food even when it exists; rising world prices; land used for cash crops or biofuels for export; poor storage and transport, so food is wasted; debt.
- **Political**: war and conflict, which destroy crops, block transport and drive farmers off their land (Yemen, Sudan, Gaza); trade restrictions (Russia's invasion of Ukraine in 2022 blocked grain exports and raised world prices); corruption and poor policy.
- **Demographic and social**: rapid population growth raises demand faster than supply; rising incomes shift diets to meat, which needs much more land and grain; loss of farm labour to cities or disease.

Consequences of food shortages:

- **Social**: malnutrition and undernutrition, stunted growth in children, diseases of deficiency (kwashiorkor, rickets, beriberi), weaker immunity and so higher IMR and death rates; children missing school; famine; migration to cities or refugee camps.
- **Economic**: higher food prices, so the poor spend more of their income on food; a weaker, less productive workforce; lower output and income; dependence on food aid and imports.
- **Political**: unrest and food riots (in around 30 countries during the 2007–2008 food price crisis), conflict over land and water, pressure on governments.
- **Environmental**: overcultivation, overgrazing and deforestation as people try to grow more, causing soil erosion and desertification, which make future shortages worse.

Technology and innovation in food production

Technology is the tools and methods; **innovation** is putting new ideas into practice. Both raise food production by getting more from each hectare, each litre of water or each worker, or by wasting less after harvest.

- **The Green Revolution** (from the 1960s): high-yielding varieties (HYVs) of wheat and rice, with fertilisers, pesticides and irrigation, made India (especially Punjab) self-sufficient in grain. Limits: costly inputs favoured richer farmers; groundwater is being used faster than it is replaced in Punjab; overuse of chemicals harmed soils and water.

- **Genetic modification and selective breeding**: crops resistant to pests (Bt cotton, grown in India since 2002), drought or disease, or richer in nutrients (Golden Rice, with vitamin A, approved in the Philippines in 2021). Concerns: cost of seed, dependence on large companies, public opposition.
- **Irrigation**: from simple channels and small dams to **drip irrigation**, developed in Israel in the 1960s, which delivers water to each plant's roots and wastes little.
- **Mechanisation and precision farming**: tractors and harvesters replace hand labour; in HICs, GPS-guided machines, sensors, drones and satellite images apply exactly the water, fertiliser and pesticide each part of a field needs.
- **Artificial environments**: greenhouses, **hydroponics** (plants in nutrient-rich water) and **vertical farming** in stacked, lit indoor layers, as in Singapore and the Netherlands, which grow food all year on little land. The Netherlands is the world's second-largest exporter of farm produce by value, after the USA.
- **After harvest**: better storage, refrigeration, packaging and processing reduce the share of food lost to pests and decay.
- **Appropriate (low-cost) technology** for LICs: zai planting pits that trap water and compost in Burkina Faso, stone lines across slopes, drought-tolerant local seeds, mobile-phone weather and price information.

Technology is not a full solution: it needs money, skills and power; it can widen the gap between rich and poor farmers; it can harm the environment; and it does not fix shortages caused by war, poverty or poor distribution. Enough food is grown in the world today to feed everyone, yet people go hungry because they cannot get it.

Constraints on sustaining a population

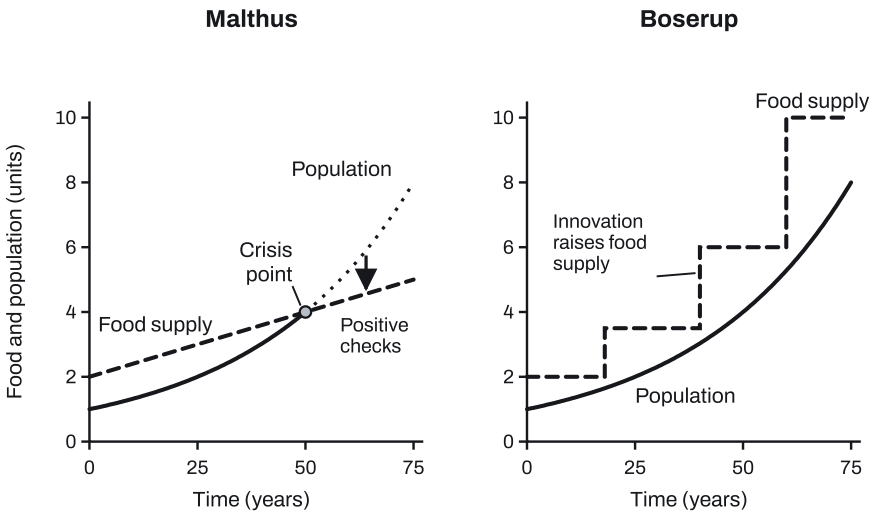
Constraints are the factors that limit a population's growth or the resources that support it, causing growth to level off or the population to fall:

- **war and conflict**, which kill people, destroy farms and stop trade (Malthus's "positive checks");
- **climatic hazards**: drought, floods, tropical cyclones and wildfires that destroy crops and homes;
- **disease and pandemics**, worse where people are crowded and poorly fed;
- **famine** from food shortages;
- **poverty** and lack of capital, so a growing population cannot be fed, housed or employed;
- **resource depletion**: soils exhausted, water used up, forests cleared;
- **political** constraints: instability, corruption, trade barriers;
- **social** change, such as women delaying children, which lowers the birth rate.

The constraint can act on the **population** (raising deaths or lowering births) or on the **resources** (cutting the food or water supply). A population is sustained when food, water and other needs keep pace with the number of people over the long run: today's demand is met without using up what later generations will rely on, and there are enough workers to make use of what the land provides.

Population and resources: Malthus and Boserup

Two opposite views frame most essays on population and resources.



Thomas Malthus (*An Essay on the Principle of Population*, 1798) argued that population, if unchecked, grows **geometrically** (1, 2, 4, 8, doubling every 25 years), while food supply grows only **arithmetically** (by the same amount each period). So population must eventually outrun food: in the graph, food starts ahead but the lines meet at year 50. Population is then held back by **positive checks**, which raise the death rate (famine, disease, war), or by **preventive checks**, which lower the birth rate (late marriage, "moral restraint").

Ester Boserup (*The Conditions of Agricultural Growth*, 1965) argued the reverse: **population growth causes food production to rise**. When population presses on food supply, people are forced to innovate: they farm more intensively, irrigate, terrace, use fertilisers and new crops ("necessity is the mother of invention"). In the graph, each time population gets close to food supply, food jumps up in a step, so food stays ahead.

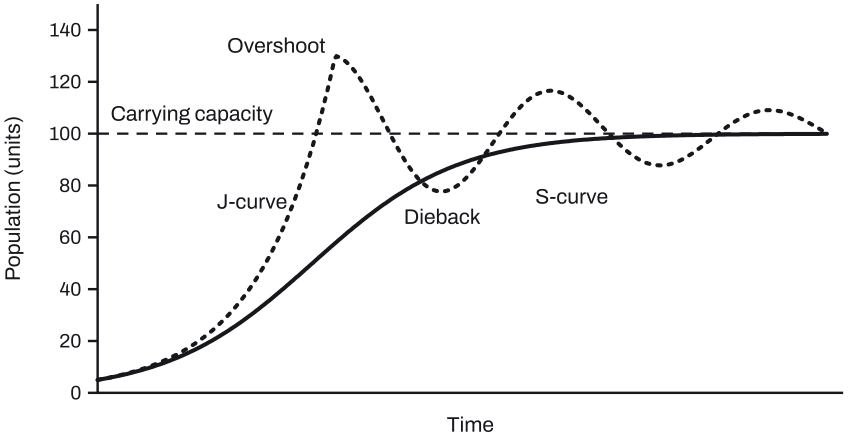
Evidence for Malthus (neo-Malthusians): famines in the Sahel and Ethiopia (1980s) and the Horn of Africa; over 700 million people still undernourished; soil degradation, overfished seas and falling water tables; Paul Ehrlich's *The Population Bomb* (1968) and the Club of Rome's *Limits to Growth* (1972) warned of collapse; climate change may cut yields.

Evidence for Boserup: people are themselves a resource, as workers, farmers and inventors; world population rose from about 4 billion in 1974 to 8 billion in 2022, yet food production per person rose; the Green Revolution; terraced hillsides in Nepal and the Philippines, and intensive farming in the Netherlands and Bangladesh; most modern famines are caused by war, poverty and poor distribution rather than an absolute lack of food (Amartya Sen's work on famines).

Judgement: neither is always right. At the **global** scale, Boserup's view has held so far, through technology and trade. At the **local** scale, especially where there is poverty, conflict or environmental damage, Malthusian crises still happen. Much depends on technology, wealth, governance, trade and whether falling fertility slows population growth first.

Carrying capacity

The **carrying capacity** is the **maximum** population that an area can support with its available resources (food, water, energy, space) at a given level of technology, without damaging the environment so that it can keep doing so.



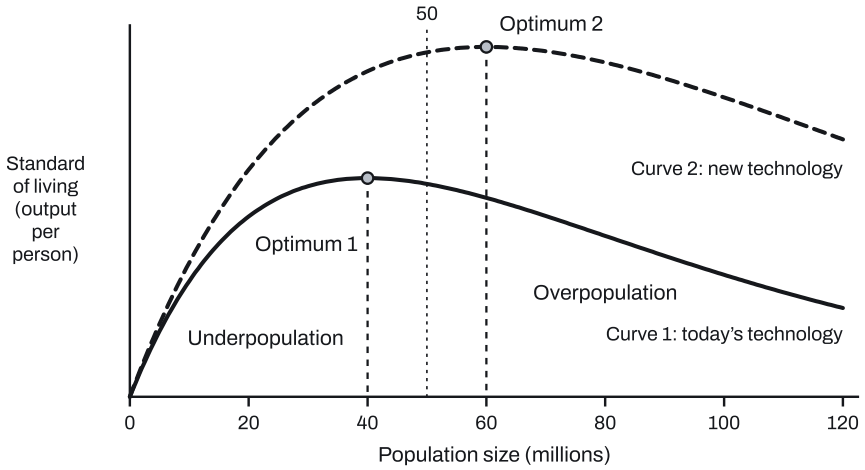
- **S-curve**: growth slows as the population approaches the carrying capacity, because resources get scarcer and birth rates fall, so the population levels off just below it.
- **J-curve**: growth continues at full speed until the population **overshoots** the carrying capacity; resources are overused and the environment is damaged; then famine, disease or emigration cause a sudden fall (**dieback**) below it.

Environmental consequences of exceeding carrying capacity: soil erosion and desertification from overcultivation and overgrazing (the Sahel), deforestation for farmland and fuelwood, falling water tables and dried-up rivers, pollution of air and water, loss of biodiversity, overfishing. These lower the carrying capacity itself, making things worse.

Why carrying capacity is hard to assess: it is a theoretical idea with different meanings; both population (numbers, skills, what they consume) and resources (new discoveries, prices, technology) keep changing, so the capacity keeps changing; it depends on what standard of living is assumed; trade lets an area support far more people than its own land could (Singapore imports over 90% of its food); environmental changes (drought, climate change) alter it; and it differs with the scale of area chosen.

Optimum population, overpopulation and underpopulation

The **optimum population** is the number of people that, with the available resources and technology, gives the **highest standard of living** (or output per person) for an area. It is **not** the same as the carrying capacity: the optimum is the best number, the carrying capacity the most that can be supported.



- **Underpopulation**: too few people to use the resources efficiently at the current level of technology. More people would **raise** the standard of living (left of the peak). Examples: Canada and Australia, which have large resource bases, 3–4 people per km², and immigration policies to attract workers; the Russian Far East; within HICs, the Scottish Highlands and the depopulating villages of inland Spain.
- **Overpopulation**: too many people for the resources and technology to support at a reasonable standard of living. Fewer people would raise the standard of living (right of the peak). Signs: unemployment, food shortages, poverty, housing shortages, environmental damage. Examples: parts of the Sahel; within HICs, the housing shortages and congestion of London.

Overpopulation is about resources, not just density. Bangladesh, with about 170 million people on 148 000 km² (over 1100 per km²), is often described as overpopulated, while Singapore, at about 8000 per km², is not, because its wealth, technology and trade provide the resources. Overpopulation can come from rising **population** (high natural increase, in-migration) or falling **resources** (desertification, soil exhaustion, a collapse in the price of a main export, conflict).

Problems of underpopulation: too few workers, especially skilled ones, to develop resources; a small market, so few businesses can grow; services (schools, hospitals, transport) are expensive per person and hard to provide over long distances; infrastructure gaps; high dependency where the young leave; few marriage partners in remote areas; difficulty defending or controlling remote regions; the usual solution, immigration, can be controversial.

Problems of overpopulation: unemployment and poverty; shortages of food, water and housing; overcrowded schools and clinics; informal settlements; soil erosion, deforestation and pollution; social unrest and conflict over resources; emigration.

Why some large countries have few people: much of the land is inhospitable (hot deserts in Australia's interior, the cold north of Canada and Russia, mountains, lack of water); much is used for extensive farming, which needs few people; settlement is recent or concentrated on the coasts for historical reasons (Australia); remoteness and the cost of building transport and power; few resources found or developed.

A critical evaluation of optimum population, for "why is it difficult to measure or achieve" questions:

- It is **dynamic**: both population and resources keep changing, so the optimum keeps moving, as the curve shift shows. Today's overpopulated area can become underpopulated after new technology or a new resource (curve 2), or the reverse after a resource runs out.
- **Different optimums**: an economic optimum (highest output per person), a social optimum (best quality of life) and an environmental optimum (sustainable use) give different numbers.
- **Measurement**: what counts as a resource, and which measure of living standards should be used? Standards people accept vary.
- **Scale**: a country can be optimum overall while some regions are overpopulated and others underpopulated.
- **Trade** means an area's own resources do not limit its people.
- It is a **theoretical idea**, useful for thinking about the balance of population and resources, but impossible to pin down as one number. In practice it is a **dynamic equilibrium** that is rarely, if ever, reached.

Case study: Singapore's population policy

Singapore is a city-state of about 6 million people (2024) on about 735 km², with no farmland, few natural resources and no hinterland. It has managed natural increase in both directions.

Why natural increase needed managing (1960s): at independence in 1965 the TFR was about 4.7. A fast-growing, youthful population threatened housing (many lived in crowded slums), jobs, schools and health care on a tiny island with high unemployment.

Attempt 1: anti-natal policy (1966–1986)

- The **Singapore Family Planning and Population Board** was set up in **1966** to provide contraception and family planning clinics.
- **Abortion and voluntary sterilisation** were made legal in **1969** and more widely available in the 1970s.
- The **"Stop at Two"** campaign of the late 1960s and 1970s used posters and slogans, and **disincentives** for third and later children: higher hospital delivery fees for each extra birth, paid maternity leave only for the first two children, income tax relief only for the first three, no priority for larger families in public housing, and priority in primary school places for children whose parents were sterilised after two children.
- **Success**: the TFR fell to replacement level (2.1) by 1975 and to about 1.4 by 1986. Housing, education and jobs could be planned, and living standards rose quickly. But it **overshot**: fertility fell far below replacement and stayed there.

Attempt 2: pro-natal policy (from 1984 and 1987)

- **1984**: the **Graduate Mothers' Scheme** gave school-place priority to children of mothers with degrees, to encourage educated women to have more children. It was so unpopular, being seen as unfair, that it was dropped in 1985. A matchmaking agency, the Social Development Unit, was set up in 1984 to help graduates meet and marry.
- **1987**: **"Have Three or More, if you can afford it"**: tax rebates for third children, priority in housing for larger families, childcare subsidies.

- **2001**: the **Baby Bonus** scheme, with cash gifts for each child and a savings account into which the government matches parents' savings; later extended with longer paid maternity and paternity leave, more childcare places and housing grants for young couples.
- **Success**: limited. The TFR rose briefly to about 2.0 in 1988 (helped by the Chinese Year of the Dragon, a lucky year for births), but kept falling afterwards, to 0.97 in 2023, among the lowest in the world. Money has not outweighed high housing costs, long working hours, competitive and expensive education, and women's careers. Low fertility now appears to be a social norm.

Managing the results of population change (an ageing population and a shrinking workforce)

- **Immigration**: foreign workers and new citizens fill labour shortages; about 30% of the people living in Singapore are non-residents. This kept the economy growing, but a 2013 government White Paper projecting up to 6.9 million people by 2030 led to public protests about crowding and jobs.
- **Working longer**: the retirement age was raised to 63 in 2022, and employers must offer re-employment to older workers.
- **Saving for old age**: the Central Provident Fund, a compulsory savings scheme, pays for housing, health care and retirement; a 1995 law requires adult children to support needy parents.
- **Planning for the elderly**: about 19% of residents were 65 or over in 2023, so more care homes, health services and barrier-free housing are being built.

Evaluation: Singapore's anti-natal policy was one of the most successful anywhere, perhaps too successful; reversing it has proved far harder, because it is easier to stop people having children than to persuade them to have more. Managing the results through immigration and longer working lives has kept the economy strong, but at the cost of social tension, and the long-term problem of very low fertility remains.

For comparison: China. Its one-child policy, introduced in 1979–1980, used fines, loss of jobs and benefits, and sometimes forced abortion and sterilisation, with exceptions for many rural families and ethnic minorities. It sped up a fall in fertility that had already begun in the 1970s, but left an ageing population and a sex ratio skewed towards boys, and was hard to enforce in remote rural areas. China moved to a two-child policy in 2016 and a three-child policy in 2021, with little effect on births; its population fell in 2022, for the first time since 1961, and India overtook it as the most populous country in 2023. Note that the one-child policy slowed China's growth; it did **not** make the population fall at the time.

Key facts and formulas

There is no formula list in Paper 2, so learn all of these.

Formula	Status
Crude birth rate (per 1000) $= \frac{\text{live births in a year}}{\text{total population}} \times 1000$	Learn it
Crude death rate (per 1000) $= \frac{\text{deaths in a year}}{\text{total population}} \times 1000$	Learn it

Formula	Status
Natural increase rate = crude birth rate – crude death rate (per 1000); divide by 10 for a percentage	Learn it
Population growth rate = natural increase rate + net migration rate	Learn it
Infant mortality rate (per 1000 live births) $= \frac{\text{deaths of infants under 1 year old in a year}}{\text{live births in that year}} \times 1000$	Learn it
General fertility rate $= \frac{\text{live births in a year}}{\text{women aged 15–49}} \times 1000$	Learn it
Dependency ratio $= \frac{\%\text{ aged 0–14} + \%\text{ aged 65 and over}}{\%\text{ aged 15–64}} \times 100$ (dependants per 100 people of working age)	Learn it
Increase in number of people = population × growth rate (%) ÷ 100 (this is the growth, not the new total)	Learn it
Percentage change = (later value – earlier value) ÷ earlier value × 100	Learn it
Population density = population ÷ area (people per km²)	Learn it
Replacement-level fertility: a total fertility rate of about 2.1 children per woman	Learn it

Term and meaning	Status
Birth rate: the number of live births per 1000 people in a year	Learn it
Death rate (mortality rate): the number of deaths per 1000 people in a year	Learn it
Natural increase: the difference between the birth rate and the death rate, the change in population without migration	Learn it
Natural decrease: when the death rate is higher than the birth rate	Learn it
Fertility rate (general): the number of live births in a year per 1000 women of childbearing age (15–44 or 15–49)	Learn it
Total fertility rate: the average number of children a woman would have in her lifetime if current age-specific fertility rates stayed the same	Learn it
Infant mortality rate: the number of deaths of children under 1 year old in a year per 1000 live births in that year	Learn it

Term and meaning	Status
Life expectancy: the average number of years a person born now can expect to live, if current death rates stay the same	Learn it
Population structure: the make-up of a population by age and gender, shown on an age/sex structure diagram	Learn it
Dependency ratio: the ratio of the young (0–14) and elderly (65 and over) to the working-age population (15–64), per 100	Learn it
Youthful population: a population with a large proportion of children under 15 and few elderly	Learn it
Ageing population: a population in which the proportion of elderly people (65 and over) is rising	Learn it
Demographic transition model: a model of how birth rates, death rates and total population change over time in five stages as a country develops	Learn it
Food security: when all people at all times can get enough safe, nutritious food for an active, healthy life	Learn it
Food shortage: when the food available falls below what a population needs	Learn it
Constraints: factors such as war, climatic hazards, disease and poverty that limit population growth or the resources that sustain it	Learn it
Carrying capacity: the maximum population an area can support with its resources at a given level of technology, sustainably	Learn it
Optimum population: the population that gives the highest standard of living per person for the available resources and technology	Learn it
Overpopulation: more people than the resources and technology of an area can support at a reasonable standard of living	Learn it
Underpopulation: too few people to use the resources of an area efficiently at the current level of technology	Learn it
Pro-natal policy: a government policy that encourages people to have more children	Learn it
Anti-natal policy: a government policy that encourages people to have fewer children	Learn it
Population momentum: continued population growth after fertility falls, because a large youthful population is reaching childbearing age	Learn it

How to do it

We have tagged 60 questions for this topic (2021–2025, all from Paper 2), 54 different (Papers 22 and 23 were the same in June 2022, 2023 and 2024). Every one is a multi-part Question 1 or Question 4, so all 60 mix types and the counts add up to 203.

Question type	Questions
Essay (15 marks): assess a claim about population	30
Explain the causes and problems of a population structure	24
Explain changes in birth rate, fertility or population growth	22
Describe or compare a trend or pattern in a figure	21
Read a value off a figure or table	19
Define or outline a term or concept	17
Explain death rate, infant mortality or life expectancy and development	15
Explain food security and food shortages	15
Calculate from a figure or table	13
Explain over-, under- and optimum population, carrying capacity and constraints	13
Describe or judge the demographic transition model	9
Use a case study of one country's population policy	5

Short parts (2–5 marks) give 1 mark for a simple point and 2 for a developed one (with detail or an example); "suggest two reasons" parts give 1 mark each. The 8-mark (b) parts are marked in three levels (Level 3, 6–8 marks), with a maximum of 4 without valid examples, and the 15-mark (c) essays in four (Level 4, 12–15 marks), with a maximum of 6 without examples.

1. Essay (15 marks): assess a claim about population (30 questions)

Every Question 4 ends with one. Claims that recur: underpopulation is easier to manage than overpopulation; population will always outgrow food or local resources (Malthus against Boserup); economic factors (or development) are the main influence on growth rates, life expectancy, infant mortality or youthful structures; the main impacts of an ageing population are social or economic; the DTM is useful; a high birth rate stops LICs' economic growth; a falling birth rate causes economic decline in HICs; managing natural increase, or increasing food production, is the best way to reach optimum population; technology solves food shortages.

1. **Introduction**: define the key terms (optimum population, underpopulation, food security, life expectancy) and say what you will weigh.
2. **The case for**, with explained points and **named, detailed examples**: for "economic factors", how income buys health care, water and diet (and how that changes birth rates); for "a high birth rate prevents growth in LICs", the cost of schools and health care for children, little left to invest, youth unemployment (Niger).

3. **The case against**: the other factors (social, cultural, political, environmental) and counter-examples: Kerala and Cuba for life expectancy; Boserup and the Green Revolution against Malthus; a young workforce attracting investment (Bangladesh's clothing industry) against "a high birth rate prevents growth"; immigration (Germany) and automation (Japan) against "a falling birth rate causes decline".
4. **"It depends"**: on scale (global against local), location, time, the type of government, wealth and technology, and migration. This is what lifts an answer into Level 4.
5. **Conclusion**: a clear judgement on "how far", which follows from the argument.

For "underpopulation is easier to manage than overpopulation": underpopulation can often be eased by immigration and investment (Canada, Australia), but pro-natal policies often fail (Singapore); overpopulation needs fewer births, more resources or economic development, all slow, but anti-natal policies can work quickly (Singapore in the 1970s). Ease depends on money, technology, the type of government, and whether the problem is the population or the resources.

Use detailed, located examples all the way through: "countries such as Uganda" with no detail earns little. Keep to the question: an essay on ageing impacts that turns into causes of ageing, or a food essay that turns into climate change in general, loses marks.

2. Explain the causes and problems of a population structure (24 questions)

1. **Causes of ageing** (two main ones): **falling fertility** (education and careers of women, contraception, the cost of children, later marriage) and **rising life expectancy** (health care, diet, clean water, medicines). Add the emigration of young adults or the arrival of retired people.
2. **Problems for a government**: for each, say what the problem is **(1)**, then develop it **(1)**, and say why it is a problem for the government **(1)** when the question says "difficulties for a government": "Pension costs rise as more people retire **(1)**, while the number of workers paying tax falls **(1)**, so the government must raise taxes, cut other spending or raise the retirement age, all unpopular **(1)**."
3. **Youthful problems**: schools, child health, jobs, housing, food, population momentum, the need for anti-natal policies.
4. **Dependency ratio questions**: how the structure changes the ratio, why the ratio varies within a country (rural and urban), and why it misstates who works, all as in "Understand it".

"Compare the economic issues of a youthful population with those of an ageing one": link each point ("both... but", "whereas"), as two separate descriptions earn at most half the marks. For **gender balance**, describe the pattern (more females in old age), then give developed reasons (life expectancy, dangerous jobs, lifestyle, war, migration of men). For **problems of gender imbalance** (8 marks), explain the social effects and the effect on the birth rate with located examples: China's surplus of young men (fewer marriages, fewer births, trafficking of brides, risk of unrest), male migrant workers in the Gulf (few births, families split), and elderly widows in HICs living alone and needing care. Keep to the problems: a rote account of China's one-child policy scores little. "Explain the issues for a country" means one country: don't drift into comparing countries.

3. Explain changes in birth rate, fertility or population growth (22 questions)

1. **"Suggest two reasons why birth rates are high"** (1 mark each, a short phrase is enough): children as labour and old-age security; high infant mortality; no contraception; religious or cultural norms; low education of women; early marriage; a youthful structure.
2. **"Explain why birth rates are falling" or "how social or economic factors influence fertility"**: give the factor and **how** it changes the number of children. Not "education lowers birth rate", but "girls who stay in school marry later and start careers, so they have fewer children".
3. **"Explain how falling death rates influence birth rates"**: families become confident their children will survive, so they need fewer births; there is a time lag while customs change.
4. **"Why might a government want to increase the birth rate"**: fertility below replacement, a falling or ageing population, too few workers and taxpayers, a smaller army, an underpopulated country.
5. **"Why is it difficult to reduce the growth rate"**: governments cannot raise death rates; culture and religion oppose contraception; a youthful structure means momentum; children are still an asset; policies are unpopular; family planning and health care cost money; remote communities are hard to reach; migration is hard to control.

When the question gives data (growth rates falling, median age rising), use it in the answer: "growth has slowed to 1.3%... the median age has risen". Growth rate questions include **net migration**, not just births and deaths.

4. Describe or compare a trend or pattern in a figure (21 questions)

1. **Overall trend first**: rising, falling, steady, from when to when, with values and units ("fell from 38 to 18 per 1000 between 1950 and 2020").
2. **Then the detail**: changes in the rate of change (faster before 2000), fluctuations, steps or anomalies (with the year), stabilising, and the projected part if the graph has one.
3. **Data**: each point backed by values with units; without data the maximum is usually 2.
4. **Compare**: link the two places or lines in each sentence ("Kenya's natural increase fell overall, whereas Niger's rose"); separate descriptions earn at most 1. Include similarities as well as differences.
5. **Describe only**: no reasons unless asked.

For a **scatter graph**, give the direction (positive or negative), the strength, examples of points, the spread and the anomalies. For **"compare the shape"** of two pyramids, describe outlines (triangular with a broad base against narrower and straighter), not bar values. For a world map, describe the distribution with named regions (highest in sub-Saharan Africa, lowest or negative in Europe and East Asia) and exceptions. For "evidence that a country is in Stage 4", quote low, fluctuating birth and death rates close together.

5. Read a value off a figure or table (19 questions)

1. **Read the exact line, year or country** the question names, and check the key and the axis scale.
2. **Give the unit** ("13 per 1000", "64%", "2016"). Without it the mark is often lost.

3. **Answer the exact thing asked**: the year when natural increase was zero is where the birth and death lines **cross**; a country with negative natural increase has its death rate **above** its birth rate; "most similar structure" means compare all three age groups.

Sometimes 2 marks for two items (an income group and a year).

6. Define or outline a term or concept (17 questions)

Three marks, one for each element of the definition:

- **Infant mortality rate**: deaths of children **under 1 year old (1)**, in a year **(1)**, per 1000 **live births (1)**.
- **Fertility rate**: live births **(1)** in a year in an area **(1)** per 1000 women aged 15–49 **(1)**; or the TFR version: average number of children **(1)** born to a woman over her lifetime **(1)** at current age-specific rates **(1)**.
- **Dependency ratio**: the young (0–14) **(1)** plus the elderly (65 and over) **(1)** relative to the working-age population (15–64), per 100 **(1)**. Never upside down.
- **Carrying capacity**: the **maximum** population **(1)** that an area **(1)** can sustain with its resources **(1)**.
- **Optimum population**: the best (ideal) size of population **(1)**, related to resources and technology **(1)**, giving the highest standard of living or output per person **(1)**.
- **Overpopulation**: a population size **(1)** that exceeds what the area's resources can sustain **(1)** at a given level of technology **(1)**.
- **Underpopulation**: too few people **(1)** to use the area's resources efficiently **(1)** at the current level of technology **(1)**.
- **Food security**: all people, at all times **(1)**, have access to enough **(1)** safe, nutritious food for an active, healthy life **(1)**.

The 7-mark versions ("describe the meaning of natural increase and fertility rate, with examples") need the definitions **plus** examples with data (Niger's TFR of over 6 against Japan's 1.20) and some description of what they show. Don't confuse fertility rate with birth rate.

7. Explain death rate, infant mortality or life expectancy and development (15 questions)

1. **Keep to the measure asked**: IMR answers must be about **babies under 1** (vaccination in the first months, antenatal and postnatal care, incubators, breastfeeding advice), not deaths in general.
2. **Link each factor to the change**: "as a country becomes richer, the government can afford vaccination programmes, so fewer babies die of measles and tetanus".
3. **Environmental factors** (when asked): malaria, dirty water and waterborne disease, air pollution, drought and famine, floods. Develop each: what the factor is and why it kills.
4. **Contrast HICs and LICs/MICs**: give values (IMR below 5 in most HICs, over 50 in parts of sub-Saharan Africa) and say which is higher, without explaining unless asked.
5. **Essays** ("economic development is the main factor"): weigh economic factors against social (education, women's status), political (conflict, government priorities), cultural and environmental ones; use Kerala, Cuba, the USA and wars as counter-examples; note uneven development within countries.

Contraception lowers the birth rate, not the IMR directly: don't link the two that way.

8. Explain food security and food shortages (15 questions)

1. **Causes** (7 marks): environmental, economic, political and demographic, each with a named example.
2. **Consequences** (8 marks): social, economic, political and environmental, each explained: "malnutrition weakens workers, so output falls" is an economic consequence; "children's growth is stunted" is social. Keep to the category asked.
3. **Challenges of increasing food security**: cost, labour, transport, storage and power (economic); rising demand (social); who owns land and pays, conflict, government policies, cash crops for export (political); poor soils, water shortage, pests, climate change (environmental), with located examples.
4. **Technology to raise food production** ("explain two ways"): name the technology **(1)** and explain **how** it increases output **(1)**: "drip irrigation delivers water directly to each plant's roots, so crops grow in dry areas with little water wasted". Vague words ("mechanisation", "chemicals") earn little. For **HICs**, give HIC examples (precision farming, vertical farms, the Netherlands): without the HIC context the maximum is 4.

"Outline" an environmental factor needs a sentence, not one word: "Drought dries the soil, so crops wilt and yields fall."

Problems of rising calorie consumption (a figure of kcal per person per day rising, as in China): more food is demanded, so food prices rise and the poor struggle to afford it; farming is intensified (more fertiliser, irrigation and land cleared, with pollution and soil damage) or more food must be imported, costing money and making the country dependent on other countries; and eating more than people need brings obesity, type 2 diabetes and heart disease, raising health care costs and lowering workers' productivity. Answers saying that some people eating more will make others in the same country starve earn no credit.

Maps of a threat to crops (such as locust swarms): they show where to spray pesticide before swarms arrive, where to send food aid or store extra food, which farmers to warn, and where food may need to be bought in from unaffected areas.

9. Calculate from a figure or table (13 questions)

Two marks: **1 for the method** written out, **1 for the answer with its unit** (allowing a small tolerance for reading the figure).

1. **Write the sum** you are doing, with the values you read: "76.2 – 56.1".
2. **Give the answer with units**: "= 20.1 years", "64%", "1.908 million".
3. **Check what is asked**: the increase, not the new total; a change, with whether it rose or fell; a percentage of the total.

Kinds: a difference or change; a remainder (100 – (0–14 % + 65 and over %)); a total of several bars or groups; a percentage share; adding pyramid bars (males plus females in each band); the increase in number from a growth rate (population × rate ÷ 100). For a 3-mark difference across two pyramids, add each pyramid's bars first, then subtract, showing both steps.

10. Explain over-, under- and optimum population, carrying capacity and constraints (13 questions)

1. **"Why is it difficult to measure (or achieve) the optimum or the carrying capacity"**: the idea is **dynamic**, because population and resources both keep changing (this alone earns 2); technology; different economic, social and environmental optimums; how to measure it; which scale; trade.
2. **Difficulties caused by overpopulation or underpopulation** (8 marks): as in "Understand it", sorted into economic, social, political and environmental, with named places.
3. **"How overpopulation can occur"**: relate **both** sides: rising population (high natural increase, in-migration) **and** falling resources (desertification in the Sahel, resource exhaustion), with examples. Reasons for high birth rates alone are not enough.
4. **Constraints**: name each, explain how it limits the population or its resources, with an example (war in Sudan, drought in the Horn of Africa).
5. **Why some areas in HICs are over- or underpopulated**: the pull of jobs and services to London (housing shortages, congestion); remoteness, harsh climate and loss of young people from the Scottish Highlands or inland Spain.

11. Describe or judge the demographic transition model (9 questions)

1. **Describe the stages** (7 marks): each of the five stages, with what the birth and death rates do and how fast the population grows, and some idea of the values (high is about 35–40 per 1000, low about 10). A **labelled diagram** like the one in "Understand it" can earn full marks. Up to 2 marks a stage; four stages are accepted.
2. **Birth rate only, or death rate only**: describe that line through all five stages, with values.
3. **Explain why LICs and MICs may not follow it** (8 marks): Eurocentric model; death rates fell faster with imported medicine and technology; higher starting birth rates; different culture, religion and politics; government policies; NGOs and international aid; large-scale migration. Use examples.
4. **Judge its usefulness** (15 marks): strengths against limits, as in the table in "Understand it", with countries.

Don't merge stages, don't explain when asked to describe, and keep Stage 2 (death rate falls fast) apart from Stage 3 (birth rate falls).

12. Use a case study of one country's population policy (5 questions)

1. **(b) "Explain why there was a need to manage natural increase"**: the country's problems before the policy, social, economic, political and environmental, with facts: for Singapore, a TFR of about 4.7, crowded housing and unemployment on a tiny island; later, below-replacement fertility, ageing and labour shortages.
2. **(c) "Assess the success"**: judge at least two attempts against their **aims** (did the TFR fall or rise?), say what problems remain, and show change over time: the anti-natal phase worked quickly, the pro-natal phase has largely failed, immigration has managed the results.

3. **Cover natural increase**, not just one policy or the birth rate alone, and say how births and deaths together changed growth.
4. **Use the same country** in (b) and (c), with accurate dates and figures.

Answer the question, not the policy's history: a narrative of China since the 1940s scores little. If you use China, check the facts: its population kept rising until 2022.

Worked examples

Example 1

Use the age/sex structure diagrams for Country A and Country B, and the table beneath them, in "Understand it".

(a) (i) State the percentage of Country B's population who are females aged 80 and over. **[1]** (ii) Calculate the dependency ratio for Country A. Show your working. **[2]**

(b) Compare the shapes of the two age/sex structures. **[3]**

(c) Explain two problems that Country A's population structure may cause for its government. **[4]**

(a)(i) 3.6% (a reading from 3.5% to 3.7% would be accepted) **(1)**.

(ii) $\frac{43.9 + 2.6}{53.5} \times 100$ **(1)** $= 86.9$ dependants per 100 people of working age **(1)**.

(b)

- Country A is triangular, with a wide base that narrows quickly to a narrow top, whereas Country B has a narrow base and is widest in the middle, at ages 50–59, like a barrel **(1)**.
- Country A's base is far wider: 8.7% are males aged 0–4, against 2.1% in Country B **(1)**.
- Country B has a much wider top: 23.3% are aged 65 and over, against 2.6% in Country A, and B's top is wider on the female side **(1)**.

(c)

- Country A has a very large share of children (43.9% under 15), so the government must spend heavily on schools, teachers and child health care such as vaccination **(1)**, while the working population that pays taxes is small, so other spending (roads, industry) is squeezed **(1)**.
- As these children grow up, a large number will need jobs every year; if the economy cannot create them, youth unemployment rises, with poverty and the risk of unrest **(1)**, and because so many will reach childbearing age, the population will keep growing for decades (momentum), adding to pressure on food, water and housing **(1)**.

Example 2

A country has a population of 24.0 million. In one year there are 912 000 live births, 216 000 deaths, 31 000 deaths of babies under 1 year old, and a net migration of −48 000.

(a) Calculate (i) the natural increase rate, as a percentage, and (ii) the infant mortality rate. Show your working. **[4]**

(b) Calculate the population at the end of the year. **[1]**

(c) Suggest which stage of the demographic transition model this country is in, and give one reason. **[2]**

(a)(i) Birth rate $= \frac{912\,000}{24\,000\,000} \times 1000 = 38.0$ per 1000; death rate $= \frac{216\,000}{24\,000\,000} \times 1000 = 9.0$ per 1000 **(1)**. Natural increase $= 38.0 - 9.0 = 29.0$ per 1000 $= 2.9\%$ **(1)**.

(ii) $\frac{31\,000}{912\,000} \times 1000$ **(1)** $= 34.0$ per 1000 live births **(1)**.

(b) $24\,000\,000 + 912\,000 - 216\,000 - 48\,000 = 24\,648\,000$, about 24.6 million **(1)**.

(c) Late Stage 2 or early Stage 3 **(1)**: the death rate has already fallen to a low 9.0 per 1000, but the birth rate is still high at 38.0 per 1000, so natural increase is rapid **(1)**.

Example 3

With the aid of examples, explain why infant mortality rates are often higher in rural areas than in urban areas of the same country. **[8]**

The infant mortality rate (IMR) is the number of deaths of babies under one year old per 1000 live births in a year. A national IMR is an average: in many LICs and MICs, babies born in the countryside are much more likely to die before their first birthday than babies born in the cities.

The main reason is access to care at birth and in the first weeks of life. Hospitals, clinics and trained midwives are concentrated in cities, so in remote villages more babies are born at home without skilled help. Complications such as a difficult delivery, infection or a premature birth are then far more likely to kill, because there is no incubator, no antibiotics and often no road or vehicle to reach a hospital in time. In rural Nigeria, for example, a mother may have to travel many kilometres on poor roads to the nearest clinic.

Vaccination also reaches fewer rural babies. Programmes need cold storage for vaccines and health workers who visit regularly, and both are harder to provide over long distances, so more rural infants catch measles, tetanus or whooping cough.

Clean water and sanitation matter too. City households are more likely to have piped water and toilets, while many villages rely on rivers or shallow wells. Diarrhoea from dirty water is one of the main killers of infants, so the lack of safe water raises rural IMR.

Rural families are usually poorer, so mothers are more likely to be undernourished during pregnancy and babies are born underweight. Women in rural areas have often had less schooling, so they may know less about hygiene, treating dehydration or the warning signs of illness, and they tend to marry younger and have births closer together, which is riskier for each baby. In India, IMR is higher in rural areas than in towns in most states, although Kerala, with high female literacy in villages as well as towns, shows that the gap can be closed.

The gap is not universal: in HICs such as the UK, rural and urban IMRs are both very low, because health care, water and transport reach almost everyone, and in some cities the poorest informal settlements have IMRs as high as the countryside's.

Level 3 (6–8 marks): several reasons clearly explained and focused on babies under 1 (not deaths in general), each linked to the rural–urban difference, with located examples.

Example 4

'Overpopulation is caused more by a shortage of resources than by population growth.' With the aid of examples, how far do you agree with this statement? **[15]**

Introduction. Overpopulation is when an area has more people than its resources and technology can support at a reasonable standard of living. It is a relationship between two things, population and resources, so it can come from a rise in the first or a fall in the second.

For. Many places described as overpopulated are short of resources rather than people. Singapore has about 8000 people per km², several times Bangladesh's density, yet it is not overpopulated, because its wealth and trade bring in food, water and energy. In the Sahel, desertification caused by drought, overgrazing and overcultivation has reduced the land that can be farmed, so the same number of people becomes too many: the resource base, not the population, changed. Conflict in Sudan and Yemen has destroyed farms and blocked supplies, creating food shortages and overpopulation relative to resources almost overnight. Amartya Sen showed that most famines happen when people lose access to food (through poverty, prices or war), not when there is too little food overall. Poverty is itself a lack of resources: the same land can support more people with irrigation, fertiliser and storage, as the Green Revolution showed in Punjab.

Against. Population growth matters too. Where natural increase is about 3.5% a year, as in Niger, the population doubles in about 20 years, faster than farming, schools and jobs can expand, especially on fragile land, so pressure on resources rises even if they do not shrink. In-migration can overpopulate an area: London's housing shortage and congestion come from people arriving for jobs faster than homes are built. Rapid growth also makes resources scarcer by overusing them (overgrazing around Sahel water points), so the two causes feed each other, as Malthus's argument suggests.

It depends. In wealthy, trading economies, population growth rarely causes overpopulation, because resources can be bought or created (Boserup). In poor, rural, landlocked countries with high fertility and degrading land, population growth and resource shortage act together, and growth is the factor that keeps rising.

Conclusion. Overpopulation is more often caused by a lack of resources, including the money and technology to use them, than by population growth alone, so the statement is largely true. But in the fastest-growing LICs, rapid population growth is a major cause, and it worsens the resource shortage, so the two cannot really be separated.

Level 4 (12–15 marks): both causes explained, weighed with detailed, located examples, the link between them, and a judgement that answers "how far".

Common mistakes

- **Confusing fertility rate with birth rate.** Birth rate is per 1000 people; fertility rate is per 1000 women of childbearing age (or children per woman).
- **Getting the IMR wrong**: it is for babies **under one**, per 1000 **live births**, in a year. Not per 1000 people, and not children under five.
- **Writing the dependency ratio upside down**, with the dependants as the divisor.
- **Ignoring "within a country"**: variation in the dependency ratio within a country needs rural against urban, not changes over time or between countries.
- **Listing factors without the link.** "Education lowers the birth rate" earns little; say how (later marriage, careers, knowledge of contraception).
- **Mixing up death rate and IMR**: answers about IMR must be about babies; "better health care" in general is not enough.
- **Saying contraception lowers infant mortality.** It lowers the birth rate.
- **Describing two items separately** when asked to compare; ignoring "shape"; explaining when asked to describe or compare.
- **Forgetting units or the word "million"**, or giving the new total when the growth is asked for.
- **Missing "maximum"** in carrying capacity, and confusing carrying capacity with optimum population.
- **Explaining overpopulation only from the population side**, without the resources.
- **Putting impacts in the wrong category**: pension costs are economic, not social.
- **Examples in name only** ("e.g. India"); generic answers are capped at 6 in essays and 4 in 8-mark parts.
- **Case studies that tell the history** instead of answering; inaccurate dates and figures (China's population did not fall because of the one-child policy).
- **Pre-learned answers**: writing about climate change, or the causes of ageing, when the question asks about something else.
- **One-word answers to "outline"**: "drought" needs a sentence on how it cuts food supply.

How to get the marks

- **Units and working.** Every reading needs its unit; every calculation shows the sum and gives the answer with units. Method and answer each earn a mark.

- **Develop each point.** In 3–5 mark parts, a simple point earns 1 and a developed point (with detail or an example) earns 2. "Two difficulties for a government" can earn 3 each when you add why it is a problem for the government.
- **Use the resource.** "Using Fig. 1.1" means quote its data, with units; without data most describe parts stop at 2.
- **Describe** = what is shown, with data, and no reasons. **Explain** = reasons and processes. **Suggest** = apply what you know to the resource; any sensible reason is credited. **Compare** = linked similarities and differences ("whereas"). **Define** = the precise meaning with every element. **Outline** = a brief description, more than one word. **Assess** / **how far** / **to what extent** = weigh both sides and reach a judgement.
- **Examples are required.** 8-mark (b) parts are levelled: Level 3 (6–8) needs clear explanation with located examples, and a maximum of 4 without them. 15-mark essays need a thorough, balanced assessment with detailed examples built in and a clear judgement for Level 4 (12–15); general answers stop at 6.
- **Stay on the question's focus**: one country, the category asked (social or economic), the measure asked (IMR, not death rate), the time (changes over time).
- **Diagrams earn credit**: a labelled DTM can carry a 7-mark description; pyramids and the Malthus–Boserup graph support essays.
- **Case studies**: the same country in (b) and (c), accurate facts, at least two attempts judged against their aims.

Quick check

1. Define the terms 'total fertility rate' and 'infant mortality rate'.
2. A country of 8.0 million people has 96 000 births, 104 000 deaths and net migration of +20 000 in a year. Calculate its natural increase rate and its population growth rate (per 1000), and say which DTM stage this suggests.
3. A population of 63.0 million grows at 2.4% a year. Calculate the increase in the number of people in one year.
4. In a country, 16% of people are aged 0–14 and 21% are aged 65 and over. Calculate the percentage aged 15–64 and the dependency ratio.
5. In the Malthus graph, suppose food supply rose by 1.5 units every 25 years instead of 1 (starting at 2 units). Calculate when population would catch up with food, and say what this shows.

Answers

1. The total fertility rate is the average number of children a woman would have over her lifetime if the current fertility rates for each age stayed the same. The infant mortality rate is the number of deaths of babies under 1 year old in a year per 1000 live births in that year.
2. Birth rate $96\,000 \div 8\,000\,000 \times 1000 = 12.0$; death rate $104\,000 \div 8\,000\,000 \times 1000 = 13.0$; natural increase $12.0 - 13.0 = -1.0$ per 1000 (natural decrease). Net migration $20\,000 \div 8\,000\,000 \times 1000 = 2.5$ per 1000, so the growth rate is $-1.0 + 2.5 = 1.5$ per 1000: the population grows only because of immigration. Stage 5 (birth rate below death rate).
3. $63.0 \times 2.4 \div 100 = 1.512$ million, or 1 512 000 people (the increase, not the new total).
4. $100 - (16 + 21) = 63\%$ aged 15–64. Dependency ratio $= (16 + 21) \div 63 \times 100 = 58.7$.
5. Population is $2^{t/25}$ units and food $2 + 1.5 \times t/25$; they are equal when t is about 63 years, instead of 50. Faster food growth only **delays** the crisis in Malthus's model: a doubling population always overtakes a supply that grows by a fixed amount.

Past questions to try

- **9696/22/O/N/25 Q4**: fertility rate, social factors and fertility, economic factors and low fertility, and an essay on the DTM.
- **9696/23/M/J/24 Q1**: growth in numbers from a growth rate, why African growth rates are high, and why reducing growth is difficult.
- **9696/21/M/J/24 Q4**: the causes and consequences of food shortages, and an essay on technology as the solution.
- **9696/22/O/N/24 Q4**: economic issues of youthful and ageing populations, social factors and fertility, and a population policy case study.