AQA A-LEVEL HUMAN GEOGRAPHY

TRANSITION WORK

Contemporary Urban Environments

Name: ___________________________________

St Joseph's College

HOW TO USE THIS BOOKLET

This transition booklet will introduce you to the first topic of your A-Level Geography course: Contemporary Urban Environments. Read each section carefully before attempting the comprehension questions. You should complete this work before your first lesson in September. Aim to spend approximately 3-4 hours on this booklet in total.

Section 1: What is Urbanisation and Why Does It Matter?

We live on an increasingly urban planet. For the first time in human history, more than half of the world's population lives in cities and towns. This shift from rural to urban living — called urbanisation — is one of the most significant transformations in human geography, with profound consequences for the economy, the environment, and society.

Understanding urbanisation is essential not just for geography, but for understanding global affairs: the growth of megacities in developing countries, pressures on housing and infrastructure, climate change, inequality, and political instability are all connected to how and where people choose (or are forced) to live.

1.1 Defining Key Terms

Key Term	Definition
Urbanisation	The process by which an increasing proportion of a country's population comes to live in towns and cities.
Urban area	A settlement with a relatively high population density, providing a range of services and employment — typically a town or city.
Rural area	A sparsely populated area, typically dominated by agriculture, natural landscapes, or small villages.
Rural-urban migration	The movement of people from the countryside to cities, often in search of employment, education, or better living standards.
Natural increase	Population growth resulting from birth rates exceeding death rates, without accounting for migration.
Megacity	An urban agglomeration with a population exceeding 10 million people.
World city	A city that plays an important role in the global economic system — e.g. London, New York, Tokyo.
Push factor	A negative condition in a place of origin that encourages people to leave (e.g. poverty, lack of jobs, conflict).
Pull factor	A positive condition in a destination that attracts migrants (e.g. higher wages, better services, opportunity).
Suburbanisation	The outward growth of urban areas causing the suburbs to expand beyond the original city boundary.
Counter-urbanisation	The movement of people from cities to rural areas or smaller settlements, often enabled by improved transport and communications.
Re-urbanisation	The movement of people back into urban areas that had previously declined, often through regeneration.

1.2 Causes of Urbanisation

Urbanisation is driven by two main processes working together: rural-urban migration and natural population increase within cities. It is important to understand both, as their relative importance varies across different parts of the world and different time periods.

Rural-urban migration occurs when people leave the countryside and move to cities. This movement is driven by a combination of push factors — negative conditions that encourage people to leave rural areas — and pull factors — positive conditions that attract them to cities. In many lower-income countries today, push factors such as poverty, agricultural unemployment, drought, and lack of access to education or healthcare drive people away from rural areas. At the same time, cities offer pull factors including the prospect of better-paid work, access to schools and hospitals, and a wider range of social opportunities.

Natural increase also plays a major role. Once people move to cities, birth rates often remain relatively high (particularly in the early stages of development), whilst improved healthcare in cities reduces infant mortality and increases life expectancy. The result is a growing urban population even without further in-migration. In many Sub-Saharan African cities today, natural increase is now a more significant driver of urban growth than migration.

Additionally, it is important to recognise that urbanisation is closely linked to economic development. As countries industrialise, labour shifts from agriculture (primary sector) to manufacturing (secondary) and services (tertiary). These jobs are concentrated in cities, drawing workers in from rural areas. This is the pattern that drove urbanisation in Europe and North America during the 18th and 19th centuries, and which many parts of Asia, Africa, and Latin America are experiencing today.

CASE STUDY: Rural-Urban Migration in China

China has experienced the largest rural-urban migration in human history. Between 1980 and 2020, China's urban population grew from around 200 million to over 900 million — a staggering increase of 700 million people in just four decades.

Key push factors included: rural poverty and low agricultural wages, the collapse of collective farming after economic reforms in the late 1970s, and limited access to education and healthcare in rural villages.

Pull factors were equally powerful: rapidly expanding industrial cities offered factory jobs paying 3-5 times rural agricultural wages. Cities like Shenzhen — which grew from a small fishing village of 30,000 people in 1979 to a megacity of over 12 million by 2020 — symbolised this transformation. The promise of higher wages, better schools, and modern amenities proved irresistible to hundreds of millions of young rural workers.

China's government initially tried to restrict this movement through the hukou (household registration) system, which tied citizens' rights to their place of birth. However, market forces proved too powerful, and illegal rural-urban migration — often called the 'floating population' — swelled to an estimated 250 million people by 2010.

1.3 Social and Economic Impacts of Urbanisation

Urbanisation produces a complex mixture of positive and negative impacts. These vary greatly depending on the pace of urbanisation, the level of a country's economic development, and the quality of urban governance and planning.

Economic impacts: Cities are engines of economic growth. Urban areas generate a disproportionately large share of GDP because they bring together workers, businesses, knowledge, and innovation in close proximity — an effect known as agglomeration. Firms benefit from shared infrastructure, a large labour pool, and proximity to suppliers and customers. Workers can access a wider range of jobs and earn higher wages. In many countries, urbanisation has been accompanied by a significant reduction in extreme poverty. However, rapid urbanisation can also increase inequality, as the benefits of city growth are often unevenly distributed.

Social impacts: Urban living offers improved access to education, healthcare, and social services compared to many rural areas. Cities also tend to offer greater social freedoms and opportunities for women and marginalised groups. However, rapid urbanisation can overwhelm housing and infrastructure, leading to the growth of informal settlements (slums), overcrowding, poor sanitation, and increased crime. Urban stress, loneliness, and mental health problems can also be significant in densely populated cities.

Environmental impacts: Cities place enormous pressure on natural environments. They require vast quantities of energy, water, and food, and generate significant quantities of waste, air pollution, and greenhouse gases. Urban heat islands — where cities are several degrees warmer than surrounding rural areas due to human activity and lack of vegetation — are a growing concern. At the same time, the concentration of people in cities can make it more efficient to deliver services and reduce per-capita carbon footprints compared to dispersed rural living.

CASE STUDY: Mumbai, India — Rapid Urbanisation and Its Impacts

Mumbai (formerly Bombay) is India's largest city and its financial capital, with a population of approximately 21 million in the city proper and over 20 million in the wider metropolitan area. It exemplifies both the extraordinary potential and the severe challenges of rapid urbanisation in the Global South.

Economic positives: Mumbai generates approximately 6% of India's GDP and accounts for around 25% of industrial output. It is home to the Bombay Stock Exchange, the headquarters of many major Indian corporations, and a thriving entertainment industry (Bollywood). The city offers wages far higher than rural Maharashtra, attracting millions of migrants.

Social and environmental challenges: Dharavi — one of Asia's largest informal settlements — is located in the heart of Mumbai and is home to an estimated 600,000-1,000,000 people, many of whom live in single-room shelters without adequate sanitation. Traffic congestion, air pollution, pressure on water supplies, and flooding caused by overdevelopment of floodplains all pose serious challenges. The city's infrastructure — built for a far smaller population — struggles to cope.

The case of Mumbai illustrates that urbanisation is neither simply 'good' nor 'bad' — it creates both opportunity and hardship, often at the same time, for different groups of people.

1.4 The Importance of Urbanisation in Global Affairs

Urbanisation matters far beyond individual cities. It has become a central concern of global governance, international development, and geopolitics. Here are some of the key ways in which urbanisation shapes global affairs:

- Economic development: The United Nations and World Bank recognise that cities are crucial to achieving sustainable economic development. The Sustainable Development Goals (SDGs) — particularly SDG 11 ('Sustainable Cities and Communities') — reflect the global commitment to managing urbanisation well.
- Climate change: Cities account for approximately 70% of global CO_2 emissions. How cities are designed and powered will be a critical factor in achieving international climate targets set out in the Paris Agreement.
- Inequality and political instability: Rapidly growing cities with large informal settlements can become centres of social tension and political unrest. When urban populations feel left behind economically or politically, the consequences can include protest movements, crime, and in extreme cases, political instability.
- Migration and geopolitics: Rapid urbanisation is closely connected to international migration patterns. As cities in the Global South struggle to absorb rural migrants, some urban dwellers then migrate internationally — to Europe, North America, or the Gulf states — creating political tensions around immigration in destination countries.
- Global food systems: As urban populations grow, demand for food increases and agricultural land is lost to development. Managing global food security in an increasingly urban world is a major challenge for international organisations and governments alike.

Section 1: Comprehension Questions

Answer the following questions using the reading in Section 1. Some questions require extended written answers — use the line prompts to guide the length of your response. Key terms should be used accurately in your answers.

Q1	Define the term 'urbanisation'. [2 marks]

Q2	Explain the difference between 'push factors' and 'pull factors' in the context of rural-urban migration. Give one example of each. [4 marks]

Q3	Using the China case study, explain why rural-urban migration has occurred on such a large scale. [4 marks]

Q4 Outline TWO economic impacts and TWO social impacts of urbanisation. [4 marks]

Q5 What is a 'megacity'? Name one example from the reading. [2 marks]

Q6 Explain what the term 'natural increase' means and explain why it is an important cause of urbanisation in cities of Sub-Saharan Africa today. [4 marks]

Q7 Using the Mumbai case study, assess the extent to which rapid urbanisation has had positive impacts. [9 marks]

For 9-mark questions at A-level, aim to: use specific evidence from the case study, present arguments on both sides, and reach a clear overall judgement in your conclusion. Write in full paragraphs below.

Q8 Explain TWO reasons why urbanisation is important in global affairs. [4 marks]

Section 2: Global Patterns of Urbanisation Since 1945

The story of urbanisation since the Second World War is one of the most dramatic demographic transformations in human history. In 1950, just 30% of the world's population lived in urban areas. By 2023, that figure had risen to over 57%, and the United Nations projects it will reach 68% by 2050. However, this global trend masks very significant regional differences in both the pace and character of urbanisation.

2.1 The Post-War Urban Explosion (1945–1980)

The immediate post-war period saw rapid urbanisation across much of the world, though driven by very different forces in different regions:

The Developed World (Europe, North America, Australia): In Western Europe and North America, urbanisation had already been underway for over a century by 1945, driven by industrialisation. After the Second World War, rising prosperity fuelled further urban growth, but also a new phenomenon: suburbanisation. As car ownership grew and governments invested in road networks, middle-class families began moving outwards from dense city centres to newly built suburbs. Cities like Los Angeles exemplified this pattern of low-density, car-dependent suburban sprawl. By the 1970s, many traditional industrial cities in the UK, USA, and Germany began to experience urban decline as manufacturing industries collapsed — a process known as deindustrialisation. Cities like Liverpool, Detroit, and the Ruhr Valley lost population and economic activity as factories closed.

The Developing World: In contrast, cities across Asia, Africa, Latin America, and the Middle East were experiencing explosive growth from the 1950s onwards, driven by independence from colonial rule, population growth, and rural-urban migration. Latin America led this process, becoming the most urbanised developing region. Cities like Mexico City, Buenos Aires, and Sao Paulo grew at extraordinary speed, often without adequate infrastructure or housing, leading to the proliferation of informal settlements known as favelas in Brazil, pueblos jovenes in Peru, or barrios in Venezuela.

CASE STUDY: The Growth of Mexico City, 1950–2000

Mexico City is one of the most striking examples of post-war urbanisation in the Global South. In 1950, it had a population of approximately 3 million people. By 2000, this had grown to over 18 million in the city proper and 20 million in the wider metropolitan area, making it one of the largest cities on Earth.

This growth was driven by industrialisation policies that concentrated manufacturing in the capital, attracting millions of rural migrants from poorer states. However, the pace of growth far outstripped the government's capacity to provide housing, water, sanitation, and transport. By the 1980s, an estimated 40-50% of the population lived in irregular settlements without legal tenure, running water, or sewage systems.

The environmental consequences were severe: air pollution became so dangerous that children were advised not to play outdoors on many days of the year. The city sits in a natural bowl, which traps pollutants, and by the 1990s it was using water from aquifers faster than they could be recharged, causing the city centre to sink.

2.2 Changing Global Patterns: 1980s to the Present

Since the 1980s, the geography of urbanisation has continued to shift dramatically. Several key trends stand out:

The rise of Asia: The most significant urbanisation story of recent decades has been in Asia. China's economic opening after 1978 triggered one of history's fastest urban transformations (as explored in Section 1). India's urban population grew from around 200 million in 1980 to over 550 million by 2020 and continues to grow rapidly. Southeast Asian cities — Bangkok, Jakarta, Ho Chi Minh City — have all experienced extraordinary growth driven by export-oriented manufacturing and services. By 2007, Asia as a region overtook Europe in terms of total urban population.

Africa's urban future: Sub-Saharan Africa is now the world's fastest urbanising region, though it starts from a relatively low base. In 1950, only about 14% of Sub-Saharan Africans lived in urban areas; by 2020 this had risen to around 43%, and it is projected to exceed 60% by 2050. Crucially, unlike earlier waves of urbanisation in Europe or East Asia, African urbanisation has not always been accompanied by industrialisation or strong economic growth — a pattern some scholars call 'urbanisation without growth'. Cities like Lagos (Nigeria), Kinshasa (Democratic Republic of Congo), and Dar es Salaam (Tanzania) are growing rapidly, but many new urban dwellers struggle to find formal employment.

Megacities and beyond: In 1950, there were only two megacities (cities with over 10 million people): New York and Tokyo. By 2023, there were 35 megacities globally, with the majority located in the Global South. Some urban geographers now speak of 'metacity regions' — vast urban corridors of tens of millions of people, such as the Pearl River Delta in China (comprising Guangzhou, Shenzhen, Hong Kong, and surrounding cities) with a population exceeding 65 million.

Slowing and reversing urbanisation in the Global North: In contrast, many cities in Western Europe and North America reached peak urbanisation decades ago. Some have experienced significant population decline. Detroit in the USA lost over 60% of its peak population due to deindustrialisation. Several European cities are now experiencing re-urbanisation, where regeneration projects attract residents and investment back to formerly declining inner-city areas — London's Docklands, Glasgow's Merchant City, and Berlin's former East German districts are examples of this trend.

CASE STUDY: Lagos, Nigeria — Urbanisation Without Growth?

Lagos is the commercial capital of Nigeria and the most populous city in Africa, with a population estimated at between 15 and 25 million depending on how the metropolitan area is defined. It is growing by an estimated 600,000 people per year — one of the fastest rates of urban growth anywhere on Earth.

This growth is driven primarily by natural increase and migration from Nigeria's rural north and from other West African countries. However, Lagos's formal economy has not grown fast enough to absorb this population. An estimated 60-70% of Lagos residents live in informal settlements such as Makoko — a waterborne slum where hundreds of thousands live in structures built on stilts over Lagos Lagoon — with little access to clean water, electricity, or healthcare.

Despite this, Lagos is not without economic dynamism. It has a growing technology and entrepreneurship sector (sometimes called 'Silicon Lagos'), a large informal economy, and a rapidly expanding middle class. The city generated an estimated 25% of Nigeria's GDP in 2020. Some economists argue that with better governance and infrastructure investment, Lagos could become a major African economic hub. Others warn that without urgent intervention on housing, water, and sanitation, the city's challenges will only worsen as its population continues to grow.

2.3 The Significance of the Urban-Rural Divide

One of the most significant geographical patterns that has emerged from global urbanisation is a deepening divide between urban and rural areas — not just in terms of population, but in terms of wealth, opportunity, health, and political power.

In many countries, urban areas — particularly capital cities and major economic centres — capture a disproportionate share of government investment and economic growth. Rural areas, by contrast, can be left behind. This can fuel resentment and political tensions, as evidenced by the 'left behind' narrative in UK and US politics following the Brexit referendum and the 2016 US presidential election, where rural and post-industrial communities expressed frustration at perceived neglect.

In the Global South, the gap between booming city centres and their surrounding informal settlements is also stark. Within cities themselves, the geography of inequality is often visible at the neighbourhood level: gleaming financial districts and luxury apartments stand in close proximity to overcrowded slums without clean water. In a city like Nairobi (Kenya), the upscale suburb of Karen — associated with luxury housing and international NGOs — lies just a few kilometres from Kibera, one of Africa's largest informal settlements.

CASE STUDY: Detroit, USA — Deindustrialisation and Urban Decline

Detroit's experience illustrates the 'other side' of urbanisation — the decline and shrinkage of cities in the Global North. Once the 'Motor City' and global centre of automobile manufacturing, Detroit reached its population peak of approximately 1.85 million in 1950. By 2020, its population had fallen to around 640,000 — a decline of over 65%.

The causes of Detroit's decline included the automation of car manufacturing, competition from Japanese and German car producers, and the movement of industry and middle-class residents to the suburbs. This process left vast areas of the city depopulated, with thousands of abandoned buildings and empty lots.

Detroit filed for bankruptcy in 2013 — the largest municipal bankruptcy in US history. However, in recent years there have been signs of regeneration, particularly in the downtown area, driven by technology firms, urban agriculture projects, and arts initiatives. Detroit's story illustrates how rapidly cities can both grow and decline, and the enormous social costs when urban economies collapse.

2.4 Summary: A Divided Urban World

Region	Key Characteristics Since 1945	Example Cities
Western Europe & North America	Industrialisation pre-1945; post-war suburbanisation; deindustrialisation & urban decline; recent re-urbanisation	London, Detroit, New York, Liverpool

East Asia	Rapid industrialisation-driven urbanisation from 1960s–2000s; explosive growth of megacities	Shanghai, Shenzhen, Tokyo, Seoul
South Asia	Fast-growing cities; urbanisation driven by migration & natural increase; large informal settlements	Mumbai, Delhi, Dhaka, Karachi
Latin America	Early rapid urbanisation 1950s–1980s; highly urbanised; significant inequality and informality	Mexico City, Sao Paulo, Buenos Aires
Sub-Saharan Africa	World's fastest-growing urban region; 'urbanisation without growth'; large informal settlements	Lagos, Kinshasa, Nairobi, Dar es Salaam

Section 2: Comprehension Questions

Answer the following questions using the reading in Section 2. Some questions ask you to use evidence from specific case studies — make sure you include relevant facts and statistics where possible.

Q9	What percentage of the world's population lived in urban areas in 1950, and what is the projected figure for 2050? [2 marks]

Q10	Define the term 'suburbanisation' and explain ONE reason why it occurred in the USA and Western Europe after 1945. [3 marks]

Q11	Explain why some urban areas have experienced a slowing down/reversing of urbanisation in the Global North. Use examples to support. [4 marks]

Q12 How many megacities existed in 1950, and how many exist today? What does this tell us about global urbanisation? [3 marks]

Q13 Describe the pattern of urbanisation in Sub-Saharan Africa since 1945, making reference to ONE named city. [4 marks]

Q14 What is meant by 'urbanisation without growth'? Use the Lagos case study to illustrate your answer. [4 marks]

Q15 Using evidence from Section 2, explain how patterns of global urbanisation have varied between different world regions since 1945. [6 marks]

For this 6-mark question, aim to contrast at least TWO different regions and use specific data or case study evidence to support your points. Write in full paragraphs.

Q16 Explain ONE way in which urbanisation has created political tensions, using evidence from the reading. [3 marks]

Extension Task: Thinking Like a Geographer

This extension section is optional but highly recommended. It will help you develop the analytical and evaluative thinking skills that are essential for A-Level Geography. These questions do not have a single 'right' answer — you should aim to argue a point of view using evidence.

Extended Writing Tasks

Choose ONE of the following questions and write a structured essay response of approximately 400-600 words. You should draw on evidence from both sections of this booklet and your own wider knowledge.

Option A:
"Urbanisation brings more benefits than problems." Assess the validity of this statement, using evidence from at least two case studies.

Option B:
"The experiences of cities in the Global South and Global North since 1945 have been fundamentally different." To what extent do you agree?

Well done for completing this transition booklet. You are now ready to begin A-Level Geography.

AQA A-Level Physical Geography

Year 12 Transition Work

Water and Carbon Cycles

Name: ________________________________ Form: __________

Complete this booklet before your first lesson on Water and Carbon Cycles.

How to use this booklet:

Read each section of text carefully before attempting the questions. This is independent reading — you are expected to extract information and apply it. Key terms are shown in bold. Write your answers in the spaces provided.

Section 1: Systems in Physical Geography

1.1 What is a System?

Geography uses systems thinking to understand how different parts of the physical world connect and interact. A system is a set of interrelated components that work together, transferring energy and matter between them. Understanding systems helps geographers explain why landscapes change over time and how human actions can have far-reaching consequences.

All systems share common features: they have inputs (energy or matter entering the system), outputs (energy or matter leaving the system), stores or components (where energy or matter is held), and flows or transfers (movement of energy or matter between stores).

Open and Closed Systems

Systems can be classified as open or closed depending on whether they exchange matter and energy with their surroundings.

An open system exchanges both energy and matter with its surroundings. The drainage basin (the area of land drained by a river and its tributaries) is a classic example of an open system. Water enters as precipitation (input), moves through the basin via a range of transfers such as surface runoff and throughflow, is stored temporarily in soil, groundwater, or channel stores, and eventually leaves as river discharge to the sea or as evapotranspiration to the atmosphere.

A closed system exchanges energy but not matter with its surroundings. The global water cycle (hydrological cycle) is often considered a closed system at a planetary scale — the total amount of water on Earth remains approximately constant, though it moves between stores. Energy from the Sun drives the cycle.

Input	Matter or energy entering a system from outside. E.g. precipitation entering a drainage basin.
Output	Matter or energy leaving a system. E.g. river discharge to the sea.
Store / Component	A reservoir where matter or energy is held for a period of time. E.g. soil moisture, glaciers, ocean.
Flow / Transfer	Movement of matter or energy between stores. E.g. evaporation, infiltration, surface runoff.
Open system	Exchanges both energy AND matter with surroundings. E.g. a drainage basin.
Closed system	Exchanges energy but NOT matter with surroundings. E.g. the global water cycle.

Feedback Mechanisms

Within systems, changes in one component often trigger responses elsewhere. These responses are called feedback loops and they are central to understanding how systems behave over time.

Negative feedback acts to dampen or counteract a change, pushing the system back towards its original state. This stabilises the system. For example, if rainfall increases in a drainage basin, vegetation cover tends to increase over time. Increased vegetation intercepts more rainfall and promotes greater infiltration, reducing surface runoff — thus counteracting the original increase in water reaching the channel. Negative feedback helps maintain dynamic equilibrium (see below).

Positive feedback amplifies a change, pushing the system further from its original state. This can lead to rapid or dramatic change. A well-known example is the ice-albedo feedback: as global temperatures rise, ice and snow melt, exposing darker ocean or land surfaces. These darker surfaces absorb more solar radiation (lower albedo), causing further warming, which melts more ice. This feedback loop accelerates the original warming.

Negative feedback	A response that reduces or counteracts a change in the system, promoting stability. E.g. increased vegetation reducing runoff after a wet period.
Positive feedback	A response that amplifies or accelerates a change in the system. E.g. ice-albedo feedback accelerating ice melt.
Dynamic equilibrium	A state where a system fluctuates around a long-term average. The system is constantly adjusting but remains broadly stable unless disturbed by a major input.

Dynamic Equilibrium

A system is said to be in dynamic equilibrium when its inputs and outputs are broadly balanced over time. The system is not static — stores fluctuate, flows vary — but the overall state remains relatively stable. For instance, a river channel adjusts its width, depth and gradient in response to the amount of water and sediment it carries. If the inputs change significantly (for example, due to increased rainfall or deforestation), the system will adjust until a new equilibrium is reached.

When a system is disturbed — by a storm, an earthquake, human intervention, or climate change — it may be pushed out of equilibrium. It will then undergo changes (via feedback loops) until a new steady state is achieved. The time taken to reach this new equilibrium is called the relaxation time.

Section 1 Questions

Answer the following questions using the reading above. Write in full sentences where indicated.

Q1. Define the term 'system' as used in physical geography.

Q2. State TWO differences between an open system and a closed system.

Q3. Give ONE example of an open system and ONE example of a closed system from the water cycle.

Q4. Explain what is meant by negative feedback. Use an example in your answer.

Q5. The ice-albedo feedback is an example of positive feedback. Describe how this feedback loop works.

Q6. What is meant by 'dynamic equilibrium'? Explain how a river channel demonstrates dynamic equilibrium.

Section 2: The Global Water Cycle — Stores

2.1 Global Distribution of Water

Water is the only substance found naturally on Earth in all three physical states: solid, liquid and gas. The total volume of water on Earth is approximately 1.386 billion km³. However, the vast majority of this water is held in just a few large stores, and only a tiny fraction is available as fresh, accessible water.

Water is distributed between four major spheres: the lithosphere (solid rock and soil), the hydrosphere (all liquid water), the cryosphere (all frozen water) and the atmosphere (water vapour and clouds).

The Hydrosphere

The oceans are by far the largest store of water on Earth, holding approximately 96.5% of all water (around 1.335 billion km³). This water is saline (salty) and cannot be used for drinking or most agricultural purposes without desalination. Despite its size, water in the ocean turns over relatively slowly — the average residency time of a water molecule in the ocean is approximately 3,200 years.

Freshwater lakes and rivers hold only a small fraction of global water — around 0.013% — but are critically important because they are accessible. The Great Lakes of North America, Lake Baikal in Russia (which alone holds around 20% of the world's unfrozen surface fresh water), and the Amazon River system are examples of major freshwater stores.

The Cryosphere

The cryosphere includes all forms of frozen water: ice sheets, glaciers, permafrost, sea ice and snow. Approximately 1.74% of all water on Earth is stored in the cryosphere. The Antarctic and Greenland ice sheets together account for the vast majority of this. If the Antarctic ice sheet were to melt entirely, global sea levels would rise by approximately 58 metres.

The cryosphere is a relatively slow-moving store. Water can be locked in glaciers for thousands of years — the residency time for ice in the Antarctic ice sheet is estimated at around 20,000 years. This makes the cryosphere an important long-term regulator of sea level and ocean salinity.

The Atmosphere

Despite being vital for driving the water cycle, the atmosphere holds only a tiny proportion of global water — around 0.001%, or roughly 12,900 km³ at any given time. This water exists as water vapour, cloud droplets and ice crystals. Because this store is so small, water vapour in the atmosphere has a very short average residency time of just 8–10 days. This means the same water molecules cycle through the atmosphere frequently, driving precipitation across the globe.

The Lithosphere

The lithosphere stores water in two main ways: as soil moisture (water held in the pores of soil close to the surface) and as groundwater (water stored in permeable rock layers called aquifers). Groundwater is the world's largest store of unfrozen fresh water, holding approximately 30% of all freshwater. The Ogallala Aquifer beneath the Great Plains of the USA and the Guaraní Aquifer in South America are among the largest in the world. Residency times for groundwater can range from a few weeks to tens of thousands of years depending on the depth and permeability of the aquifer.

Store	Sphere	% of total water	Approximate residency time
Oceans	Hydrosphere	96.5%	~3,200 years
Glaciers & ice sheets	Cryosphere	~1.74%	Up to 20,000 years (Antarctica)
Groundwater	Lithosphere	~1.69%	Days to tens of thousands of years
Freshwater lakes & rivers	Hydrosphere	~0.013%	Days to years
Soil moisture	Lithosphere	~0.001%	Weeks to months
Atmosphere (water vapour)	Atmosphere	~0.001%	8–10 days

Section 2 Questions

Q7. What percentage of all water on Earth is stored in the oceans?

Q8. Explain what is meant by 'residency time'. Why does the atmosphere have such a short residency time compared to the cryosphere?

Q9. Suggest why groundwater is described as 'the world's largest store of unfrozen fresh water', yet remains inaccessible to many people.

Q10. Using evidence from the text, explain why the cryosphere is described as a 'long-term regulator of sea level'.

Section 3: Processes Driving Change in Water Stores

3.1 Key Processes in the Water Cycle

The movement of water between stores is driven by a range of physical processes. Energy from the Sun is the primary driver, supplying the heat needed for evaporation and the atmospheric circulation that carries moisture around the globe. Gravity is also essential, driving water downhill through drainage basins and eventually to the oceans.

Evaporation

Evaporation is the process by which liquid water is converted into water vapour and enters the atmosphere. It occurs at the surface of oceans, lakes, rivers, and moist soils. The rate of evaporation depends on temperature, wind speed, humidity and the availability of water. Higher temperatures increase the kinetic energy of water molecules, making it easier for them to escape into the atmosphere.

Evapotranspiration is the combined loss of water from the surface through both evaporation from the ground and transpiration from plants. It is the dominant pathway by which water leaves the land surface and returns to the atmosphere. In the Amazon rainforest, evapotranspiration is so significant that it generates enough atmospheric moisture to sustain rainfall across much of the continent — a process sometimes called the 'flying rivers' of the Amazon.

Condensation and Cloud Formation

As water vapour rises in the atmosphere, it cools. When it cools to its dew point temperature, it condenses onto tiny particles of dust, sea salt or pollutants called condensation nuclei, forming cloud droplets. This process is condensation. The collection of millions of these tiny water droplets forms clouds.

Clouds form when moist air is forced to rise. This can happen in several ways: when air is heated at the surface and rises by convection (convectional uplift), when air is forced over a mountain barrier (orographic uplift), or when warm air meets cold air at a frontal boundary (frontal uplift). As the air rises, it expands and cools at the dry adiabatic lapse rate (approximately 10°C per 1000m) until it becomes saturated. Further cooling causes condensation and cloud formation.

Causes of Precipitation

Precipitation is any form of water falling from the atmosphere to the surface, including rain, snow, sleet, hail and drizzle. For precipitation to occur, cloud droplets must grow large enough to fall. This happens when droplets collide and coalesce, or when ice crystals in the upper atmosphere attract water vapour and grow larger (the Bergeron–Findeisen process).

There are three main mechanisms that cause precipitation:

- Convectional precipitation occurs when the ground heats the air above it, causing it to rise rapidly. As it cools, clouds form and intense, short-lived rainfall follows. This is common in tropical regions and during UK summer thunderstorms.
- Orographic (relief) precipitation occurs when moist air is forced to rise over a mountain range. As it rises, it cools and precipitation falls on the windward side. The lee (sheltered) side receives less rain — the rain shadow effect. The Lake District in northwest England receives some of the highest rainfall in the UK due to orographic precipitation from prevailing westerly winds.
- Frontal precipitation occurs at the boundary between warm and cold air masses. As the less dense warm air is forced over the denser cold air, it cools, condenses and produces prolonged, widespread precipitation. Frontal systems are common across the British Isles.

Cryospheric Processes

The cryosphere interacts with the water cycle through several key processes. Accumulation is the process by which snowfall and freezing rain add to the mass of ice sheets and glaciers. Ablation refers to all forms of ice loss, including melting (from surface temperatures above 0°C), sublimation (the direct conversion of ice to water vapour) and calving (when blocks of ice break off glaciers into the sea).

When glaciers and ice sheets gain more from accumulation than they lose through ablation, they advance. When ablation exceeds accumulation, they retreat. In a warming climate, accelerating ablation is transferring large volumes of previously locked-up water back into the oceans and atmosphere, contributing to sea level rise and altering regional precipitation patterns.

At the hillslope scale, freeze-thaw weathering is an important cryospheric process. Water enters cracks in rock, freezes and expands by approximately 9%, exerting pressure on the rock. Repeated freezing and thawing progressively breaks the rock apart. This is significant in periglacial environments and contributes to the release of sediment into drainage systems.

Drainage Basin Processes

A drainage basin is the area of land drained by a river and its tributaries. It is bounded by a watershed — the ridge of high land separating one drainage basin from another. Within the drainage basin, water moves through a cascade of stores and transfers:

- Interception: rainfall is caught by vegetation before it reaches the ground. Intercepted water may evaporate or drip to the ground as throughfall.
- Infiltration: water soaks into the soil. The infiltration capacity of a soil depends on its texture, structure and saturation. Sandy soils have high infiltration rates; clay soils have lower rates.
- Percolation: water moves downward through the soil into underlying rock.
- Throughflow: lateral (sideways) movement of water through the soil towards a river channel.
- Surface runoff (overland flow): water flowing across the surface, occurring when precipitation intensity exceeds infiltration capacity, or when the soil is saturated.
- Groundwater flow: very slow movement of water through saturated rock (aquifers) towards rivers or the sea.

Residency Time

Residency time (also called residence time) is the average length of time a water molecule spends in a particular store. It varies enormously across different parts of the water cycle, as shown in the table in Section 2. Water cycles through the atmosphere rapidly (about 8–10 days) but may remain locked in Antarctic ice for 20,000 years or longer. Understanding residency times is important because it determines how quickly a store can respond to change. If the atmosphere warms and causes increased evaporation, changes to rainfall patterns may be felt within days or weeks. Changes to ocean circulation or ice sheet volume, by contrast, operate on timescales of centuries to millennia.

Section 3 Questions

Use the reading in Section 3 to answer the following questions.

Q11. Describe the process of evaporation. What conditions increase the rate of evaporation?

Q12. Explain the difference between evaporation and evapotranspiration.

Q13. Name and describe the THREE mechanisms that cause precipitation. Include a named example for each.

Q14. Describe how water moves through a drainage basin from rainfall to reaching the river channel. Use the following terms in your answer: interception, infiltration, throughflow, surface runoff.

Q15. Using examples, explain why residency time varies so greatly between different water stores. What are the implications of this for our understanding of how quickly water stores can change?

Q16. Explain how cryospheric processes connect the cryosphere to other parts of the water cycle.

Section 4: Consolidation Tasks

Task A: Diagram Annotation

In the space below (or on a separate sheet), draw and annotate a diagram of the drainage basin hydrological cycle. Label: inputs, outputs, stores and transfers. Include at least FOUR transfers and THREE stores.

Task B: Systems Application

A farmer in the English Lake District decides to remove all hedgerows and trees from their land to increase field size.

1. Using your knowledge of systems, explain how this might affect the inputs, stores and flows within the local drainage basin.

2. Explain whether the feedback triggered by deforestation of hedgerows is more likely to be positive or negative. Justify your answer.

Task C: Case Study Application

Read the following passage and then answer the question below.

The Sahel Region, West Africa

The Sahel is a semi-arid zone stretching across Africa, south of the Sahara Desert. In the 1960s and 1970s, a severe drought led to widespread crop failure and famine. Scientists studying the region noted a troubling feedback: as vegetation died due to reduced rainfall, the bare soil reflected more sunlight (increased albedo), reducing the energy available to drive evapotranspiration. Less moisture entered the atmosphere, further reducing rainfall. Meanwhile, overgrazing by cattle reduced vegetation cover further. The Sahel appeared to be locked in a positive feedback loop driving desertification.

However, since the 1980s, parts of the Sahel have experienced re-greening. Some researchers attribute this to increased rainfall linked to sea surface temperature changes in the Atlantic. Others point to changes in farming practices that allowed vegetation to recover. As vegetation returned, evapotranspiration increased, feeding more moisture into the atmosphere and potentially promoting further rainfall — a negative feedback stabilising the system.

Q17. Using the Sahel case study and your knowledge of systems, explain how both positive and negative feedback mechanisms have shaped water cycle processes in the Sahel over the past 60 years.

Key Terms Glossary

Use this glossary to check your understanding of core terminology before your first lesson.

Ablation	All forms of mass loss from ice — melting, sublimation and calving.
Accumulation	The addition of mass to a glacier or ice sheet through snowfall.
Aquifer	A layer of permeable rock that stores and transmits groundwater.
Condensation	The conversion of water vapour into liquid water as air cools to its dew point.
Condensation nuclei	Tiny particles (dust, salt, pollutants) onto which water vapour condenses to form cloud droplets.
Cryosphere	All frozen water on Earth: ice sheets, glaciers, sea ice, permafrost and snow.
Dynamic equilibrium	A state in which a system fluctuates around a stable average, adjusting continuously to changing inputs.
Evapotranspiration	Combined water loss from evaporation from surfaces and transpiration from plants.
Hydrosphere	All liquid water on Earth, including oceans, rivers and lakes.
Infiltration	The movement of water from the surface into the soil.
Interception	The capture of rainfall by vegetation before it reaches the ground.
Lithosphere	The solid rock and soil of the Earth's crust and upper mantle.
Negative feedback	A system response that counteracts a change, restoring equilibrium.
Orographic precipitation	Rainfall caused by moist air being forced to rise over a mountain barrier.
Percolation	The downward movement of water through soil into rock.
Positive feedback	A system response that amplifies a change, driving the system further from equilibrium.
Precipitation	Any water falling from the atmosphere — rain, snow, sleet, hail or drizzle.
Residency time	The average time a water molecule spends in a particular store.
Surface runoff	Water flowing across the land surface when infiltration capacity is exceeded.
Throughflow	Lateral movement of water through the soil towards a river channel.
Watershed	The boundary of a drainage basin — typically a ridge of high land.

Well done on completing this booklet – keep it safe and bring it to your first physical geography lesson