The water cycle

Global stores of water

Water exists on Earth in three forms: liquid water (freshwater and salt water), solid ice (frozen ocean, ice sheets, ice caps, glaciers and permafrost) and gaseous water vapour. The amounts are summarised in Table 1.1.

Table 1.1

All water	
Location	**%**
Oceanic salt water	97
Fresh water	3

Fresh water	
Location	**%**
Crysospheric water	79
Ground water	20
Easily accessible surface water	1

Easily accessible surface water	
Location	**%**
Lakes	52
Soil	38
Atmosphere	8
Biomass	1
Rivers	1

6 **Using the data from Table 1.1, describe the distribution of the Earth's water. (AO3)** 4 marks

Movement of water between stores

A drainage basin (or catchment area) is the area that supplies a river with its water. This includes water found below the water table as well as soil water and any surface flow. A useful way of looking at drainage basins is to consider them as cascading systems. These are a series of open systems that link together so that the output of one is the input of the next. Like all systems they have inputs, outputs, stores and transfers.

7 **Figure 1.3 (on page 6) shows how water moves about a small drainage basin and the nearby ocean. Using Table 1.2, complete Figure 1.3. (AO1, AO3)** 18 marks

Table 1.2

Inputs	Stores	Transfers	Outputs
Precipitation on land	Lakes and surface water	Overland flow	Evaporation and transpiration from vegetation
Precipitation onto the sea	River channel	Channel flow	Evaporation from water surfaces
	Interception by plants	Infiltration	Runoff from the river
	Soil water	Percolation	Evaporation from the sea
	Groundwater	Throughflow	
		Groundwater flow	
		Throughfall/Stemflow	

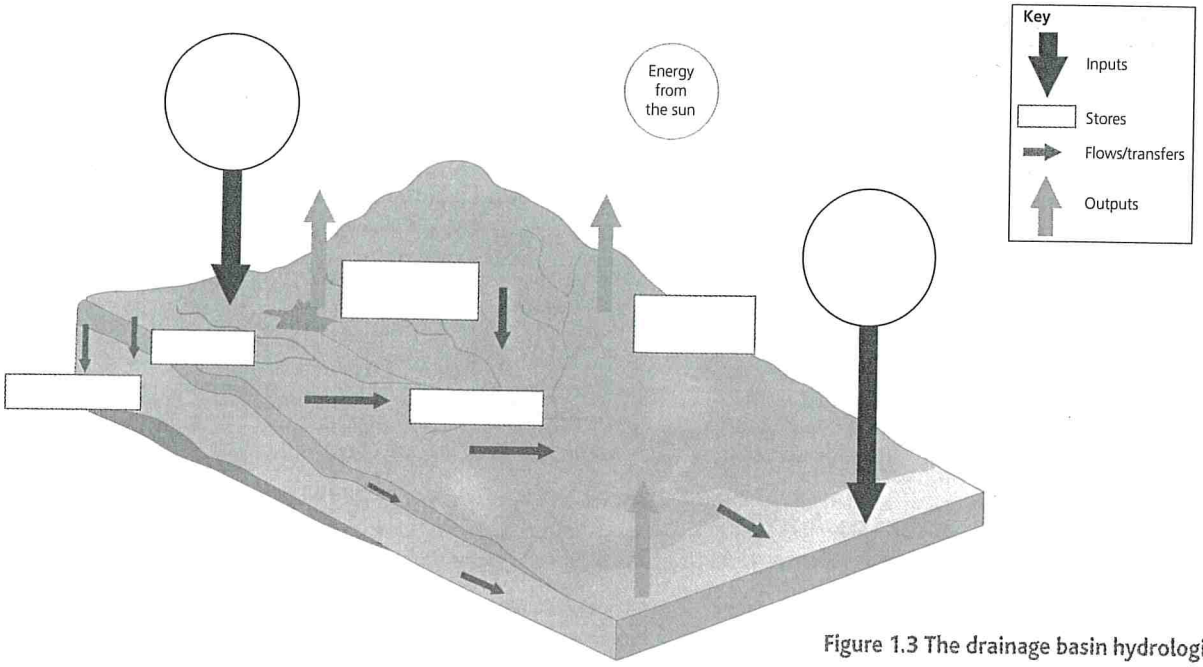


Figure 1.3 The drainage basin hydrological cycle

The water balance

Within a drainage basin, the balance between inputs (precipitation) and outputs (runoff, evapotranspiration, soil and groundwater storage) is known as the water balance or budget.

precipitation (P) = discharge (Q) + evapotranspiration (E) ± changes in storage (S)

A river is a natural stream of water flowing in a channel to the sea, a lake or another river. Rivers obtain water when:

- precipitation falls directly into the channel
- other water stores release it to travel by a variety of means to the channel

8 **Describe the different ways that water can enter a river channel. (AO1 AO2)** 5 marks

The flood hydrograph

River levels rise and fall, often showing an annual pattern (called the river's **regime**). They also vary in the short term following heavy rainfall. These short-term changes in river discharge can be displayed using a flood (or storm) hydrograph.

Although all storm hydrographs have the same common elements, they are not all the same shape. Hydrographs that have a short lag time, high peak discharge, and steep rising and falling limbs are described as being '**flashy**'. Others are a lot more **subdued** with gentle rising and falling limbs, long lag times and low peak discharge. This shape is determined by both physical and human factors.

9 **Complete Figure 1.4, using the following labels: (AO1, AO2)** 10 marks

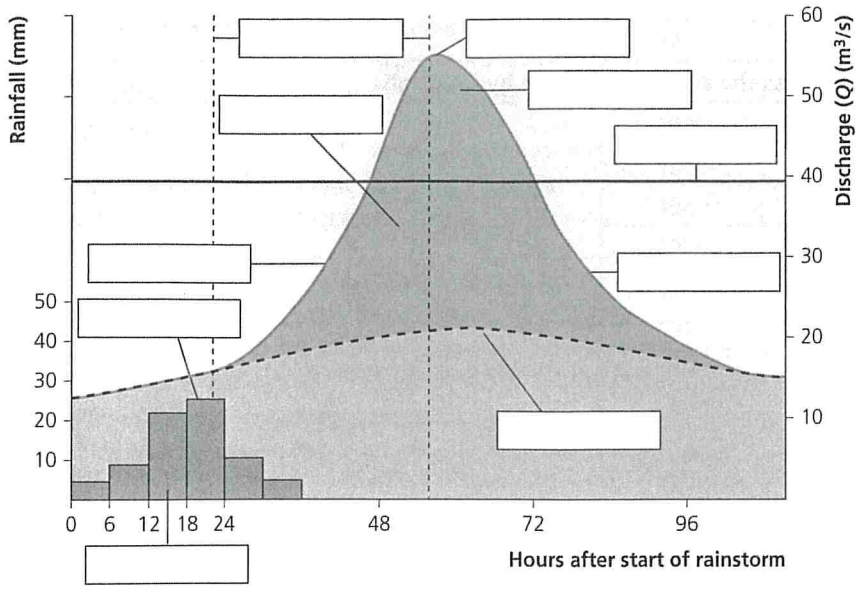


Figure 1.4 A storm hydrograph

Base flow | Recession limb | Peak rainfall | Rising limb | Peak discharge
Storm flow | Lag time | Flood water | Rainfall event | Bankfull discharge

10 **Complete Table 1.3 by describing how changes in the named physical factors might change the shape of a storm hydrograph. Give a brief explanation. (AO1, AO2)** 10 marks

Table 1.3

Physical factor	How it affects the shape of a storm hydrograph
Impermeable underlying rock	
Steep sides to the drainage basin	
A period of wet weather followed by intense rainfall	
A densely forested drainage basin	
The shape of a drainage basin	

11 **Complete Table 1.4 by describing how changes in the human factors shown might change the shape of a storm hydrograph. Give a brief explanation. (AO1, AO2)** **8 marks**

Table 1.4

Human factor	How it affects the shape of a storm hydrograph
Deforestation	
Growth of urban areas	
Dam construction in the upper drainage basin	
Ploughing up of grassland	

The carbon cycle

Carbon forms more compounds than any other element and scientists predict that there are more than 10 million different carbon compounds in existence today on Earth. It is found in all life forms in addition to sedimentary rocks, diamonds, graphite, coal and petroleum (oil and natural gas).

12 **Describe the chemical make-up, occurrence and importance to the carbon cycle of: (AO1)** **9 marks**

a **carbon dioxide (CO_2)**

.....

.....

.....

b **calcium carbonate ($CaCO_3$)**

.....

.....

.....

c **liquid petroleum**

.....

.....

.....

The global carbon cycle is the pathway by which carbon moves through the Earth system, including the land, oceans, atmosphere and biosphere. Some components of the Earth system, such as the oceans and land, at times act as stores of carbon by storing it for long periods, and at other times act as carbon sources by releasing it back into the atmosphere.

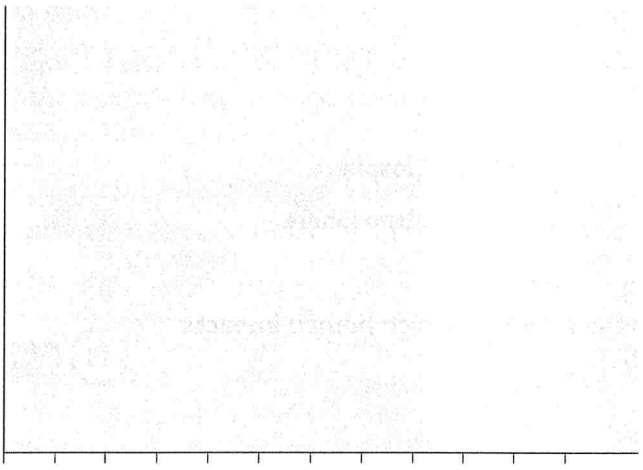
Of growing importance in the global carbon cycle are the emissions from burning hydrocarbons. These are shown in Table 1.5.

Table 1.5 Global carbon emissions from fossil fuels, 1900–2010

Year	Global carbon emissions in millions of metric tonnes of carbon
1900	600
1910	850
1920	1,000
1930	1,100
1940	1,300
1950	1,600
1960	2,600
1970	4,050
1980	5,300
1990	6,100
2000	6,850
2010	9,200

13 **Complete the graph in Figure 1.5 from the data in Table 1.5. You must label the axes and plot the data. (AO3)** 6 marks

Figure 1.5



14 **Describe the changes in the amount of global carbon emissions as shown in Figure 1.5. What effect could this have on the Earth's climate? (AO2, AO3)** 6 marks

Exam-style questions (AS)

1 Outline the potential impacts of human interventions in the carbon cycle. (AO1, AO2)

4 3 marks

2 Study a completed version of Figure 1.3. With the aid of Figure 1.3, describe the drainage basin hydrological cycle and the processes that operate in it. (AO1, AO3)

7 6 marks

3 The major global stores of carbon are:

- the lithosphere
- the hydrosphere
- the cryosphere
- the biosphere
- the atmosphere

Take any TWO of these stores and assess the extent to which human impacts have changed them over time. (AO1, AO2)

10 9 marks

Write your answer on a separate sheet of paper.

4 As part of your course you have studied a drainage basin at a local level. Describe the impact of precipitation upon the water stores and transfers in that drainage basin and explain the implications for either a sustainable water supply and/or flooding. (AO1, AO2)

22 20 marks

Write your answer on a separate sheet of paper.

Exam-style questions (A-level)

5 Explain the concept of negative feedback in relation to the carbon cycle. (AO1, AO2)

5 4 marks

Write your answers to questions 6–8 on a separate sheet of paper.

6 Study Figure 1.6. Analyse the varying potential for global carbon sequestration from different types of forestry management, 1995–2050. (AO2, AO3)

7 6 marks

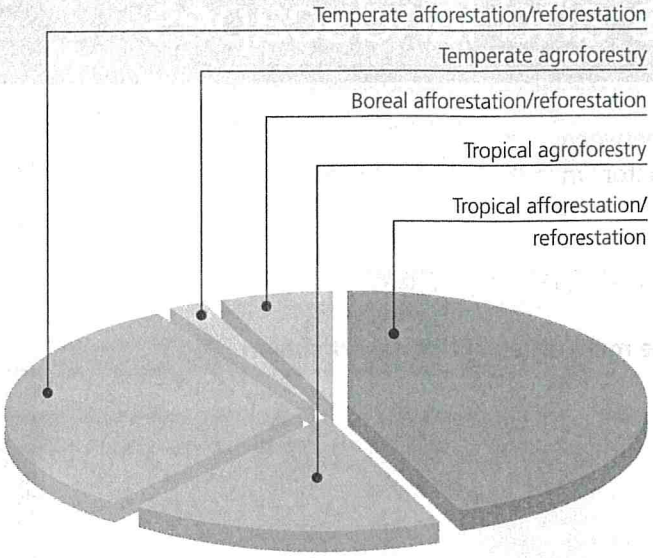


Figure 1.6 Potential contribution of afforestation/reforestation and agroforestry activities to global carbon sequestration, 1995–2050

7 Figure 1.7 shows the predicted change in global rainfall intensity by the end of the twenty-first century. Using Figure 1.7, analyse this predicted change. (AO2, AO3)

7 6 marks

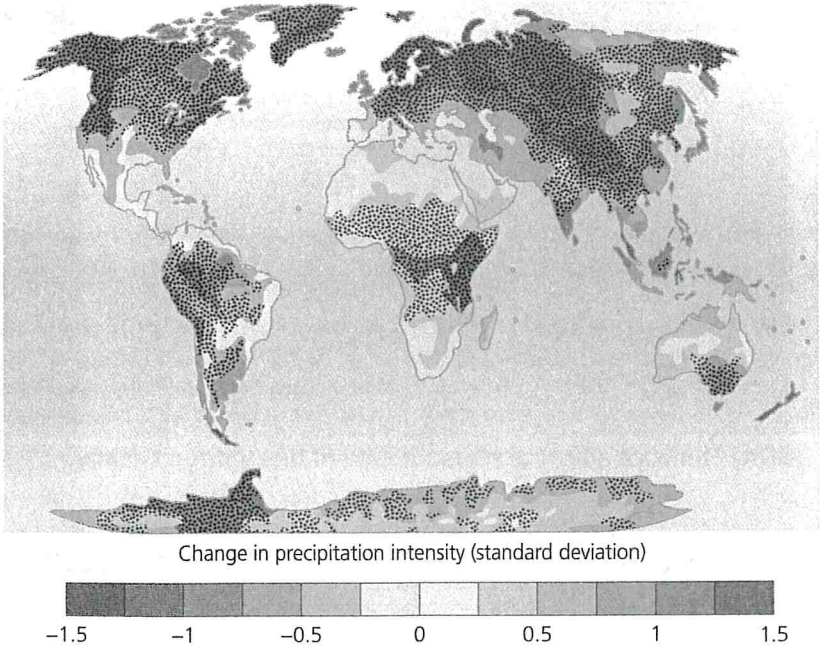


Figure 1.7 The predicted change in rainfall intensity by the end of the twenty-first century

8 With reference to a river catchment you have studied, assess the extent to which runoff depends on natural variation in the water cycle rather than human activity. (AO1, AO2)

25 20 marks