## Chapter 1-Answer Key

## CONCEPT CHECK

**1.1** What is the hydrologic cycle? What are the pathways that precipitation falling onto the land surface of the Earth is dispersed to the hydrologic cycle?

**ANSWER:**

The hydrologic cycle is a continuous process in which water is evaporated from water surfaces and the oceans, moves inland as moist are masses, and produces precipitation if the correct vertical lifting conditions exist.

A portion of precipitation (rainfall) is retained in the soil near where it falls and returns to the atmosphere via evaporation (the conversion of water to water vapor from a water surface) and transpiration (the loss of water vapor through plant tissue and leaves). Combined loss is called evapotranspiration and is a maximum value if the water supply in the soil is adequate at all times. Some water enters the soil system in infiltration which is a function of soil moisture conditions and soil and may reenter channels later as interflow or may percolate to recharge the shallow ground water. The remaining portion of precipitation becomes overland flow or direct runoff which flows generally in a down-gradient direction to accumulate in local streams that then flow into rivers.

**1.2** Who is responsible for the first recorded rainfall measurements? Describe the technique used to obtain these measurements.

**ANSWER:**

The first recording was obtained in the seventeenth century by Perrault. He obtained his data by comparing measured rainfall to the estimated flow in the Seine River to show how the two were related.

**1.3** Explain the difference between humidity and relative humidity.

**ANSWER:**

Humidity is a measure of the amount of water vapor in the atmosphere and can be expressed in several ways. Specific humidity is a mass of water vapor in a unit mass of moist air while relative humidity is a ratio of the air's actual water vapor content compared to the amount of water vapor at saturation for that temperature.

**1.4** Explain how air masses are classified. Where are these types of air masses located?

**ANSWER:**

They are classified in two ways: the source from which they are generated, land (continental) or water (maritime), and the latitude of generation (polar or tropical).
These air masses are present in the United States. The Continental polar emanates from Canada and passes over the northern United States. The maritime polar air mass also comes southward from the Atlantic Coast of Canada and affects the New England states. Another maritime polar comes from the Pacific and hits the extreme northwestern states. The maritime tropical air masses come from the Pacific, the Gulf of Mexico and the Atlantic (these affect the entire Southern United States). Continental tropical air masses from only during the summer. They originate in Texas and affect the states bordering the north.

**1.5** List seven major factors that determine a watershed's response to a given rainfall.

**ANSWER:**

Drainage Area
Channel Slope
Soil Types
Land Use
Land Cover
Main Channel and tributary characteristics-channel morphology
The shape, slope and character of the floodplain

**PROBLEMS**

**1.6** A lake with a surface area of 1050 acres was monitored over a period of time. During a one-month period the inflow was 33 cfs, the outflow was 27 cfs, and a 1.5-in. seepage loss was measured. During the same month, the total precipitation was 4.5 in. Evaporation loss was estimated as 6.0 in. Estimate the storage change for this lake during the month.

**ANSWER:**

A = 1050 acres
T = 1 month
I = 33 cfs
O = 27 cfs
G = 1.5 in.
P = 4.5 in.
E = 6 in.

I-O+P-G-E = ΔS

First convert inflow and outflow into inches

$$\text{Inflow} = \frac{33\frac{ft^3}{s}\cdot\frac{1ac}{43560ft^2}\cdot\frac{12in}{1ft}\cdot\frac{3600s}{1hr}\cdot\frac{24hr}{1day}\cdot\frac{30days}{1month}\cdot 1month}{1050acres} = 22.4 \text{ in.}$$

$$\text{Outflow} = \frac{27\frac{ft^3}{s}\cdot\frac{1ac}{43560ft^2}\cdot\frac{12in}{1ft}\cdot\frac{3600s}{1hr}\cdot\frac{24hr}{1day}\cdot\frac{30days}{1month}\cdot 1month}{1050acres} = 18.4 \text{ in.}$$

ΔS = 22.4 in. - 18.4 in. + 4.5 in. - 1.5 in. – 6 in. = **1 in.**

$$\Delta S \text{ in volume} = 1in.\cdot\frac{1ft}{12in.}\cdot 1050acres = \textbf{87.5 ac-ft}$$

**1.7** Clear Lake has a surface area of $708{,}000\ m^2$ $(70.8\ ha)$. For a given month the lake has an inflow of 1.5 $m^3/s$ and an outflow of 1.25 $m^3/s$. A +1.0-m storage change or increase in lake level was recorded. If a precipitation gage recorded a total of 24 cm for this month, determine the evaporation loss (in cm) for the lake. Assume that seepage loss is negligible.

**ANSWER:**

A = 708,000 $m^2$

$I = 1.5\ \frac{m^3}{s}$

$O = 1.25\ \frac{m^3}{s}$

$\Delta S = 1$ m

P = 24 cm

T = 1 month

$E = I - O + P - \Delta S$

Convert everything to centimeters

$\Delta S = 100$cm

$$\text{Inflow} = \frac{1.5\frac{m^3}{s}\cdot\frac{100cm}{1m}\cdot\frac{3600s}{hr}\cdot\frac{24hr}{1day}\cdot\frac{30days}{1month}\cdot 1month}{708{,}000m^2} = 549.2 \text{ cm}$$

$$\text{Outflow} = \frac{1.25\frac{m^3}{s}\cdot\frac{100cm}{1m}\cdot\frac{3600s}{hr}\cdot\frac{24hr}{1day}\cdot\frac{30days}{1month}\cdot 1month}{708{,}000m^2} = 457.6 \text{ cm}$$

E = 549.2 cm - 457.6 cm + 24cm – 1 00cm = **15.6cm**

**1.8** In a given month, a watershed with an area of $1500m^2$ received 100cm of precipitation. During the same month, the loss due to evaporation was 15cm. Ignore losses due to transpiration and infiltration due to ground water. What would be the average rate of flow measured in a gage at the outlet of the watershed in $m^3/day$?

**ANSWER:**

A = $1500\,m^2$

P = 100cm

E = 15cm

Here precipitation is the inflow I-E = O

O = 100cm-15cm = 85cm in 1 month over an area of $1500m^2$, so

$$O = \frac{85cm}{1month}\cdot\frac{1day}{24hr}\cdot\frac{1m}{100cm}\cdot 1500m^2 = 4.92E\text{-}4\ \frac{m^3}{s} = \mathbf{42.5}\frac{m^3}{day}$$

**1.9** In a given year, a watershed with an area of $2500\ km^2$ received 130 cm of precipitation. The average rate of flow measured in a gage at the outlet of the watershed was 30 $m^3$/sec. Estimate the water losses due to the combined effects of evaporation, transpiration, and infiltration due to ground water. How much runoff reached the river for the year (in cm)?

**ANSWER:**

A = $2500\ km^2$

P = 130 cm

R = 30 $m^3$/sec

Assuming $\Delta S = 0$ in the span of the year

ET+G = P-R

Convert R to cm

$$R = \frac{30\frac{m^3}{s}\cdot\frac{100cm}{1m}\frac{3600s}{1hr}\cdot\frac{24hr}{1day}\cdot\frac{365days}{1year}\cdot 1year}{2500km^2\cdot(\frac{1000m}{1km})^2} = \textbf{37.8 cm is runoff}$$

ET + G = 130 cm - 37.8 cm = **92.2 cm**

**1.10** Using the data from problem 1.9, what is the runoff coefficient?

**ANSWER:**

$$\text{Runoff coefficient} = R/P = \frac{37.8cm}{130cm} = \mathbf{0.29}$$