Методичні вказівки для СРС та навчальний матеріал з англійської мови для студентів III курсу заочної форми навчання. Напрям підготовки — «Гідрометеорологія»
Спеціальність — гідрологія та гідрохімія

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ЗМІСТ

ПЕРЕДМОВА

Нормативна дисципліна «Англійська мова» відноситься до гуманітарного циклу освітньо-кваліфікаційного рівня бакалавр / спеціаліст і є складовою частиною загальноосвітньої підготовки студентів ОДЕКУ. Практичне володіння англійською мовою є невід'ємним компонентом сучасної підготовки спеціалістів вищими навчальними закладами. Метою вивчення іноземної мови у немовному вузі є підготовка студентів до читання, розуміння та перекладу літератури за фахом, спілкування англійською мовою в різних видах мовної діяльності, можливості її використання у практичних цілях.

Іноземна мова у вищому навчальному закладі представляє собою самостійний курс, який має свій зміст і структуру. Загальний обсяг навчального часу з англійської мови визначається робочим навчальним планом і становить для студентів III курсу заочного відділення за напрямом підготовки «гідрометеорологія» за спеціальністю «гідрологія та гідрохімія» **20** годин практичної та **144** години самостійної роботи.

Метою запропонованих методичних вказівок для самостійної роботи студентів (СРС) та навчального матеріалу з англійської мови для студентів III курсу заочної форми навчання, напрям підготовки — ***«гідрометеорологія»*** (спеціальність — ***«гідрологія та гідрохімія»***) є:

- виробити у студентів навички читання та перекладу науково-технічної англомовної літератури за фахом;
- розвинути вміння та навички розуміння змісту прочитаного;
- реферувати оригінальну літературу за фахом для отримання необхідної інформації;
- брати участь в усному спілкуванні іноземною мовою в обсязі матеріалу, передбаченого програмою;
- підготувати студентів до складання іспиту з англійської мови.

Методичні вказівки складаються з **трьох частин.** У першій частині подаються 7 неадаптованих текстів, що взяті з оригінальної наукової літератури за спеціальністю. Подані тексти за вказівкою викладача використовуються як матеріал для практичної роботи на заняттях під час сесії, чи як поза аудиторне читання, метою якого є знайомство з англомовною науковою оригінальною літературою, накопичення слів та виразів, характерних для гідрологічної галузі науки та надбання навичок перекладу перед виконанням контрольних робіт №№ 8, 9, 10, що подаються у другій частині методичних вказівок і є контролем самостійної роботи студентів (СРС). Контрольні роботи мають два варіанти. Критерієм обрання І чи ІІ варіанту контрольної роботи є індивідуальний шифр залікової книжки студента (якщо остання цифра шифру є непарною, то студенту надається І варіант контрольної роботи, якщо остання цифра шифру є парною — надається ІІ варіант контрольної роботи). Під час письмового перекладу поданих текстів студентам рекомендовано користуватися загальними та спеціалізованими словниками.

У третій частині подані тексти країнознавчого характеру для усного переказу, які призначені для розвитку навичок усного мовлення та засвоєння відповідного лексичного матеріалу.

Програма з дисципліни англійська мова для студентів ІІІ курсу заочної форми навчання (напрям підготовки — гідрометеорологія, спеціальність — гідрологія та гідрохімія)

Змістовні модулі	№ п.п	Назва теми заняття	Кількість годин				Форма Контролю
			загальна	лекції	практичні заняття	самостійна робота	
	1	Деякі особливості перекладу науково-технічної літератури. Розмовна тема «*About Myself*». Самостійний переклад текстів за фахом — 5.000 друкованих знаків.	16	-	2	14	УО

ЗМ – П1	2	Особливості перекладу, видо-часових форм дієслів (Active Voice, Passive Voice). Розмовна тема «***My Future Profession***». Самостійний переклад текстів за фахом — 5.000 друкованих знаків.	16	-	2	14	УО
	3	Особливості перекладу модальних дієслів. Розмовна тема «***Ukraine***». Самостійний переклад текстів за фахом — 5.000 друкованих знаків.	16	-	2	14	УО
ЗМ – П2	4	Особливості перекладу інфінітиву. Розмовна тема «***Kyiv***». Самостійний переклад текстів за фахом — 5.000 друкованих знаків.	16	-	2	14	УО
	5	Особливості перекладу дієприкметників. Розмовна тема «***Odessa***». Самостійний переклад текстів за фахом — 5.000 друкованих знаків.	16	-	2	14	УО
	6	Особливості перекладу герундія. Розмовна тема «***Great Britain***». Самостійний переклад текстів за фахом — 5.000 друкованих знаків.	16	-	2	14	УО
ЗМ – П3	7	Особливості перекладу дієслів з післялогами. Особливості перекладу суспільно-політичного тексту. Розмовна тема «***London***». Самостійний переклад суспільно-політичного тексту — 5.000 друкованих знаків.	17	-	2	15	УО

	8	Особливості перекладу іменників у функції означення. Розмовна тема «***The Political System of Ukraine»***. Самостійний переклад суспільно-політичного тексту — 5.000 друкованих знаків.	17	-	2	15	КР № 8
ЗМ – П4	9	Особливості перекладу прикметників з прийменниками. Практика у перекладі. Розмовна тема «***The Political System of Great Britain***». Самостійний переклад суспільно-політичного тексту — 5.000 друкованих знаків.	17	-	2	15	КР № 9
	10	Найбільш уживані скорочення прийняті в англо-американській технічній літературі. Самостійний переклад текстів за фахом — 5.000 друкованих знаків.	17	-	2	15	КР № 10
		Усього	164	-	20	144	

Умовні позначення:
УО — усне опитування;
КР — контрольна робота.

Організація контролю знань та вмінь студента

При самостійному вивчинні дисципліни «Англійська мова» контроль здійснюється за допомогою системи контролюючих заходів, що складаються з поточного та підсумкового контролю.

Поточний контроль здійснюється впродовж усього навчального курсу за формами: перевірка контрольної роботи, перевірка знань та вмінь студента підчас аудиторних занять на протязі заліково-екзаменаційної сесії шляхом усного опитування.

Підсумковий контроль здійснюється підчас ***іспиту.*** Термін проведення контролюючих заходів — згідно графіку заочної форми навчання.

Письмовий контроль містить 3 контрольні роботи (№№8, 9, 10), максимальна оцінка за одну контрольну роботу — 20 балів, (тобто за три контрольні роботи — 60 балів).

Оцінюється виконання завдання контрольної роботи наступним чином:

- 18–20 балів (відмінно) — при бездоганному виконанні завдання, якщо переклад тексту в контрольній роботі здійснено без суттєвих граматичних та стилістичних помилок, студент відповів правильно на поставлені запитання, а також продемонстрував знання основних англомовних термінів за фахом «гідрологія та гідрологія», які наявні у поданій контрольній роботі;
- 15–17 балів (добре) — переклад тексту у контрольній роботі виконано на належному рівні, але відповіді на запитання викладача не є повними, або не є правильними;
- 12–14 балів (задовільно) — переклад тексту у контрольній роботі виконано з помилками, відповіді на запитання викладача є неправильними;
- менш 12 балів (незадовільно) — студент переклав текст контрольної роботи, де припустив більше 10 помилок, при відповідях на поставлені запитання припустив велику кількість помилок та не продемонстрував знання основних англомовних термінів за фахом «гідрологія», що наявні у поданих контрольних роботах.

Усне опитування оцінюється наступним чином:

- студент правильно переказав текст з дотриманням граматичних, стилістичних, фонетичних правил англійської мови на задану тему, а також дав правильні повні відповіді, що наведені в кінці кожної контрольної роботи — 18 – 20 балів (відмінно);

- студент переказав текст з деякими граматичними, стилістичними та фонетичними помилками та не дав повні відповіді на запитання — 15–17 балів (добре);
- студент переказав текст з суттєвими граматичними, стилістичними, фонетичними помилками і відповів лише на базові питання — 12–14 балів (задовільно);
- студент переказав текст з великою кількістю граматичних, стилістичних, фонетичних помилок і не зміг відповісти на базові питання — менше 12 балів (незадовільно).

Студенти, які виконали контрольні роботи та отримали за результатами перевірки не менш ніж 36 балів (60%) мають допуск до іспиту з дисципліни.

Оцінки за іспит виставляються наступним чином:

- 18–20 балів (відмінно) — повна відповідь на запитання білету;
- 15–17 балів (добре) — відповіді на питання білету не є повними;
- 12–14 балів (задовільно) — студент відповів лише на базові питання;
- менш 12 балів (незадовільно) — студент не може відповісти на запитання білету.

Підсумкова оцінка з дисципліни виставляється як сумарна за контрольну роботу, усне опитування та складання іспиту. Таким чином студент може отримати максимально 100 балів. Якісна оцінка є такою:

- **91–100** — відмінно;
- **76–90** балів — добре;
- **61–75** балів — задовільно;
- менш **60** балів — незадовільно.

Студенти, які не отримали за контрольні роботи мінімальної кількості балів (36 балів), повинні виконати інший варіант контрольних робіт, який надається викладачем, або виправити помилки попереднього варіанту та отримати відповідну кількість балів для допуску до іспиту.

PART I

READING AND TRANSLATION

Text 1

BASIN RECHARGE AND RUNOFF

As rain falls towards the earth, a portion of it is intercepted by the leaves and stems of vegetation. The water so retained, interception, together with depression storage and soil moisture, constitutes basin recharge, the portion of precipitation which does not contribute to streamflow or ground-water. Depression of storage includes the water which is retained as puddles in surface depressions. Soil moisture is held as capillary water in the smaller pore spaces of the soil or as hydroscopic water absorbed on the surface of soil particles.

Rainwater or melting snow, exclusive of the water withheld as basin recharge, may follow their path to the stream. A portion travels as overland flow (surface runoff) across the ground surface to the nearest channel. Still other water may infiltrate into the soil and flow laterally in the surface soil to the stream channel as interflow. A relatively impermeable stratum in the subsoil favours the occurrence of interflow. A third portion of the water may percolate downward through the soil until it reaches the groundwater. Vertical percolation of rainwater results in groundwater accretion only if the soil is highly permeable if the groundwater is near the surface. Low soil permeability encourages overland flow, while a thick soil mantle, even though permeable, may retain so much water as soil moisture that none can reach the groundwater.

It is convenient but inaccurate to discuss recharge and runoff as if runoff began only after recharge of the basin was complete. While the potential rate of recharge is at the maximum at the beginning of a storm, recharge normally continues at decreasing rates as long as the storm lasts. A condition of complete saturation, i.e., all moisture-storage capacity of the basin fully used, occurs

very rarely. The distinction between the three types of runoff is also somewhat artificial. Water moving as surface runoff may infiltrate and become interflow or groundwater, while infiltrated water may come to the surface and finally reach the channel as surface flow. These concepts do, however, permit a rational approach to hydrology.

Overland flow and interflow are frequently grouped together as direct runoff. This water reaches the stream shortly after it falls as rain and is discharged from the drainage basin within a few days. Much of the low water flow of streams is derived from groundwater. Stream channels which have perennial flow are below the groundwater table and the called effluent streams. Intermittent streams, which go dry if much time elapses between rains, are usually influent streams, i.e., their channels are above the level of the ground-water, the percolation from the stream channel to the groundwater occurs. Most river basins contain streams which fall into both categories, and some streams may be either influent or effluent depending upon the rate of flow and existing groundwater levels.

Hydrograph analysis. The characteristics of direct and groundwater runoff differ so greatly that they must be treated separately in problems involving short-period, or storm, runoff. There is no practical means of differentiating between groundwater flow and direct runoff after they have been intermixed in the stream and the techniques of hydrograph analysis are arbitrary. The typical hydrograph resulting from a single storm consists of a rising limb, peak, and recession. The recession represents the withdrawal of water stored in the stream channel during the period of rise. Double peaks are sometimes caused by the geography of the basin but more often results from two or more periods of rainfall separated by periods of little or no rain.

Vocabulary

depression storage — затримання у пониженнях
basin recharge — затримання у басейні

overland flow — поверхневий (стоковий) стік
soil maul — покров ґрунту
intermittent stream — пересихаючий струмок
moisture-storage capacity — вологоємність
perennial flow — багатолітній потік
recession — відступ

Answer the following questions:
1. What does basin recharge consist of?
2. What way may rain water or melting snow follow?
3. What favours the occurrence of interflow?
4. Speak about effluent streams.
5. What does the typical hydrograph represent?

Text 2

OCCURRENCE OF GROUNDWATER

Zones of underground water. Immediately below the surface, the soil pores contain both water and air in varying amounts. After a rain, water may move downward through this zone of aeration. Some water is dispersed through the soil to be held by capillary forces in the smaller or by molecular attraction about the soil particles. Water in the upper layers of the zone of aeration is known as soil moisture. If the retention capacity of the soil in the zone of aeration is satisfied, water moves downward into the region where the pores of the soil or rock are filled with water. The water in this zone of saturation is called the groundwater. Above the zone of saturation is a capillary fringe in which the smaller soil pores contain water lifted by capillary action from the zone of saturation.

Sources of groundwater. The main source of groundwater is precipitation which may penetrate the soil directly to the groundwater or may enter surface streams and percolate from these channels to the groundwater. It should be emphasized that the groundwater has the lowest priority on the water from

precipitation. This low priority is an important factor in limiting the rates at which groundwater may be utilized. Interception, depression storage, and soil moisture must be satisfied before any large amount of water can percolate to the groundwater. Except where sandy soils occur, only prolonged periods of heavy precipitation can supply large quantities of water for groundwater recharge. Groundwater recharge is an intermittent and irregular process.

Geologic conditions determine the path by which water from precipitation reaches the zone of saturation. If the water table is near the surface, there may be considerable percolation through the soil. Relatively impermeable layers above the water table may prevent such direct percolation. Stream channels which cut through permeable alluvial deposits offer a path for water to reach the groundwater, provided the stream is above the level of the ground-water. The rate of percolation from an influent stream is limited by the extend and character of the underlying material and flood flows in excess of the limiting percolation rate may discharge into the ocean or to lakes.

Other sources of groundwater include water from deep in the earth which is carried upward in instrusive rocks and water which is trapped in sedimentary rocks during their formation. The quantities of such waters are small, and they are often so highly mineralized as to be unsuited for use.

Aquifers. Formations which contain and transmit groundwater are known as aquifers. The amount of groundwater which can be obtained in any area depends on the character of the underlying aquifer and the extend and frequency of recharge. The capacity of a formation to contain water is measured by the porosity, or ratio of the pore volume to the total volume of the formation. Pores vary in size from submicroscopic opening in clay and shales to large caverns and tunnels in limestone and lava. The porosity of the material can be determined by ovendrying an undisturbed sample and weighed again. The sample is then saturated with some liquid such as kerosene and weighed again. Finally the saturated sample

is immersed in the same liquid and the weight of liquid displaced is noted. The weight of liquid required to saturate the sample divided by the weight of the displaced liquid gives the porosity as a decimal. It is sometimes necessary to inject the liquid under pressure to completely displace all air in the voids.

A high porosity does not indicate that an aquifer will yield large volumes of water to a well. The only water which can be obtained from the aquifer is that will flow by gravity. The specific yield is the volume of water (expressed as a percentage of the total volume of the aquifer) which will drain freely from the aquifer. Specific yield is always less than porosity since some water will be retained in the aquifer by molecular or capillary forces. The specific yield of fine-grained materials is much less than that of coarse materials. Clay, although having a high porosity, is so fine grained that it ordinarily yields little water to wells. In contrast, a cavernous limestone or fractured sand stone with low porosity may yield almost all the water it contains. The most important aquifers economically are deposits of sand and gravel, which have a fairly high specific yield.

Vocabulary

retention capacity — здатність збереження, регулююча здатність
groundwater recharge — живлення підземних вод
intrusive rocks — плутонічні породи
specific yield — питома водовіддача, питомий дебит
fine-grained materials — дрібнозернистий матеріал
fractured sandstone — піщаник

Answer the following questions:

1. Speak about the zones of underground water.
2. What can you say about the main sources of groundwater?
3. When may considerable percolation through the soil be?
4. How do geologic conditions determine the path by which water from precipitation reaches the zone of saturation?

5. What sources of groundwater do you know?
6. What are aquifers?
7. How can we determine the porosity of the material?
8. What is the «specific yield»?

Text 3

THE WATER TABLE

The static level of water in wells penetrating the zone of saturation is called the water table. The water table is often described as a subdued replica of the surface topography. It is commonly higher under the hills than under valleys, and a contour map of the water table in an area may look much like the surface topography. The water table in the surface of the water body which is constantly adjusting itself towards an equilibrium condition. If there were no recharge to or outflow from the groundwater in a basin, the water table would eventually become horizontal. Few basins have uniform recharge conditions at the Surface. Some areas receive more rain than others. Some portions of the basin have more permeable soil. Thus, when intermittent recharge does occur, mounds and ridges form in the water table under the areas of greatest recharge. Subsequent recharge creates additional mounds, perhaps at other points in the basin, and the flow pattern is further changed. Superimpose upon these fairly simple picture variations in permeability of the aquifers, impermeable strata, and the influence of lakes, streams and wells, and one obtains a picture of a water table constantly adjusting towards equilibrium. Because of the low flow rates in most aquifers this equilibrium is rarely attained before additional disturbances occur.

When water occurs in cracks, fissures, and caverns, the situation is somewhat different. Flow in large openings is usually turbulent, and adjustments take place fairly rapidly. Water is usually found at about the same level anywhere within a system of interconnected openings. Water levels may vary considerably; however, between entirely separate openings in the same formation. Wells driven

into such formation will yield little water unless they intersect one of the fissures of caverns.

Artesian Aquifers. Sometimes an aquifer is confined by strata of low permeability. Such artesian aquifers are analogous to pipelines. The static pressure at a point within the aquifer is equivalent to the elevation of the water table in the recharge area less the loss in heat through the aquifer to the point in question. A well piercing the confining stratum acts much like a piezometer in a pipe, and water will rise in the well to the level of the local static pressure (artesian head). If the pressure is sufficient to raise water above the ground, the well is called a flowing well. The surface defined by the water level in a group of artesian wells is called the piezometric surface and is the artesian equivalent of the water table.

The shape of the piezometric surface may be visualized in much the same manner as the hydraulic grade line of a pipe. If no flow takes place through the aquifer, the piezometric surface will be level. As discharge increases, the surface slopes more steeply towards the discharge point. The slope of the gradient is steep through areas of low permeability and relatively flat where permeability is high. Because of the low velocities of flow in groundwater, velocity head is negligible and minor variations in the cross section of the aquifer are not reflected in the artesian levels.

When water is withdrawn from an artesian well, a local depression of the piezometric surface results. This decrease in pressure permits a slight expansion of the water and a compaction of the aquifer. The lowered pressure around the well increases the flow towards the well, and after sufficient time has elapsed, this increased flow is reflected in a lowering of the water table in the recharge area. In expensive aquifers the elapsed time may be measured in years.

Artesian aquifers usually have relatively small recharge areas as compared with water-table aquifers and generally yield less water. The economic importance of artesian aquifers

lies in the fact that they transmit water substantial distances and deliver it above the level of the aquifer, thus minimizing pumping costs.

Vocabulary

subdued replica — згладжена модель
equilibrium condition — умова рівноваги
permeable soil — водопроникний ґрунт
flowing well — фонтануюча свердловина
hydraulic grade line — лінія гідравлічного схилу
cross section — поперечне січення
mound — пагорбок

Answer the following questions:

1. Explain the term «water table».
2. What can you say about artesian aquifers?
3. When the well is called a flowing well?
4. Describe the shape of the piezometric surface.
5. What occurs when a local depression of the piezometric surface results?
6. Which aquifers have relatively small recharge?

Text 4

MOVEMENT OF GROUNDWATER

Except in large caverns and fissures, groundwater flow is almost exclusively laminar. Hagen (1839) and Poisseuille (1846) showed that the velocity in capillary tubes is proportional to the slope S of the energy gradient. Darcy (1856) confirmed the applicability of this principle to flow in uniform sands, and the resulting equation

$$V = KS$$

is commonly called **Darcy's law**. The velocity V is an apparent one, that is,

$$V = \frac{Q}{A}$$

where Q is the flow rate (volume per unit time) through a cross-sectional area A of aquifer. The term K in Darcy's law is referred to as saturated hydraulic conductivity or coefficient of permeability. It has the same unite as V (ft/day or m/day) since the slope S (ft/ft or m/m) is dimensionless. Since velocity heads are negligible in groundwater flow S is also the slope of the water table or the piezometric surface.

The actual velocity varies from point to point through the medium. On the average, the actual velocity at which water is moving through an aquifer is given by

$$V_{act} = \frac{Q}{A_{act}} = \frac{Q}{pA} = \frac{V}{p}$$

where p is the porosity of the medium expressed as a decimal. The Vact represents, on the average, the velocity at which a tracer would move through a permeable medium. In the case of aquifers made up of very fine particles, the p of the last equation should be replaced by the effective porosity ap where a is the fractional part of pore space that is occupied by moving water. The term 1-a c represents the fraction of pore space occupied by inactive water that does not contribute to the flow as it is held in the medium by molecular forced. For sands and gravels 1.0.

The standard coefficient of permeability Ks is usually expressed in English units as gallons per day through an area of 1 ft2 under a hydraulic gradient of unity or in meters per day under unit gradient (in SI metric units). Since viscosity plays an important part in laminar flow, Ks is defined for laboratory determination at 60°F (15°C), a fairly representative temperature for groundwater. Permeability at temperatures other than 60°F (15°C) varies inversely as the respective kinematic viscosities v. Hence

$$K = K_S \frac{V}{V_T} 60.$$

The transmissibility T is the flow in gallons per day (cubic meters per day) through a section of aquifer 1ft (1m) wide under a hydraulic gradient of unity. The flow through an aquifer in gallons per day can be written as

$$Q = K_s AS = TBS$$

where B is the width of the aquifer and S is the slope of the water table. This equation is similar to the equation of the flow of electricity (Ohm's law) where S is analogous to the gradient of the voltage drop, KS A (or TB) to the conductance of the circuit, and Q to the amperage. From this equation it is seen that the transmissibility of an aquifer may be expressed as

$$T = K_s (A/B) = K_s Y$$

where Y is the thickness (depth) of the saturated zone within the aquifer.

The coefficients K, KS and T depend not only on the medium but also upon the fluid; a more rational concept of permeability would express it in terms that are independent of the fluid properties. The intrinsic permeability k of a medium can be defined as

$$k = Cd^2$$

where C is dimensionless and depends on the various properties of the medium such as porosity and particle shape and distribution; the term d is the mean particle diameter and K is the measure of the pore area.

The dimensions of k are L2 or area. When expressed in square feet or square centimeters the numerical value of k is very small. The darcy has been adopted as the standard unit of intrinsic permeability. The equivalent conversions are:

$$1 \text{ darcy} = 0.987 \times 10^{-8} \text{ cm}^2$$

$$1 \text{ darcy} = 1.062 \times 10^{-11} \text{ ft}^2$$

By dimensional analysis the relation between coefficient of permeability K and intrinsic permeability k can be shown to be

$$K = \frac{kg}{V}$$

Vocabulary

hydraulic conductivity — гідравлічна проникність
velocity head — швидкісний напір
on the average — у середньому
decimal — десятинна дріб
permeable medium — проникне середовище
gallon per day — галон на добу = (4,546л)
voltage drop — падіння напруги
amperage — сила стоку
intrinsic permeability — істинна водопроникність

Answer the following questions:
1. What equation is called Darcy's law?
2. How is the term K in Darcy's law referred to?
3. Does the actual velocity vary through the medium?
4. How is the standard coefficient of permeability expressed?
5. What is transmissibility?

Text 5

DETERMINATIONS OF PERMEABILITY

Laboratory determinations of permeability are made with devices called permeameters. Many types of permeameters have been used, but all are similar in principle. A sample of material is placed in a container, and the rate of discharge through the material under a known head is measured. A disadvantage of laboratory measurement of permeability is that the test sample is email and possible not representative of average conditions in the aquifer. In many cases it is difficult to obtain undisturbed samples which represent the true conditions in the aquifer. To avoid wall effect, permeameter diameter should be at least 40 times the mean particle diameter. To avoid difficulties from air bubbles, the water should be dearated, and the medium should be saturated before test. With proper care good results can be obtained.

Field measurements of permeability are made by conducting pumping tests on wells. The well is pumped at a uniform rate and the drawdown is measured. Another method of estimating the permeability of an aquifer is to introduce a tracer into a well and determine its time of arrival at a downstream well. Because of dispersion, the tracer concentration will vary with time as it passes the downstream well. Also the downstream sampling point cannot be far from the point of tracer application as the tracer concentration decreases rapidly with distance. The time of arrival at he downstream well can be assumed to be coincident with the centroid of the tracer-concentration versus time curve. Having thus determined the mean value of the actual velocity, the flow rate can then be determined from the equation

$$V_{act} = \frac{Q}{A_{act}} = \frac{Q}{pA} = \frac{V}{p}$$

if the porosity of the aquifer is known.

Various tracers such as common salt, dyes, and radioactive materials have been used successfully in groundwater studies, particularly investigations of pollution. Some dyes and radioactive materials are unsuited for use in aquifers containing clay fractions because of Base Exchange and absorption phenomena. Tracer methods give only a rough evaluation of velocity and permeability. They are, however, useful in tracing the path of groundwater flow. For example, dye may be introduced into a cesspool or septic tank suspected of being a source of pollution for a well. If the dye subsequently appears in the well, the suspicion is confirmed.

Vocabulary

permeameter — перміаметр (прилад для визначення коефіцієнту фільтрації)
rate of discharge — витрачення води
undisturbed sample — непорушений зразок

drawdown — відпомпування, штучне пониження рівня грунтових вод
flow rate — швидкість течії, потоку

Answer the following questions:
1. By means of what can laboratory determinations of permeability be made?
2. What disadvantage has laboratory measurement of permeability?
3. How are field measurements of permeability made?
4. What tracers are used in groundwater studies?
5. Are tracer methods exact?

Text 6

YIELD OF GROUNDWATER

Safe yield. Withdrawal of water from the ground at rates greater than those at which it is replenished results in lowering the water table and an increase in pumping cost. In coastal areas an overdraft may reverse the normal seaward gradient of the water table and permit salt water to move island and contaminate the aquifer. An aquifer undisturbed by pumping is in approximate equilibrium. Water is added by natural recharge and removed by natural discharge.

In years of abundant water the water table rises and in years of drought the water level declines, but rates of recharge and discharge tend to remain an approximate balance. When a well is put into operation, new conditions are created. Water may be removed from storage in the aquifer or mined in the sense that other minerals are mined. The depression in the water table caused by the well may induce increased recharge or may decrease natural discharge. The concept of safe yield has been used to express the quantity of groundwater which can be without imparing the aquifer as a water source, causing contamination, or creating economic problems from increased pumping lift. Actually, safe yield cannot be defined in truly practical and general terms. The location of wells with

respect to areas of recharge and discharge, the character of the aquifer, the potential sources of pollution, and many other factors are involved in estimates of the maximum feasible withdrawal from an aquifer. A number of closely spaced wells will cause much more rapid decline of local water levels than the same number of wells more widely dispersed.

Determination of safe yield is a complex problem in hydrology, geology, and economics for which each aquifer requires a unique solution. The general type cases are:

1. Aquifers in which safe yield is limited by the availability of water for recharge.
2. Aquifers in which safe yield is limited by the transmissibility of the aquifer.
3. Aquifers in which safe yield is limited by potential contamination.

The first case is commonly encountered in arid regions. The groundwater may be visualized as a large reservoir which is drawn down to supply water needs during periods of low recharge. Lowering of the water table during dry periods is not evidence that the safe yield has been exceeded, but a continuing decline during rainy periods warns of excessive withdrawals. The safe withdrawals from such a groundwater reservoir is equal to annual recharge less the unavoidable discharge. Thus

$$\text{Safe yield} = P - R - E_{act} - G_0$$

where P and E act are the mean annual precipitation and evapotraspiration, respectively, from the area tributary to the aquifer, R is the mean annual runoff from the tributary area, and G_0 is the net mean annual subsurface discharge from the aquifer.

The transmissivity of aquifers may be so low that although adequate water is available this water does not move towards the wells fast enough to permit its full utilization. Lowering the water table may increase the gradient from the recharge area and permit greater flow to the wells. This problem is sometimes referred to as a pipeline problem, since it is analogous to a city supplied by a large reservoir but with an inadequate pipeline.

Where contamination of the groundwater is possible, the layout of the well field, the rates of use, and the types of wells must be planned in such a way that conditions permitting contamination cannot develop. All three cases offer several possible values of safe yield depending upon the physical situation and the methods used to collect the groundwater. Safe yield is a concept which can be given quantitative significance only when all controlling conditions are defined.

Vocabulary

safe yield — гарантований запас (ґрунтових вод)
overdraft — відпомпування
withdrawal — забирання, вилучення (води)
pipeline — трубопровід
layout — розбивка
contamination — забруднення
decline — пониження
subsurface discharge — підповерхневий стік

Answer the following questions:

1. What happens to the water table in years of abundant water and in years of drought?
2. For what is the concept of safe yield used?
3. How is the safe yield determined?
4. Speak about the first type of determination of safe yield.
5. What problem is referred to as a pipeline problem?

Text 7

ARTIFICIAL RECHARGE

If the rate of recharge of a reservoir-type aquifer is increased, the safe yield is also increased. If an aquifer of low transmissibility can be recharged close to the point of withdrawal, the safe yield may also be increased. There are several advantages in storing

water underground. The cost of recharge may be less than the cost of equivalent surface reservoirs. The aquifer serves as a distribution system and eliminates the need for surface pipelines or canals. The reduction in first cost may offset the cost of pumping. A water store in surface reservoirs is subject to evaporation and to pollution, which may be avoided by underground storage. Even more important may be the fact that suitable sites for surface reservoirs may not be available. The groundwater can therefore be viewed as a reservoir to be operated alone or in conjunction with surface storage.

Artificial groundwater recharge may be accomplished by induced infiltration, spreading, and recharge wells. Induced infiltration is accomplished by increasing the water-table gradient from a source of recharge. This may be done by placing wells close to a stream or lake. Induced infiltration has been used along large rivers to develop municipal and industrial supplies

Water spreading involves diversion of surface water over permeable ground, where it may infiltrate to the groundwater. Shallow ditches or low earth dikes may be used to divert the occasional flows from small arroyos over adjacent flatlands. In areas where the main route of recharge is through the beds of the river channels, surface reservoirs may be used to store flows in excess of the percolation capacity of the channel. These waters may be released for percolation when the natural stream flow is low. A major problem in any percolation area is that of maintaining the percolation rate at a high level. Scarifying the area at intervals is sometimes helpful. Vegetation is also reported to increase in transpiration losses. Water containing sediment should be avoided as it may seal the spreading area.

A proposed spreading area should be explored with test holes to assure that subsurface conditions favor the spreading. If a stratum of low permeability is found, recharge through wells may be desirable. The physical details of recharge wells are essentially the same as for recharge during an off-season when water is not required. Water for recharge into wells should be free of suspended matter, which may clog the screen, or bacteria, which can form bacterial slimes. Water

may be fed into the well by gravity or may be pumped under pressure to increase the recharge rate if subsurface conditions will permit. Recharge wells permit the water to be injected into the aquifer where it is most needed and may be particularly advantageous in dealing, with pipeline-type aquifers. The recharge capacity of wells is, however, often quite low.

The temperature and chemical quality of the recharge water should be studied to determine the conditions which will result in groundwater. Use of treated sewage for recharge has been proposed. However, sewage normally contains relatively large amounts of dissolved salts, especially sodium chloride, nitrates, and boron (from soaps). The effect of such compounds on the groundwater should be carefully considered. Since wells inject water directly into the aquifer, sewage for recharge through wells should generally be bacteriologically pure. Surface water is often warmer than the groundwater, and recharge may raise the temperature of the ground-water to the detriment of its use for cooling purposes.

Vocabulary

offset — знижувати, зрушувати
to be subject to — підпадати під щось, зазнавати
surface storage — запас поверхневих вод; поверхнева затримка
induced infiltration — індуктована інфільтрація
spreading of water — розповсюдження водної маси, поповнення запасів ґрунтових вод, дощування
recharge well — поглинаючий колодязь
diversion — відведення, відхилення
ditch — канава
dike — дамба
arroyo — арройо (сухе річище)
flood flow — паводковий стік
scarify — розрихлять поверхню
sewage — стічні води

Answer the following questions:

1. What favours the increasing of safe yield?
2. What advantages in storing water underground do you know?
3. By means of what is artificial groundwater accomplished?
4. Speak about water spreading.
5. What is the reason to study the temperature and chemical quality of the recharge water?

PART II

CONTROL PAPERS

Control Paper 8

Variant 1

1. Translate the text in writing:

THE HYDROLOGIC CYCLE

The world's supply of fresh water is obtained almost entirely as precipitation resulting from evaporation of seawater. The processes involved in the transfer of moisture from the sea to the land and back to the sea again form what is known as the hydrologic cycle. An understanding of these processes is important to the water-resources engineer.

The Hydrologic Cycle. The first stage in the hydrologic cycle is the evaporation of water from the oceans. This vapor is carried over the continents by moving air masses. If the vapor is cooled to its dew point, it condenses into visible water droplets which form cloud or fog. Under favourable meteorological conditions the tiny droplets grow large enough to fall to earth as precipitation.

Cooling of large masses of air is brought about by lifting. The resulting decrease in pressure is accompanied by a temperature decrease in accordance with the gas laws. Orographic lifting occurs when air is forced to rise over a mountain barrier. Per this reason the windward slopes of mountains are usually regions of high precipitation. Air also may rise over a cooler air mass. The boundary between these air masses is called a frontal surface, and the lifting process is called frontal lifting. Finally, air heated from below may rise by convection through cooler air (convective lifting) to cause the isolated convective thunderstorm characteristic of summer climate in much of the world.

About two-thirds of the precipitation which reaches the land surface is returned to the atmosphere by evaporation from water surfaces, soil, and vegetation and through transpiration by plants. The remainder of the precipitation returns ultimately to the ocean through surface or underground channels. The large percentage of precipitation which is evaporated has often led to the belief that increasing this evaporation by construction of reservoirs or planting of trees will increase the moisture (usually much less than 10 percent) which passes over any given point on the earth's surface is precipitated. Hence, moisture evaporated from the land surfaces is a minor part of the total atmospheric moisture.

The River Basin. A river basin is the area tributary to a given point on a stream and is separated from adjacent basins by a divide, or ridge, which can be traced on topographic maps. All surface water originating in the area enclosed by the divide is discharged through the lowest point in the divide through which the main stream of the basin passes. It is commonly assumed that the movement of the groundwater conforms to the surface divides, but this assumption is not always correct, and large quantities of water may be transported from one basin to another as groundwater.

Vocabulary

in accordance with (in accord with) — згідно з
frontal surface — фронтальна поверхня
under ... conditions — за ... умовою
windward — навітряний
divide — вододіл
ridge — підводна гряда, вододіл

Answer the following questions in writing:

1. Explain the term «hydrologic cycle».
2. What is the first stage in the hydrologic cycle?
3. How does precipitation form?
4. When does orographic cooling occur?

5. What happens to precipitation after reaching the earth?
6. What can you say about a river basin?

Control Paper 8

Variant 2

1. Translate the text in writing:

PRECIPITATION

Types of Precipitation. Precipitation includes all water which falls from the atmosphere to the earth's surface. Precipitation occurs in a variety of forms which are of interest to the meteorologist, but the hydrologist is interested in distinguishing only between liquid precipitation (rainfall) and frozen precipitation (snow, hail, sleet, freezing rain). Rainfall runs to the streams soon after it reaches the ground and is the cause of most floods. Frozen precipitation may remain where it falls for a long time before it melts. Melting snow is rarely the cause of major floods although, in combination with rainfall, it may contribute to the major floods. Mountain snowpacks are often important sources of water for irrigatation and other purposes. The snowfields serve as vast reservoirs which store winter precipitation until spring thaws release it near the time it is required for irrigatation.

Fog Drip and Dew. Fog consists of water droplets so small that their fall velocities are negligible. Fog particles which contact vegetation may adhere, coalesce with other droplets, and eventually form a drop large enough to fall to the ground. Fog drip is an important source of vegetation during the rainless summers.

On clear nights lose of heat by radiation from the soils causes cooling of the ground surface and of the air immediately above it. Condensation of the water vapor present in the air results in a deposit of dew. The small quantities of dew and fog drip deposited any day do not contribute to streamflow or ground-water. They do, however, offer a source of water which may be exploited locally.

Snow. Snow on the ground is measured in terms of its depth (in inches or centimeters). Shallow depths are measured on a snow stake, a graduated post permanently installed at the desired site. Because of variations in snow density, a depth measurement is not sufficient to tell how much water is contained in the snow pack. The water equivalent, or depth of water, which would result from melting a column of snow, is measured by forcing a small tube into the snow, withdrawing it, and weighing the tube to determine the weight of the snow core removed. There are a number of types of snow samplers. The specific gravity of freshly fallen snow is usually about 0.1. Thus, its water equivalent is 0.1 in for each inch of snow depth. The specific gravity increases with time as snow remains on the ground and may reach a maximum of about 0.5 in heavy mountain snowpacks.

Precipitation Measurement. Amount of precipitation is expressed as the depth in inches or millimeters which falls on a level surface. This may be measured as the depth of water deposited in an open, straight-sided container.

In order to determine rates of rainfall over short periods of time, recording rain gages are used. The weighing rain gage has a bucket supported by a spring or level balance. Movement of the bucket is transmitted to a pen which traces a record of the increasing weight of the bucket and its contents on a clock-driven chart or punched paper tape. The tipping-bucket gage consists of a pair of buckets pivoted under a funnel in such a way that when one bucket receive 0.01 in. (0,25 mm) of precipitation in tips, discharging its contents into a reservoir and bringing the other bucket under the funnel. A recording mechanism indicates the time of occurrence of each tip. The tipping-bucket is well adapted to the measurement of rainfall intensity for short periods, but the more rugged construction of the weighing-type and its ability to record snowfall as well as rain make it preferable for most purposes.

Subsequent to the development of radar in World War II it was found that microwaved radar (1 to 20 cm wavelength) would indicate the presence of rain within its scanning area. The

amount of reflected energy is dependent on the raindrop size and the distance from the transmitter. Drop size is roughly correlated with rain intensity, and the image on the radar screen (isoecho map) can be interpreted as an approximate indication of rainfall intensity. A calibration may also be determined from actual rain-gage measurements in the area scanned by the radar. Radar offers a means of obtaining information on rainfall distribution which would be only roughly defined by the usual network of rain-gages.

Vocabulary

fog drip — осадження крапель туману на деревах
snow stake — снігомірна рейка
specific gravity — питома вага
snow sampler — снігомір, щільномір
recording rain-gage — дощомір-самописець
weighing rain-gage — ваговий дощомір
punched paper tape — перфострічка
scanning area — район дослідження

Answer the following questions in writing:

1. Say all you know about precipitation.
2. What is fog drip?
3. How is snow measured?
4. With the help of what are rates of rainfall determined?
5. How can radar be used in precipitation measurement?

Control Paper 9

Variant 1

1. Translate the text in writing:

EVAPORATION AND TRANSFORMATION

Evaporation is the transfer of water from the liquid to the vapor state. Transpiration is the process by which plants remove moisture from the soil and release it to the air as vapor. More than half of the precipitation which reaches the land surfaces of the earth is returned to the atmosphere by the combined processes, evapotranspiration. In arid regions evaporation may consume a large portion of the water stored in reservoirs.

Factors Affecting Evaporation. The rate of evaporation from a water surface is proportional to the difference between the vapor pressure at the surface and the vapor pressure in the overlying air (Dalton's law). In still air, the vapor-pressure difference soon becomes small, and evaporation is limited by the rate of diffusion of vapor away from the water surface. Turbulence caused by wind and thermal convection transports the vapor from the surface layer and permits evaporation to continue.

Evaporation of a pound of water at 68°F requires about 1050 Btu (585 cal/g at 20°C), and unless a heat supply is available, there can be no evaporation. Hence, total evaporation over a period of time is controlled by the available energy. This is a feedback process — a high rate of evaporation at any time utilizing energy which might have caused evaporation at some other time.

Evaporation may also be controlled by conditions at the surface from which evaporation is occurring. Loss from soil cannot exceed the water available in the soil. Evaporation from snow or ice can occur only if the dew point of the overlying air is less than the temperature of the snow surface (which cannot exceed 32°F, or 0°C). If the dew point of the air is over 32°F (0°C), condensation of vapor on the snow surface will occur. Dissolved salts reduce

the vapor pressure of a water surface. Hence saline water will evaporate less readily than fresh water, the reduction being about 1% for each percent of dissolved salts.

Determination of Evaporation. A direct determination of evaporation from a reservoir requires accurate knowledge of all items of inflow, outflow and storage. Generally the method is too inaccurate to calculate evaporation.

In principle, if one measured humidity, temperature and wind at two levels above a water surface, it should be possible to compute the upward vapor transport by use of turbulence theory, and many complex equations have been derived to express this relation. Tests showed that simple empirical equations such as

$$E = 0.00241\,(p_{Vs} - p_{V8})V_8$$

were as satisfactory as the theoretical equations. In this equation E is evaporation in inches per day, pVs is the vapor pressure (inches of mercury) at the water surface, and pV8 and V are the vapor pressure and the wind velocity (miles per day) 8m above the surface. The terms V and pV must be measured carefully, otherwise large errors will result. With vapor pressure in millibars, wind speed in meters per second, and evaporation in millimeters, the constant in this equation becomes 0.097.

Another approach to the problem of estimating lake evaporation is the energy-balance method. This method is expressed by the equation

$$E = \frac{H_i - H_o - \Delta H}{\rho\,[\lambda(I - R)]}$$

where H is the total heat input to the lake including solar radiation and heat entering with flowing water, Ho is the heat leaving the lake as reflected and back radiation and the heat content of the outflowing water, DH is the change in heat content of reservoir water, r is the density of the evaporated water, l the latent heat of vaporization, and R is a ratio of the heat used for evaporation to that transferred to the air as sensible heat. Known as Bowen's ratio, R is given by

$$R = \frac{0.61 \text{patm} (Ts - Ta)}{1000 (p_{Vs} - p_{Va})}$$

where Ts and Ta are the surface and air temperatures in degrees Celsius and pressures are in millibars. This approach is theoretically sound but difficult to utilize because of the problems in gathering the necessary data.

Vocabulary

pound — фунт
Btu — британська теплова одиниця (0,252 ккал)
feedback process — процес зворотного зв'язку
dissolved salt — розчинена сіль
energy-balance method — метод енергетичного балансу
total heat input — подача тепловмісту
heat content — тепловміст
latent heat — приховане тепло
sensible heat — активне тепло

Answer the following questions in writing:

1. Explain the term of evaporation.
2. What do we call transpiration?
3. What factors affect evaporation?
4. How do conditions at the surface control evaporation?
5. What way can evaporation be determined?
6. What methods do you know for estimating evaporation?

since mean annual humidity, temperature, and winds vary only moderately from year to year.

Vocabulary

abundant rainfall — рясні опади
shallow-rooted grass — трава з неглибокою кореневою системою
deep-rooted grass — трава з глибокою кореневою системою
consumptive use — споживання
continuity equation — рівняння безперервності
subsurface outflow — підповерхневий відтік (глибинний)
subsurface inflow — підповерхневий потік
vegetal species — рослинність

Answer the following questions in writing:
1. What does the term «transpiration» mean?
2. What can you say about the rates of transpiration?
3. What influences upon the total quantity of transpiration?
4. How can you explain the term «evapotranspiration»?
5. By what means can the potential evapotranspiration be estimated?
6. Are there any variations in evaporation and transpiration? What are they, if any?

Control Paper 10

Variant 1

1. Translate the text in writing:

INFILTRATION

Infiltration is the movement of water through the soil surface and into the soil. The infiltration capacity of a soil at any time is the maximum rate at which water will enter the soil. Infiltration capacity depends on many factors. A loose, permeable soil will have

a higher capacity than a tight clay soil. If much of the pore space is filled with water, infiltration, capacity is generally less than when the soil is relatively dry. If the pore space of the surface soil is completely filled with water, further downward movement of moisture is controlled by the subsoil permeability. A hard, driving rain will pack surface dirt into soil pores and reduce infiltration. A good vegetal cover provides protection against raindrop impact, and, addition, plant roots and organic plant litter help to increase soil permeability. Theoretically, if the infiltration capacity of a soil were known, the volume of runoff resulting from a given rainfall could be computed by subtracting infiltration and surface retention (interception plus depression storage) from total rainfall.

The infiltration rate is the rate at which water actually enters the soil during a storm; and it must equal infiltration capacity or the rainfall rate, whichever is lesser. Infiltration rates or capacities are estimated experimentally by measuring the surface runoff from a small test plot subjected to either natural or artificial rain[1]. I f the plot is subjected to rainfall rates in excess of the infiltration capacity, the capacity will vary with time. Different capacity curves will be obtained for different values of initial soil moisture.

Many thousands of infiltration tests have been conducted. Infiltrometer may consist of small plots of ground sprayed with water to simulate rainfall or tubes partially embedded in the soil and filled with water. These tests have indicated that the infiltration capacity of bare soil under average summer conditions and after 1 hr of rain will vary from 0.01 in./hr (0.25 mm/hr) for heavy clay soils to 1.0 in./hr (25mm/hr) for loose sandy soil. A permanent forest or grass in good conditions will increase these rates three to seven times.

Natural rain of varying intensity, sometimes below and sometimes above the prevailing infiltration capacity, results in a

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[1] This statement includes surface retention and infiltration. Unless the plot surface contains large depression or is covered with heavy vegetation, surface retention will be small and computed infiltration rates not greatly in error.

distortion of the capacity-time curve. The decrease in infiltration capacity during periods with rainfall rates less than capacity is not as great as it is when infiltration takes place at capacity rates. It is often assumed that the infiltration capacity at any time is determined by the mass infiltration which had occurred to that time. Thus, if a rain begins at low rates and rainfall during the first hour is one-half the infiltration capacity, the capacity at the and of the hour would be taken as that at about 0.5 hr on the applicable time-capacity curve.

Infiltration Indicates. The direct application of infiltration curves to large heterogeneous areas is difficult. At any instant both infiltration capacity and rainfall rate may differ greatly from point to runoff; and, since interflow is a part of infiltration, it will not normally be included in the runoff computed with infiltration-capacity curves determined on test plots. Estimates of runoff volume from large areas are sometimes made by use of infiltration of infiltration indices.

One common index is the average infiltration rate (loss rate or W index) which may be computed by

$$W = \frac{P - R}{t_R}$$

where tR is the duration of rainfall in hours. A second index is the index, which is defined as that rate of rainfall above which the rainfall volume equals the runoff volume. If rainfall intensity is reasonably uniform or if rainfall is heavy, the two indices will be nearly equal. In the usual case of moderate rain at non uniform intensities, the index will be somewhat higher than the W index. These indices vary with initial soil moisture, with changes in the depression storage and interception capacity of the area, and with amount of precipitation. The mean loss rate usually increases with rainfall intensity through the lower ranges of intensity. Infiltration indices are not infiltration rates but, rather, indicators of potential basin recharge.

Vocabulary

infiltration capacity — інфільтраційна здатність
raindrop impact — удар дощової краплі
surface retention — поверхнева затримка
loose sandy soil — рихлий піщаний грунт
interflow — підповерхневий стік, проміжна притока
test plot — випробуваний стоковий майданчик
less rate — середня величина втрат по підношенню до поверхневого стоку
infiltration indices — інфільтраційний індекс

Answer the following questions in writing:

1. What do we mean by the term «infiltration»?
2. What is infiltration capacity and what does it depend on?
3. What is infiltration rate?
4. How are infiltration rates or capacities estimated?
5. By means of whet is the infiltration' determined at any time?
6. Which infiltration indices do you know? Write about them.

Control Paper 10

Variant 2

1. Translate the text in writing:

STREAMFLOW

In the streamflow phase of the hydrologic cycle, the water from a given drainage basin is usually concentrated in a single channel and it is possible to measure the entire quantity of water in this phase of the cycle as it leaves the basin.

Measurement of streamflow. A continuous record of streamflow requires the establishment of a relation between rate of flow and water level in a channel. In small channels may sometimes be accomplished by the use of a weir or measuring

flume for which a head discharge relation can be determined in the laboratory. Measurements of head may then be converted to rates of flow.

In large streams, the use of laboratory-rated flow measuring devices becomes impracticable, and measurements of discharge are made with a current meter. A stage-discharge relation, or rating curve, is constructed by plotting the measured discharge against the stage (water-surface elevation) at the time of measurement. If the station is located just upstream from a rapids or other natural control which fixes a definite relation between stage and discharge, an accurate and permanent rating is obtained. An artificial control consisting of a low weir of concrete or masonry is sometimes constructed on small streams. It may be necessary to accept the rating curve fixed by the channel geometry of large streams, and erosion or deposition of sediment may change the rating from time to time. Under these conditions a satisfactory streamflow record can be obtained only by frequent current-meter measurements to fix the position of the rating curve at any time. Even when a good control exists, routine check measurements are considered desirable.

The velocity variation with depth in most streams is logarithmic, and the average of the velocities at 0.2 and 0.8 of the depth is very nearly equal to the mean velocity in a vertical section. A single measurement at 0.6 depths below the surface is only slightly less accurate as an estimate of the mean velocity. A streamflow measurement is usually made by determining the mean velocity in a number of vertical sections across the stream.

The velocity in any vertical section is assumed to represent the velocity in a portion of the total cross section extending halfway to the adjacent vertical sections. The discharge in this portion of the cross section is computed by multiplying its area by the mean velocity. The total discharge of the stream is the sum of the discharges in the several partial sections.

Discharge may also be estimated by application of open-channel formulas, use of weir formulas for dams and spillway,

calculation of flow through a contracted opening at a bridge, or timing the travel of floats in the stream. If surface floats are used, mean velocity is ordinarily assumed to be 0.85 times the float velocity. These methods are dependant on the selection of proper coefficients and are often inaccurate. They are normally used for reconnaissance purposes or for computing flood flow in the absence of meter measurements.

Measurements of river stage. The simplest device for measuring river stage is a staff gage, a scale graduated in feet or meters. Staff gages are usually read by an observer once or twice a day, but on streams subject to rapid changes in stage it is not possible to get a reliable record without use of recording equipment. The most common type of recording gage uses a float connected to the recording mechanism in such a way that motion of the float is recorded on a paper chart. A gage house and stilling well of corrugated steel, concrete, or timber is required to protect the recording equipment and float. A simple diaphragm-type pressure cell and recorder constituite a lees costly installation which is useful in many circumstances. Bubbler gages which measure the pressure required to force gas from the end of a submerged pipe also proved accurate and relatively inexpensive. The stage-recording equipment must be upstream from the control; but current-meter measurements may be made at any convenient section along the stream, provided there is no large difference in discharge between the measuring section and the gaging station.

Variations in streamflow. The general pattern of normal annual runoff is quite similar to that of precipitation, but modified by soil and geologic characteristics and other factors. Relatively more precipitation appears as runoff in the cool, moist regions where evaporation is high. Variations in streamflow throughout the year are controlled by the precipitation distribution. In most of the country the ratio of runoff to precipitation is lowest in summer.

A plot of streamflow against time is called a hydrograph.

Vocabulary

weir — гребля, загата, водозлив
measuring flume — гідрометричний лоток
head-discharge relation — залежність між напором й розходом води
current meter — гідрометрична вертушка
stages-discharge relation — залежність між розходом і рівнем води
rating curve — крива розрахунку
spillway — водозлив, водозбір
staff gage — водомірний піст, водомірна рейка

Answer the following questions in writing:

1. What can you say about the streamflow phase of the hydrologic cycle?
2. By means of what can we measure streamflow?
   a) in small channels
   b) in large streams
3. What instrument is used for measuring river stage? Describe it.
4. What is a hydrograph?

PART III

TEXTS FOR RETELLING

ABOUT MYSELF

Let me introduce myself. My full name is.... I'm from Ukraine and my home city is Odessa. I'm 18 years old. I'm not married yet and I live with my parents. My family is large and friendly.

This year I entered the Odessa State Environmental University. Now I'm a first-year student. I'm proud to be a student of our University. My future job is dealing with hydrology. Nowadays, there is a dangerous threat for environment throughout the world. The air, water, soil pollution and greenhouse effect is the global problem of great importance. I think that my future occupation is very necessary in our every day life. At our University I study a lot of special subjects. But there are some subjects which I'm good at. They are: ecology, hydrology, economy, physics and foreign languages. Generally, I go to my University six times a week. Every day I have 3 or 4 classes. As a rule, I get to my University by bus. But some of my group mates get there on foot because our hostel is not far from the University. My working day is not easy and I have a lot of work to do after my classes. I try to be a conscientious and efficient student. That's why I spend much time on preparing for my lectures. Being diligent, I'm never late or cut classes without valid reason. I do my best to be a well-rounded person. I'm interested in economy, politics, history and computers. I'm fond of reading, listening to music and playing computer games. I believe I'm a friendly, frank, inventive and cheerful person.

Besides that, I'm sociable that's why I have a lot of friends. I like having my close friends for dinner, discussing different interesting points with them or just chatting on my free time.

I'm eager to be a high qualified specialist, useful citizen of our society and do my bit in solving of urgent problems of our independent country.

THE ODESSA STATE ENVIRONMENTAL UNIVERSITY

Our University has a glorious past indeed. It was founded in 1932 in Kharkov as Hydrometeorological Institute. During the Great Patriotic War the Institute was completely destroyed and it was immediately evacuated to Ashhabad. In 1944 it was transferred to Odessa as the most suitable place for the Institute.

In August, 9, 2001 it was renamed into the Odessa State Environmental University. At present our University is the only one of its type in Ukraine.

In 2002 it celebrated its 70 anniversary. For this period, it has trained over 25 thousand specialists such as: hydrometeorologists, ecologists, managers, computer operators etc. Among its graduates there are a lot of outstanding scientists, scientific researchers of environment.

Since 1993 a three-staged graduated system has been exercised in our University. It means bachelors, specialists and masters of degree. It has six faculties such as: ecological, hydrometeorological, computer science and management, corresponding and faculty for secondment. Besides that it has 18 chairs.

Due to all-rounded development of our educational establishment, advanced studies in educational and science processes, there was the reason for renaming the Odessa Hydrometeorological Institute into the Odessa State Environmental University. The students and post graduates from 35 countries are taught here.

Now our University is rather new four-storeyed building in Lvovskaya street. It has all necessary accommodations: well-equipped laboratories, convenient classrooms, computer rooms, library, reading room, students' canteen, first-aid post

and sport complexes. About 190 member — high-qualified faculty staff teaches its students, writes a lot of theses and carries out scientific work. Our University takes an active part in International cooperation. It successfully collaborates with specialised UN agency (WMO) — World Meteorological Organization.

Our University is to be proud of its graduates who work not only in different, parts of Ukraine but far from its boundaries.

UKRAINE

Ukraine is a self-contained, sovereign state. The Declaration of Ukrainian independence was proclaimed on August 24, 1991 by the Ukrainian Parliament.

Ukraine has its own territory, higher and local bodies of state power (the Supreme Council and local Councils), government, national emblem, state flag and anthem.

Our country is situated in the south-east of Europe. Its territory is 603.7 thousand sq. km and it stretches from the west to the east for 1.316 km and from the north to the south for 893 km. The geographical centre of Europe is located near the little Ukrainian town Rakhiv. Ukraine borders on Russia, Bielarus, Moldova, Poland, Slovakia, Hungary, Romania. Land boundaries are 4.558 km total. Being washed by the Black Sea and the sea of Azov in the south Ukraine has a coastline of 9.789 km. The major part of the Ukrainian area is flat and only 5% of it is mountainous. The Carpathian Mountains in the West and the Crimean Mountains in the south are extremely picturesque. The major rivers are the Dnipro, the Dniester, the Buh, the Desna and others.

Ukraine is a well developed industrial and agricultural country. It is richly endowed by nature, possessing such resources as coal, natural gas, iron ore, salt and other minerals. The country has a big metallurgical, machine-building, fuel and power base. One of the most important branches of national economy is the

power industry. Besides, Ukraine produces planes, tractors, cars, up-to-date instruments and equipment. TV-sets, computers and synthetic diamonds.

Scientists of Ukraine enriched the world science with important discoveries and inventions. They contributed much to solving the main problems of automation of production processes and electric welding. Ukraine is blessed with potentially rich agro and forestry land resources. About 70% of the national territory is in agricultural use and some 55% is under cultivation, two-thirds of it on the famed «black soil» (chernozem).

The population of Ukraine is 48 mln people. It is the Motherland of representatives of more than 100 nationalities. It has a very rich and varied culture and history. There are a lot of higher educational establishments in Ukraine, many professional theatres, public libraries and state museums. Nowadays people of Ukraine display a keen interest in Ukrainian history and cultural heritage. Many masterpieces of Ukrainian culture have been revived.

Ukraine is a member of the United Nation Organization (UNO) and takes part in the work of many international organizations.

THE POLITICAL SYSTEM OF UKRAINE

On the 24th of August 1991 Ukraine became an independent state. Nowadays Ukraine is a sovereign, independent, democratic, social, legal state. The powers of the government are divided into three branches: the executive, the legislative and the judicial.

The President of Ukraine is a Chief executive. He is elected by universal equal and direct suffrage by secret ballot for the term of 5 years and not more than for two successive terms. The executive power is exercised by the Cabinet of, Minister of Ukraine. It is responsible to the President and is accountable to the Verkhovna Rada.

The Verkhovna Rada (the Supreme Council), the legislative body of state power, is a single-chamber parliament. The parliament provides seat for 450 deputies elected for the term of 4 years.

Justice in Ukraine is exercised entirely by courts. It is administered by the Constitutional Court and by courts of general jurisdiction. The Supreme Court of Ukraine is the highest juridical body of general jurisdiction.

It is a very important fact that the reform processes in Ukraine are of peaceful character and they are accompanied by creation of new political parties and public organizations totaling about 40. The largest of them are People's Movement of Ukraine («Rukh»), the Communist Party, the Socialist Party, the Peasant Party, the Democratic Party, the Republican Party, the Liberal Party.

KYIV

Kyiv is the capital of Ukraine. In 1982 it was 1500 years old. It is one of the oldest cities in Europe and therefore there are a lot of places of historic interest in it. From older times it is referred to as «the Mother of all cities of ancient Rus». Ancient Kyiv was a large commercial centre of the East Slavs. A great role in the history of Kyiv was played by Prince Volodymyr who united Slav peoples. So Kyiv was made the capital of Ancient Rus and it lasted for nearly three centuries.

But it is not only its old age and long history that makes Kyiv stand out among other cities. It is a unique and extremely harmonious combination of historic values and ways of life that draws crowds of people from all over the world to Kyiv.

The capital of Ukraine is in itself a huge monument which over a long period of time has been erected by the collective wisdom and creative effort of many generations.

The cultural life of our capital is rich and varied. There are a lot of fine museums, theatres, many research institutes and higher educational establishments.

Today Kyiv is a leading industrial, political and scientific centre. Its population equals 3 mln people. It is situated on the picturesque banks of the Dnipro river. One half of the Kyiv's territory is occupied by gardens and parks and in spring and summer time the trees and bushes are full of greenery and the city looks like one huge park.

GREAT BRITAIN

Text A

Great Britain formally known as the United Kingdom of Great Britain and Northern Ireland, is situated on the British Isles that lie to the north-west of the continent of Europe.

The British Isles consist of Great Britain, Ireland and some 5,600 smaller islands.

The total area of the United Kingdom which consists of England, Wales, Scotland and Northern Ireland is 244.027 square kilometres. Great Britain is divided into 55 administrative counties. The English Channel separates the country from the continent of Europe. The narrowest part of the English Channel is called the Strait of Dover. It is only 31 km wide. The North Sea washes the eastern coast of the county. The Irish Sea is situated between Great Britain and Ireland. The western coast of the country is washed by the Atlantic Ocean. The country is known for its typically maritime climate with frequent rains, strong winds and continuous fogs. Owing to the Gulf Stream and cool winds from the sea the climate of Great Britain is cooler in summer and warmer in winter than that on the continent.

There are many rivers in Great Britain, but none of them is very long. Most of the rivers are connected with one another by means of canals. The surface of England and Ireland is rather flat. The mountains in Great Britain are not high. They are all in the North and West. In the centre of England is a range of hills called the Pennines, which are also known as the «backbone

of England». The highest mountains are in Scotland and Wales; Ben Nevis (1343m) and Snowdon (1085m). Great Britain is one of the most populated countries in the world and there are only nine other countries with more people. It has the population of 56 million.

Great Britain is a parliamentary monarchy. This means that it has a monarch (a king or a queen) as its Head of State. But in practice the monarch has very little power and can only reign but does not rule. The country is governed in her name by the Government. The supreme legislative body is Parliament. The Parliament in Great Britain which is by the way one of the oldest in Europe consists of two chambers: the House of Commons and the House of Lords.

The British democrative system depends on political parties. The main political parties are: the Conservative Party (sometimes called the Tory Party), the Labour Party, the Liberal Party, the Social Democratic Party. The Party which wins the majority of seats forms the Government and its leader usually becomes the Prime Minister. The Prime Minister chooses about twenty Members of Parliament (MPs) from his or her party to become Cabinet of Ministers.

Text B

Great Britain is one of the most developed industrial countries in Europe. Coal-mining, metallurgy, textile, shipbuilding are the oldest branches of industry. The new industries are the electrotechnical, automobile, aviation and electronics. The new industries have developed hand in hand with scientific and technology and are equipped to meet the present technical demands.

Coal is the main source for the development of British industry. The biggest centres of iron and steel industries are situated in the neighbourhood of coal basins. They are Middlesbrough, Newcastle, Cardiff, Glasgow.

Birmingham and Sheffield are the most ancient centres of English iron and steel industry. Birmingham, a city with over a million inhabitants; is about 112 miles north-west of London. The district of Birmingham is known as the Black Country. It is the land of factories and mines.

Manchester is the centre of the cotton industry. Leeds is the chief centre of the woollen industry in England. Grimsby is the wealthiest fishing port in Europe. Over two and half million pounds worth of fish is landed here every year. Liverpool and Glasgow are the biggest English ports. Liverpool is the main port of Western England. It is the first in Great Britain in exports and it comes the second after London in imports. Imports passing through Liverpool consist of cotton, wool, non-ferrous metals and oil; exports consist of fabrics, textile machinery, electrical equipment and chemicals.

Agriculture is one of the largest and most important activities in Great Britain. For centuries the country has been famous for its cattle- and sheep breeding and also for dairy farming. The chief grain crops are wheat and barley.

LONDON

London is one of the world's three largest cities (the other two are New York and Tokyo). It is one of the world's most important ports and it is the capital of Great Britain.

The history of London dates back to the time when the Romans founded a settlement on the River Thames 2000 years ago, and called it Londinium. London is really a very large and beautiful city.

There are four main parts in London: the City, Westminster, the West End and the East End.

For almost 2000 years the City has been the financial and business centre of Great Britain. When we say «the City» we mean British monopoly capital. It's the monopolies that own the wealth of the country.

The very centre of London is Trafalgar Square. It was named in memory of the victory in the battle of Trafalgar where in 1805 the English fleet under Nelson's command defeated the combined fleet of France and Spain. The victory was won at the cost of Nelson's life. Here stands Nelson's column with the statue of Admiral Nelson on the top. In the north of Trafalgar Square there is the National Gallery. It houses the paintings of famous Italian, Dutch, French and other European schools from the 13th to the 20th century.

Not far from Trafalgar Square there is a little street with ordinary houses. This is Downing Street, and for the last 200 years at house number 10 the British Prime Minister has resided.

Downing Street leads to Whitehall. In Whitehall there was a palace where from the 12th to the 16th century the England kings and queens were living. Now it is just a street of government offices.

A little further we can see Parliament Square, Westminster Abbey is on one side, the House of Parliament on the other. The building of the House of Parliament is not old, it dates only back to from the 19th century and is in Gothic Style.

One of the most beautiful and distinguished of all English buildings is Westminster Abbey, founded in the 11 century. It is famous for many tombstones, monuments and statues honouring well-known people. For nearly 1000 years all the kings and queens of Great Britain — 41 in all have been crowned here and many of them are buried here too. Here is the Poet's Corner. Many of the greatest Britain writers and poets such as Chaucer, Dickens Tennyson, Browning, Hardy, Kipling and others are buried here. Here, too, though these writers are not buried in Westminster Abbey, are memorials to Shakespear, and Milton Goldsmith and Scott, Thackeray and Longfellow.

Next is Buckingham Palace — the Royal residence. The vast house is comparatively new and has no style. Here we can see the colourful and stirring of all London ceremonies, the changing of the Guards. The West End is famous for all the historical palaces,

beautiful buildings, fine parks, fashionable shopping centres, hotels and restaurants. It's here in the West End that colleges and schools and the University of London are centered.

One of the popular sights of the West End is Picadilly Circus. At its centre stands the famous statue of Eros. And here in this part of London is the largest and the most popular of the London parks — the Hyde Park with the well-known speaker's Corner. The East End is a vast area running from the City. It includes all the dock areas and is heavily industrialised. It's in the East End that most plants and factories are situated.

In London there is so much to see that even Londoners can often find new sights. They like to say: «When a man is tired of London he is tired of life».

THE UNITED STATES OF AMERICA

The United States of America is one of the largest, powerful and highly developed countries in the world. The USA is situated in the central part of the North American Continent. Its western coast is washed by the Pacific Ocean and eastern one by the Atlantic Ocean and the Gulf Stream. The USA is separated from Canada in the north by the 49th parallel and the Great Lakes, and from Mexico in the south by a line following the Rio Grande River and continuing across the highlands to the Pacific Ocean.

The total area of the United States is over 9 million square kilometres. The USA consists of three separate parts. They are the Hawaiian Islands, situated in the central part of the Pacific Ocean, Alaska, separated by the Canadian territory, and the rest major part of the USA.

The Great Rocky mountains run north and south. Some of them form a divide between rivers that flow westward and those that flow towards the Atlantic or the Gulf of Mexico. The continental part of the USA consists of the highland regions and the two lowland regions. The highland regions are the Appalachian mountains in

the east and the Cordillera in the west. The lowlands are situated between the Cordillera and the Appalachian mountains and are usually called the prairie. Eastern lowlands are called Mississippi valley.

The main rivers of the United States are the Mississippi, one of the longest rivers in the world, and the Hudson river. The Mississippi and the Missouri River and their branches form a 19.000-kilometre system of waterways that are connected to the Great Lakes in the north by a canal. There are other important rivers in the USA such as the Yukon in Alaska, the Rio Grande, the Columbia, the Colorado which flows through the magnificent Grand Canyon, carved through the ages by the river's waters.

The population of the USA is about 250 million people. Attracted by the reports of great economic opportunities and religious and political freedom, immigrants, from many countries went to the USA which was populated by native Indian. And nowadays all of them make the American people.

The Nation's capital, Washington, is the seventeenth in population city, the largest being New York — 7 mln. Chicago — 3 mln, Los Angeles — about 3 mln, Philadelphia — 1.7 mln.

The United States is rich in most of the metals and minerals needed to supply its basic industries. It possesses large quantities of coal, oil and gas, which satisfy all branches of economy with energy. The USA has a highly developed motor-car industry which is concentrated in and around Detroit. Electric and electronic engineering, transport, communication, ship building, textile industry are very powerful there. In the United States there are plenty of fertile soil. So 47 per cent of the land area is farmland. Fishing is very important in the national economy. Half of the fish caught is used for food, the other half is converted into fish meal for animals and fish oil for industry use.

The USA is a federation of states. It consists of 50 states and the district of Columbia. America elects a President as Head of State

every leap year, on a fixed November day. America's President is the head of his political party. The USA has two main political parties: Democrats and Republicans. The US Congress consists of two chambers: the House of Representatives and the Senate. America has a Congress election every two years.

ODESSA

Odessa is a major industrial, cultural and health resort centre of Ukraine, a first-class port of world wide reputation on the Black Sea.

The population of the city amounts to over a million citizens.

The beginning of the bright and rich in historical events biography of Odessa is believed to date from the end of the 18th century. Before a Slavonic settlement Kotsiubievo was located in its place.

On August 22 (September 2) 1794 the first constructions were laid down initiating the building of the new port and city.

There are many versions of legends how the city was named. However, the most truthful one is that its name commemorates the ancient Greek colony Odessos which was situated in the 6th century B.C. on the Northern coast of the Black Sea.

The city was being built according to the preliminary drafted plan considering the relief of the surroundings.

Wide and straight streets of the central part, spacious squares, fine architectural ensembles soon made Odessa one of the most beautiful cities.

The odessans are very proud of their Opera House considering it one of the best in the world. Caruso and Shaliapin once sang here. The theatre has played a great role in the rich cultural life of the city.

The Art Museum and the Museum of Western and Oriental Art are also well worth a visit with their canvases by famous Caravaggio, Franz Hals, O. Kiprensky, A. Venetsianov, I. Ayvasovsky and others.

There is hardly a person in the country who has not seen films made at the Odessa Film Studio. The city streets were trodden by A. Pushkin, Yu. Kotsyubinsky, N. Gogol, Yu. Olesha, V. Kataev, I. Babel, S. Kirsanov, I. Ilf, Ye. Petrov, K. Paustovsky, E. Bagritsky.

Odessa is an industrial, educational and scientific centre. The main products of the city are refined petroleum, processed food, plastics, pharmaceuticals and clothing.

The Institutions of higher learning include the Odessa National University, the Marine academy, the Music conservatory and over a dozen others. That is why Odessa is often called a city of students.

Among the numerous scientific institutions in Odessa the distinguished Filatov Clinic of Ophthalmology deserves special mention.

The city is a pleasant spa and vacational resort with sandy beaches stretching for some 40 km, a mild climate and plenty of sunshine. Yearly scores of thousands of guests from many countries of the world visit Odessa.

The city suffered heavy damage during World War II. Today monuments to the heroes who fell in the action defending the city form an entire Belt of Glory which traces the former defence lines.

Odessa has grown considerably within the last decades, new dwelling areas, social institutions and trading centers are being constructed.

The future days offer new prospects for the development of the city.

THE ODESSA OPERA HOUSE

The Odessa Opera House was built in 1897 according to a project designed by the Viennese architects G. Hellmer and F. Felkner. The work was carried out by home bred artisans under the guidance of local architects.

The architecture of the theatre combines the elements of two styles: the Viennese baroque and Italian Renaissance and resembles the Vienna Opera and the Dresden Court Theatre.

The building is of a horseshoe form. It has three porticos, the central portico being embellished with sculptural groups symbolizing the four genres of art: opera, ballet, tragedy, comedy. The round niches just above the second floor carry the busts of M. Glinka, A. Pushkin, N. Gogol, A. Griboedov.

The interior decoration of the Opera House in Lous XVI style and is distinguished for its richness. Its sculptured and decorated ceiling with a filigree chandelier has four paintings in golden medallion frames. These paintings are scenes from Shakespeare's plays: «Hamlet», «A Midsummer Night's Dream», «The Winter's Tale», «Twelfth Night or What You Will».

The hall has faultless acoustics and its rated holding capacity is 1664 seats.

The theatre has a long and interesting artistic history. Prominent singers sang on its stage such as E. Caruso, F. Shalyapin, L. Sobinov, A. Nezhdanova, S. Krushelnitskaya. P. Tchaikovsky, A. Rubinshtein, N. Rimsky-Korsakov all conducted here.

When in 1893 Tchaikovsky's opera «The Queen of Spades» was first staged in Odessa the actors presented the composer with a fine ivory baton bearing the following inscription on it: «From mortals to an immortal».

During the Second World War the fascists pillaged the theatre and were going to blow it up. But the rapid advance of the Soviet Army prevented them from carrying out their barbaric plan.

Today the Odessa State Academic Theatre of Opera and Ballet with its big and talented company plays a leading part in the cultural life of the city.

HYDROLOGY

Hydrology is a branch of physical geography which deals with the waters of the earth with special reference to their properties,

phenomena and distribution. It is a science that treats of the waters of the earth, their occurrence, circulation and distribution, their chemical and physical properties, and their reaction with their environment, including their relation to living things. That is, the domain of hydrology embraces the history of water on the earth.

Although man has been greatly affected by water in the development of his civilization, and although there is an enormous literature on this subject, it is not yet possible to call hydrology an exact science because when given a factor such as rainfall, one cannot accurately deduce the resulting deposition of the water in scientific and mathematical terms. This inaccuracy is due to the great complexity of the hydrologic cycle, the lack of accurate observational data, and the almost innumerable combinations of hydrologic phenomena that occur in nature. Two phases of the water cycle — rainfall and runoff measured as stream flow — are such commonplace phenomena that many are apt to think that much is known about the behaviour of water. On the contrary, much is yet to be learned, for science is only now escaping from an almost complete dependence on relationship between these hydrologic factors. Hydrology provides the engineer with the basic data and methods required to solve problems relating to the regulation, control and utilization of water.

Generally, five subdivisions of hydrology are recognized: 1) potomology — the study of surface streams, 2) limnology — the study of lakes, 3) cryology — studies dealing with snow and ice, 4) geohydrology — studies related to subsurface waters and 5) hydrometeorology — the study of problems intermediate between the fields of hydrology and meteorology. However, very few hydrologic problems can be limited to but one of these branches. It means that hydrology is an extremely broad science and therefore borrows from other branches of science and integrates them for its own interpretation and use. Such sciences as physics, mathematics, statistics, geology, geography, chemistry, computer science are but a few which may be used in hydrologic investigations.

THE ROLE OF WATER IN NATURE AND MAN'S LIFE

Water, the most essential constituent of the biosphere, may be found in nature in gaseous, liquid and solid state. Water is a powerful factor that remakes the earth's surface and is the only source of the process of replenishing oxygen in the atmosphere that is continuously going on in photosynthesis.

Water is one the commonest of all substances, and without it life would be impossible. The seas and oceans cover about seven-tenth of the Earth's surface but water is also contained in the soil, in the atmosphere and in all living things. More than half of the human body consists of water, which also form a large part of the food we eat, especially vegetables and fruits. Man cannot live as long as ninety days or more without water.

Water exists as a substance in three states: ice, which melts at 0 degrees Centigrade; liquid and steam, the latter is formed when water boils at 100 degrees Centigrade.

Water differs from other liquids in that it expands when cooled from 0° C, contracts when heated from 0° C to 4° C, and reaches its maximum density at 4° C. No other liquid possesses this property.

Pure water is rarely found in nature. This is because water is able to dissolve so many substances from the air, the soil and the rocks. The saltness of sea water is caused by the mineral substances which are dissolved from the Earth's surface by rivers and carried down to the sea. The Sun's heat causes the surface sea water evaporate, or change into vapour, leaving behind the salt and other minerals. This explains why the seas are much more salty than rivers flowing into them.

The total amount of water contained in our planet is constant and invariable and can neither be increased, nor diminished.

Water is necessary for many aspects of man's life and economic activities. Great amounts of water, are daily used for agriculture needs for irrigation. Evergrowing amounts of water

are used to meet industrial and domestic needs of the cities. Cascades of hydro-electric stations are going up on big rivers to generate tremendous amounts of electrical energy. Many water wells, lakes, rivers and seas estuaries are used for medical treatment.

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для студентів III курсу
заочної форми навчання
Напрям підготовки — «Гідрометеорологія»
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