МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
МИКОЛАЇВСЬКИЙ НАЦІОНАЛЬНИЙ АГРАРНИЙ УНІВЕРСИТЕТ

Факультет культури й виховання

Кафедра іноземних мов

АНГЛІЙСЬКА МОВА

методичні рекомендації

для аудиторних занять та самостійної роботи здобувачів вищої освіти ступеня «бакалавр» всіх спеціальностей денної та заочної форм навчання

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ЗМІСТ

ПЕРЕДМОВА

«Англійська мова: методичні рекомендації для аудиторних занять та самостійної роботи здобувачів вищої освіти ступеня «бакалавр» всіх спеціальностей МНАУ денної та заочної форм навчання» підготовлено згідно з кредитно-трансферною системою навчання. Дане видання забезпечує здобувачів вищої освіти навчальним матеріалом для практичних занять, що допомагає їм поглибити та систематизувати лексико-граматичний матеріал, а також набути практичні уміння і навички читання текстів наукової та загальнокультурної тематики.

Методичні рекомендації містять фахові тексти для читання для здобувачів вищої освіти факультету агротехнологій (спеціальність «Геодезія та землеустрій») та для здобувачів вищої освіти всіх спеціальностей з метою підготовки до ЄВІ.

Мета даних методичних рекомендацій – розвиток навичок читання загальнонаукових та соціально-культурних текстів, що є основою професійно-орієнтовного навчання, активізація лексико-граматичного матеріалу у здобувачів вищої освіти та перевірка їх знань шляхом самостійного виконання різнорівневих завдань до текстів. Методичні рекомендації складаються з 10 уроків та підсумкового тесту для визначення рівня іноземної мови (А1–В2):

Кількість пунктів тестового завдання	**Кількість правильних відповідей**	**Рівень англійської мови (А1–В2)**
60	0-5	(незадовільно, FX)
	6-15	A1 elementary (задовільно, DE)
	16-30	A2 pre-intermediate (добре, BC)
	31-45	B1 pre-intermediate (дуже добре, BC)
	46-60	B2 intermediate (відмінно, A)

Кожен урок складається з завдань для тренування вимови, активного словника термінів, фахового тексту та завдань після тексту.Виконання завдань після текстів сприятиме закріпленню лексико-граматичного матеріалу з тем, які відповідають типовим програмам з даної дисципліни.

Дані методичні рекомендації допоможуть здобувачам вищої освіти для підготовки до тестування з англійської мови для вступу в магістратуру.

UNIT 1
HISTORY OF GEODESY

1.1 Practise reading the following words.

[ð] – the, this, that, therefore, their, logarithm,
[ɜ:] – circle, early, earth, concern, were, determine
[i:] – Greek, east, increase, reason, believe
[ʌ] – much, result, another, such, reduction, sun

Alexandria [ˌalɪgˈzɑːndrɪə], Anaximenes [ˌanakˈsɪmɪniːz], Archimedes [ˌɑːkɪˈmiːdiːz], Aristotle [ˈarɪstɒt(ə)l], Cassini [kaˈsiːni], Dunkirk [dʌnˈkəːk], Eratosthenes [ˌɛrəˈtɒsθəniːz], geodesy [dʒɪˈɒdɪsi], Picard [ˈpɪkɑːd, pikaʀ], Plato [ˈpleɪtəʊ], Ptolemy [ˈtɒlɪmi], Pythagoras [pʌɪˈθagərəs], Rhodes [rəʊdz].

1.2 Translate words of the same root into Ukrainian.

To determine – determined – determination – determining – determinant – determinate – determiner.

To observe – observed – observer – observable – observant – observation – observatory.

To defend – defense – defendant – defensive – defender – defenseless – defensible – defensor.

1.3 Fill in the sentences with words from exercise 1.2.

Determinate vapour pressure corresponds to … temperature.
"That's a new dress, isn't it?" "Yes, you are … !"
If you go alone into the forest, you'd better … yourself with a knife.
Her reasons for acting are morally … .
She is … to finish law school.
I was invited to attend their conference as an … .

ACTIVE VOCABULARY

Word	Pronunciation	Translation
accomplish, v.	[ə'kɔmplɪʃ]	здійснювати, виконувати
accuracy, n.	['ækjərəsɪ]	правильність, відповідність, точність; syn. exactness, precision
angle, n.	['æŋgl]	кут
arc, n.	[ɑːk]	дуга
cast, v.	[kɑːst]	кидати; syn. throw
circle, n.	['sɜːkl]	коло

circumference n.	[sə'kʌmf(ə)r(ə)ns]	окружність
contribute, v.	[kən'trɪbjuːt], ['kəntrɪbjuːt]	робити внесок, сприяти
controversy, n.	['kɔntrəvɜːsɪ], [kən'trɔvəsɪ]	дебати, дискусія, полеміка, суперечка; syn. discussion, argument, debate, dispute
derived, adj.	[dɪ'raɪvd]	похідний, вторинний, отриманий, витягнутий
elevation, n.	[ˌelɪ'veɪʃ(ə)n]	висота небесного тіла над горизонтом, піднесення, височина, висота
estimate, v.	['estɪmeɪt]	оцінювати; syn. value
explicit, adj.	[ɪk'splɪsɪt]	докладний, визначений, точний; syn. definite
flatten, v.	['flæt(ə)n]	вирівнювати, розгладжувати
graze, v.	[greɪz]	злегка торкатися, зачіпати
promulgate, v.	['prɔm(ə)lgeɪt]	оголошувати, проголошувати, опубліковувати; оприлюднювати; syn. publish, proclaim
rectangular, adj	[rek'tæŋgjələ]	прямокутний, syn. right-angled
reduction, n.	[rɪ'dʌkʃ(ə)n]	зниження, скорочення, зменшення, спад
solstice, n.	['sɔlstɪs]	сонцестояння
speculation, n.	[ˌspekjə'leɪʃ(ə)n]	роздум, припущення, теорія, здогадка; syn. reflection, contemplation
vicinity, n.	[vɪ'sɪnətɪ]	близькість, сусідство, околиці; syn. neighbourhood

1.4 Read the text and answer the following questions.
What interested man about the earth for many centuries?
What did Pythagoras and Anaximenes consider the earth to be in shape?
What measurements did Eratosthenes make and what did he observe?
What unit of measurements did Eratosthenes use in his calculations?
Whose maps influenced the cartographers of the middle ages?
What measurements did Picard and his followers perform?
What controversy was between French and English scientists?
What conclusion was made during geodetic expedition to Peru?

HISTORY OF GEODESY

Man has been concerned about the earth on which he lives for many centuries. During very early times this concern was limited, naturally, to the immediate vicinity of his home; later it expanded to the distance of markets or exchange places; and finally, with the development of means of transportation man became interested in his whole world. Much of this early "world interest" was evidenced by speculation concerning the size, shape, and composition of the earth.

The early Greeks, in their speculation and theorizing, ranged from the flat disc advocated by Homer to Pythagoras' spherical figure-an idea supported one hundred years later by Aristotle. Pythagoras was a mathematician and to him the most perfect figure was a sphere. He reasoned that the gods would create a perfect figure and therefore the earth was created to be spherical in shape. Anaximenes, an early Greek scientist, believed strongly that the earth was rectangular in shape.

Since the spherical shape was the most widely supported during the Greek Era, efforts to determine its size followed. Plato determined the circumference of the earth to be 40,000 miles while Archimedes estimated 30,000 miles. Plato's figure was a guess and Archimedes' a more conservative approximation. Meanwhile, in Egypt, a Greek scholar and philosopher, Eratosthenes, set out to make more explicit measurements. He had observed that on the day of the summer solstice, the midday sun shone to the bottom of a well in the town of Syene (Aswan). At the same time, he observed the sun was not directly overhead at Alexandria; instead, it cast a shadow with the vertical equal to 1/50th of a circle (7° 12'). The actual unit of measure used by Eratosthenes was called the "stadia." No one knows for sure what the stadia that he used is in today's units. The measurements given above in miles were derived using one stadia equal to one-tenth statute mile. It is remarkable that such accuracy was obtained in view of the fact that most of the "known" facts and his observations were incorrect.

Another ancient measurement of the size of the earth was made by the Greek, Posidonius. He noted that a certain star was hidden from view in most parts of Greece but that it just grazed the horizon at Rhodes. Posidonius measured the elevation of the same star at Alexandria and determined that the angle was 1/48th of circle. Assuming the distance from Alexandria to Rhodes to be 500 miles, he computed the circumference of the earth as 24,000 miles. While both his measurements were approximations when combined, one error compensated for another and he achieved a fairly accurate result.

Revising the figures of Posidonius, another Greek philosopher determined

18,000 miles as the earth's circumference. This last figure was promulgated by Ptolemy through his world maps. The maps of Ptolemy strongly influenced the cartographers of the middle ages. It is probable that Columbus, using such maps, was led to believe that Asia was only 3 or 4 thousand miles west of Europe. It was not until the 15th century that his concept of the earth's size was revised. During that period the Flemish cartographer, Mercator, made successive reductions in the size of the Mediterranean Sea and all of Europe which had the effect of increasing the size of the earth.

The telescope, logarithmic tables, and the method of triangulation were contributed to the science of geodesy during the 17th century. In the course of the century, the Frenchman, Picard, performed an arc measurement that is modern in some respects. He measured a base line by the aid of wooden rods, used a telescope in his angle measurements, and computed with logarithms. Cassini later continued Picard's arc northward to Dunkirk and southward to the Spanish boundary. Cassini divided the measured arc into two parts, one northward from Paris, another southward. When he computed the length of a degree from both chains, he found that the length of one degree in the northern part of the chain was shorter than that in the southern part. This unexpected result could have been caused only by an egg-shaped earth or by observational errors.

The results started an intense controversy between French and English scientists. The English claimed that the earth must be flattened, as Newton and Huygens had shown theoretically, while the Frenchmen defended their own measurement and were inclined to keep the earth egg-shaped.

To settle the controversy, once and for all, the French Academy of Sciences sent a geodetic expedition to Peru in 1735 to measure the length of a meridian degree close to the Equator and another to Lapland to make a similar measurement near the Arctic Circle. The measurements conclusively proved the earth to be flattened, as Newton had forecast. Since all the computations involved in a geodetic survey are accomplished in terms of a mathematical surface (reference ellipsoid) resembling the shape of the earth, the findings were very important.

1.5 Mark the following sentences True or False.

Pythagoras believed that the earth was created to be rectangular in shape.

Archimedes determined the circumference of the earth to be 30000miles.

Measuring the distance from Alexandria to Rhodes and computing the circumference of the earth Posidonius achieved a fairly accurate result.

Columbus was led to believe that Asia was 3 or 4 thousand miles east of Europe.

Having computed the length of a degree from both chains Cassini found that the length of one degree in the southern part of the chain was longer than that in the northern part.

In 1737 a geodetic expedition was sent to Peru to measure the length of a meridian degree close to the Equator.

1.6 Match words similar in meaning.

1. boundary	a. estimate
2. method	b. combine
3. backing	c. limit
4. consequently	d. compute
5. value	e. means
6. outstanding	f. accuracy
7. precision	g. therefore
8. unite	h. reduction
9. calculate	i. support
10. lessening	j.remarkable

1.7 Match words opposite in meaning.

1. correct	a. similar
2. separate	b. increase
3. imprecise	c.unexpected

4. decrease	d. incorrect
5. outdated	e. create
6. expected	f. combine
7. sharpen	g. modern
8. different	h. perfect
destroy	i. accurate
imperfect	j. flatten

1.8 Match two halves of the statements and translate them into Ukrainian.

1. development	a. error
2. spherical	b. controversy
3. conservative	c. table
4. to measure	d. of means of transportation
5. logarithmic	e. solstice
6. to perform	f. shape
7. observational	g. an arc measurement
8. summer	h. the elevation of the star
9. the bottom	i. of a well
10. intense	j. approximation

UNIT 2

GEODETIC SURVEYING TECHNIQUES (part I)

2.1 Practise reading the following words.

a) [**u:**] – thr**ough**, evol**u**tion, incl**u**de, concl**u**de
[**aɪ**] – defi**ne**, l**i**ne, comb**i**ne, h**i**ghway, satell**i**te, w**i**de
[**æ**] – l**a**titude, **a**ngular, m**a**nner, tr**a**ct, c**a**talogue, **a**zimuth

[**k**] – tra**c**t, fun**c**tion, exa**c**t, **c**losely, te**ch**nological

[**s**] – surfa**ce**, **sc**ience, pre**c**ise, referen**ce**, distan**ce**, accura**cy**

b) catalogue ['kæt(ə)lɔg], chronometer [krɔ'nɔmɪtə], equator [ɪ'kweɪtə], geoid [ˈdʒiːɔɪd], geodetic [ˌʤiːəu'detɪk], geometry [ʤ(ɪ)'ɔmɪtrɪ], hydrographic [hʌɪdrəˈgrafɪk], perpendicular [ˌpɜːp(ə)n'dɪkjulə], triangulation [trʌıaŋgjuˈleıʃn], trigonometry [ˌtrıgə'nɔmıtrı], trigonometric [ˌtrıgənə'metrık], zenith ['zenıθ].

ACTIVE VOCABULARY

Word	**Pronunciation**	**Translation**
adjust, *v.*	[ə'ʤʌst]	Підганяти, пристосовувати, регулювати; вивіряти, налаштовувати; ***syn***. fit, adapt
anticipate, *v.*	[æn'tısıpeıt]	очікувати, передбачати, передчувати; ***syn.*** expect, hope, foresee
astrolabe, *n.*	['æstrə(u)leıb]	астролябія
compile, *v.*	[kəm'paıl]	збирати, накопичувати, складати; ***syn.*** pile up
contribute, *v.*	[kən'trıbjuːt], ['kɔntrıbjuːt]	сприяти, робити внесок
establish, *v.*	[ıs'tæblıʃ]	засновувати, встановлювати; ***syn.*** set up
framework, *n*.	['freımwɜːk]	основа, структура, будова
justify, *v.*	['ʤʌstıfaı]	підтверджувати, доводити; ***syn.*** confirm, prove, verify
latitude, *n.*	['lætıt(j)uːd]	широта
longitude, *n.*	['lɔngıt(j)uːd]	довгота
measure, v.	['meʒə]	вимірювати, міряти, відміряти, відраховувати
plumb line	[plʌm]	схил(прилад для визначення перпендикулярності чого-л.)
positioning, *n*.	[pə'zıʃ(ə)nıŋ]	орієнтація, визначення положення, позиціонування
precise, *adj.*	[prı'saıs]	точний, визначений; ***syn.*** exact, punctual
rigorous, *adj.*	['rıg(ə)rəs]	точний, досконалий, ретельний; ***syn.*** careful, thorough, precise, accurate

survey, *n.*	['sɜːveɪ]	огляд, обстеження, інспектування, зйомка
traverse, *n.*	[trə'vɜːs]	полигонометрия
triangle, *n.*	['traɪæŋgl]	трикутник

2.2 Read the text and answer the following questions.

1. What are traditional surveying techniques? What are they used for?
2. How are astronomic positions obtained?
3. How is astronomic latitude defined?
4. What is astronomic longitude? How is it measured?
5. How do optical instruments astronomic observations made by work (function)?
6. What are the differences between the plane survey and triangulation?
7. What is the principle of triangulation based on?
8. What are four general orders of triangulation?
9. When is each triangulation order used?
10. Which accuracy should four orders of triangulation indicate?

GEODETIC SURVEYING TECHNIQUES (part I)

Four traditional surveying techniques (1) astronomic positioning, (2) triangulation, (3) trilateration, and (4) traverse are in general use for determining the exact positions of points on the earth's surface.

Horizontal positioning. Astronomic Position Determination

Astronomic positioning is the oldest positioning method. It has been used for many years by mariners and, more recently, by airmen for navigational purposes. Geodesists must use astronomic positions along with other types of survey data such as triangulation and trilateration to establish precise positions.

As the name implies, astronomic positions are obtained by measuring the angles between the plumb line at the point and a star or series of stars and recording the precise time at which the measurements are made. After combining the data with information obtained from star catalogues, the direction of the plumb line (zenith direction) is computed.

While geodesists use elaborate and very precise techniques for determining astronomic latitude, the simplest method, in the northern hemisphere, is to measure the elevation of Polaris above the horizon of the observer. Astronomic latitude is defined as the angle between the perpendicular to the geoid and the plane of the equator.

Astronomic longitude is the angle between the plane of the meridian at Greenwich (Prime Meridian) and the astronomic meridian of the point. Actually, it is measured by determining the difference in time-the difference in hours, minutes, and seconds between the time a specific star is directly over the Greenwich meridian and the time the same star is directly over the meridian plane of the point.

Astronomic observations are made by optical instruments-theodolite, zenith camera, prismatic astrolabe-which all contain leveling devices. When properly adjusted, the vertical axis of the instrument coincides with the direction of gravity and is, therefore, perpendicular to the geoid. Thus, astronomic positions are referenced to the geoid.

Triangulation

The most common type of geodetic survey is known as triangulation. It differs from the plane survey in that more accurate instruments are used, instrumental errors are either removed or predetermined. Another very important difference is that all of the positions established by triangulation are mathematically related to each other.

Basically, triangulation consists of the measurement of the angles of a series of triangles. The principle of triangulation is based on simple trigonometric procedures. If the distance along one side of a triangle and the angles at each end of the side are accurately measured, the other two sides and the remaining angle can be computed. Normally, all of the angles of every triangle are measured for the minimization of error and to furnish data for use in computing the precision of the measurements. Also, the latitude and longitude of one end of the measured side along with the length and direction (azimuth) of the side provide sufficient data to compute the latitude and longitude of the other end of the side.

There are four general orders of triangulation. First-Order (Primary Horizontal Control) is the most accurate triangulation. It is costly and time-consuming using the best instruments and rigorous computation methods. First-Order triangulation is usually used to provide the basic framework of horizontal control for a large area such as for a national network. It has also been used in preparation for metropolitan expansion and for scientific studies requiring exact geodetic data. Its accuracy should be at least one part in 100,000. Second-Order, Class I (Secondary Horizontal Control) includes the area networks between the First-Order arcs and detailed surveys in very high value land areas. It should indicate an accuracy of at least one part in 50,000. The demands for reliable horizontal control surveys in areas which are not in a high state of development or where no such development is anticipated in the near future justifies the need for a triangulation classified as Second-Order, Class II (Supplemental Horizontal Control). This class is used to establish control along the coastline, inland waterways and interstate highways. The control data contributes to the National Network and is published as part of the network. The minimum accuracy allowable in Class II of Second-Order is one part in 20,000. Third-Order, Class I and Class II (Local Horizontal Control) is used to establish control for local improvements and developments, topographic and hydrographic surveys, or for such other projects for which they provide sufficient accuracy. Its accuracy should be at least one part in 10,000 for Class I and one part in 5,000 for Class II. The sole accuracy requirement for Fourth-Order triangulation is that the positions be located without any appreciable errors on maps compiled on the basis of the control. Normally, triangulation is carried out by parties of surveyors occupying preplanned locations (stations) along the arc and accomplishing all the measurements as they proceed.

2.3 Match words similar in meaning.

1. purpose	a. method
2. data	b. surveyor
3. along with	c. aim
4. imply	d. establish
5. observer	e.information
6. technique	f. mistake
7. compute	g. together
8. accurate	h. measure
9. error	i. precise
10. determine	j. mean

2.4 Form words opposite in meaning using the following prefixes: un-, im-, ir-, il- .

Definite, sufficient, regular, known, different, important, accurate, relative, measured, logical, perfect, possible.

2.5 Give English equivalents for the following word combinations.

1. визначати точне положення
2. вимірювання кутів
3. широта
4. довгота
5. правильно встановлений

6. виключати помилки
7. вимагати точні відомості
8. підтверджувати необхідність
9. забезпечувати точність
10. група дослідників

2.6 Give Ukrainian equivalents for the following word combinations.

1. surveying techniques
2. to measure the elevation
3. the Greenwich meridian
4. a leveling device
5. to be related to each other
6. to be costly and time-consuming
7. to provide the basic framework
8. the area networks
9. to establish control
10. to accomplish all the measurements

2.7 Match sentence halves.

1. The position of a point can be obtained	**a**. to compute the astronomic longitude of the point.
2. The difference between the time at the point and the time at Greenwich is used	**b**. when distances between two points are too long.
3. Astronomic positions are	**c.** measure much longer distances without losing accuracy.
4. The laser equipped geodimeter can	**d.** directly by observing the stars.
5. Flare triangulation is a method which is used	**e.** wholly independent of each other.

2.8 Ask all possible questions to the sentences from exercise 2.7.

Read the text and give a short summary.

Snel (Snellius or Snel van Royen), Willebrord

(b. Leiden, Netherlands, 1580; d. Leiden, 30 October 1626), mathematics, optics, astronomy.

Snel was the son of Rudolph Snellius, or Snel van Royen, professor of mathematics at the new University of Leiden, and of Machteld Cornelisdochter. He studied law at the university but became interested in mathematics at an early age. Through the influence of Van Ceulen, Stevin, and his father, he received permission in 1600 to teach mathematics at the university. Soon afterward he left for Würzburg, where he met Van Roomen. He then went to Prague to conduct observations under

Tycho. He also met Kepler, and traveled to Altdorf and Tübingen, where he saw

Mästlin, Kepler's teacher. In 1602 Snel studied law in Paris. He returned home in 1604, after having traveled to Switzerland with his father, who was then in Kassel at the court of the learned Prince Maurice of Hesse.

After his father's death in March 1613, Snel succeeded him at the university, and two years later he became professor. He taught mathematics, astronomy, and optics, using some instruments in his instruction.

Sharing the admiration of his father and of Maurice of Hesse for Ramus, Snel published Ramus' Arithmetica, with commentary, in 1613. During this period Snel prepared the Latin translation of two books by Van Ceulen. Snel's lack of attention to this translation may have been due to preoccupation with geodetic work. In 1615 he became deeply involved in the determination of the length of the meridian, selecting for this work the method of triangulation, first proposed by Gemma Frisius in 1533 and also used by Tycho. Snel developed it to such an extent that he may rightfully be called the father of triangulation. Starting with his house (marked by a memorial plaque in 1960), he used the spires of town churches as points of reference. Thus, through net of triangles, he computed the distance from Alkmaar to Bergen-op-Zoom (around 130 kilometers). The two towns lie on approximately the same meridian. Snel used the distance from Leiden to Zoeterwoude (about 5 kilometers) as a baseline. His instruments were made by Blaeu; and the huge, 210-centimeter quadrant used for his triangulations is suspended in the hall of the Leiden astronomical observatory. The unit of measure was the Rhineland rod (1 rod = 3.767 meters), recommended by Stevin to the States General in 1604 (Stevin, Principal Works, IV [1964], 24); and, following Stevin, the rod was divided into tenths and hundredths. The results were presented In Eratosthenes batavus (1617).

Dissatisfied with his geodetic work Snel began to correct it, aided by his pupils, and extended his measurements to include the distance from Bergen-op-Zoom to Mechelen. Unaided by logarithms, he continued this work throughout his life. His early death in 1626 prevented him from publishing his computations, which are preserved his own copy of Eratosthenes batavus at the Royal Library in Brussels. They were recently checked by N. D. Haasbroek and were found to be conscientious and remarkably accurate. Haasbroek could not say as much for the way in which

Musschenbroek handled these notes in his ―De magnitudine terrae,‖ in Physicae experimentales ... (1729).

Snel published some observations by Biürgi and Tycho in 1618, and his descriptions of the comets of 1585 and 1618. Although he demonstrated from the parallax that the comet was beyond the moon and therefore could not consist of terrestrial vapors, he still believed in the character of comets as omina.

In 1624 Snel published his lessons on navigation in Tiphys batavus (Tiphys was the pilot of the Argo). The last works published by Snel himself were Canon triangulorum (1626) and Doctrina triangulorum (1627), the latter completed by his pupil Hortensius.

Snel's best-known discovery, the law of refraction of light rays, which was named after him, was formulated probably in or after 1621, and was the result of many years of experimentation and of the study of such books as Kepler's Ad Vitellionem paralipomena (1604) and Risner's Optica (1606. Snel's manuscript, which contained his results, has disappeared, but it was examined by Issac Vossius (1662) and by Huygens, who commented on it in his Dioptrica (1703, 1728).

The priority of the publication of the law remains with Descartes in his Dioptrique (1637), stated without experimental verification. Descartes has been accused of plagiarism (for example, by Huygens), a fact made plausible by his visits to Leiden during and after Snel's days, but there seems to be no evidence for it.

Snel was buried in the Pieterskerk in Leiden. The monument erected to him and his wife, who died in 1627, is still there.

UNIT3

GEODETIC SURVEYING TECHNIQUES (part 2)

3.1 Practise reading the following words.

[aɪ] – island, h**ei**ght, upr**i**ght, beh**i**nd, impl**y**, l**i**ne

[əʊ] – old, locate, closure, c**oa**stline, p**o**le

[eɪ] – navig**a**tion, calibr**a**te, obt**ai**n, w**a**ve, rem**ai**n

[dʒ] – agency, ad**j**oin, chan**g**e, **g**eodetic, ad**j**ust

barometer [bə'rɔmɪtə], barometric [ˌbɑːrəu'metrɪk], bubble ['bʌbl], interior [ɪn'tɪərɪə], mountainous ['mauntɪnəs],) radar ['reɪdɑː], technique [tek'niːk], telescope

['telɪskəup], thermometer [θə'mɔmɪtə], surface ['sɜːfɪs].

3.2 Translate words of the same root into Ukrainian.

To measure – measured – measureless – measurement – measuring – measurable - measurer
To extend – extended – extending – extensive – extension – extensible
To compute – computer – computation – computable – computing – computerize(d)

3.3 Fill in the sentences with words from exercise 3.2.

1. We … the fence to the edge of our property.
2. Final results had not yet been … .
3. An odometer … the number of miles your car travels.
4. Have you ever done any … for your research?
5. The exhibition has received … coverage in the national press.
6. The assistant took my ... and showed me what was available in my size.

ACTIVE VOCABULARY

Word	**Pronunciation**	**Translation**
aneroid, *n.*	['ænərɔɪd]	барометр-анероїд
calibrate, *v.*	['kælıbreıt]	градуювати, калібрувати
conterminous, *adj.*	[kɔn'tɜːmınəs]	суміжний, примикає, прикордонний, сусідній; ***syn.*** adjacent, adjoining
correspond, *v.*	[ˌkɔrı'spɔnd]	відповідати, узгоджуватися, співвідноситися
differential, *adj.*	[ˌdıf(ə)'ren(t)ʃ(ə)l]	диференціальний
execute, *v.*	['eksıkjuːt]	здійснювати, виконувати, робити; ***syn***. perform, fulfil
gauge, *n.*	[geıʤ]	вимірювальний прилад
leveling, *n.*	['lev(ə)lıŋ]	нівелювання
loop, *n.*	[luːp]	петля
mercurial, *adj.*	[mɜː'kjuərıəl]	ртутний
missile, *n.*	['mısaıl]	реактивний снаряд, ракета
reckoning, *n.*	['rek(ə)nıŋ]	обчислення, розрахунок, визначення місцезнаходження; ***syn.*** calculation, computation

reconnaissance, *n*.	[rɪ'kɔnɪs(ə)ns]	розвідка, розслідування, зондування
sparsely, *adj*.	['spɑːslɪ]	рідко
supplementary, *adj*.	[ˌsʌplɪ'ment(ə)rɪ]	додатковий; ***syn.*** additional, extra
tidal, *adj*.	['taɪd(ə)l]	пов'язаний з припливом і відливом, періодичний, що чергується, переміжний
undulation, *n*.	[ˌʌndjə'leɪʃ(ə)n]	хвилеподібний рух
upright, *adj*.	['ʌpraɪt]	вертикальний, прямий
yield, *v*.	[jiːld]	давати, видавати, виробляти

3.4 Read the text and match paragraphs A-D with gaps 1-5.

GEODETIC SURVEYING TECHNIQUES (part 2)

Trilateration

Another surveying method involves the use of radar and aircraft. The SHORAN, HIRAN and SHIRAN electronic distance measuring systems have been applied to performing geodetic surveys by a technique known as trilateration. Since very long lines (to 500 miles) could be measured by these systems, geodetic triangulation networks have been extended over vast areas in comparatively short periods of time. In addition, the surveys of islands and even continents separated by extensive water barriers have been connected by the techniques.

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Traverse

The simplest method of extending control is called traverse. The system is similar to dead reckoning navigation where distances and directions are measured. In performing a traverse, the surveyor starts at a known position with a known azimuth (direction) to another point and measures angles and distances between a series of survey points.

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If the traverse returns to the starting point or some other known position, it is a closed traverse, otherwise the traverse is said to be open. The traverse consists of a series of high-precision length, angle and astronomic azimuth determinations running approximately east-west and north-south through the conterminous states, forming somewhat rectangular loops.

Vertical positioning

Vertical surveying is the process of determining heights-elevations above the mean sea level surface. The geoid corresponds to the mean level of the open sea. In geodetic surveys executed primarily for mapping purposes, there is no problem in the fact that geodetic positions are referred to an ellipsoid and the elevations of the positions are referred to the geoid.

Precise geodetic leveling is used to establish a basic network of vertical control points. From these, the height of other positions in the survey can be determined by supplementary methods. The mean sea level surface used as a reference (vertical datum) is determined by obtaining an average of the hourly water heights for a period of several years at tidal gauges.

There are three leveling techniques-differential, trigonometric, and barometricwhich yield information of varying accuracy. Differential leveling is the most accurate of the three methods. With the instrument locked in position, readings are made on two calibrated staffs held in an upright position ahead of and behind the instrument. The difference between readings is the difference in elevation between the points.

The exact elevation of at least one point in a leveling line must be known and the rest computed from it. Trigonometric leveling involves measuring a vertical angle from a known distance with a theodolite and computing the elevation of the point.

It is, therefore, a somewhat more economical method but less accurate than differential leveling. It is often the only practical method of establishing accurate elevation control in mountainous areas. In barometric leveling, differences in height are determined by measuring the difference in atmospheric pressure at various elevations. Air pressure is measured by mercurial or aneroid barometers, or a boiling point thermometer. Although the degree of accuracy possible with this method is not as great as either of the other two, it is a method which obtains relative heights very rapidly at points which are fairly far apart. It is widely used in the reconnaissance and exploratory surveys where more exacting measurements will be made later or are not required.

With the angular measurements, the direction of each line of the traverse can be computed; and with the measurements of the length of the lines, the position of each control point computed.

A The optical instrument used for leveling contains a bubble tube to adjust it in a position parallel to the geoid. When properly "set up" at a point, the telescope is locked in a perfectly horizontal (level) position so that it will rotate through a 360 arc.

B However, geodetic data for missiles requires an adjustment in the elevation information to compensate for the undulations of the geoid above and below the regular mathematical surface of the ellipsoid. The adjustment uses complex advanced geodetic techniques.

C The Canadian SHORAN network connecting the sparsely populated northern coastal and island areas with the central part of the country and the North Atlantic HIRAN Network tying North America to Europe are examples of the application of the trilateration technique. SHIRAN has been used in the interior of Brazil.

D With this method, vertical measurements can be made at the same time horizontal angles are measured for triangulation.

3.5 Match words with their definitions.

barrier	**azimuth**	**technique**	**loop**	**level**	**ellipsoid**
elevation					

………. - a way of carrying out a particular task, especially the execution or performance of an artistic work or a scientific procedure;

1. ………. - the direction of a celestial object from the observer, expressed as the angular distance from the north or south point of the horizon to the point at which a vertical circle passing through the object intersects the horizon;
2. ………. - a three-dimensional figure symmetrical about each of three perpendicular axes, whose plane sections normal to one axis are circles and all the other plane sections are ellipses;
3. ………. - a height or distance from the ground or another stated or understood base;
4. ………. - the action or fact of raising or being raised to a higher or more important level, state, or position;
5. ………. - a circumstance or obstacle that keeps people or things apart or prevents communication or progress;

6. ……… - a length of thread, rope, or similar material, doubled or crossing itself, used as a fastening or handle

3.6 Mark the following sentences True or False.

1. Only distances are measured in trilateration.
2. If the traverse returns to the starting point or some other known position, it is an open traverse.
3. Reckoning navigation methods in geodesy involve the determination of an observer's position from observations of the moon, stars and satellites.
4. Vertical surveying is the process of determining heights-elevations above the mean sea level surface.
5. Trigonometric, differential and barometric leveling techniques turn in information of varying accuracy.
6. Differential leveling measures a vertical angle from a known distance with a theodolite and computing the elevation of the point.
7. In barometric leveling, differences in angles are determined by measuring the difference in atmospheric pressure at various elevations.

3.7 Find words in the text similar in meaning.

1. fulfill
2. spacious
3. space
4. use
5. dot
6. apparatus
7. precision
8. right-angled
9. vertical
10. compression

Match adjectives with suitable nouns.

1. extending	a. technique
2. surveying	b. length
3. rectangular	c. control
4. trilateration	d. instruments
5. high-precision	e. method
6. vertical	f. traverse
7. angular	g. pressure
8. air	h. loops
9. closed	i. angle

10. optical j.measurements

UNIT 4
GEODETIC SYSTEMS

4.1 Practise reading the following words.

a) **[eɪ] –** elev**a**tion, m**ay**, n**a**tion, m**a**jor, surv**ey**, b**a**se

[aʊ] – hour, h**o**wever, **our**, f**ou**nd, **ou**t

[ʃ] – condi**t**ion, accompli**sh**, expan**s**ion, establi**sh**, ini**t**ial, offi**c**ial

[ɔ:] – f**o**r, **o**rder, l**au**nch, therefo**r**e, m**o**re

b) ellipsoid [ɪ'lɪpsɔɪd], numerical [njuː'merɪkl], geometric(al) [ˌʤɪə'metrɪk((ə)l)], basis ['beɪsɪs], coordinate [kəu'ɔːdɪnət], error ['erə], gravimetric [ˌgrævɪ'metrɪk], system ['sɪstəm], geocentric [ˌʤiːəu'sentrɪk].

4.2 Complete the chart below with the common noun suffixes and mark the stress. There are some spelling changes.

nouns	- ation - ion - ness - ity - ence/ance - sion - ment

noun	**verb/ adjective**
	1. quantify
	2. adjust
	3. capable
	4. refer
	5. rotate
	6. commit
	7. require
	8. separate
	9. differ
	10. expand

4.3 Fill in the sentences with words from exercise 4.2.

1. I'm not sure how he'll make the emotional ….. to retirement.
2. The book is an ….. of a lecture series.
3. She made no ..... to her opponents.
4. He is considering the offer but he has not yet ….. himself.
5. It ….. careful consideration.
6. She ….. from her sister in the colour of her eyes.

ACTIVE VOCABULARY

Word	Pronunciation	Translation
adjustment, *n.*	[ə'ʤʌstmənt]	залагодження, врегулювання, налагодження, налаштування
axis, *n., pl.* axes	['æksɪs]	вісь
coincident, *adj.*	[kəu'ɪnsɪd(ə)nt]	співпадаючий, відповідний
concurrent, *adj.*	[kən'kʌr(ə)nt]	співпадаючий; узгоджений
conterminous, *adj.*	[kɔn'tɜːmɪnəs]	суміжний, примикає, прикордонний, сусідній; **syn.** adjacent, adjoining
curvature, *n.*	['kɜːvəʧə]	вигин, викривлення, кривизна
datum, *n.*	['deɪtəm]	база, базова точка(лінія, площина) , початок відліку, точка (лінія, площина) приведення
deflection, *n.*	[dɪ'flekʃ(ə)n]	відхилення; **syn.** deviation
discrepancy, *n.*	[dɪs'krep(ə)nsɪ]	різниця; відмінність, розбіжність, протиріччя; **syn.** difference, disagreement
extend, *v.*	[ɪk'stend]	простягатися, тягнутися, тривати
flattening, *n.*	['flæt(ə)nɪŋ]	вирівнювання, сплюснутость, згладженість
involve, *v.*	[ɪn'vɔlv]	залучати, втягувати
leveling, *n.*	['lev(ə)lɪŋ]	нівелювання
overlap, *v.*	[ˌəuvə'læp]	частково покривати; перекривати
particular, *adj.*	[pə'tɪkjələ]	особливий, специфічний, винятковий
scope, *n.*	[skəup]	масштаб, межа, розмах, сфера, область дії

stretch, *n.*	[stretʃ]	витягування, розтягування, подовження, напруга; простір, ділянка, відрізок
survey, *n.*	['sɜːveɪ]	землемірна, геодезична, топографічна зйомка місцевості

4.4 Read the text and answer the following questions.

1. What is datum?
2. How many types of datums are there in geodesy?
3. What does a horizontal datum consist of?
4. Why do discrepancies between datums occur?
5. What are three methods of datum connection?
6. Why are elevations in vertical datums referred to the geoid?
7. What are discrepancies among vertical datums?
8. What are vertical datum problems in Europe and in Asia?

GEODETIC SYSTEMS

A datum is defined as any numerical or geometrical quantity or set of such quantities which serve as a reference or base for other quantities. In geodesy two types of datums must be considered: a horizontal datum which forms the basis for the computations of horizontal control surveys in which the curvature of the earth is considered, and a vertical datum to which elevations are referred. In other words, the coordinates for points in specific geodetic surveys and triangulation networks are computed from certain initial quantities (datums).

Horizontal Geodetic Datums

A horizontal geodetic datum may consist of the longitude and latitude of an initial point (origin); an azimuth of a line (direction) to some other triangulation station; the parameters (radius and flattening) of the ellipsoid selected for the computations; and the geoid separation at the origin. A change in any of these quantities affects every point on the datum.

In areas of overlapping geodetic triangulation networks, each computed on a different datum, the coordinates of the points given with respect to one datum will differ from those given with respect to the other. The differences occur because of the different ellipsoids used and the probability that the centers of each datum's ellipsoid is oriented differently with respect to the earth's center. In addition, deflection errors in azimuth cause a relative rotation between the systems. Finally, a difference in the scale of horizontal control may result in a stretch in the corresponding lines of the geodetic nets.

Datum Connection

There are three general methods by which horizontal datums can be connected. The first method is restricted to surveys of a limited scope and consists of systematic elimination of discrepancies between adjoining or overlapping triangulation networks. The second one is the gravimetric method of Physical Geodesy and the third – the methods of Satellite Geodesy. These methods are used to relate large geodetic systems to each other and/or to a world system. Both the gravimetric and satellite methods produce necessary "connecting" parameters from reduction of their particular observational data.

Vertical Datums

Just as horizontal surveys are referred to specific original conditions (datums), vertical surveys are also related to an initial quantity or datum. Elevations are referred to the geoid because the instruments used either for differential or trigonometric leveling are adjusted with the vertical axis coincident to the local vertical. As with horizontal datums, there are many discrepancies among vertical datums. There is never more than 2 meters variance between leveling nets based on different mean sea level datums; however, elevations in some areas are related to surfaces other than the geoid; and barometrically determined heights are usually relative.

In the European area, there are fewer vertical datum problems than in Asia and Africa. Extensive leveling work has been done in Europe and practically all of it has been referred to the same mean sea level surface. However, in Asia and Africa the situation has been different. In places there is precise leveling information available based on mean sea level. In other areas the zero elevation is an assumed elevation which sometimes has no connection to any sea level surface. China has been an extreme example of this situation where nearly all of the provinces have had an independent zero reference. There is very little reliable, recent, vertical data available for much of the area of Africa and Asia including China.

The mean sea level surface in the United States was determined using 21 tidal stations in this country and five in Canada. This vertical datum has been extended over most of the continent by first-order differential leveling. Concurrent with the new adjustment of the horizontal network, mentioned previously, is the readjustment of the vertical network. Countries of North and Central America are involved. In the conterminous United States 110,000 kilometers of the basic network are being releveled.

4.5 Mark the following sentences True or False.

1. A horizontal datum is a datum to which elevations are referred and vertical one is a datum in which the curvature of the earth is considered.
2. There are some quantities which may affect every point on the datum.
3. The survey of the limited scope, the gravimetric method of Physical Geodesy and the methods of Satellite Geodesy are methods of horizontal datum.
4. There are no differences among vertical datums.
5. There are more vertical datum problems in Europe than in Asia.
6. China is an example of zero elevation which has no connection to the sea level surface.
7. The mean sea level surface in Canada was determined by 31 tidal stations.

4.6. Match words similar in meaning.

1. kind	a. error
2. suppose	b. initial
3. primary	c. restrict
4. chose	d. deflection
5. deviation	e. type
6. adjust	f. determine
7. mistake	g. consider
8. limit	h. instrument
9. tool	i. orient
10. resolve	j. select

4.7 Match words opposite in meaning.

1. ruin	a. differ
2. lower	b. connect
3. be alike	c. unify
4. shrink	d. form
5. enlarge	e. reduce
6. separate	f.accurate
7. unreliable	g. stretch
8. following	h.previous
9. inaccurate	i. elevate
10. diversify	j. reliable

4.8 Match two halves of the statements and translate them into Ukrainian.

1. neighboring	a. advanced nation
2. military interests of	b. existing local surveys
3. different surveys	c. countries
4. various weapon	d. requirement
5. technically	e. each country
6. economic	f. international nature
7. surveys of	g. varying size
8. military	h. distance requirements
9. the size and	i. systems
10. the expansion and unification of	j. shape of the earth

UNIT5
PHYSICAL GEODESY (part 1)

5.1 Practise reading the following words.

a) [ɔɪ] – sp**oi**lt, enj**oy**, p**oi**nt, empl**oy**, j**oi**nt **[ɪə] –**n**ear**, cl**ear**, per**io**d, conven**ie**nt, h**ere**

[w] – with, bet**w**een, **w**hich, net**w**ork, s**w**ing, **w**ere [**tʃ**] – **ch**ange, struc**t**ure, su**ch**, ea**ch**, a**ch**ieve, mu**t**ual **b) underline the stressed syllable** acceleration, airplane, although, characteristic, consequently, gravimeter, interval, successive, technique.

5.2 Translate words of the same root into Ukrainian.

To compare – comparison – comparative – comparable – comparatively – comparability

To distribute – distributed – distributor – distributing – distributive – distribution

To occupy – occupied – occupational – occupancy – occupant – occupier – occupation.

5.3 Fill in the sentences with words from exercise 5.2

1. A steady stream of clients kept her … until the middle of the afternoon.
2. The remake was OK but it cannot … with the original.
3. It is clear that a reorganization is necessary on the … side of this industry.
4. The new homes will be ready for … in August.
5. I sat out in the open air in … comfort.
6. The books will be … free to local schools.

ACTIVE VOCABULARY

Word	Pronunciation	Translation
approximately, *adv*.	[ə'prɔksɪmətlɪ]	приблизно, близько, майже
associate, *v*.	[ə'səusɪeɪt], [-ʃɪeɪt]	асоціювати, пов'язувати з (ким-л. / чим-л.)
attraction, *n*.	[ə'trækʃ(ə)n]	Притяжіння, тяжіння; **syn.** gravitation, gravity
consideration, *n*.	[kənˌsɪd(ə)'reɪʃ(ə)n]	роздуми, обговорення, розгляд
deduce, *v*.	[dɪ'djuːs]	приходити до висновку, робити висновок
drift, *n*.	[drɪft]	зрушення, напрямок, тенденція
flip, *v*.	[flɪp]	перевертати; перекидати
instability, *n*.	[ˌɪnstə'bɪlətɪ]	нестійкість, мінливість
invar, *n*.	[ɪn'vɑː]	Інвар (сплав заліза з нікелем)
pendulum, *n*.	['pendj(ə)ləm]	маятник
pivot, *n*.	['pɪvət]	штир, болт, штифт
relative, *adj*.	['relətɪv]	відносний, порівняльний, релятивный
reversible, *adj*.	[rɪ'vɜːsəbl]	з переднім і заднім ходом, реверсивний
solution, *n*.	[sə'luːʃ(ə)n]	рішення, дозвіл, роз'яснення
sufficient, *adj*.	[sə'fɪʃ(ə)nt]	достатній; обґрунтований
supersede, *v*.	[ˌs(j)uːpə'siːd]	замінювати, заміщати, зміщувати; **syn.** displace, dislocate
swing (swung, swung), *v*.	[swɪŋ]	гойдатися, коливатися, підвішувати

tie, *v.*	[taɪ]	з'єднувати, скріплювати, зв'язувати; **syn.** connect, join
value, *n.*	['vælju:]	величина, значення
virtually, *adv.*	['vɜ:ʧuəlɪ]	фактично, практично, по суті; воістину

5.4 Read the text and answer the following questions.

1. What does Physical Geodesy study?
2. What types of gravity measurements exist?
3. What did scientists use to measure the gravity until the middle of the 20^{th} century?
4. Why was the pendulum method superseded by the ballistic method?
5. What instruments were used for relative gravity measurements?
6. When was the first gravimeter developed?
7. What is drift?
8. What points are called base stations?

PHYSICAL GEODESY (part 1)

Physical geodesy utilizes measurements and characteristics of the earth's gravity field as well as theories regarding this field to deduce the shape of the geoid and in combination with arc measurements, the earth's size. With sufficient information regarding the earth's gravity field, it is possible to determine geoid undulations, gravimetric deflections, and the earth's flattening.

In using the earth's gravity field to determine the shape of the geoid, the acceleration of gravity is measured at or near the surface of the earth. It might be interesting to compare the acceleration measured by the gravimetrist and the acceleration experienced in an airplane. In an airplane, the acceleration is simply called a G force and is measured by a G meter. A G factor of one is used to indicate the acceleration due to the attraction of the earth and is considered a neutral condition. The gravity unit used and measured in geodesy is much smaller. A G factor of one is approximately equal to one thousand gals, a unit named after Galileo. The still smaller unit used in geodesy is the milligal (mgal) or one-thousandth part of a gal. Thus, in geodesy we are dealing with variations in acceleration equal to one millionth of one G aircraft acceleration. <u>The most accurate modern instruments</u> permit measurement of acceleration changes of one hundred millionth part of the well known G factor or better.

Gravity Measurements

Two distinctly different types of gravity measurements are made: absolute gravity measurements and relative gravity measurements. If the value of acceleration of gravity can be determined at the point of measurement directly from the data observed at that point, the gravity measurement is absolute. If only the differences in the value of the acceleration of gravity are measured between two or more points, the measurements are relative. *Absolute measurement of gravity*

Until the middle of the 20th century, virtually all absolute measurements of gravity were made using some type of pendulum apparatus. The most usual type of apparatus contained a number of pendulums that were swung in a vacuum. By measuring the peroid of the pendulums, the acceleration of gravity could be computed. In 1818, Kater developed the so-called reversible pendulum that had knife edge pivots at both ends. These pendulums were flipped over (reversed) during the measurements and, using this procedure, a number of important error sources were eliminated. Still, there were numerous other problems and error sources associated with pendulum measurements of absolute gravity, and the results obtained were not sufficiently accurate to meet the needs of geodetic gravimetry. Consequently, in recent years, the pendulum method has been superseded by the ballistic method which is based on timing freely falling bodies. The acceleration of gravity can be determined by measuring the time taken by a body to fall over a known distance.

Relative measurement of gravity

Solution of some of the problems of gravimetric geodesy requires knowledge of the acceleration of gravity at very many points distributed uniformly over the entire surface of the earth. Since absolute gravity measurements have been too complicated and time consuming and, until recently, could not be obtained with sufficient accuracy, relative gravity measurements have been used to establish the dense network of gravity measurements needed. The earliest relative gravity measurements were made with reversible pendulums. The most accurate relative pendulums to be developed were the Gulf quartz pendulum and the Cambridge invar pendulum. These two instruments were used as late as 1969.

Modern relative gravity measurements are made with small, very portable, and easily used instruments known as gravimeters (gravity meters). Using gravimeters, highly accurate relative measurements can be made at a given site, known as a gravity station, in half-an-hour or less. Modern gravimeter-type instruments were first developed in the 1930's. There are two other important considerations when relative gravity measurements are made: drift and base station connections. Gravimeter drift is a phenomenon related to certain instrumental instabilities that cause the dial reading to change slowly with time even when the acceleration of gravity remains constant. Since relative gravity surveys can determine only differences in gravity from point to point, every relative gravity survey must include measurements at one or more reoccupiable points where acceleration of gravity is known. Such points are called base stations. Then all gravity difference measurements are computed with respect to the known gravity value at the base station. Hence, tying a relative gravity survey to a base station establishes the "gravity datum" of that survey. The earliest "gravity datum" was the so-called Potsdam System. The Potsdam system, however, was found to be in error and, in 1971, was replaced by the International Gravity Standardization Net 1971 (IGSN71).

5.5 Mark the following sentences True or False.

1. Having information about the earth's gravity field, you can determine geoid undulations, gravimetric deflections and the earth's flattening.
2. In geodesy it is dealt with variations in acceleration equal to one thousandth of one G aircraft acceleration.
3. Kater developed a pendulum but measurements and results were not rather accurate.
4. Absolute gravity measurements were simple but time consuming.
5. Reversible pendulums are small, portable and easily used instruments.
6. Gravimeter-type instruments were first developed at the beginning of the 20th century.
7. Base stations are reoccupiable points where acceleration of gravity is known.
8. The Potsdam System was replaced by the IGSN in 1977.

Ask questions to the underlined words and phrases.

Match words with their definitions.

point geoid instability gravity apparatus pivot instrument acceleration

……… - a hypothetical solid figure whose surface corresponds to mean sea level and its imagined extension under (or over) land areas;

1. ……… - the force that attracts a body towards the centre of the earth, or towards any other physical body having mass;
2. ……… - the rate of change of velocity per unit of time;
3. ……… - a tool or implement, especially one for precision work;
4. ……… - tendency to unpredictable behaviour or erratic changes of mood;

5. ………. - the technical equipment or machinery needed for a particular activity or purpose;
6. ………. - the central point, pin, or shaft on which a mechanism turns or oscillates; 8. ………. - a particular spot, place, or position in an area or on a map, object, or surface.

UNIT 6
PHYSICAL GEODESY (part 2)

6.1 Practise reading the following words.

a) **[θ] –** ear**th**, bo**th**, me**th**od, mon**th**, **th**ought, **th**eory
[ŋ] – bei**ng**, alo**ng**, emergi**ng**, wi**ng**, si**n**gle, le**n**gth
[e] – d**e**nse, n**e**t, l**e**vel, d**e**nsity, r**e**gular, eff**e**ct

b) submarine [ˌsʌbm(ə)'riːn], compensate ['kɔmpenseɪt], anomaly [ə'nɔməlɪ], uniform ['juːnɪfɔːm], satellite ['sæt(ə)laɪt], apparatus [ˌæp(ə)'reɪtəs], inertial [ɪˈnəːʃ(ə)l], equivalent [ɪ'kwɪv(ə)lənt], ellipsoidal [ˌelɪp'sɔɪd(ə)l], topography [tɔ'pɔgrəfɪ], Vening Meinesz [ˌvɛnɪŋ ˈmʌɪnɛs].

6.2 Cross out the word with a different sound.

ʌ	red**u**ction cr**u**st ass**u**me p**u**blish str**u**cture
æ	**a**verage v**a**lue gr**a**vity **a**fter v**a**rious
k	air**c**raft surfa**c**e su**cc**ess **c**onsider a**cc**uracy
əʊ	m**o**tion comp**o**nent pr**o**minent **o**cean kn**o**w
w	**w**ave **w**hole for**w**ard **w**ould **w**here

ACTIVE VOCABULARY

Word	**Pronunciation**	**Translation**
airborne, *adj.*	['eəbɔːn]	переноситься або перевозиться по повітрю
altitude, *n.*	['æltɪt(j)uːd]	висота
application, *n.*	[ˌæplɪ'keɪʃ(ə)n]	застосування, додаток
correlation, *n.*	[ˌkɔrə'leɪʃ(ə)n]	взаємозв'язок, співвідношення

crust, *n.*	[krʌst]	земна кора
data, *n.*	['deɪtə]	дані, факти, відомості
eliminate, *v.*	[ɪ'lɪmɪneɪt]	усувати, виключати, анулювати; **syn**. remove, expel
encounter, *v.*	[ɪn'kauntə]	натрапляти на (труднощі), зіткнутися з
justify	['ʤʌstɪfaɪ]	підтверджувати,доводити, пояснювати, обґрунтовувати; **syn.** confirm, prove, verify
lack, *n.*	[læk]	недолік, потреба, відсутність
magnitude, *n.*	['mægnɪt(j)uːd]	величина, важливість, значення, магнітуда
mantle, *n.*	['mæntl]	(земна) мантія
oscillatory, *adj.*	['ɔsɪlət(ə)rɪ]	коливальний
purpose, *n.*	['pɜːpəs]	мета, намір; задум, прагнення; **syn.** aim, goal, objective
shore, *n.*	[ʃɔː]	берег, узбережжя; **syn**. bank, beach, coast
sparse, *adj.*	[spɑːs]	розкиданий, рідкісний
spurious, *adj.*	['spjuərɪəs]	підроблений, помилковий, фальшивий; **syn.** faked, counterfeit
velocity, *n.*	[vɪ'lɔsətɪ]	швидкість, прудкість

6.3 Read the text and answer the following questions.

1. When did first gravimeters on ships appear?
2. What instruments were used on surface ships?
3. What is a problem with ocean surface measurements?
4. What systems are used near the shore and in the deep ocean?
5. What problems are there with gravity measurements in the air?
6. What is gravity anomaly?
7. What is the most common type of gravity anomaly?

8. Who developed formulas for computing the gravimetric deflection of the vertical?
9. What does the effectiveness of the gravimetric method depend on?
10. What geophysical data are correlated with each othe

PHYSICAL GEODESY (part 2)

Gravity measurement at sea

The earliest measurements at sea were made by F.A. Vening Meinesz who, in 1927, installed a pendulum apparatus in a submarine. The submarine pendulum gravity measurements of Vening Meinesz are mainly of historical interest today. The first gravimeters installed in surface ships appeared during the 1950's. These early ocean surface gravity measurements were only of modest accuracy and, again, now are mainly of historical value. Reasonably accurate measurements from gravimeters on surface ships date only from the late 1960's. Instruments used include LaCosteRomberg S Meter, Askania Meter, Bell Meter, and the Vibrating String Gravimeter. All of these meters are compensated to minimize the effects of oscillatory motion of the ship due to ocean surface waves. The effects are also eliminated or averaged out by computational techniques. A big problem with ocean surface measurements is that the forward motion of the ship adds a centrifugal reaction component to measured gravity which must be eliminated by the so-called Eotvos correction. Therefore, the ship's velocity and heading, as well as the ship's position, must be known accurately. Near shore, shore based electronic positioning/navigation systems (such as LORAN) are used. In the deep ocean, satellite navigation and inertial systems must be used.

Gravity measurement in the air

Problems in airborne gravity measurements are similar to those encountered for surface ships. The position, velocity, and heading of the aircraft must be known accurately. Because of the higher aircraft speeds, the Eotvos correction is much larger for airborne measurements than for surface ship measurements. It also is very difficult to compensate for spurious aircraft accelerations. In addition, reduction of the gravity value from aircraft altitude to an equivalent surface value is a problem that has not yet been solved satisfactorily.

Gravity Anomalies

Gravity measurements provide values for the acceleration of gravity at points located on the physical surface of the earth. Before these measurements can be used for most geodetic purposes, they must be converted into gravity anomalies.

A gravity anomaly is the difference between a gravity measurement that has been reduced to sea level and normal gravity. Normal gravity, used to compute gravity anomalies, is a theoretical value representing the acceleration of gravity that would be generated by a uniform ellipsoidal earth. By assuming the earth to be a regular surface without mountains or oceans, having no variations in rock densities or in the thickness of the crust, a theoretical value of gravity can be computed for any point by a simple mathematical formula. The most common type of gravity anomaly used for geodetic applications is the so-called free-air gravity anomaly.

Undulation and Deflections by the Gravimetric Method

The method providing the basis from which the undulations of the geoid may be determined from gravity data was published in 1849 by a British scientist, Sir George Gabriel Stokes. However, the lack of observed gravity data prevented its application until recent years. In 1928, the Dutch scientist, Vening Meinesz, developed the formulas by which the gravimetric deflection of the vertical can be computed. The computation of the undulations of the geoid and the deflections of the vertical require extensive gravity observations. The areas immediately surrounding the computation point require a dense coverage of gravity observations and detailed data must be obtained out to distances of about 500 miles. A less dense network is required for the remaining portion of the earth. While the observational requirements for these computations appear enormous, the results well justify the necessary survey work. Effective use of the gravimetric method is dependent only on the availability of anomalies in sufficient quantity to achieve the accuracy desired. Successful use of Stoke's integral and Vening-Meinesz formulas depends on a good knowledge of gravity anomalies in the immediate vicinity of the point under consideration and a general knowledge of anomalies for the entire earth.

There are many large regions on the continents where gravity measurements are lacking or available only in small quantities. Gravity data for ocean areas has always been sparse, however, Satellite Altimetry has overcome this deficiency. In regions where an insufficient number of gravity measurements exists, some other approach must be used to obtain or predict the mean gravity anomalies for the areas.

Correlations exist between variations in the gravity anomaly field and corresponding variations in geological, crustal, and upper mantle structure, regional and local topography and various other types of related geophysical data. In many areas where gravity information is sparse or missing, geological and geophysical data is available. Therefore, the various prediction methods take into account the actual geological and geophysical cause of gravity anomalies to predict the magnitude of the anomalies.

6.4 Mark the following sentences True or False.

1. V. Meinesz used submarines for marine gravity surveys.
2. Early ocean surface gravity measurements were of precise accuracy.
3. Problems with gravity measurements in the air and in the sea are different.
4. The problem of reduction of gravity value from aircraft altitude to an equivalent surface is not solved.
5. Before being used for geodetic purposes, gravity measurements are converted into gravity anomalies.
6. In 1939 a British scientist published his method of determining the undulations of the geoid from gravity data.
7. Extensive gravity observations are necessary for computing the undulations of the geoid and the deflection of the vertical.
8. Geological and geophysical data is not available in areas where gravity information is sparse or missing.

6.5 Match words similar in meaning.

1. precise	a. recent
2. expel	b. heading
3. speed	c. accurate
4. route	d. dense
5. resolve	e. eliminate
6. normal	f. variation
7. variety	g. velocity
8. modern	h. extensive
9. vast	i. regular
10. thick	j. solve

6.6 Give English equivalents for the following word combinations.

1. коливальний рух
2. обчислювальна техніка
3. швидкість і курс корабля
4. Система навігації
5. товщина / потужність земної кори
6. недостатня кількість даних
7. в достатній кількості
8. прийняти до уваги

6.7 Give Ukrainian equivalents for the following word combinations.

1. gravity measurements

2. forward motion of the ship
3. the acceleration of gravity
4. to compute gravity anomaly
5. undulation of the geoid
6. to require extensive observations
7. to justify the necessary survey work
8. other types of related geophysical data

6.8 Match sentence halves.

1. The word, anomaly, as used in geodesy refers to a deviation from the normal	**a.** suitable for use aboard a fixed wing KC-135 aircraft.
2. To make use of the anomalies,	**b.** and a Del Norte transponder electronic navigation system to establish aircraft position,
3. The axis of rotation for the ellipsoid passes	**c.** geoid undulations cannot be computed directly but must be determined point by point.
4. The theoretical value of gravity at a point on the ellipsoid's surface depends both	**d.** and can be used either for a single point or to describe a regional or area effect.
5. The distance between the mathematical ellipsoid and the actual geoid	**e.** the observed gravity must be reduced to a common frame of reference, the geoid-mean sea level.
6. In 1959, the US Air Force was instrumental in developing a gravimeter	**f.** through the earth's center of gravity.

7. The gravity measurement system aboard the helicopter uses a LaCosteRomberg S Meter to sense gravity	**g.** on the size and shape of the ellipsoid and on a value, computed from observational data.
8. Since the geoid is so irregular,	**h.** is called the undulation of the geoid.

6.9. Ask all possible questions to the sentences from exercise 6.8.

UNIT 7
GEODESY AND SATELLITE NAVIGATION

7.1 Practise reading the following words.

a) **[eə] –** th**ere**, wh**ere**, c**are**ful, th**eir**, p**air**, b**are** **[ɒ] -** electr**o**nic, c**o**ncept, l**o**ng, horiz**o**ntal, ad**o**ption

[i] – limit, **ini**tial, s**i**gnal, pos**i**tion, cr**iti**cal, cont**i**nuous

[f] – enou**gh**, **ph**ase, octanogra**ph**er, o**ff**, **f**ield, lau**gh**

b) astronomer [ə'strɔnəmə], dynamics [daɪ'næmɪks], interferometry [ˌɪntəfəˈrɒmɪtri] methodology [ˌmeθə'dɔləʤɪ], reservoir ['rezəvwɑː], technical ['teknɪk(ə)l], technology [tek'nɔləʤɪ], tectonics [tek'tɔnɪks]

7.2 Put the words in the correct column.

Th**ough**t he**a**vy **a**sk set c**ou**ple **aw**ful the**f**t h**al**f l**aw** bl**oo**d h**or**se s**o**me **ar**m s**o**n he**a**d he**ar**t

ɑ:	**ʌ**	**e**	**ɔ:**

ACTIVE VOCABULARY

Word	**Pronunciation**	**Translation**
advance, *n.*	[əd'vɑːns]	успіх, прогрес, досягнення; ***syn.*** improvement, progress
baseline, *n.*	['beɪslaɪn]	стандарт, критерій, база
carrier, n.	['kærɪə]	носій, тримач, кронштейн
cumbersome, *adj.*	['kʌmbəsəm]	громіздкий, об'ємний; ***syn.*** bulky
curvature, *n.*	['kɜːvəʧə]	викривлення, кривизна

drawback, *n.*	['drɔːbæk]	перешкода, недолік; ***syn.*** obstacle, disadvantage
frequency, *n.*	['friːkwənsɪ]	частота
ingenuity, *n.*	[ˌɪnʤɪ'njuːətɪ]	винахідливість, винахідливість
instantaneous, *adj*.	[ˌɪn(t)stən'teɪnɪəs]	миттєвий; негайний; ***syn.***
		momentary, immediate
obscure, *v*.	[əb'skjuə]	загороджувати, заважати, затьмарювати
offshore, *adj.*	[ˌɔf'ʃɔː]	знаходиться на деякій відстані від берега, у відкритому морі
pipeline, *n.*	['paɪplaɪn]	трубопровід, нафтопровід, канал
plate, *n*.	[pleɪt]	плита, лист, смуга
receiver, *n*.	[rɪ'siːvə]	радіоприймач
scaling, *n*.	[skeɪlɪŋ]	масштабування, шкалювання
strengthen, *v*.	['streŋθ(ə)n]	посилювати, зміцнювати
substantial, *adj.*	[səb'stænʃ(ə)l]	значний, суттєвий, важливий; ***syn***. essential, important
supplement, *v*.	['sʌplɪment]	додавати, доповнювати, поповнювати,***syn.*** add
suspension	[sə'spenʃ(ə)n]	підвішування, зависання
terrestrial, *adj*.	[tə'restrɪəl]	земний
tool, *n*.	[tuːl]	інструмент, обладнання

7.3 Read the text and fill it with sentences A-F.

GEODESY AND SATELLITE NAVIGATION

There has always been a love-hate relationship between geodesy and satellite navigation. **1** …….. . When the first satellite, Sputnik 1, started orbiting the Earth in 1957, geodesists in several countries realised that satellites offered substantial potential as a geodetic positioning and navigation tool.

The basic technologies of terrestrial geodesy of the day, notably triangulation, traversing, and precise leveling, were slow and cumbersome, mainly because of the effect of the curvature of the surface of the Earth, which limited the range of measurements to theodolite observations between points situated on hilltops, observation towers, and triangulation masts. The advent of EDM (electronic distance measurement) in the 1960s helped terrestrial geodesy, but it, too, was affected by the same limitation, namely the shortness of observable EDM ranges due to the Earth's curvature.

Earth orbiting satellites did not suffer from this drawback. They could be viewed simultaneously from several points on Earth, and therefore direction and range measurements made, provided that the space vehicles were not obscured by high natural features or tall man-made structures. **2** …….. .

The first of these was satellite triangulation, which was used initially to supplement and strengthen terrestrial triangulation networks. This situation changed significantly when geodesists realized that they could use the Doppler shift on the signal broadcast from a satellite to obtain differential range measurements that, together with the known Keplerian orbit of the satellite, could lead to a relatively fast positioning, or navigation, method. **3**…….. . Transit-Doppler was used in the late 1970s and early 1980s not only for the positioning of naval ships and of submarines surfacing in the polar regions, but also for the strengthening and scaling of national and continental terrestrial triangulation networks.

Enter GPS

These were the early days of a new global satellite positioning, navigation, and timing system, first called the NAVSTAR Global Positioning System, a name later shortened to just GPS. The close relationship between the early GPS and geodesy was further demonstrated by the adoption of WGS84, the World Geodetic System 1984, as the basis of the 3-D coordinate system of GPS.

As always, human ingenuity did not disappoint, and two new differential techniques were developed. The first was the differential GPS (DGPS) technique, which improved relative positioning accuracies of GPS by at one order of magnitude, down to a few meters. **4** …….. . The next advance in improving the accuracy of satellite positioning was made on the advice of radio-astronomers, who proposed replacing the standard GPS pseudo-range measurements, which are based on timing the modulated signal from satellite to receiver.

Instead, they suggested making measurements on the basic carrier frequencies of these signals, just as they did with extra-galactic signals arriving at, say, two widely spaced radio telescopes in so-called very long baseline interferometry (VLBI), leading as a by-product to the Cartesian coordinate differences between the two telescopes. **5** …….. .

GPS had now become the universal high precision quasi-instantaneous positioning and navigation tool, creating the basis for hundreds of new applications. **6** …….. . These included surveying and mapping, positioning in offshore engineering, the monitoring of local crustal dynamics and plate tectonics, the relative vertical movements of tide gauges, and the continuous 3-D movements of critical engineering structures, such as tall buildings, dams, reservoirs, and long suspension bridges.

A. As a result, DGPS soon became the standard methodology for the offshore positioning of oil platforms, pipelines, etc.

B. Indeed, satellite positioning started life as an extension of terrestrial geodesy.

C. Again, geodesists led the way, concentrating on high precision scientific and engineering applications.

D. This technical advance gave birth to Transit-Doppler, the first satellite navigation technology.

E. This was the beginning of centimetric positioning by the carrier phase GPS method, which was later developed further by geodesists into kinematic GPS and centimetric navigation.

F. This led to several new satellite geodesy positioning methodologies.

7.4 Read the text again and answer the following questions.

1. What limited the range of measurements to theodolite observations?
2. What was the advantage of satellite observations?
3. What was satellite triangulation used for?
4. What technology was used for strengthening and scaling of national and continental terrestrial triangulation networks?
5. What was the basis of the 3D coordinate system of GPS?
6. What is the difference between DGPS and VLBI?
7. What applications did GPS serve for?

7.5 Mark the following sentences True or False.

1. Geodesy and satellite navigation has always got a good relationship.

2. The curvature of the surface of the Earth was the main obstacle to theodolite observations.
3. Transit-Doppler was the first satellite navigation technology.
4. Transit-Doppler technology was used to supplement and strengthen terrestrial triangulation networks.
5. The adoption of WGS84 was the result of the close relationship between GPS and geodesy.
6. VLBI technique is used for the offshore positioning of oil platform, pipelines, etc.
7. The monitoring of local crustal dynamics and plate tectonics was one of the applications based on GPS.

7.6 Match words with their definitions.

receiver navigation network vehicle broadcast tectonics magnitude

1 ………. - a thing used for transporting people or goods, especially on land, such as a car, lorry, or cart;
2………. - a group or system of interconnected people or things;
3………. - transmit (a programme or some information) by radio or television;
4 ………. - the process or activity of accurately ascertaining one's position and planning and following a route;
5. ………. - the degree of brightness of a star, as represented by a number on a logarithmic scale;
6. ………. - a piece of radio or television apparatus that detects broadcast signals and converts them into visible or audible;
7. ………. - large-scale processes affecting the structure of the earth's crust.

Match adjectives with suitable nouns.

1. substantial	a. leveling
2. precise	b. signal
3. terrestrial	c. engineering structures
4. global	d. potential
5. human	e. movement
6. modulated	f. geodesy
7. local	g. crustal dynamics
8. differential	h. satellite positioning
9. critical	i. range measurements
10. vertical	j. ingenuity

UNIT8
CREATION OF GEODETIC SATELLITE NETWORK (part 1)

8.1 Practise reading the following words.

a) **[aɪ] –** w**i**dely, satell**i**te, p**i**pel**i**ne, prov**i**de, h**i**gh **[u:] –**pr**o**ve, sol**u**tion, incl**u**de, m**o**ve, tr**u**e

[ɑ:] – ap**a**rt, adv**a**ntage, tr**a**nsport, l**a**rge, rad**a**r

[dʒ] – ima**g**ery, **g**eodetic, ob**j**ect, ran**g**e, volta**ge**

b) agriculture ['ægrɪkʌlʧə], automobile ['ɔːtəmə(u)biːl], cadastre [kə'dæstə], exploitation [ˌeksplɔɪ'teɪʃ(ə)n], laser ['leɪzə], marine [mə'riːn], mechanical [mɪ'kænɪk(ə)l], reservoir ['rezəvwɑː].

8.2 Translate words of the same root into Ukrainian.

To manage – management – manager – managing – manageable.

To apply – application – applicable – applied – applicant – appliance.

To recognize – recognition – recognized – recognizable – recognizing – recognizer.

Fill in the sentences with words from exercise 8.2.

1. The shareholders demanded a change in ….. .
2. There's plenty of space for all the usual kitchen ….. .
3. He was ….. for having saved many lives.
4. How do you ….. to stay so slim?
5. He has achieved ….. and respect as a scientist.
6. He was one of 30 ….. for the manager's job.

ACTIVE VOCABULARY

Word	Pronunciation	Translation
ability, *n.*	[ə'bɪlətɪ]	здатність, можливість
acquire, *v.*	[ə'kwaɪə]	отримувати, здобувати, опановувати
aerial, *adj.*	['eərɪəl]	надземний, повітряний
asset, *n.*	['æset]	майно
canopy, *n.*	['kænəpɪ]	укриття, прикриття, притулок, притулок
comprise, *v.*	[kəm'praɪz]	включати, укладати в собі, містити
emergency, *n.*	[ɪ'mɜːʤ(ə)nsɪ]	непередбачений випадок, крайня необхідність, надзвичайне положення

emission, *n.*	[ɪ'mɪʃ(ə)n]	виділення, поширення, випромінювання
exterior, *adj.*	[ɪk'stɪərɪə]	зовнішній, поверхневий, зовнішній
feature, *n.*	['fiːʧə]	особливість, характерна риса, деталь, ознака, властивість; ***syn***. characteristic, quality, form, shape
image, *n.*	['ɪmɪʤ]	образ, зображення
imagery, *n.*	['ɪmɪʤ(ə)rɪ]	ряд, група зображень, зображення, проекція
imply, *v.*	[ɪm'plaɪ]	припускати, мати на увазі, укладати в собі, означати; ***syn.*** suggest, involve
inventory, *n.*	['ɪnv(ə)nt(ə)rɪ]	опис, інвентаризація
mapping, *n.*	['mæpɪŋ]	картографія, картування
oblique, *adj.*	[ə'bliːk]	похилий, похилий, скошений; ***syn.*** inclined
resolution, *n.*	[ˌrez(ə)'luːʃ(ə)n]	дозвіл
spatial, *adj.*	['speɪʃ(ə)l]	просторовий
spotting, *n.*	[spɒtɪŋ]	поставлення
terrain, *n.*	[tə'reɪn]	місцевість, територія, район

8.4 Read the text and answer the following questions.

1. What are methods and technologies of geodetic satellite survey used for?
2. What is the most efficient method in the modern geodetic base network?
3. What tasks does satellite geodetic network solve?
4. What systems are used to perform digital aerial survey?
5. What can be used for creation of spectrozonal colour-infrared images?
6. What does oblique aerial survey allow to do?
7. What are the tasks of digital aerial survey?
8. What does aerial laser scanning imply?

9. What allows acquiring a high-density cloud of laser reflection points?
10. What is aerial laser scanning used for?

CREATION OF GEODETIC SATELLITE NETWORK (part 1)

Methods and technologies of geodetic satellite survey based on GNSS methods are widely used for creation of reference geodetic networks, field aerial survey control point referencing , on-board positioning of aerial imagery photos perspective centres, field topographic survey, land management and cadastre works, monitoring of critical objects.

In the modern world geodetic base network is usually created with the use of global navigation satellite systems (GNSS) GLONASS/GPS principally by application of a differential method. The differential method is the most efficient where there is a network of reference (base) stations with specified geodetic coordinates. Application of the differential method provides for spatial objects' coordinate setting of +/-2 cm accuracy in real time and +/-5 cm in post-processing.

Satellite geodetic network consisting of reference stations can be used for solution of the following tasks: geodesy, cartography, cadastre; planning, construction, exploitation of automobile and railroads; navigation and security control of automobile, railway, air, river and marine transport; planning, construction and exploitation of buildings and engineering constructions, complex engineering objects: bridges, tunnels, oil and gas pipelines, etc.; real-time monitoring of critical objects.

Digital aerial survey

Digital aerial survey is performed with the use of modern topographic mapping aerial survey systems of high productivity, geometric accuracy, spatial resolution and photometric radiometric image quality.

Aerial survey data obtained with the use of full large-format digital aerial cameras is presented in a set of colour and multispectral images in four spectral ranges (red, green, blue, near infrared). Imagery in spectral channels can be used for creation of spectrozonal color-infrared images which possess high decoding interpretation features ability.

Digital aerial survey is performed with the use of on-board positioning and orientation systems which allow direct in-flight determination of imagery horizontalization exterior orientation parameters and thus cutting of expenses on field aerial ground control points referencing survey and the timing of work performance.

Apart from field aerial survey performed at the vertical position of a visual optical axis, oblique aerial survey (tilted visual optical axis) can be performed as well, which allows more efficient spotting recognition of objects and analyzing of their relative spatial position.

Digital aerial survey is efficiently applied for solution of the following tasks:

creation and updating of topographic and special plans maps; creation of the mapping base for real estate cadastre; ecology and nature management (agriculture and forestry); monitoring of various objects; creation of 3D models of objects and territories; reaction to emergencies; creation of visual information systems.

Aerial laser scanning

Aerial laser scanning (lidar aerial survey) implies optic-mechanical scanning of an area by high-frequency pulse laser emission (for instance, 150 kHz), receiving and registration of a signal (pulse) reflected from the object's surface, determination of the distance from the reflection point and coordinates setting computation of the reflection point laser scanning points.

In order to ensure compute coordinates of laser scanning points (LSP) the aerial laser scanning system (aerial survey lidar) comprises equipped with a positioning and orientation system providing on the base of GNSS and inertial measurements for location position and orientation of a laser scanning system at the moment of pulse emission. This allows acquiring a high-density cloud of laser reflection points with set spatial coordinates.

Aerial laser scanning data is used for: topographic terrain survey and creation of high-accuracy detailed 3D terrain models; lidar survey has unquestionable advantages in solution of this task as this technology provides for high-accuracy survey and point density and allows coordinate setting to get laser reflection scanning points even in forest areas under the canopy; creation of 3D network models of territories and objects (surface models); 3D modelling of buildings and constructions, built-up territories; inspection of electric-technical objects (highvoltage power transmission lines, electric substations, etc.); inspection of transport infrastructure objects; bathymetry of inland water-storage bodies reservoirs and the shelf (with use special kind of laser scanning system); inventory and monitoring of forests; inventory of the land and asset complex; monitoring of big engineering objects, for instance, open mines of natural resources.

Laser scanning data processing is performed by a software complex Terra Scan H and TerraModeler based on MicroStation.

8.5 Mark the following sentences True or False.

1. Methods and technologies based on GNSS methods are used for many geodetic works.

2. GLONASS and GPS were used to create geodetic base network.
3. Planning, construction and exploitation of building and engineering constructions are the tasks that satellite geodetic network solve.
4. Aerial survey data is presented in a set of colour and multispectral images in six spectral ranges.
5. The use of on-board positioning and orientation systems rise the expenses on field aerial ground control points referencing survey.
6. Aerial laser scanning can be used for creation of 3D network models territories and objects.

8.6 According to the text find words opposite in meaning.

1. destroy
2. inaccuracy
3. out of date
4. give away
5. coding
6. interior
7. inefficient
8. absorption
9. questionable
10. forbid

8.7 Match adjectives with suitable nouns.

1. modern	a. applications
2. unencrypted civil	b. incentives
3. intentional	c. signals
4. essential	d. broadcast
5. spoofing	e. element
6. strong	f. businesses
7. myriad	g. advantage
8. illegitimate	h. attacks

8.8 Fill in the text with the statements from exercise 8.7.

During the past two decades, the Global Positioning System, together with other

GNSSes, has become an **1** … of the global information infrastructure, with **2** … in almost every facets of **3** ... and lifestyles, including communication, energy distribution, finance and insurance, and transportation. Ever-growing dependence on GNSS creates **4** … to attack civil GNSS, for either an **5** … or a terrorism purpose. Unfortunately, security is not a built-in feature of GNSS open service. It has been known that low-received-power, **6** … are vulnerable to jamming and **7** … . Jamming is the **8** … of a high-power ―blocking‖ signal at the GNSS frequency. Hence, jamming is disruptive but usually detected by the receiver whenever it stops tracking satellites.

8.9 Complete the text using the words in CAPITALS in the correct form. So far, a variety of methods have been proposed to 1) HARD civil GNSS receivers against spoofing attacks. These defensive methods can be 2) GENERAL categorized into three groups: external 3) ASSIST, signal statistics, and cryptographic authentication. The first group performs consistency checks against metrics external to the GNSS 4) SYSTEM, such as the information from inertial sensors, odometers, cellular networks, and high-stability clocks. The second group performs statistical tests on features inherent in GNSS signals, 5) INCLUDE angle of arrival, signal quality, signal power, and multipath. The third group relies on cryptographic, 6) PREDICT information carried by GNSS signals. Unlike the first group of methods, cryptographic methods need no 7) ADDITION hardware. In comparison to the second group, cryptographic methods enable users to 8) DIFFERENT authentic signals from counterfeit signals with higher 9) CONFIDENT, especially in a complex environment where the statistics of authentic signals can be highly 10) STABLE.

Make a brief report on one of the following topics:

a. A Reference station;

b. On-board positioning and orientation systems;

Lidar survey

UNIT 9

CREATION OF GEODETIC SATELLITE NETWORK (part 2)

9.1 Practise reading the following words.

a) [i:] – h**ea**t, **e**ven, f**ea**ture, fr**ee**ze, b**ea**m l**ea**d

[əʊ] – rem**o**te, l**o**cation, pr**o**cess, z**o**ne, l**o**cator, **o**ver

[aʊ] – all**ow**, with**ou**t, am**ou**nt, h**o**wever, b**ou**ndary, d**ow**n

[ʌ] – res**u**lt, fl**u**ctuation, destr**u**ct, constr**u**ction, p**u**lse, **u**nderground

c) analysis [ə'næləsɪs], anthropogenic [ˌanθrəpəˈdʒɛnɪk], characteristic [ˌkærəktə'rɪstɪk], hydrology [haɪ'drɔlədʒɪ], instrument ['ɪnstrəmənt], localization [ˌləuk(ə)laɪ'zeɪʃ(ə)n], micrometer [maɪ'krɔmɪtə], thermal ['θɜːm(ə)l], thermogram

[ˈθəːməgram].

9.2 Cross out the word with a different sound.

i	vis**i**ble forest fr**ee**ze d**e**tect w**i**ndow
aɪ	t**y**pe dev**i**ce sl**i**de ver**y** appl**y**
ð	wi**th** **th**eir **th**ough wi**th**out **th**ermal
h	**h**eat **h**our **h**igh **h**umidity **h**ydrographic
ɪə	cr**ea**tion ar**ea** engin**ee**r aer**ia**l th**eo**ry

ACTIVE VOCABULARY

Word	**Pronunciation**	**Translation**
acquisition, *n.*	[ˌækwɪ'zɪʃ(ə)n]	придбання
anthropogenic, *adj.*	[ˌænθrə(u)pə(u)'ʤenɪk]	антропогенний, викликаний діяльністю людини
ballast, *n.*	['bæləst]	баласт
bed, *n.*	[bed]	пласт, шар
boundary, *n.*	['baund(ə)rɪ]	кордон, межа; ***syn.*** border, frontier
cavity, *n.*	['kævətɪ]	порожнина, западина
contour, *n.*	['kɔntuə]	Обрис(очертание), контур, форма
detect, *v.*	[dɪ'tekt]	відкривати, виявляти
		розкривати; ***syn.*** find
display, *n.*	[dɪs'pleɪ]	показ, демонстрація, дисплей, зображення
distinctive, *adj.*	[dɪ'stɪŋktɪv]	відмітний, характерний; ***syn.*** distinguishing
distortion, *n.*	[dɪ'stɔːʃ(ə)n]	спотворення, викривлення
flooring, *n.*	['flɔːrɪŋ]	настил, підлога
infiltration, *n.*	[ˌɪnfɪl'treɪʃ(ə)n]	просочування, проникнення
infringement, n.	[ɪn'frɪnʤmənt]	порушення
layer, *n.*	['leɪə]	шар, пласт, рівень
moisturize, *v.*	['mɔɪsʧ(ə)raɪz]	мочити, змочувати, зволожувати

pillar, *n.*	['pɪlə]	стовп, колона, опора, стійка; ***syn.*** pole, column, post
reduction, *n.*	[rɪ'dʌkʃ(ə)n]	зниження, скорочення, зменшення
reveal, *v.*	[rɪ'viːl]	відкривати, виявляти, показувати
soil, *n.*	[sɔɪl]	грунт, земля, ґрунт
volumetric, *adj.*	[ˌvɔlju'metrɪk]	об'ємний

9.3 Read the text and answer the following questions.

1. What is thermal aerial survey?
2. What devices are used to detect thermal emission?
3. What is a peculiarity of the thermal observation device?
4. What areas is thermal aerial survey used?
5. What does georadiolocation imply?
6. What geophysical instruments are used to get large amounts of data during a short period of time?
7. Where is georadar survey used?
8. What does exploitation of a shelf zone require?
9. What method analyses pulses reflected from boundaries of spheres with different electrophysical characteristics?
10. How is georadiolocation survey performed?

CREATION OF GEODETIC SATELLITE NETWORK (part 2)

Thermal aerial survey

Thermal aerial survey is registration of electromagnetic objects' emission in thermal infrared spectrum range and its reflection in an image and representation of its result like an image.

Thermal emission, whose intensity depends on temperature, can be detected by thermal detectors and transformed into a visible image showing differences in objects' temperature. Thermal survey can be performed both in day and at night time.

At thermal-range Earth remote sensing transmission windows are used with a 3-5, 8-

14 micrometer wave length. This range shows own emission of earth surface objects.

Thermal vision observation is a type of thermal control for which a thermal observation device is used as measuring equipment. The thermal observation device allows ―seeing the heat‖ and detecting a thermal image on the display. The main distinctive feature of this method is that the thermal observation device allows seeing what cannot be seen with an unaided eye. Man's eye cannot detect objects' temperature, but the thermal observation device is capable of showing its display a

+/-1 °C accuracy thermogram of an object.

Thermal survey application areas are engineering applications, ecology, forest resources management, agriculture, engineering geology and hydrology.

Georadar sensing

Georadar sensing is performed with the use of georadars operating at depths up to 5 m and a 20 cm resolution and providing for detection of density fluctuations of the surveyed surface at creation of georadiolocation profile, thus enabling this method to reveal underground communications including those without a temperature contrast.

Georadiolocation or georadar survey is a modern non-destructing method of soil and construction base inspection which implies analysis of pulses reflected from boundaries of spheres with different electrophysical characteristics.

Modern georadars are a powerful geophysical instrument whose application provides for acquisition of large amounts of detailed data during a relatively short time period. Application of a georadar for survey allows creation of a high-reliability volumetric picture during analysis of different spheres at varied depths.

Georadar survey is used for inspection of: soil, which allows detecting the composition and width of layers, presence of frozen or over-moisturized areas, land slide processes and tectonic distortions, cavities, deconsolidation areas, underground communications, boundaries of soil and anthropogenic waters, etc.; automobile roads, which allows assessing the width of road surface construction layers, types, humidity and density of soil and under-surface base; location of soil water levels, location of a sliding curve at land slide areas, spatial contour of geologic horizon base under a back of ballast bed, locations of deconsolidated soil, cavities and infiltration of underground waters; bases and industrial floorings; constructions of buildings (beams, floors, pillars, etc.), which allows detection of inner cracks, uneven settlement, presence of iron reinforcement and its deformation, infringement of construction regulations and project requirements, assess the density and toughness of materials; ice situation, which allows performing control of the width and condition of ice both during freeze-up and flood water periods.

In automobile roads planning the economic effect of application of 3D models acquired with the use of georadars is reached due to reduction of drilling operations with a several-times' enhancement of reliability of the engineering-geologic data, choosing of efficient reconstruction and overhaul types differentiated by automobile road areas.

Exploitation of a shelf zone requires acquisition of data on sea bottom condition, underwater and on-surface constructions. A modern method of sea bottom, underwater and on-surface construction inspection implies analysis of pulses reflected from boundaries of spheres with different electrophysical characteristics.

The georadiolocation method allows observation of ice for assessment of its width, monitoring in the areas of automobile ice passages, winter trails, detection and localization of uneven areas inside ice massives.

Georadiolocation survey can be performed by contact - shifting a georadar antenna on the ice surface, and non-contact - placing a georadar on board an aerial survey aircraft with the use of a side-looking locator.

9.4 Mark the following sentences True or False.

1. Thermal survey can be performed only in day time.
2. Thermal observation device is used to detect a thermal image on the display.
3. Georadar sensing reveals underground communication including those with a temperature contrast.
4. It is possible to get a high-reliability volumetric picture with a help of georadars.
5. Using georadar survey one can detect the inner cracks of the building, composition and width of soil layers.
6. The economic effect of application of 3D models is reached due to increasing of drilling operations.
7. The georadiolocation method allows detection and localization of even areas inside ice massives.

9.5 According to the text find words similar in meaning.

1. evident
2. to discover
3. to convert
4. a machine
5. to work
6. to supply

7. an instability
8. to contain
9. a border
10. a distortion

9.6 Match words with their definitions.

application data survey transmission radar equipment layer emission

1………. - examine and record the area and features of (an area of land) so as to construct a map, plan, or description;
2………. - a programme or signal that is broadcast or sent out;
3………. - the production and discharge of something, especially gas or radiation;
4………. - the necessary items for a particular purpose;
5………. - the action of putting something into operation;
6………. - a system for detecting the presence, direction, distance, and speed of aircraft, ships, and other objects, by sending out pulses of radio waves which are reflected off the object back to the source;
7………. - a sheet, quantity, or thickness of material, typically one of several, covering a surface or body;
8………. - facts and statistics collected together for reference or analysis.

9.7 Match sentence halves.

1.GPR (ground penetrating radar) can search for objects	**a.** to locate buried objects.
2. GPR can be detected both metal and non-metallic objects,	**b.** GPR is used to define landfills, contaminant plumes.
3. GPR uses the principle of scattering of electromagnetic waves	**c.** through the thickness of the ice and water, sand, earth and stone.
4. The fundamental principle of operation is the same as that used to detect aircraft overhead,	**d.** and buried evidence.
5. The depth range of GPR is limited by	**e.** as well as empty under a layer of
the electrical conductivity of the ground,	Earth, masonry walls, and foundations.

6.Optimal depth penetration is achieved in ice where the depth of penetration	**f.** can achieve several hundred metres.
7.In environmental remediation,	**g.** but with GPR that antennas are moved over the surface rather than rotating about a fixed point.
8. GPR is used in law enforcement for locating clandestine graves	**h.** the transmitted center frequency and the radiated power.

9.8 Ask all possible questions to the sentences from exercise 9.7.

9.9 Reorder the words to make a sentence.

1. into GPR been the near developed a sophisticated detailed that can provide technique images of has surface.
2. the research on for has GPR been environmental conducted and of engineering Most applications.
3. depths GPR few provides a pseudo-image three that can that converted easily be to are to accurate down dimensional a centimeters.
4. GPR responds to both metallic and non-metallic objects.
5. is an tool in homogenity for mapping any in the that subsurface is excellent GPR characterized by a density nearly small porosity difference in or.
6. Thermal monochrome is data in to full retain resolution recorded.
7. Conversion purposes analysis to useful for presentation is colour specific and.

9.10 Make a brief report on the following topic:

a. Ground penetrating radar (GPR)

UNIT 10
CREATION OF GEODETIC SATELLITE NETWORK (part 3)

10.1 Practise reading the following words.

a) **[æ] –** an**a**lysis, pl**a**n, overl**a**p, c**a**vity, cr**a**ck, f**a**ct
[ɜ:] – res**ear**ch, s**ur**vey, p**ur**pose, determine, s**ur**face, w**or**k
[ʃ] – spe**c**ial, **sh**all, portion, i**ss**ue, emi**ss**ion, loca**t**ion
[θ] – bo**th**, me**th**od, dep**th**, wid**th**, ear**th,** leng**th**

b) characteristic [ˌkærəktə'rɪstɪk], consequently ['kɔnsɪkwəntlɪ], hydrography [haɪ'drɔgrəfɪ], hydrologic [hʌɪdrəˈlɒdʒɪk], hydrosphere ['haɪdrəusfɪə], percentage [pə'sentɪʤ], oceanographic [ˌəʊʃənəˈgrafɪk], visualize ['vɪʒuəlaɪz].

10.2 Translate words of the same root into Ukrainian.

To change – changing – changed – changer – changeover

To create – creative – creation – creature – creativity – creator

To represent – representative – representation – represented – representing – representational – representable

10.3 Fill in the sentences with words from exercise 10.2

1. All organisations need to adapt to … circumstances.
2. Minority groups need more effective parliamentary … .
3. This job is so boring. I wish I could do something more … .
4. The pollsters asked a … sample of New York residents for their opinions.
5. The question is, will the president … his tune on taxes?
6. The software makes it easy to … colourful graphs.

ACTIVE VOCABULARY

Word	**Pronunciation**	**Translation**
anchor, *n.*	['æŋkə]	ставити на якір
assessment, *n.*	[ə'sesmənt]	оцінка, визначення
attribution, *n.*	[ˌætrɪ'bjuːʃ(ə)n]	визначення
bottom, *n.*	['bɔtəm]	дно
capture, *n.*	['kæpʧə]	збору
carrier, *n.*	['kærɪə]	носій, тримач, кронштейн, що підтримує або несе пристосування
duly, *adv.*	['djuːlɪ]	належним чином, правильно
entail, *v.*	[ɪn'teɪl]	тягти за собою, викликати(що-Л.)
implementation, *n.*	[ˌɪmplɪmen'teɪʃ(ə)n]	виконання, здійснення, реалізація; ***syn.*** realization, accomplishment
monitor, *n.*	['mɔnɪtə]	наставляти, рекомендувати, радити, відстежувати, контролювати; ***syn***. observe, supervise
mounted*, adj.*	['mauntɪd]	змонтований, встановлений; ***syn.*** established, fixed
overlap, *n.*	['əuvəlæp]	часткове накладення, перекриття, суміщення
specify, *v.*	['spesɪfaɪ]	точно визначати, встановлювати

submersible, *adj.*	[səb'mɜːsəbl]	здатний занурюватися у воду, здатний працювати під водою
substantiation, *n.*	[səbˌstænʃɪ'eɪʃ(ə)n]	доказ; ***syn.*** proof, evidence
vessel, *n.*	['ves(ə)l]	корабель, судно
viable, *adj.*	['vaɪəbl]	життєздатний

10.4 Read the text and answer the following questions.

1. What is hydrographic research?
2. How is hydrographic work considered regarding topographic and geodetic works?
3. What devices are used for hydrographic operations?
4. How is the hydrographic survey performed?
5. What is the purpose of the hydrographic survey and how to achieve it?
6. What are the main elements of the modern hydrographic survey?
7. What is a digital orthophoto?
8. What files are necessary to create a digital orthophoto?
9. What are digital orthophotos used for?

CREATION OF GEODETIC SATELLITE NETWORK (part 3)

Hydrographic research

Hydrographic research is a survey process of separate hydrosphere areas which includes scientific design, performance of hydrographic works, processing and analysis of their results. The contents of a hydrographic survey are determined by the composition and amount of the data the Orderer Customer requires.

Similar to assessment of altitude determination of large numbers of points in an area during topographic earth terrain survey, in hydrography for survey of underwater terrain depths are measured in all surveyed area. In fact, hydrographic works are a continuation of topographic and geodetic works in the areas of the World Ocean and inland waters.

But qualities of every geographic sphere and specific purposes lead to important features both in operational methods and applied means. What are these features? First of all, the necessity of special carriers for measuring equipment. When in shore survey geodetic and topographic devices can be placed directly in any point of the surveyed area, for performance of underwater terrain survey as well as other types of hydrographic operations special platforms shall be used and duly equipped to be kept on water surface or under water. Surface vessels and deep-sea submersibles are used as such platforms. Only at complete freezing of a water zone survey can be performed directly from the ice surface.

Further, the platform with the mounted equipment will move in order to perform survey of all water zone of the surveyed area. Consequently, its position is changing non-stop. Even if the vessel is anchored, its shift must be taken into consideration. It is evident that for attribution of measurement results to any fixed point the measurements will be performed very fast. The said circumstance entails the following important feature of hydrographic works: they will be accompanied with frequent and precise coordinate setting of a point in which the measurements were carried out. Ideally, it should be determined non-stop so that measurements at any moment would be linked with the real place.

The purpose of the survey is not only to reliably determine mutual location of different objects at sea, but also to specify the precise location of surveyed objects on the Earth surface. To achieve this, their planned fixing shall be made to a uniform coordinate system of the earth ellipsoid. In on-surface survey planned fixing is made with the use of geodetic networks. At sea there are no such networks, which lead to significant features of plan substantiation of hydrographic works.

The modern hydrographic survey complex includes survey of the following main elements: underwater terrain; sea shores; sea bottom soil; geophysical fields; oceanographic and hydrologic characteristics.

Measurements and observations carried out in water zones and in the process of hydrographic survey are called hydrographic works.

TrueOrtho

A digital orthophoto is simply a photographic map that can be used to measure true distances. It is an accurate representation of the earth's surface. To create a digital orthophoto, several key input files are necessary: aerial photos with a highpercentage overlap, scanned imagery, aerotriangulation (A.T.) results, and a digital elevation model (DEM). Scanned imagery can be obtained from scanning aerial photo diapositives or negatives on an image-quality scanner. The A.T. results include a camera calibration report and the ground control. At a minimum, the DEM can be a regularly spaced grid of masspoints, each containing an x, y, and z value. A more robust digital terrain model (DTM) can also be used because it includes strategically placed masspoints, dense breaklines, and ridgelines.

Digital orthophotography is a resource being utilized by a significant portion of GIS users. It has become a popular base layer in modern GIS. With the price of disk space dropping and the speed of computers increasing, digital orthophotos are a viable option for building a fully developed GIS. Digital orthophotos can be used for technically specific needs such as planimetric or cadastral mapping; utility data capture and quality control; and accurate project analysis and design implementations.

Digital orthophotos can also be used to explain projects and issues to the general public because real-world pictures are easier for the untrained eye to understand. They contain landmarks and recognizable places. For example, digital imagery can help an audience visualize the new light rail corridor by showing existing conditions. Proposed changes can be overlaid as vector information. The world is constantly changing, and digital orthophotography can help monitor change.

10.5 Mark the following sentences True or False.

1. Composition and amount of the data is the basis of hydrographic survey.
2. Geodetic and topographic devices should be placed in special point of the surveyed area.
3. Geodetic networks are used for underwater survey.
4. Hydrographic works are measurements and observations carried out in water zones.
5. Aerial photo diapositives or negatives are necessary to obtain a scanned imagery.
6. The DEM includes a camera calibration report and the ground control.
7. Digital orthophotography is an option for building a fully developed GIS.

10.6 According to the text find words similar in meaning.

1. gist
2. region
3. particular
4. coast
5. ship
6. connect
7. site
8. constant

10.7 According to the text find words opposite in meaning.

1. exclude
2. foreign
3. strip
4. shallow
5. individual
6. trivial
7. false
8. die

10.8 Match two halves of the statements and translate them into Ukrainian.

1. the assignment of	a. methods
2. standardization of	b. photograph
3. ground	c. X & Y coordinate values
4. optical	d. improvements
5. came into	e. features
6. the radiometric or	f. displacement
7. removing the relief	g. use
8. vertical aerial	h. software algorithms
9. sophisticated computer	i. tonal adjustments
10. technological	j. scale

10.9 Fill in the sentences with the statements from exercise 10.8.

1. Orthophotography first … in the 1960's.
2. By the early 1970's, … brought this data source into affordable commercial applications and its use has continued to expand.
3. The first orthophotography was produced by computer driven … and equipment.
4. Today, these pieces of equipment have been replaced by the computer workstation and … .
5. The orthophoto is able to display actual … , not cartographic representations of those features.
6. Regardless of the method of construction, four basic operations or corrections must be applied to the standard … to produce the orthophoto.
7. The first correction is the … across the image.
8. The second correction involves … to position the terrain in its true location.
9. The third operation entails … to the image.
10. The final task involves … to allow the image to blend with neighboring images.

10.10 Make a brief report on the following topic:

a. Geodetic satellite network

ЛЕКСИКО-ГРАМАТИЧНИЙ ТЕСТ

(Для визначення рівня англійської мови рівень А1–В2)

1 She's … university teacher.
A a B an C the D one

2 I like … small animals.
A theB ─(= nothing)C everyD all

3 Is this coat … ?
A yoursB yourC the yours

4 Is Diana … ?
A a friend of yoursB a your friendC your friend

5 Who are … people over there?
A thatB theC theseD those

6 … is your phone number?
A WhichB WhatC How

7 Could I have … drink?
A otherB an otherC another

8 There aren't … for everybody.
A chairs enoughB enough chairsC enough of chairs

9 They're … young to get married.
A too muchB tooC very too

10 Most … like travelling.
A of peopleB of the peopleC people

11 Ann and Peter phone … every day.
A themB themselfC themselvesD each other

12 It's … weather.
A terribleB a terribleC the terrible

13 The plural of car is cars. Which of these are correct plurals?
A journeysB ladysC minutsD sandwichsE babies

14 Which of these is/are correct?
A happierB more happierC unhappierD beautifuller
15 This is … winter for 20 years.
A the more badB worseC the worseD worstE the worst

16 She’s much taller … me.
A thanB asC that
17 He lives in the same street … me.
A thatB likeC asD than
18 Her eyes … a very light blue.
A areB haveC has
19 … help me?
A Can you toB Do you canC Can you
20 You … worry about it.
A not mustB don’t mustC must notD mustn’t
21 It … again. It … all the time here in the winter.
A ‘s raining, ‘s rainingB rains, rains
C rains, ‘s rainingD ‘s raining, rains
22 I … she … you.
A think, likesB am thinking, is likingC think, is liking
D am thinking, likes
23 Who … the window?
A openB openedC did opened
24 Why … ?
A those men are laughingB are laughing those men
C are those men laughing
25 What … ?
A does she wantB does she wantsC she wants
26 I didn’t … he was at home.

A to thinkB thinkC thinkingD thought

27 … a hole in my sock.

A There’sB There isC It’sD It isE Is

28 I’ll see you … Tuesday afternoon.

A atB onC in

29 What time did you arrive … the station?

A atB toC —

30 We're going … the opera tomorrow night.

A atB ─C inD to

31I went out without … money.
A some B any
32 He's got … money.
A much B many C a lot of D lots of
33 'Who's there' '… .'
A It's me B It is I C Me D I
34 Although he felt very …, he smiled … .
A angrily, friendly B angry, friendly C angry, in a friendly way
35 I … to America.
A have often beenB often have beenC have been often
36 My mother … my birthday.
A always forgetsB always is forgettingC forgets always
37 You look … a teacher.
A likeB asC the same like
38 How many brothers and sisters … ?
A have you gotB do you haveC are you having
39 Good. I … work tomorrow.
A mustn'tB don'thave toC haven't got to
40 I … smoke.
A ─ (= nothing)B use toC used to
41 Andrew … to see us this evening.
A will comeB comesC is coming
42 Alice … have a baby.
A willB shallC is going to
43 I knew that he … waiting for somebody.
A isB wasC would
44 … Gloria last week?
A Have you seenB Did you seeC Were you seeing
45 She's an old friend ─ I … her … years.
A 've known, forB know, forC 've known, sinceD know, since
46 We met when we ... in France.
A studiedB were studyingC had studied
47 As soon as she came in I knew I … her before.
A have seenB sawC had seen
48 This picture … by a friend of my mother's.
A is paintingB is paintedC was paintingD was painted

49Can you … ?

A make me some tea B make some tea for me C make for me some tea

50 Try … be late.

A not to B to not

51 I went to London … clothes.

A for buy B for to buyC for buying D to buy

52 You can't live very long without … .

A to eatB eatC eatingD you eat

53 I enjoy … , but I wouldn't like … it all my life.

A to teach, to do B teaching, doing C to teach, doing D teaching, to do

54 Her parent's don't want … married.

A her to getB her getC that she getD that she gets

55 I'm not sure what …

A do they want?B do they want.C they want.

56 The policeman … me not to park there.

A askedB saidC toldD advised

57 I … you if you … that again.

A hit, sayB 'll hit, 'll sayC hit, 'll sayD 'll hit, say

58 It would be nice if we … a bit more room.

A would haveB hadC have

59 If … me, I … in real trouble last year.

A didn't help, would have been

B hadn't helped, would have been

C hadn't helped, would be

D didn't help, would be

60 There's she man … took your coat.

A whichB whoC thatD ─

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