1 INTRODUCTION

NOTE: Answers for some of these problems, and some in later chapters, can be obtained by consulting the bibliographies, later chapters, websites, or professional surveyors.

1.1 List 10 uses for surveying in areas other than boundary surveying.

Answers may vary many are included in Section 1.6, which lists control, topographic hydrographic, alignment, construction, as-built, mine, solar, optical tooling, ground, aerial, and satellite surveys. This list is not complete and could also include other types of surveys such as hydrographic surveys, for example.

1.2 Explain the difference between geodetic and plane surveys.

From Section 1.4:

In geodetic surveys the curved surface of the earth is considered by performing the computations on an ellipsoid (curve surface approximating the size and shape of the earth). In plane surveys, except for leveling, the reference base for fieldwork and computations is assumed to be a flat horizontal surface. The direction of a plumb line (and thus gravity) is considered parallel throughout the survey region, and all measured angles are presumed to be plane angles.

1.3 List some application of surveying in geology, forestry, and mining. (Note this problem requires the student to research external. Answers can vary.)

In geology – Some uses include the positions of geological formations, water resources, ore bodies, dips, outcrops, headings, strikes, as well as perform gravity surveys.

In forestry – Some uses include identifying forest boundaries, locating spread of diseases and insects through remote sensing, using GIS to help inventory and keep records on resources in forested regions

In mining – Some uses include the mapping of quantity piles, mining operations, and the establishment of control to locate and determine the direction and extent of future mining operations.

1.4 Why is it important to make accurate surveys of underground utilities?

To provide an accurate record of the locations of these utilities so they can be found if repairs or servicing is needed, and to prevent their accidental destruction during excavation for other projects.

1.5 Discuss the uses for topographic surveys.

Topographic surveys are used whenever elevation data is required in the end product. Some examples include (1) creating maps for highway design; (2) creating maps for construction surveys; (3) creating maps for flood plain delineation; (4) creating maps for site location of buildings; and so on.

1.6 What are hydrographic surveys, and why are they important?

From Section 1.6, hydrographic surveys define shorelines and depths of lakes, streams, oceans, reservoirs, and other bodies of water. Sea surveying is associated with port and offshore industries and the marine environment, including measurements and marine investigations made by ship borne personnel.

1.7 Print a view of your location using Google Earth.®

Answers will vary but should be an image in your region.

1.8 Briefly explain the procedure used by Eratosthenes in determining the Earth's circumference.

From Section 1.3, paragraph 8 of text: His procedure, which occurred about 200 B.C., is illustrated in Figure 1.3. Eratosthenes had concluded that the Egyptian cities of Alexandria and Syene were located approximately on the same meridian, and he had also observed that at noon on the summer solstice, the sun was directly overhead at Syene. (This was apparent because at that time of that day, the image of the sun could be seen reflecting from the bottom of a deep vertical well there.) He reasoned that at that moment, the sun, Syene, and Alexandria were in a common meridian plane, and if he could measure the arc length between the two cities, and the angle it subtended at the earth's center, he could compute the earth's circumference. He determined the angle by measuring the length of the shadow cast at Alexandria from a tall vertical staff of known length. The arc length was found from multiplying the number of caravan days between Syene and Alexandria by the average daily distance traveled. From these measurements Eratosthenes calculated the earth's circumference to be about 25,000 mi. Subsequent precise geodetic measurements using better instruments, but techniques similar geometrically to Eratosthenes', have shown his value, though slightly too large, to be amazingly close to the currently accepted one.

1.9 Describe the steps a land surveyor would need to do when performing a boundary survey.

Briefly, the steps should include (1) preliminary walking of property with owner; (2) courthouse research to locate deed of property and adjoiners to determine ownership, possible easements, right-of-ways, conflicts of interest, and so on; (3) location survey of property noting any encroachments; conflicting elements; and so on; (4) resolution of conflicting elements between deed and survey; (5) delivery of surveying report to owner.

1.10 What is the name of the state-level professional surveying organization in your state or region?

Answer will vary by location.

1.11 List the tasks of a surveyor as defined by the International Federation of Surveyors?

(See Section 1.1)

1.12 What organizations in your state furnish maps and reference data to surveyors and engineers?

Responses will vary but some common organizations are the (1) county surveyor, (2) register of deeds, (3) county engineer or county highway department (4) Department of Transportation, (5) Department of Natural Resources of its equivalent, and so on.

1.13 List the legal requirements for registration as a land surveyor in your state.

Responses will vary. Contact with your licensing board can be found on the NCEES website at http://www.ncees.org/licensure/licensing_boards/.

1.14 Briefly describe an Earth-Centered, Earth-Fixed coordinate system.

From Section 1.4 and 13.4.3, a ECEF coordinate system is an Earth-based three-dimensional coordinate system with its origin a the mass-center of the Earth, it Z axis aligned with the semi-minor (spin) axis of the Earth defined at some epoch, it X axis in the plane of the equator passing through mean Greenwich meridian, and it Y axis in the plane of the equator and creating a right-handed coordinate system. At this stage of their introduction to surveying it should be sufficient for students to simply know that it is a Earth-based three-dimensional coordinate system.

1.15 List the professional societies representing the geospatial industry in the

(a) United States.

There are several including AAGS, ASCE, ASPRS, NSPS, and SaGES.

(b) Canada.

Canadian Institute of Geomatics (CIG)

(c) International.

International Federation of Surveyors (FIG)

1.16 Explain how aerial photographs and satellite images can be valuable in surveying.

Photogrammetry presently has many applications in surveying. It is used, for example, in land surveying to compute coordinates of section corners, boundary corners, or point of evidence that help locate these corners. Large–scale maps are made by photogrammetric procedures for many uses, one being subdivision design. Photogrammetry is used to map shorelines, in hydrographic surveying, to determine precise ground coordinates of points in control surveying, and to develop maps and cross sections for route and engineering surveys. Photogrammetry is playing an important role in developing the necessary data for modern Land and Geographic Information Systems.

1.17 List the various specialized types of surveys.

From Section 1.6: Control surveys, topographic surveys, land, boundary, and cadastral surveys, hydrographic surveys, alignment surveys, construction surveys, as-built surveys, mine surveys, solar surveys, optical tooling, ground, aerial, and satellite surveys.

1.18 What types of office work will a surveyor encounter?

From Section 1.7: "The office work involves (1) conducting research and analysis in preparing for surveys, (2) computing and processing the data obtained from field measurements, and (3) preparing maps, plats, charts, reports, and other documents according to client specifications."

1.19 Visit one of the surveying websites listed in Table 1.1, and write a brief summary of its contents. Briefly explain the value of the available information to surveyors.

Responses will vary with time, but below are brief responses to the question

- NGS – control data sheets, CORS data, surveying software
- USGS – maps, software
- BLM – cadastral maps, software, ephemerides
- U.S. Coast Guard Navigation Center - GPS information
- U.S. Naval Observatory –Notice Advisory for NAVSTAR Users (NANU) and other GPS related links
- National Society of Professional Surveyors – professional organization for boundary and construction
- American Association for Geodetic Surveying – professional organization for control surveying
- Association of Professional Pipeline Surveyors – tackles the growing demand for a qualified and eager pipeline surveyor workforce. APPS educates industry project managers, policy makers, and community stakeholders about surveyors' roles in assuring safe and effective pipelines throughout North America
- American Society for Photogrammetry and Remote Sensing – professional organization for photogrammetry and remote sensing
- The Pearson Prentice Hall publishers access to software and support materials that accompany this book.

- SaGES – An organization to advance surveying/geomatics education

1.20 Read one of the articles cited in the bibliography for this chapter, or another of your choosing, that describes an application where satellite surveying methods were used. Write a brief summary of the article.

Answer will vary.

1.21 Same as Problem 1.20, except the article should be on safety as related to surveying.

Answers will vary but should be related to safety issues in surveying.

2 Units, Significant Figures, and Field Notes

Asterisks (*) indicate problems that have answers given in Appendix G.

2.1 List the five types of measurements that form the basis of traditional plane surveying.

From Section 2.1, they are (1) horizontal angles, (2) horizontal distances, (3) vertical (altitude or zenith) angles, (4) vertical distances, and (5) slope (or slant) distances.

2.2 Give the basic units that are used in surveying for length, area, volume, and angles in

(a) The English system of units.
From Section 2.2:
length (U.S. survey ft or in some states international foot), area (sq. ft. or acres), volume (cu. ft. or cu. yd.), angle (sexagesimal)

(b) The SI system of units.
From Section 2.3:
length (m), area (sq. m. or hectare), volume (cu. m.), angle (sexagesimal, grad, or radian)

2.3 The easting coordinate for a point is 646,284.381 m. What is the coordinate using the

(a) Survey foot definition?
(b) International foot definition?
(c) Why was the survey foot definition maintained in the United States?

(a) **<u>2,120,351.34 sft</u>**; $646{,}284.381\left(\frac{39.37}{12}\right) = 2{,}120{,}351.340$ sft
(b) **<u>2,120,355.58 ift</u>**; $646{,}284.381\,/0.3048 = 2{,}120{,}355.581$ ift
(c) From Section 2.2, due to the difficulty in modifying vast number of survey records. Note: Due to the minor differences between the sft and ift definitions and the short lengths in most property surveys, this is not a problem, as is evidenced by the 6 states who adopted the ift in 1983.However, it is a problem with large values such as SPCS coordinates (see Chapter 20).

2.4 Convert the following distances given in meters to U.S. survey feet:

***(a)**	4129.574 m	**<u>13,548.44 sft</u>**	4129.574(39.37/12)
(b)	640.137 m	**<u>2100.18 sft</u>**	640.137(39.37/12)
(c)	487,356.009 m	**<u>1,598,933.84 sft</u>**	487,356.009(39.37/12)

2.5 Convert the following distances given in feet to meters:

***(a)**	537.52 sft	**<u>163.84 m</u>**	537.52(12/39.37)
(b)	2,128,453.84 sft	**<u>648,754.028 m</u>**	2,128,453.84(12/39.37)
(c)	4809.34 ift	**<u>1465.89 m</u>**	4809.34(0.3048)

2.6 Compute the lengths in survey feet corresponding to the following distances measured with a Gunter's chain:

*(a) 10 ch 13 lk **668.6 sft** 10.13(66)
(b) 6 ch 23 lk **411 sft** 6.23(66)
(c) 14 ch 33 lk **945.8 sft** 14.33(66)

2.7 Express 487,300 sft^2 in:

*(a) acres **11.19 ac** 487,300/43,560
(b) hectares **4.527 ha** 487,300(12/39.37)^2/10,000
(c) square Gunter's chains **111.9 sq. ch.** 487,300/66^2

2.8 Convert 9.5438 ha to:

(a) square survey feet **1,027,300 sft^2** 9.5438(10,000)(39.37/12)^2
(b) acres **23.583 ac** 1,027,281.97/43,560
(c) square international feet **1,027,300 ift^2** 9.5438(10,000)/0.3048^2

2.9 What are the lengths in feet and decimals for the following distances shown on a building blueprint:

(a) 42 ft 6-1/2 in. **42.54 ft** (42×12×2+6×2+1)/2/12 = 1021/24
(b) 30 ft 6-3/4 in. **30.56 ft** (30×12×4+6×4+3)/4/12 = 1467/48

2.10 What is the area in acres of a rectangular parcel of land measured with a Gunter's chain if the recorded sides are as follows:

*(a) 9.17 ch and 10.64 ch **9.76 ac** (9.17×10.64)/10
(b) 16 ch 78 lk and 52 ch 49 lk **88.08 ac** (16.78×52.49)/10

2.11 Compute the area in acres of triangular lots shown on a plat having the following recorded right-angle sides:

(a) 220.36 ft and 440.02 ft **1.1130 ac** 0.5(220.36)440.02/43,560
(b) 60.005 m and 30.006 m **0.22246 ac** .5(60.005)30.006(39.37/12)^2/43,560

2.12 A distance is expressed as 9756.12 sft. What is the length in

(a)* international feet? **9756.14 ift** 9756.14(12/39.37)/0.3048
(b) meters? **2973.67 m** 9756.14(12/39.37)

2.13 What are the radian and degree-minute-second equivalents for the following angles given in grads:

(a)* 136.000 grads **122°24′00″**; 2.13628 rad
(b) 146.845 grads **132°09′38″**; 2.30664 rad
(c) 202.964 grads **182°40′03″**; 3.18815 rad

2.14 Give answers to the following problems in the correct number of significant figures:

*(a) sum of 23.15, 0.984, 124, and 12.5 **161**
(b) sum of 8.106, 34.28, 14.5, and 202.96 **259.8**
(c) product of 220.08 and 220.1 **48,440**
(d) quotient of 42,568.83 divided by 220.61 **192.96**