Lesson A2–2

Using Surveying Equipment

Unit A. Mechanical Systems and Technology

Problem Area 2. Soil and Environmental Technology Systems

Lesson 2. Using Surveying Equipment

New Mexico Content Standard:

Pathway Strand: Natural Resources and Environmental Systems

Standard: **I:** Recognize importance of resource and human interrelations to conduct management activities in natural habitats.

Benchmark: **I-B:** Apply cartographic skills to natural resources.

Performance Standard: **5.** Use land survey and coordinate system.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Explain the proper use of the equipment for a taping exercise.
2. Explain the proper use of the hand sighting level.
3. Explain the proper use of the tripod level.
4. Explain the proper way to read a leveling rod.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

U3010b. *Surveying in Agriculture*. Urbana, Illinois: Vocational Agriculture Service, University of Illinois at Urbana-Champaign.

Other Resources. The following resources will be useful to students and teachers:

Benton, Arthur R., Jr., and Philip J. Taetz. *Elements of Plane Surveying*. New York, New York: McGraw-Hill, Inc., 1991. (Chapters 2 and 3)

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copy of student lab sheet

Terms. The following terms are presented in this lesson (shown in bold italics):

Hand sighting level
Taping

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Discuss with the students buying a new tool. In order to get the most benefit from the tool, it must be used properly. Most likely the purchaser will need some instruction and training on the new tool's proper use. The same is true for the equipment used in surveying.

Summary of Content and Teaching Strategies

Objective 1: Explain the proper use of the equipment for a taping exercise.

Anticipated Problem: What is the proper use of the equipment used in a taping exercise?

I. ***Taping***, formerly called chaining, is the most common method of measuring horizontal distances in agricultural surveying. Tapes used in surveying are most often graduated in feet, one-tenth, and one-hundredth of a foot. Most steel or nylon tapes used for measuring land are 100 feet in length. Survey lines are measured in full tapes, or stations, plus a final distance of less than 100 feet. Fractions of a foot are indicated in decimals to the nearest 0.1 or

0.01 foot, depending upon the accuracy required. Equipment needed for taping includes a field notebook, a steel or nylon tape with a reel, a ring with 11 pins, and a plumb bob. Range poles are also used if the ends of the distance to be measured are not clearly visible because of hilly ground. Nylon tapes are accurate enough for most agricultural surveying. As they get older, they may stretch slightly, so they should be checked periodically with a steel tape for accuracy. The procedure for taping is quite simple. The crew for taping includes at least two persons. One acts as the head tape person and the other as rear tape person. A third person may serve as a note keeper. The proper steps in a taping exercise are as follows:

A. The head tape person picks up the ring of marking pins and sets one pin at the starting point.
B. The head tape person takes the zero end of the tape and advances in the direction of the line to be measured, pulling the tape behind. The rear tape person stands at the starting point.
C. When the 100-foot end of the tape comes even with the first pin, the rear tape person calls "tape."
D. The head tape person then sets a pin even with the zero mark.
E. The rear tape person then pulls the first pin and both advance down the line to be measured.
F. This same procedure is repeated for each 100 feet. At all times the number of pins in the rear tape person's hand indicates the number of 100-foot lengths that have been measured. The pin in the ground is not counted.
G. When the head tape person has set the eleventh, or last pin, the rear tape person delivers the other ten pins to the head tape person.
H. When the last distance to be measured is a fractional tape length, the pin at the last even 100-foot mark or station should not be pulled or counted.
I. Read the final measurement accurately and add this plus-station to the distance, which has already been measured in even 100-foot stations.

A variety of techniques may be used to assist students in mastering this objective. Students should use text materials to understand the proper use of the equipment used in a taping exercise. Surveying in Agriculture is recommended.

Objective 2: Explain the proper use of the hand sighting level.

Anticipated Problem: What is the proper use of the hand sighting level?

II. The ***hand sighting level***, or hand level is a simple instrument for approximate measurements and estimates. It consists of a sighting tube with a horizontal cross line to mark the line of sight, a bubble tube, and a small mirror to reflect the bubble through to the eyepiece. It is not a telescope, but through it the bubble can be seen along with the cross line and the object sighted. When the bubble is centered in sighting, a point on the cross line is level with your eye. Two basic procedures that can be completed using a hand sighting level are:

A. Locating contour lines—To locate contour lines it takes a crew of two. One person will act as level person and the other as rod person. The level person will stand on a level spot facing the rod person who should be about a step away. The level person should look through the hand level and find a feature or mark on the rod person that is level with his or her eye. Next, set stake number 1 to mark the start of the contour line. The level person should stand at this stake and direct the rod person to move 50 to 100 feet along the approximate contour line. The level person should then direct the rod person up or down the slope until both are standing at the same level. Then the rod person should set stake number 2 which will also be on the contour line. Repeat this process until the entire contour line has been located.

B. Measuring slopes—Again a crew of two is needed, as well as a leveling rod, to complete this exercise. The rod person stands at the top of the slope to be measured. The level person should move down the slope to be measured and take a reading on the rod. Then have the rod person move down the slope so that his or her new location is the same distance from the level person as the previous point. The level person should then take a rod reading on the rod person's new location at the bottom of the slope to be measured. The difference between the two rod readings should then be divided by the distance traveled by the rod person and multiplied by 100. This will determine the percent slope.

A variety of techniques may be used to assist students in mastering this objective. Students should use text materials to understand the proper use of the hand sighting level. Surveying in Agriculture is recommended. Use TM: A2–2A thru TM: A2–2C to assist in the discussion on this topic.

Objective 3: Explain the proper use of the tripod level.

Anticipated Problem: What is the proper use of the tripod level?

III. Levels with a tripod vary considerably in quality, accuracy, and cost. Types range from simple levels for basic construction work and agricultural use to the most accurate engineer's transit levels. All levels have essentially the same parts: a telescope, a leveling device with three or four screws, a leveling plate and head for fastening the level firmly to the tripod, and the tripod itself. There are three basic items a surveyor should know about the level before beginning. They are:

A. Care of the level—To assure dependable service, you need to use the level properly and handle it with great care. The following are suggestions that should be followed concerning the care and handling of the leveling instrument.

1. When transporting the instrument, protect it from shock and vibration.
2. Keep the instrument in the box provided except when in use.
3. When the instrument is removed from the box, place the lens cap and tripod cap in the box.
4. Close the box and place it where it will not be damaged while the instrument is in use.

5. Thread the instrument onto the tripod carefully and make sure it is firmly fastened before picking it up.
6. Carry the tripod and instrument on your shoulder when in the open, but hold it under your arm with the telescope in front when passing through brush or inside an enclosure or building.
7. Never run with the instrument as this increases the chance of falling and breaking it.
8. Never force the screws or other moving parts as they may be damaged.
9. Loosen the tripod leg nuts before picking up or setting down the instrument.
10. Tighten leveling screws snugly, but do not force them. Make sure each leveling screw is snug against the plate before adjusting the level.
11. Do not carry the instrument while crossing a fence.
12. Protect the lens form the direct rays of the sun by using a sunshade at all times.
13. Clean lenses only with soft tissue, not with fingers or rough cloth and do not remove the lenses.

B. Setting up the tripod level—This could be considered the most important part of completing a leveling exercise. If the level is not properly set up, then all data that is collected with the level will be incorrect. Therefore, all the time and money spent completing the exercise is wasted. In preparing to use the tripod level, complete the following steps:
   1. Loosen the tripod screws for the legs before setting up the tripod.
   2. Adjust the tripod legs so that the tripod head or plate is approximately level. On hillsides, place one leg on the uphill side and the other two on the downhill slope.
   3. Spread the tripod legs so the instrument will be stable and the telescope at eye height.
   4. Push the tripod legs firmly into the soil.
   5. Tighten the tripod screws.
   6. Remove the tripod cap and place it in the instrument box.
   7. Lift the level from its case by lifting on the frame, not by grasping the telescope.
   8. Fasten the instrument carefully and securely onto the tripod.
   9. Remove the lens cap and place it in the carrying case.
   10. Place the sunshade on the telescope. Some models have a built in sunshade.
   11. Place the instrument case in a safe location.
   12. Loosen the telescope clamp and move the telescope until it is in position directly over an opposite pair of leveling screws. Adjust the four leveling screws so they are snug against the leveling plate.
   13. Tighten one leveling screw and loosen the other simultaneously to center the bubble. (The bubble follows the left thumb.)
   14. Rotate the telescope to a position directly over the other pair of leveling screws and again center the bubble.

15. Repeat this leveling procedure for each pair of screws until the bubble stays level for a complete revolution of the telescope.
16. Turn the telescope to bring the target rod into the field of focus.

C. Moving the level—When it is necessary to move the level, loosen the tripod screws. Lift the legs from the soil, fold them together, and re-tighten the tripod screws. Be certain to take care when transporting so as not to strike any objects with the level. When you have reached the new location for the level, follow the steps for setting up.

A variety of techniques may be used to assist students in mastering this objective. Students should use text materials to understand the proper use of the tripod level. Surveying in Agriculture is recommended.

Objective 4: Explain the proper way to read a leveling rod.

Anticipated Problem: What is the proper way to read a leveling rod?

IV. A leveling rod is generally used with a tripod level to measure a vertical distance from the line of sight down to a point. It may or may not have a sliding sight, or target, for use in making readings. The most common type of rod used for agricultural applications is called a self-reading rod. It can be read through a telescope without the use of a target, if desired. Each black and white segment is one-hundredth of a foot in width and readings are made at the top and bottom of the black segments. A large red number marks each foot. Each one-tenth of a foot is marked with a smaller black number. The top edge of black segments are even one-hundredth of a foot values. The bottom edge of black segments are the odd one-hundredth of a foot values. A two-person crew uses a variety of hand signals to indicate the direction in which the leveling rod should be moved.

A variety of techniques may be used to assist students in mastering this objective. Students should use text materials to understand the proper way to read a leveling rod. Surveying in Agriculture is recommended. Use TM: A2–2D and TM: A2–2E to assist in the discussion on this topic.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the end of each chapter in the recommended textbooks may also be used in the review/summary.

Application. The following lab sheet will be helpful to students in reinforcing the content:

LS: A2–2A — Survey Hand Signals

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activity. A sample written test is attached

Answers to Sample Test:

Part One: Matching

1 = a, 2 = c, 3 = b

Part Two: Completion

1. self-reading
2. incorrect
3. 100
4. care

Part Three: Short Answer

See Objective 3 in the lesson.

Sample Test Name _____

Test

Lesson A2–2: Using Surveying Equipment

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. hand sighting level b. taping c. leveling rod

_____ 1. A simple instrument for approximate measurements and estimates if carefully used.

_____ 2. Piece of equipment from which readings are taken.

_____ 3. Process used to measure distances.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. The most common type of rod used for agricultural applications is called a _____ rod.
2. If the level is not properly set up, then all data that is collected with the level will be _____.
3. Most steel or nylon tapes used for measuring land are _____ feet in length.
4. To assure dependable service, you need to use the level properly and handle it with great _____.

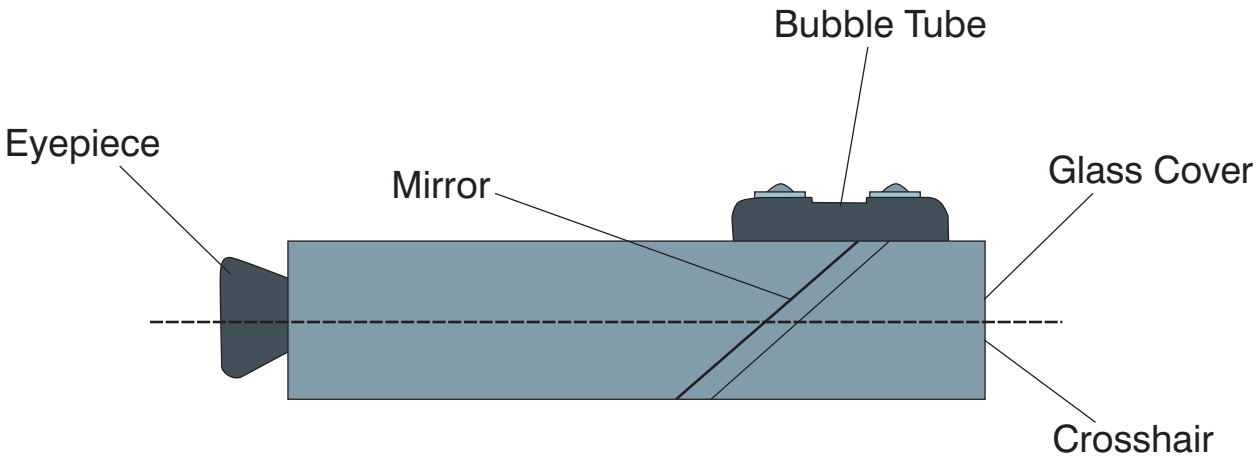
Part Three: Short Answer

Instructions. Provide information to answer the following questions.

Explain the procedure to follow with setting up a leveling instrument.

TM: A2–2A

A HAND SIGHTING LEVEL

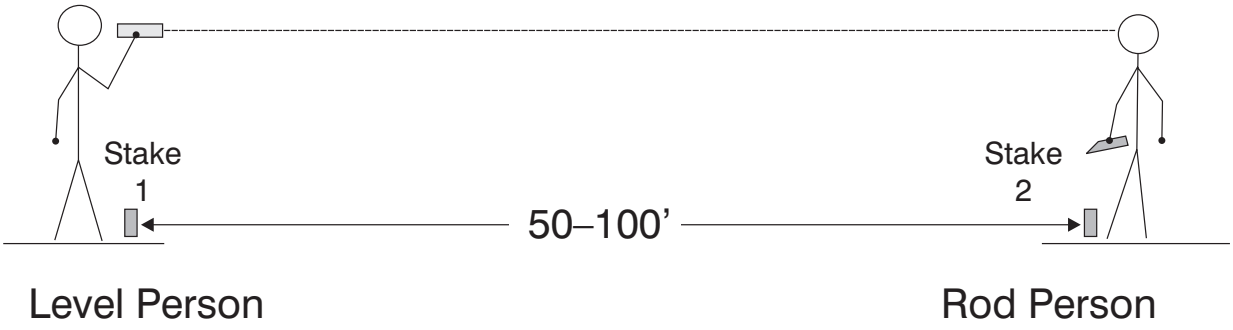


The bubble is reflected to the eyepiece by a small mirror.

(Courtesy, Interstate Publishers, Inc.)

TM: A2–2B

LOCATING CONTOUR LINES

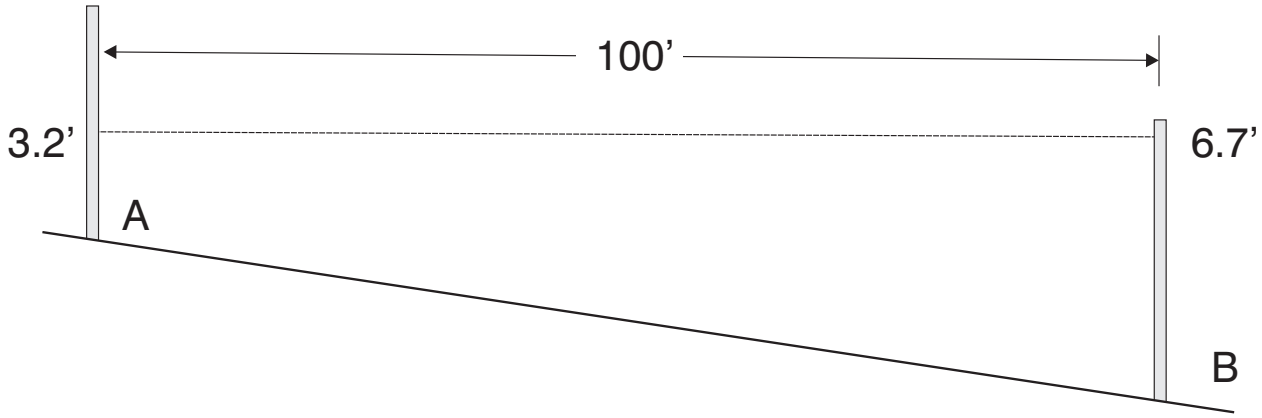


The level person directs the rod person up or down the slope until both are standing at the same level.

(Courtesy, Interstate Publishers, Inc.)

TM: A2–2C

MEASURING SLOPES

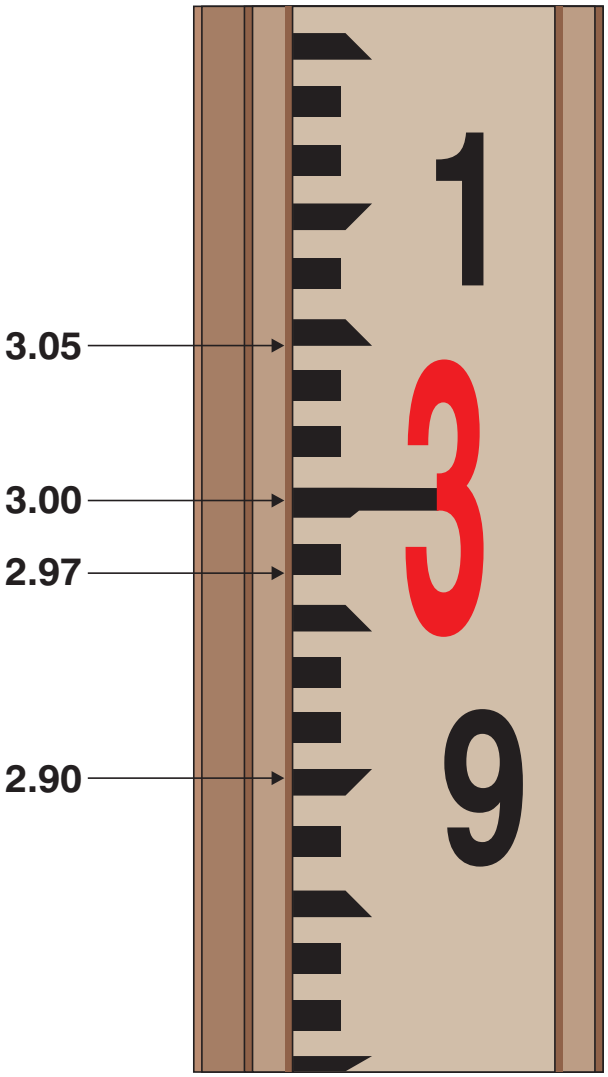


At a horizontal distance of 100 feet, the difference in elevation between A and B equals the percent slope. In this example the slope is 3.5%.

[(6.7 – 3.2) ÷ 100] = 3.5%

(Courtesy, Interstate Publishers, Inc.)

LEVELING ROD



On the leveling rod, the large, red number 3 reads 3.00 feet. The smaller, black numbers read one-tenth of a foot.

(Courtesy, Interstate Publishers, Inc.)

TM: A2–2E

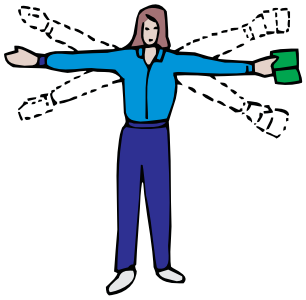
HAND SIGNALS FOR MOVEMENT OF LEVELING ROD

Move Up

Move Down

Move Rod to Right

Move Rod to Left

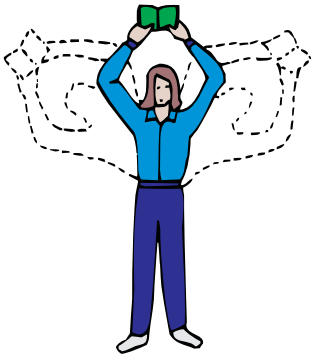


Observation Completed *or* Move On *or* Understood

Come In

Wrong Face *or* Check Clamp *or* Rod Upside Down

Use Long Rod



Wave Rod from Side to Side

Turning Point

LS: A2–2A Name: _____

Lab Sheet

Survey Hand Signals

Purpose: To understand the meaning of survey hand signals.

Directions: Below each illustration, write the meaning of the hand signal.