Circumferentor

Topic

Indirect measurement of objects

Time

l hour

Safety

Please click on the safety icon to view safety precautions.
Be careful when hammering.

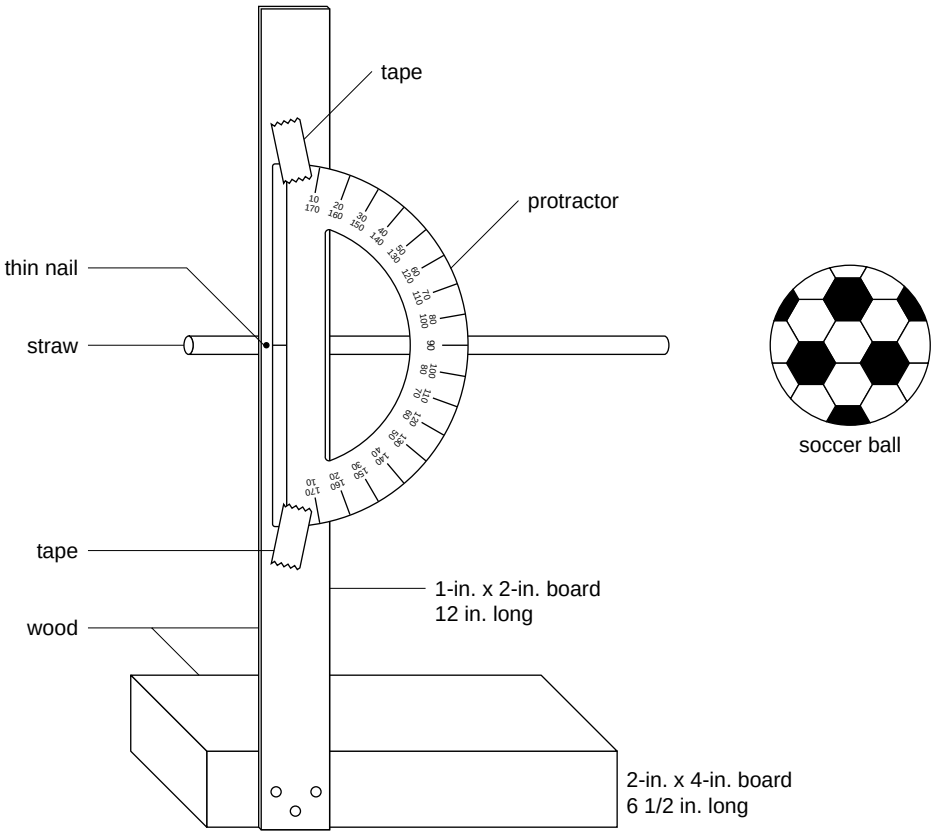
Materials

two pieces of lumber, one 6- to 12-in. 2 2 4 board, one 12-in. 1 2 2 board
five nails
protractor
tape
one drinking straw
two soccer balls, one large, one small
hammer
graph paper
one additional thin nail to fasten the straw

Procedure

1. Nail the two boards together, using all five nails (figure 1).
2. Tape the protractor to the 1 2 2 board.
3. Fasten the straw to the board with a thin nail so that the straw is in the center of the protractor (figure 1).
4. Place a soccer ball 20 ft away from the circumferentor.
5. Site the top of the ball through the straw. Write down on the data table the number on the protractor.
6. Site the bottom of the ball through the straw. Write down on the data table the number on the protractor.
7. Subtract the two readings. Record on the data table.
8. Repeat steps 4 to 7 using a larger ball.
9. Repeat steps 4 to 7 using a smaller ball.
10. Repeat steps 4 to 7 at a distance of 10 ft.
11. Repeat step 8 at a distance of 10 ft.
12. Repeat step 9 at a distance of 10 ft.
13. Repeat steps 4 to 7 at a distance of 30 ft.
14. Repeat step 8 at a distance of 30 ft.
15. Repeat step 9 at a distance of 30 ft.
16. Graph all the results.

Figure 1



17. What happens when you vary the ball size?
18. What happens when you vary the distance?

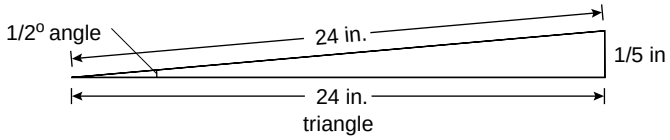
What's Going On

A circumferentor measures the angular diameter of an object from a distance. The angular diameter becomes smaller as the distance increases. Therefore, the angular diameter is dependent on the size of the object and the distance the object is from you.

Connections

Astronomers have used the circumferentor to calculate the angular diameter of planets and the moon. They determined that the angular diameter of the moon is ½ degree. A graph of these data, with a scale of 1 in. equals 10,000 mi, produces an angle with sides 24 in. long. Since we know that the distance from the earth to the moon is approximately 240,000 mi, when both sides of the angle are completed, the diameter is about ⅕ in. or 2,000 mi (see figure 2). The actual diameter is 2,160 miles.

Figure 2



DATA TABLE			
Object	10 ft	20 ft	30 ft
Soccer ball	top of ball number _____	top of ball number _____	top of ball number _____
	bottom of ball number _____	bottom of ball number _____	bottom of ball number _____
	difference between top and bottom _____	difference between top and bottom _____	difference between top and bottom _____
Smaller ball	top of ball number _____	top of ball number _____	top of ball number _____
	bottom of ball number _____	bottom of ball number _____	bottom of ball number _____
	difference between top and bottom _____	difference between top and bottom _____	difference between top and bottom _____
Larger ball	top of ball number _____	top of ball number _____	top of ball number _____
	bottom of ball number _____	bottom of ball number _____	bottom of ball number _____
	difference between top and bottom _____	difference between top and bottom _____	difference between top and bottom _____

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say "be careful with hot liquids" or "don't cut yourself with the knife" does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don't use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES