




## RATIONALE FOR ADVENTURE

Taking part in this Webelos/Arrow of Light elective adventure will help Webelos understand and apply the role of fair investigations in science. They will acquire and evaluate information using processes associated with science, such as experiments, observation, and note taking.

## TAKEAWAYS FOR CUB SCOUTS

- Increased content knowledge in one or more areas
- Methodical problem solving
- Evaluating evidence
- A Scout is cheerful. 

*Webelos Handbook, page 184*

## ADVENTURE REQUIREMENTS

Complete the following requirements.

1. An experiment is a "fair test" to compare possible explanations. Draw a picture of a fair test that shows what you need to do to test a fertilizer's effects on plant growth.
2. Visit a museum, a college, a laboratory, an observatory, a zoo, an aquarium, or other facility that employs scientists. Prepare three questions ahead of time, and talk to a scientist about his or her work.
3. Complete any four of the following:
  - A. Carry out the experiment you designed for requirement 1.
  - B. If you completed 3A, carry out the experiment again, but change the independent variable. Report what you learned about how changing the variable affected plant growth.
  - C. Build a model solar system. Chart the distances between the planets so that the model is to scale. Use what you learned from this requirement to explain the value of making a model in science.
  - D. With adult supervision, build and launch a model rocket. Use the rocket to design a fair test to answer a question about force or motion.
  - E. Create two circuits of three light bulbs and a battery. Construct one as a series circuit and the other as a parallel circuit.
  - F. Study the night sky. Sketch the appearance of the North Star (Polaris) and the Big Dipper (part of the Ursa Major constellation) over at least six hours (which may be spread over several nights). Describe what you observed, and explain the meaning of your observations.
  - G. With adult assistance, explore safe chemical reactions with household materials. Using two substances, observe what happens when the amounts of the reactants are increased.
  - H. Explore properties of motion on a playground. How does the weight of a person affect how fast they slide down a slide or how fast a swing moves? Design a fair test to answer one of those questions.
  - I. Read a biography of a scientist. Tell your den leader or the other members of your den what the scientist is famous for and why his or her work is important.



## NOTES TO DEN LEADER

Note that these plans outline more meetings than necessary to complete the requirements. Only four activities must be completed for requirement 3, but the meeting plans offer ideas for all nine options, depending on what the Scouts select. Den leaders should plan accordingly and decide which meetings best lead to completing the adventure.

The Meeting 1 plan outlines a den outing to an institution that employs a scientist, and an optional Meeting 5 could be an outing to observe the night sky. In advance of each outing, the leader will need to make arrangements with the outing location and confirm the outing plan with families, including transportation and any additional items they need to bring. Make sure activity consent forms are distributed, signed, and collected.

If some Scouts decide to read the biography of a scientist, it would be helpful to establish this early in the adventure. This would allow them time to share with others in the den what they learned about the scientist.

Brainstorming how to carry out an activity one week before it is scheduled will help you to use den time well and to have any needed materials on hand. See the meeting resource sections for guidelines and suggested materials lists to carry out the investigations.

See the appendix for optional den meeting activities, including openings, gatherings, and closings.

## MEETING 1 PLAN (Den Outing)

The outing may take place any time during this adventure. However, scheduling it first will allow Webelos the opportunity to meet a scientist and see science in action, and further provide context and inspiration for the remainder of the adventure.

### PREPARATION AND MATERIALS NEEDED

- Identify a college or university, museum, laboratory, zoo, planetarium, aquarium, agricultural experiment station, commercial firm, or organization that employs a scientist.
- Contact the scientist or organization at least a month ahead of time to schedule a visit with him or her.
- Provide the scientist with a copy of the requirements to prepare for the visit. Other things to discuss include:
  - A visit to the actual laboratory, depending on the willingness or interest of the organization and the scientist
  - A demonstration of equipment used in the scientist's work
  - Giving Scouts an opportunity to assist in the process
  - Can the host assist the Scouts with any of the adventure requirements?
- Once the visit has been confirmed, secure signed activity consent forms from the Webelos' families and make sure they all know the arrangements:
  - Who will attend?
  - When are you planning to go?
  - Where you will meet?
  - What should the Webelos Scouts wear or bring?
- As another option, the scientist might visit a den meeting.
- You may wish to put questions the Scouts should ask on index cards to help in remembering them. In addition, give each Scout a second card to write more questions that come to them; be sure to review the questions for appropriateness.



- Questions might include:
  - How did you become interested in science?
  - When did you decide you wanted to be a scientist?
  - What is the greatest challenge that a scientist has to work with?
  - What should people know about what a scientist does?
  - How might a Webelos Scout become a scientist?
  - Which points of the Scout Law (trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent) are most important in the life of a scientist?

## GATHERING

- Share with the Scouts some key thoughts about what they are going to observe and learn about during the visit.

## ACTIVITIES

### ◆ Activity 1: Den Outing

- Begin by introducing the staff member who will lead the visit. An appropriate greeting prepared by the Webelos for their outing leader might be as simple as, "Hello, my name is ..."
- Remember to mention that the Scouts have some questions they would like to ask at the end of their session.
- During the visit, make sure the Scouts ask the scientist to explain his or her duties, and what is the best way to prepare for a career in this field. Include some hands-on activities, if possible.

## CLOSING

- Have the den thank the person in charge of the visit; prompt Scouts in advance to think of how they want to do this. Ways to show courtesy might include a "thank-you," handshake, cheer, or applause. This might be an opportunity to use the den yell as a means of showing appreciation.
- Commend everyone on their obedience and respect for the rules of the facility, and remind them that "a Scout is courteous" and obedient to the rules of any place they enter.



### **Do-at-Home Project Reminder:**

Tell Webelos Scouts who wish to read a biography of a scientist (requirement 3I) that now is a good time to start. Plan for them to share what they learn at den meetings during this adventure.

## AFTER THE MEETING

- Serve refreshments, if desired and appropriate. Sharing them with the outing host would be a nice gesture.
- Prepare thank-you notes that Scouts can sign at the next meeting and send to anyone who helped with the outing, including the scientist. Consider putting the denner in charge of this responsibility.
- Record completion of requirement 2.



# MEETING 2 PLAN

## PREPARATION AND MATERIALS NEEDED

- U.S. and den flags
- Thank-you notes for those who led or assisted with the den outing
- Items for the Gathering: Sheets of blank paper and three or four “whatzit” boxes—sealed boxes with one or two items inside for Scouts to guess the contents
- Items for the fair test activities: Markers, crayons, or colored pencils; paper cups; dirt or planting soil (without fertilizer); fertilizer or plant food; water; and seeds. Choose a seed that germinates quickly so Scouts can see growth within the time frame of this adventure. Possible choices include:

| Seed             | Days |
|------------------|------|
| Lima bean        | 6    |
| Beets            | 4    |
| Broccoli         | 4    |
| Brussels sprouts | 4    |

| Seed     | Days |
|----------|------|
| Cabbage  | 4    |
| Pumpkin  | 4    |
| Radish   | 4    |
| Cucumber | 3    |

| Seed       | Days |
|------------|------|
| Lettuce    | 3    |
| Sweet corn | 3    |
| Turnip     | 3    |
|            |      |

## GATHERING: WHATZIT BOXES

- Set the sealed whatzit boxes (see Meeting 2 Resources) on a table before the meeting. As Scouts arrive, they should handle the boxes and deduce what might be inside. Then give each member of the den some paper to sketch an image of the possible contents.

## OPENING

- Conduct a flag ceremony of your choosing that includes the Pledge of Allegiance and the Scout Law.

## TALK TIME

- Carry out business items for the den.
- Allow time for sharing among Webelos Scouts.
- Pass the thank-you notes around for the Scouts to sign.
- Lead a discussion about the whatzit boxes, and have Scouts compare their drawings and guesses about the possible contents. Tie their comments to points of the Scout Law: Did they share information (a Scout is helpful, friendly), laugh about it (cheerful), or take turns sharing their thoughts (courteous)?
- Say: *In a similar way, scientists often must measure things indirectly. It may take lots of scientists working together over time, perhaps many years, to reach a certain conclusion.*

## ACTIVITIES

### ◆ Activity 1: Fair Tests (Requirement 1)

- Have Scouts draw a picture of a fair test (experiment) that would explore how fertilizer affects the growth of a plant (see Meeting 2 Resources).
- The fair tests may be drawn as diagrams or in comic strip form—where the step-by-step boxes may help outline the process.

### ◆ Activity 2: Simple Investigations (Requirements 3A and 3B)

- Each Scout will carry out two versions of the experiment they drew in Activity 1, using the seeds you collected. They will take the experiments home—both clearly marked with their name—and bring them back or take photos during the next few weeks to compare at den meetings.



- The first experiment will directly follow the Scout's drawing from Activity 1. The second will be the same, except that the Scout will change the independent variable. For example, one experiment could have fertilizer in the soil while the other doesn't, or one could receive six hours of light per day and the other gets 12 or more. Ask Scouts to offer more ideas about what could change and what could remain the same.
- It may be best to have the Scouts decide on a single factor to change. This is helpful when looking for trends, as the change will be based on several plants having a similar change. This reduces the likelihood that a bad seed will fail to germinate and influence the results.
- As an option, each Scout could make two side-by-side drawings in the first activity—one with the independent variable and one without.

## CLOSING

- Gather the den members together and close with the Scout Oath or Scout Law.
- Comment on science as a long-term activity, with multiple steps and attention to details, and tie that idea to the activities and goals that lie ahead for these Scouts.

## AFTER THE MEETING

- Serve refreshments, if desired.
- In cleaning up the meeting place, solicit help from the Scouts while encouraging the behavior of those who help without prompting.
- Record completion of requirement 1.
- Remind the denner or other Scout who will plan and lead the next meeting's flag ceremony.
- Review plans for next week and see who will be ready to report on a scientist's biography.

# MEETING 2 RESOURCES

## GATHERING: WHATZIT BOXES

- Scientists often cannot observe things directly; sometimes, they need to make use of evidence to create a model or to generate an explanation.
- A whatzit box is a sealed box with one or two items inside. Scouts may shake and play with the boxes to gain indirect evidence about the contents. Then they must write down or make a sketch of what they believe is there without opening the boxes.
- In much the same way, scientists build their understanding of nature through indirect explorations. They do not have the luxury of "opening up a box" to get answers. Scientists build certainty only over a long period of time.
- This activity may be helpful in coaching Scouts to deal appropriately with ambiguity and uncertainty. However, the more they play with the boxes and describe what they think is inside, the more likely they are to find the correct answer.
- A whatzit box can be constructed from a box that holds shoes or other products. Film canisters can also be used to create smaller versions of the same thing.

| Large Whatzit Box<br>(shoebox size) | Small Whatzit Box<br>(film canister size) |
|-------------------------------------|---|
| Wooden building block(s)            | Coins                                     |
| Coins                               | Paper clips                               |
| Rubber ball(s) or golf ball(s)      | Marbles                                   |
| Folded paper                        | Sand                                      |
| Fishing weights                     | BBs                                       |

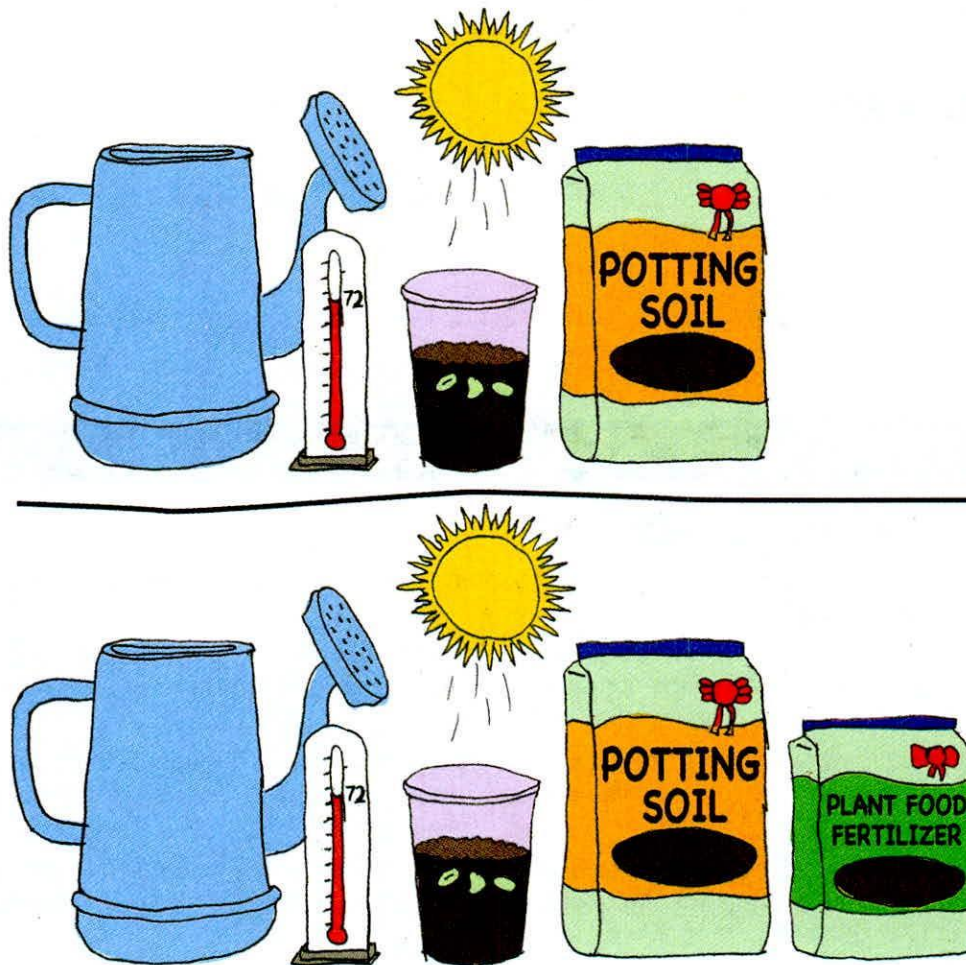
- If Webelos Scouts want to continue this activity, encourage them to make their own whatzit boxes at home and bring them to the next den meeting or a pack meeting to challenge other Scouts.



## ACTIVITIES

### ◆ Activity 1: Fair Tests (Requirement 1)

- At the heart of an experiment is testing a question, and doing so fairly. This activity helps Scouts to understand fair testing—an essential skill of scientific literacy.
- If the independent variable will be the presence or lack of fertilizer, two side-by-side drawings might look like this, with the bag of fertilizer missing in one. Otherwise, both sides would have the same number of seeds or plants in a cup, and could be expanded to include light (sun), water, planting soil, and temperature.
- The important thing is that only one factor will change between the two experiments. If that single factor is the presence or lack of fertilizer, any difference in the way the plants grow can be fairly attributed to it. This principle can be generalized across many fields that lend themselves to scientific investigation.



### ACTIVITY 2: SIMPLE INVESTIGATIONS (REQUIREMENTS 3A AND 3B)

- For the fertilizer/no fertilizer plan, each Scout should have a pair of plastic cups, several seeds of the same type, potting soil, and a sample of plant food. In both cups, seeds need to be planted the same way (with the exception of fertilizer) and in the same amount of soil. Label the cups with a permanent marker so it is clear which cup has the fertilizer.
- It is best that the Scouts take their plants home to finish the investigations themselves, but if necessary the plants could be left in the care of the den leader. In the fertilizer/no fertilizer plan, care should be taken to ensure all plants have exactly the same lighting, watering schedule, and temperature/environmental controls.

# MEETING 3 PLAN

## PREPARATION AND MATERIALS NEEDED

- U.S. and den flags
- Items for the Gathering:
  - Paper suitable for making paper airplanes
  - Wastebasket or similar target for the planes
- Items for Activity 1: Zip-top plastic bags; balloons (check for latex allergies); drinking straws; water-filled plastic bottles; baking soda and vinegar or another pair of household materials. **Note:** Be cautious when selecting materials for this investigation. See information in Meeting 3 Resources.
- Items for Activity 2: Model rocket kits, ideally one per Scout
- Items for Activity 3: Batteries, flashlight bulbs, wire

## GATHERING: PAPER PLANES

- Provide paper to Scouts when they arrive and have them make paper airplanes. Place a wastebasket in the middle of the room and challenge them to toss their planes into the basket.
- As the Scouts' skills improve, have them move farther away from the basket or ask them to aim in a different direction—which requires modifying the surfaces of the planes.

## OPENING

- Conduct a flag ceremony of your choosing that includes the Pledge of Allegiance and the Scout Law.

## TALK TIME

- Carry out business items for the den.
- Allow time for sharing among Webelos Scouts.
- Discuss findings that members of the den have recorded in their plant investigations since the last meeting.
- If any of the Scouts has been reading a scientist's biography, have them share what they learned with the rest of the den.

## ACTIVITIES

### ◆ Activity 1: Chemical Reactions (Requirement 3G)

- With adult assistance, have Scouts explore a safe chemical reaction using baking soda and vinegar or a different pairing of household materials (see Meeting 3 Resources). Investigate changes that take place when the amount of either substance is increased.

### ◆ Activity 2: Model Rockets (Requirement 3D)

- With adult supervision, have each Scout build and launch a model rocket (see Meeting 3 Resources). Depending on how much time is available, this activity may need to be finished at home.

### ◆ Activity 3: Series and Parallel Circuits (Requirement 3E)

- Scouts will create series circuits and parallel circuits, first using three light bulbs and then using a battery. In both cases they will observe how the two circuits differ in light output and battery life (see Meeting 3 Resources).



## CLOSING

- Close with a thought tied to the meeting's activities. For example, the height of rockets can be compared to how high Scouts soar. For the chemical reaction, you might note that the two chemicals combined to produce an effect, just like the den works better when all members do their part. For the electrical circuits, which kind of "circuit" are we: shining examples of the Scout Oath and Scout Law, or dim in comparison?

## AFTER THE MEETING

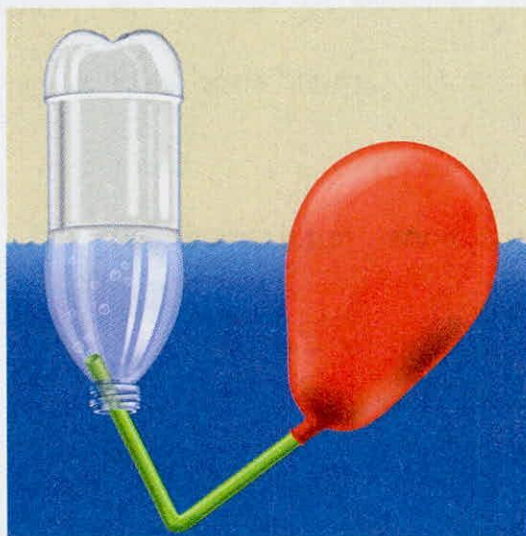
- Serve refreshments, if desired.
- Work together to clean up the meeting place.
- Record completion of requirements 3D, 3E, 3G, and 3I. **Note:** If Scouts have already completed 3A and 3B, only two more options are required under requirement 3.

# MEETING 3 RESOURCES

## ACTIVITIES

### ◆ Activity 1: Chemical Reactions (Requirement 3G)

- A safe but vigorous chemical reaction for Scouts to explore comes from combining baking soda and vinegar. One of the more noticeable products is the generation of carbon-dioxide gas. This is the same gas that you exhale from respiration.
- **Be cautious when selecting materials to explore.** Some household chemicals, such as bleach and ammonia, give off a toxic gas when combined. Read the safety information on the container to see if it offers any warnings.
- Scouts should find a way to observe how much gas is produced when the amount of either chemical is changed. There are a number of ways to test this. Having the chemicals expand inside a plastic zip-top bag is one way to capture the gas. Another, illustrated below, is to bubble the emerging gas through a straw and catch it in an overturned water-filled bottle.



- The process is simple in concept, but you will want to walk your Scouts through some questions ahead of time to help them capture good results. For example:
  - How can you make the zip-top bag as empty as possible before combining the two chemicals inside it?
  - How will you measure changes in the volume of the bag when it expands?
  - Can you use what you learn to predict how much the bag will expand if the investigation is repeated?



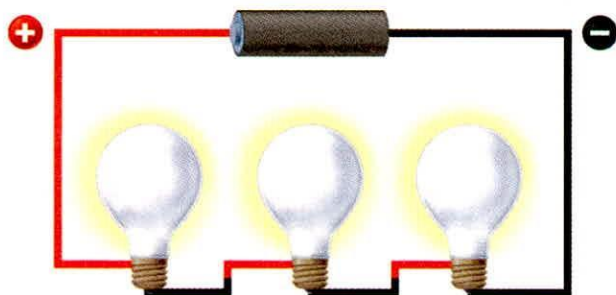
### ◆ Activity 2: Model Rockets (Requirement 3D)

- Follow the instructions and safety guidelines in the kits. Have all Scouts build the same type of rocket so that an initial set of variables can be controlled.
- Similar to the plant investigation, Scouts may find it helpful to draw a fair test sketch before starting—or a chart like the one below. To change an independent variable, Scouts could do this activity in pairs: One Scout builds a rocket following the complete directions while their buddy alters the weight of their model or adds fins, etc.

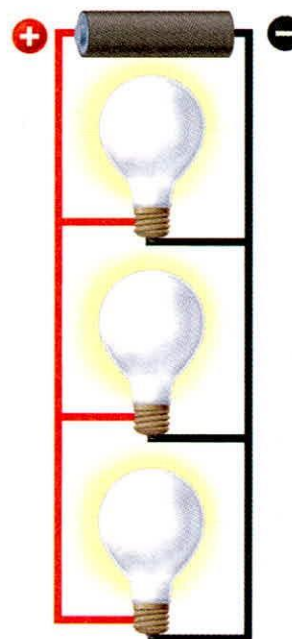
| Dependent Variable               | Controls          | Independent Variable      |
|----------------------------------|-------------------|---------------------------|
| Heavy rocket versus light rocket | Same rocket motor | How high the rocket flies |
|                                  | Same size rocket  |                           |
|                                  | Same wind speed   |                           |

### ◆ Activity 3: Series and Parallel Circuits (Requirement 3E)

- Exploring key properties of electricity can be done with very simple materials. The diagrams of the three-bulb series circuit and the three-bulb parallel circuit can serve as a start for Scouts as they explore electricity.
- Scouts will observe that the bulbs connected in parallel are brighter than the bulbs connected in series. Using three pathways for the current to pass through not only causes the bulbs in the parallel circuit to burn brighter than the series circuit, but also makes the battery run down more rapidly. However, this will not be immediately obvious, and Scouts may need help to determine what they are seeing and what evidence to record.
- Part of the fun in this activity is figuring out how long a bulb will last when it is left “on.” Encourage creative problem-solving to see what solution the den arrives at.
- They should build the circuit presented in the *Webelos Handbook* to make their comparisons. You may also encourage Scouts to build circuits with four, five, and six pathways if you have enough supplies. Challenge them to discern any variations in the battery life with different circuit arrangements.
- More questions to consider:
  - What is the effect on the circuit if a bulb burns out or is removed in a series circuit? In a parallel?
  - What are the advantages of a series circuit over a parallel circuit?



Series circuit



Parallel circuit



# MEETING 4 PLAN

## PREPARATION AND MATERIALS NEEDED

- U.S. and den flags
- Items for the Gathering: a Jenga game (check with families to see if anyone has one) or a deck of playing cards
- The activities for this meeting should be conducted outdoors because of the space and materials required:
  - For Activity 1, a tape measure (at least 20 feet if the scale of the model solar system is in inches; 50 or 100 feet if the scale is in feet) and signs to mark the planets
  - For Activity 2, access to a playground swing or slide
- If this is the last meeting for the adventure, make sure all Scouts who were reading biographies give their reports to you or the den.

## GATHERING

- As Scouts arrive, have them play a game of Jenga. Encourage them to work together to keep the tower standing as long as possible. Then explore what they learned about balance, as it has applications in science.
- An alternative could be building towers of stacked cards. Webelos Scouts could challenge each other to build the tallest standing structure.

## OPENING

- Conduct a flag ceremony of your choosing that includes the Pledge of Allegiance and the Scout Law.
- Have the denner build a small Jenga tower one block at a time while calling each Scout's name; or a 12-block tower as the den recites the points of the Scout Law.

## TALK TIME

- Carry out business items for the den.
- Allow time for sharing among Webelos Scouts.

## ACTIVITIES

### ◆ Activity 1: Model Solar System (Requirement 3C)

- The scale of the solar system—and the universe—presents a tremendous challenge to youth as they begin to “wrap their minds around it.” This activity involves building a model solar system to scale, based on the distance chart in the *Webelos Handbook*. Go outside where you will have enough space, and remind Scouts of the importance of working together on the model.
- As an option, each Scout may create a sign to place in the model that represents a particular planet or star. Using the measuring tape to ensure accurate distances, start with a sign marking the sun—this could be an image of a Scout wearing a sun logo. Then put signs at appropriate distances away from the starting point.

If you find it easier to convert the inch-based scale to feet, simply divide the distance figures by 12; the resulting figure is the number of feet between the objects. The farthest object (Neptune) will be 232 feet away from the sun.

- Another option is to have each Scout mark a planet by standing in that spot. This would reinforce for them the vastness of the solar system. If you do this, be sure to invite a few adult volunteers to help keep the Scouts in sight. Once the solar system has been created, bring the Scouts back together to discuss how their sense of “big” has changed.



- Tell the Scouts that one of the fastest spacecraft on record, Pioneer 10, was launched in 1972. It took until 1983—11 years—for it to reach the orbit of Neptune. Contact with Pioneer 10 was finally lost in 2003. By that time, it had traveled approximately 7.2 billion miles!

### ◆ Activity 2: Properties of Motion (Requirement 3H)

- Scouts will design a fair test to see if a person's weight affects how fast they go down a slide or move on a swing. The *Webelos Handbook* offers suggestions on how to approach this, and as before, the Scouts should first draw a picture of what their fair test will look like.
- If they use a slide, placing waxed paper under the person should reduce surface friction—which could really slow down the slide's operation. The Scouts may find it helpful to create an average for the trials, based on their prior experience with slides, so a "best" value can be tracked.
- Show respect for others: Under no circumstances should any Scout be teased because of body size. (This variable [weight] was selected because it is related to a common scientific misconception that the weight of an object has an effect on its speed—it does not.) Having an adult participate will prevent any one Scout from being singled out for their weight.

## CLOSING

- Reflect on the activities in this meeting: *A model can be used to represent something that is too hard to see in the laboratory. While our model was designed so we could experience the expanse of the solar system, models can also be used to show and explore things such as atoms that are far too small to see directly. And in our playground investigation, we found a meaningful way to collect and analyze data.*
- Bring the den together and have each Scout take a point of the Scout Law and say what it means to them after going through this adventure. Has the meaning changed? Are some of the points more important to scientific inquiry than others?
- Review details if you have arranged a Meeting 5 den outing to study the night sky. Make sure all Scouts and their families know the plans.

## AFTER THE MEETING

- Serve refreshments, if desired.
- Work together to clean up the meeting place.
- Record completion of requirements 3C and 3H. **Note:** If Scouts have already completed 3A and 3B, only two more options are required under requirement 3.

# MEETING 5 PLAN (Optional Den Outing)

This meeting provides an opportunity to study the night sky (requirement 3F). This is a good activity to carry out during a Webelos den overnigher.

## PREPARATION AND MATERIALS NEEDED

- Confirm that transportation to and from the event is in place. Secure signed activity consent forms.
- The den leader should bring a copy of the *Guide to Safe Scouting*.
- Flying disc for the Gathering activity.
- Bring paper and pencils or markers. A planisphere (star chart) would also be helpful.
- If requirements 3C and 3D have not been covered at the other meetings, both would fit well here. If the outing is overnight, consider adding requirement 3E. (Remember that 3C and 3D need to take place during daylight hours.)
- If the den is partnered with a Scout troop, you may find a natural helper in an older Scout who has earned or is working on the Astronomy merit badge.



## GATHERING

- Playing catch with a flying disc would be a good Gathering activity. Scouts may also see who can throw the disc closest to a tree without touching it.

## ACTIVITIES

### ◆ Activity 1: Studying the Night Sky (Requirement 3F)

- Scouts will sketch the appearance of the North Star (Polaris) and the Big Dipper (Ursa Major) over at least six hours (see Meeting 5 Resources). If this activity is not completed in the same night, no more than two days should pass between sketches.
- The next morning, discuss what the Scouts observed and how those observations can be explained.

## AFTER THE MEETING

- Have Scouts prepare and send thank-you notes to everyone who helped with the outing, including parents.
- Record completion of requirement 3F and any others that apply.

Upon completion of the Adventures in Science adventure, your Webelos Scouts will have earned the adventure pin shown here. Make sure they are recognized for their completion by presenting the adventure pins, to be worn on their uniforms, as soon as possible according to your pack's tradition.



# MEETING 5 RESOURCES

## ACTIVITIES

### Activity 1: Studying the Night Sky (Requirement 3F)

- The earth rotates once on its axis every 24 hours. But until the 17th century properties of motion were misunderstood and it was believed that the earth could not be moving because no one felt it rotating.
- However, evidence that the earth rotates can be tracked using the night sky. In this period of six hours, we should observe the stars in the night sky making a quarter rotation.
- Astronomy is one of the oldest of the sciences. At its heart is explaining how things work. Sharing mythological explanations of the stars' patterns and movements can serve this activity well. *The Stars* by H.A. Rey (Houghton-Mifflin, 1952) has been a great introduction to astronomy and constellations for decades; use it as a resource to learn about what you see in the night sky.
- Scouts should have the opportunity to produce sketches similar to the diagrams below.

