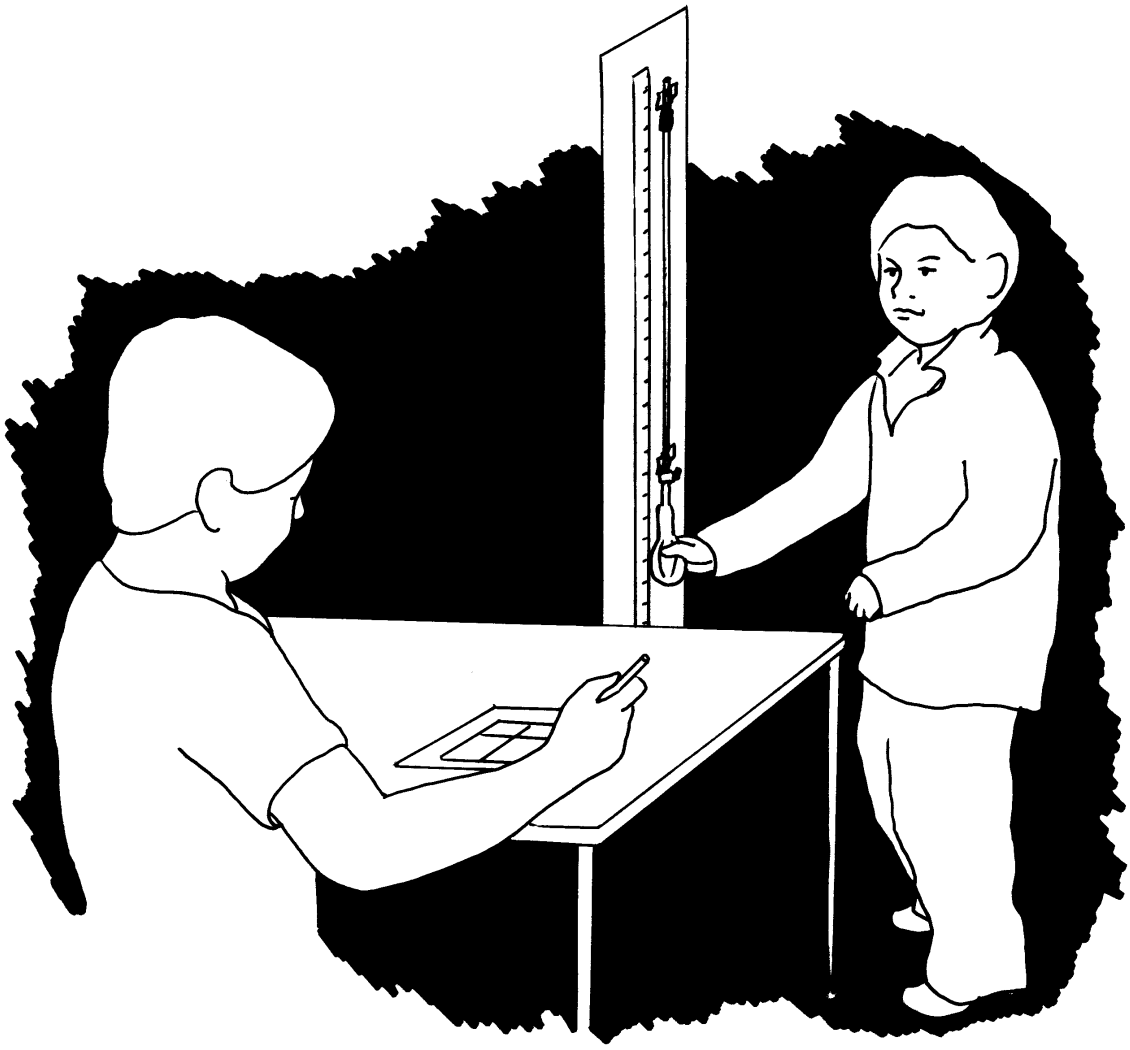
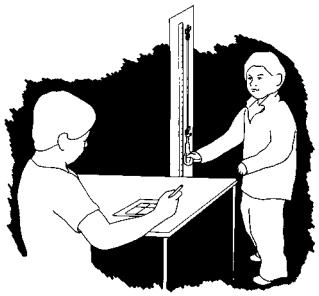
Explore It!

SCIENCE INVESTIGATIONS
IN OUT-OF-SCHOOL PROGRAMS



Measuring Ourselves

EDC CENTER FOR Science Education



Measuring Ourselves

HOW MANY HEADS?

EXPLORATION 2

In the previous activity, perhaps someone said that the kid on the bike was "kind of tall," or that the cake lady had "really long arms." But what is "tall" for a kid? And how long are arms *supposed* to be? To find out, you will make an outline of your own body on chart paper. You will measure different parts to find how big your head is compared with other parts of your body.

Discovery Question

Can you see any patterns in the size of the different parts of your body (and everyone else's body)?

WHAT TO DO

PART 1 **Outline**

1. Tape 4 sheets of chart paper together in a T shape (5 feet tall and 5 feet wide at the top) (Figure 4).

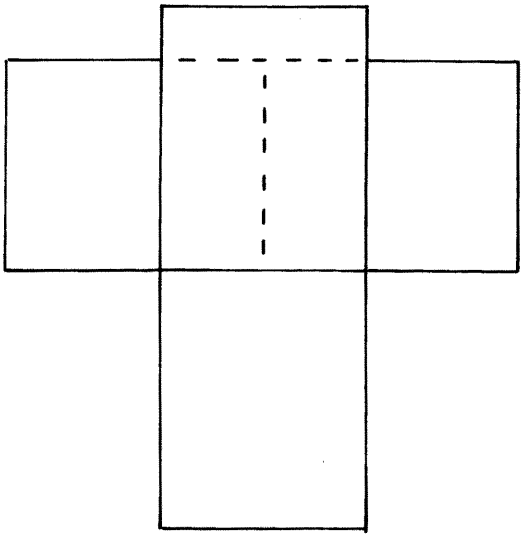


Figure 4
Lay out your four pieces of paper like this.

2. Choose one team member ("the model") to lie on the paper with arms outstretched and feet together.
3. The rest of the team members should use markers to trace the outline of the model's body on the paper (Figure 5). Trace as close to the body as possible. *Be careful not to get marker on his or her clothing*.

EXPLORERS' SHEET 2

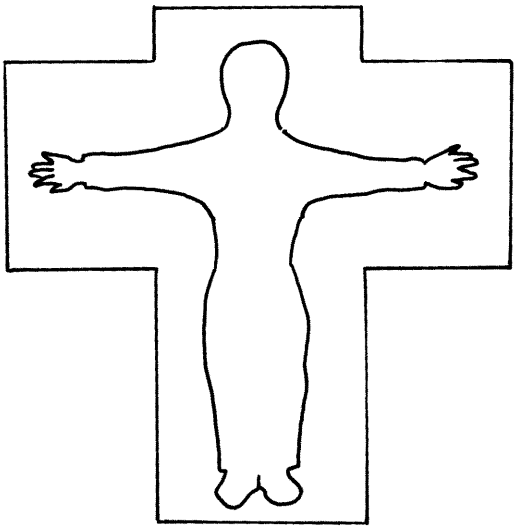


Figure 5
The outline of the model's body.

4. Before the model stands up, he or she should put both arms down to the sides with fingers pointed straight. Mark a line at the point where the fingers of each hand reach.
5. As a team (including the model), measure the length of the body parts on the outline. Measure as many parts as you can. Mark these neatly on the outline. What patterns do you notice?

PART 2 Arm Span and Height

Your program leader has set up measuring stations to measure everyone's arm span and height. (*Arm span* is the length from the left fingertips to the right fingertips of your arms, when your arms are stretched out to the sides.) Record the measurements on the *Body Measurements* chart and look for patterns across everyone's measurements.

PART 3 Heads, Shoulders, Knees, and Toes

1. Help one another measure the length of each team member's head. Hold a book horizontally (and level) on the person's head. Measure straight down from the bottom of the front edge of the book (level with where the book touches the head) to the point of each person's chin (Figure 6). Record the information on the *Body Measurements* chart.
2. Have a partner make an outline of your head on a sheet of paper. One way to do this is to lie on the floor or stand against a wall and have your partner trace around your head onto a piece of paper. Check the accuracy of the drawing with the measurements you made. Do your best to end up with an outline that is the same size and shape as your head.

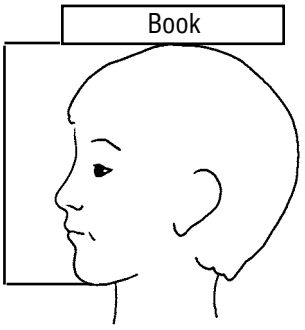


Figure 6
Make sure the book is level when measuring the height of someone's head.

3. Cut out the outline. Have your partner measure how far your eyes, nose, and mouth are from your chin, and draw these on the head cutout in the proper places (Figure 7). If your program leader gives you cardboard, paste your head cutout onto a piece of cardboard and cut the cardboard around the edge of the head.

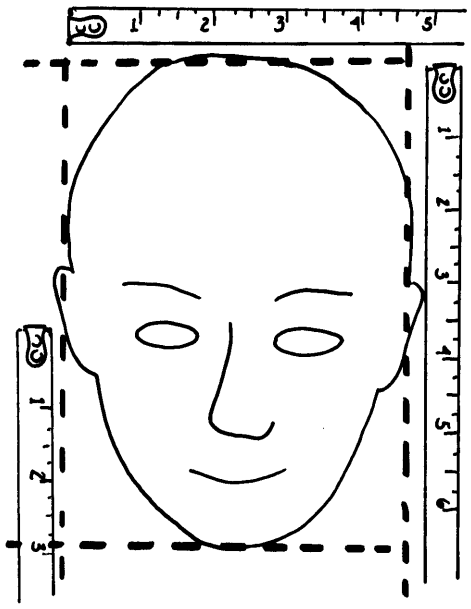


Figure 7
Draw an outline of your head using the measurements you took as a guide.

4. Using your cutout heads, you and a partner should help each other measure how many times the length of your head fits into various parts of your body. (Be sure to use the length from the top of your head to your chin, not the distance from ear to ear.) Fill in the *Body Measurements* chart with the answers.

WHAT TO THINK ABOUT

- What patterns can you see in the sizes, proportions, and shapes of the parts of your body?
- What differences can you see in the proportions and shapes of small children, grade-school kids, and grownups?
- Where is the middle of your body?

HOW MANY HEADS?

EXPLORATION 2

EXPLORERS' SHEET 2

BODY MEASUREMENTS

Your Names				
Arm Span (inches)				
Height (inches)				
Head Length (inches)				
Use your head outline to measure your body. How many heads make up each part of your body?				
Height (# of heads)				
Arm Span (# of heads)				
Hip to Toes (# of heads)				
Knee to Toes (# of heads)				
Wrist to Fingertips (# of heads)				
Elbow to Fingertips (# of heads)				

HOW MANY HEADS?
EXPLORATION 2

MATERIALS

For Each Team
- 2 flexible tape measures* (plastic or cloth, 48 inches long)
- 4 pieces of chart paper*
- 1 scissors
- clear tape (1/2 or 3/4 inch wide)
- markers (various colors)
- optional: cardboard for the head cutouts (12 x 12 sheets)
- 1 Explorers' Sheet, including the *Body Measurements* chart

**Additional information is available under Special Notes About Materials (page xiv) for those materials noted with an asterisk.*

***NOTE**: Some of the materials used in this exploration can be recycled for use in later explorations.*

PREPARING FOR THE EXPLORATION

- Tape four sheets of chart paper together in a T shape (5 feet tall and 5 feet wide at the top) (see Figure 4 on page 9). If possible, attach this arrangement to an open wall space, with the lower rim of the paper just touching the floor. Alternatively, you can lay it on the floor, with one edge just touching a wall.
- Set up one, two, or three stations around the room to measure height and arm span. At each station, fix one tape measure vertically to the wall (with the 0 touching the floor) and another tape horizontally (at a child's shoulder height). Ideally, the second tape should be set so the 0 end is in a corner or against a door frame. This allows children to more easily position the tips of their fingers exactly at the 0 on the tape.
- Make one copy of the Explorers' Sheet, including the *Body Measurements* chart, for each team.

INTRODUCING THE EXPLORATION

Show children the Body Proportions images in the appendix (page xx) and ask them to comment on the images. A good question to ask is, "What do you notice?"

Children should notice that some of the images do not look "right" or "normal": these images are not the right shape for real people. They may notice that some images look right for a particular age, while others do not look right at all. Ask them to be very specific in talking about the images—for instance, "the head on #1 is way too small," or "the legs are too long on #2." If they use the word *proportion*, ask them what they mean by this.[3] In real life, is everyone's head the same size? Or does it depend on the size of the

[3] The word *proportion* may not be familiar to all the children. This does not mean you should not use the word, but that when you (or they) do so, ask the children whether they can say what it means or know other words that have the same meaning. Do not feel you have to give a definition right up front. Really understanding the concept of proportion may take some children many projects like this or even many years. Try to keep talking about the idea and have children continually rephrase their idea of what the word means and why it matters.

person? Ask them how they know what the "right" proportions are for a person, and then ask them what the "right" proportions are. Are the proportions the same for men and women, and the same for babies, kids, and grownups?

Do not try to reach any conclusions about these questions at this time. Once the children begin measuring themselves, they will have more information on which to base their judgments.

***NOTE**: The images in the appendix deal only with the height (length) of different sections of the body (head, arms, legs, torso, etc.) None of the images addresses the issue of weight. That is a sensitive topic which you should address only if you are confident that you can make the conversation safe and constructive for all the children.*

When the initial conversation has run its course, tell the children that they will now measure their own bodies to see whether they can find out what the "normal" body proportions for humans are, and to see whether there are any differences between males and females or between older and younger people.

Form teams of two or three children and assign roles to team members (see page xii in the Overview). Have each team decide which team member will volunteer to have his or her outline drawn on chart paper, which team member will do the drawing, and so on. Distribute the Explorers' Sheet to each team. Have the materials manager from each team get the materials.

LEADING THE EXPLORATION

PART 1

The children can make accurate body outlines on the floor or against a wall. Make sure that walls are unobstructed by furniture, so that the children can stand with their backs right against the wall. Also suggest that they position the bottom edge of the paper exactly on the floor, so that the model's feet are right at the bottom edge of the paper. For the same reason, if the paper is laid out on the floor, it helps if the bottom edge touches a wall. The model can then press his or her feet against the wall to ensure that the soles are positioned at the edge of the paper.[4]

Remind each team to measure the model's fingertip height before he or she stands up or moves away from the paper. To do this, the model brings the arms to the sides, with fingertips pointing toward the feet. Someone else makes marks on the paper where the tips of the fingers on each hand reach. This is an easy way to measure how far off the ground the fingertips would be if the model were standing up straight.

4 Children tend to draw wide when outlining one another, because of clothing and because they are reluctant to touch and be touched by one another. This is fine, as long as the outline is accurate in its basic dimensions—height, head size, and arm span. Try especially to help them outline the head accurately, tracing the skull line rather than the hair.

While they do this, remind the teams to write as many dimensions on the outline as they can (Figure 8), in clear, bold writing. They should measure at least those items listed below:

Height	Top of head to heel of foot
Arm span	Fingertip to fingertip with arms outstretched
Head length	Top of head to chin, measured straight down
Arm length	Fingertip to ball of shoulder
Leg length	Hip bone to heel along the outside of the leg
Fingertips to floor	Arms alongside the body, fingers pointed

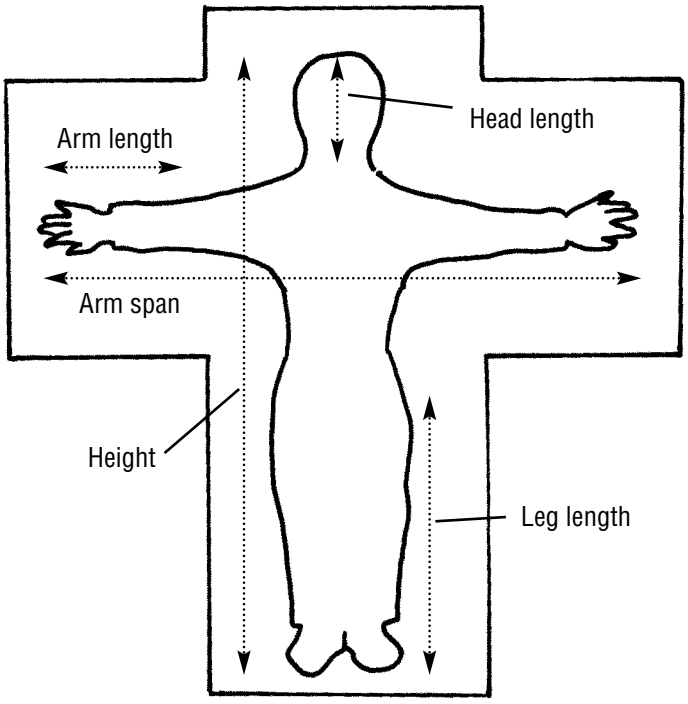


Figure 8
Body measurements.

PART 2

After each team has outlined its model, the other team members should take turns at the measuring stations you have set up. Each child should stand with his or her back against the wall, arms straight out to the sides, while his or her teammates read the measurements on the tape measure and write the results on the team's *Body Measurements* chart.[5]

5 If children use a book or other flat object on their heads to help with measurements, it is important that it be horizontal. It is also important that the person being measured stand up straight, looking straight ahead (that is, the chin should not be on the chest or pointed at the ceiling).

PART 3

Use the instructions on the Explorers' Sheet to explain to the children how they should help one another measure their head sizes. If you have cardboard, offer it as a backing material for their head cutouts. Remind the children that they are going to use the head cutouts to "measure" different parts of their bodies. Remind them also to record that information in the *Body Measurements* chart.[6]

6 To make a reasonably accurate count of how many heads fit into their height, each child should carefully "roll" his or her cutout head down one of the tape measures that are already set up at the measuring stations, as follows: Place the top of the head cutout against the number on the tape that corresponds to the child's height (51 inches, for instance.) Then, pivoting the head on its chin and crown alternately, roll the head (head over heels) down the tape measure until it reaches the floor, counting how many times it rolls from top to bottom. The most accurate way to do this is to make sure the head never breaks contact with the tape measure. The same procedure can be used to measure arm span in terms of heads—only this time the head is rolled horizontally across the wall.

LEADING THE DISCUSSION

It is better for these discussions to take place after each part of this exploration, rather than all at once, so that children are still interested in the results they just collected.

PART 1

After about 20 minutes (or after most of the teams have made an outline and completed at least some of the measurements), call the whole group together to compare results. Ask whether anyone has noticed any patterns. Ask, for instance, whether both arms and both legs are exactly the same length. Is any section of the body exactly the same size as another section, or twice or half the size?

PART 2

On chart paper, create a two-column chart. Title one column *Arm Span* and the other column *Height*. Have the children call out or fill in as many of their arm span and height measurements as possible. Then ask the children to look at the chart and tell you whether they notice anything interesting about the measurements.

What should stand out is that for many (if not most) of the measurements, a child's arm span should be the same as his or her height—if not exactly so, then within an inch or two. If this seems to be the case, ask the children what they think about that. Are they surprised? Do they think it would be true for most or all children? What about for adults?

HOW MANY HEADS?
EXPLORATION 2

If the arm span and height measurements for some children are not particularly close, ask the group what they think could explain this. Here are several possible explanations: (1) faulty measuring, (2) a child is going through a growth spurt (when different parts of the body grow at different times), or (3) some of us are just built differently from others. At some point in the discussion it is important that you emphasize that even though there *is* a general pattern of arm span being about the same as height, there is actually a great deal of variability within that pattern. Some people have shorter arms and some people have longer arms in relation to their height—it's just who they are.

PART 3

On chart paper or a whiteboard, make a list of all the children in the group. Have each one call out how many "heads" make up his or her height. Look at the list together and see whether there is a pattern. The pattern should be that older children take more heads to make up their height than younger children. This should be true even for tall youngsters and short older children, because body proportions gradually mature toward the adult ratios as we get older.

To see whether this is the case, rearrange the list of names in order of their ages by whole years (six year olds, sevens, eights, and so on.) Ask the children whether they see a pattern. If the pattern is not exact or obvious, ask the children whether they think there *should* be a pattern, and why.[7]

Talk to the children more about the relationship between head size and the rest of the body. Say something like: "If someone says that a person has a small head, what does that mean?" See whether they are able to talk about the sizes of their heads in relative terms rather than about their heads' absolute sizes. A child's head is usually smaller than the head of either of its parents—in absolute terms. But in relation to its body, the child's head is *larger* than its parents' heads.

What you are looking for is comments such as "His head was smaller than you would expect for someone of that height." This type of comment shows that the speaker has an idea of how big the head of a person that tall "should" be.

7 Most of us (children, too) know intuitively about the different body proportions (shapes) of people of different ages, even if we have never thought about it consciously. This activity, and the other activities in the exploration, encourage the children to identify the patterns that they have previously taken for granted. See "Normal Body Proportions" on page 19.

HOW MANY HEADS?

EXPLORATION 2

RATIONALE

Today's children are bombarded with messages that certain body shapes and sizes are more "beautiful" or "normal" than others. This can have profound effects on their self-image. It also clouds the fact that there is both a distinct pattern to the way human bodies are shaped *and also* a great deal of variability within all ethnic groups and within both sexes. Furthermore, it obscures the fact that body proportions change with age. Babies' heads are much larger relative to the rest of their bodies than are the heads of their parents, and it takes a child the whole period of childhood and adolescence to grow into an adult shape.

In this activity the children measure themselves and one another in order to identify this "normal" body shape. They discuss the wide range of what is "normal" for humans and talk about how to identify a pattern even though the results are seldom exact.

SCIENCE/TECHNOLOGY BACKGROUND

"Normal" Body Proportions

It is clear from the way children (and many adults) draw human figures that they have not noticed, consciously, that older children and adults have taller bodies in relation to their head size than babies and infants—it takes more of their heads to make their height.

It is often said that humans are born with "very large heads." A more accurate way of saying this is that they are born with "very small bodies in *relation to their heads*." For the first 20 or so years after birth (and particularly during the adolescent growth spurt), the torso and limbs grow at a faster rate than the head; it is not until late adolescence that adult proportions are reached.

Toddlers may be four or five of their own heads tall, while elementary and adolescent children may be anywhere between that ratio and the adult norm. Some very tall adults can be as much as eight or more heads tall, but the norm is somewhere between seven and eight.

Despite variations, the fact remains that there *is* a pattern to the human shape. Even if we have not thought about it consciously, most of us would easily recognize the "correct" shapes if we were shown silhouette images of adults or children side by side.

A handy list of adult body proportions includes:

- Adults are usually about seven or eight heads tall.
- Adult arm span is approximately the same as height.
- For adult males, the distance of the fingertips from the floor (when standing straight with arms relaxed by sides) is approximately 28 inches (regardless of the man's height).
- For adult females, the distance of the fingertips from the floor (when standing straight with arms relaxed by sides) is approximately 26 inches (regardless of woman's height).
- The torso is approximately two head-heights long.
- From the wrist to the end of the outstretched fingers is approximately one head-width.
- From the elbow to the end of the outstretched fingers is approximately two head-widths.
- From the hip to the heel is approximately four head-heights.
- From shoulder to shoulder is approximately three head-widths.

Observing Progress

Throughout "Measuring Ourselves," children will be building knowledge about the proportions of the human body. They should notice that although there is a pattern in these proportions, there is also a lot of variation from person to person. To identify these patterns, it is necessary that the children make accurate measurements of their own and one another's bodies. Therefore, you should keep an eye out for whether they understand how to measure, whether they keep accurate and clear records of the measurements they make, and how they interpret their own measurements when they compare them to other children's measurements.

Further Exploration

Height vs. Arm Span: Scatter Plot

A scatter plot is a very useful kind of graph for finding out whether there is a relationship between two things—in this case, arm span and height. The more X's you have on your scatter plot and the more of them that fall on or close to a line, the more confident you can be that there is a connection between arm span and height.

For this exploration you will need graphing chart paper and (optionally) one or more yardsticks.

Set up a sheet of graphing chart paper on a wall so that the children can plot their height and arm span data directly onto a graph. Label the vertical axis *Height (inches);* then mark this axis beginning at 36 inches and going up to 72 inches. Label the horizontal axis *Arm span (inches)*; mark that axis from 36 inches to 72 inches.

Here's how to enter data on this kind of graph:

1. Each child finds his or her height on the vertical axis and, with a finger (or a yardstick) runs a line across the graph paper at that level. If you like, they can very faintly draw a horizontal line across the whole graph running through their height number.
2. Then the same child finds his or her arm span on the horizontal axis and runs a finger (or a line) up the graph from the arm span number.
3. Where the two lines cross, the child marks an X.
4. When everyone has plotted his or her own X, ask the children to look at the graph. Can they see a pattern in the way the X's lie on the page? If there is a pattern, it probably will not be perfect, but if everyone has measured and plotted accurately, the X's should all lie quite close to a straight line that runs at about 45 degrees from the lower left corner to the upper right side of the graph (Figure 9). Draw this line.

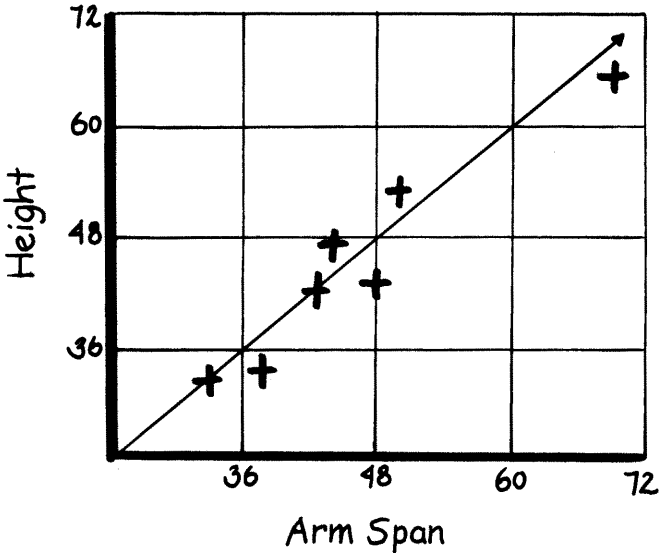


Figure 9
Scatter plot graph. Draw a straight line that goes as close as possible to most of the points.