The FUTURES Channel®

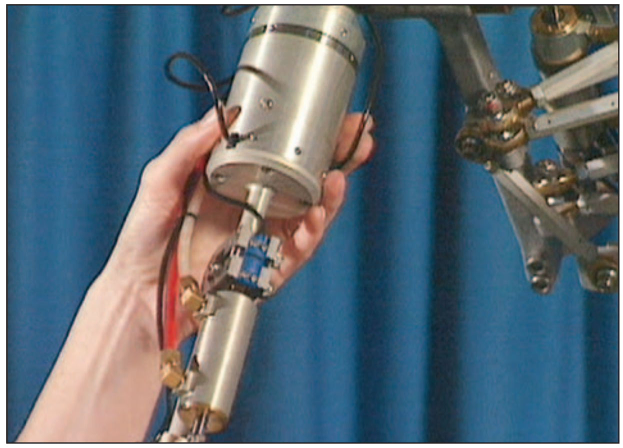
MOVIE GUIDE

MOVIE NUMBER 1005

An Engineer and Her Robot

The Movie:

To build an anthropomorphic (human-shaped) robot, an engineer has to know biology, electronics, computer programming, physics, math—and which music she wants to have it dance to. Featured: Anne Murray, robotics engineer, Johnson Space Center, NASA *(Movie length: 2:36)*



Background:

The word "robot" was coined by science fiction writer Karel Capek in 1921, to describe a machine which could move and think like a human being. No such machine has ever been invented, and the word has come to mean any machine with a high degree of flexibility of motion, whose movements can be pre-programmed to follow a complex pattern. In the most sophisticated robots, motion can be based on information gathered through sensing devices which have some similarities to the human senses of sight, sound, and touch.

The science of "robotics", which consists of knowledge of the design, building and testing of robots, is an extremely promising field for the 21st century. However, it is a highly technical one, since it involves a combination of metallurgy, motors and mechanics, electronics, computer programming and, for "anthropomorphic" (human-like) robots, human anatomy.

Curriculum Connections:

Fractions

1

The small electric motors that control the motions of the parts of a robot must be tested to make sure that they work properly before they are installed. At right are the results of testing 5 sets of motors. Compute the fraction of each set which failed. Then find the average of those fractions.

Which set has the lowest fraction of failures? Which the highest?

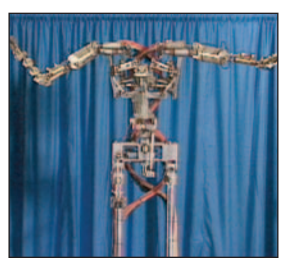
Set #	Tested	Failed
1	24	3
2	35	5
3	30	4
4	40	5
5	18	2

Counting Principle

2

Suppose a set of 5 switches can be used to put a robot arm into different positions. Each switch can be set to *1* or *2*. How many positions can the arm be in? (Hint: It is the number of possible combinations of switch positions.)

How many positions can the arm be in if each switch can be set to *1, 2,* or *3*?



Decimals

3

The moving parts of a robot must fit together nearly perfectly, so they must be very close to the size specified in the design.

Therefore the size of a part, such as a metal rod, is generally given as something like 15.655 inches, plus or minus .005 inches. The smallest the rod could be is 15.650 inches, and the longest is 15.660 inches.

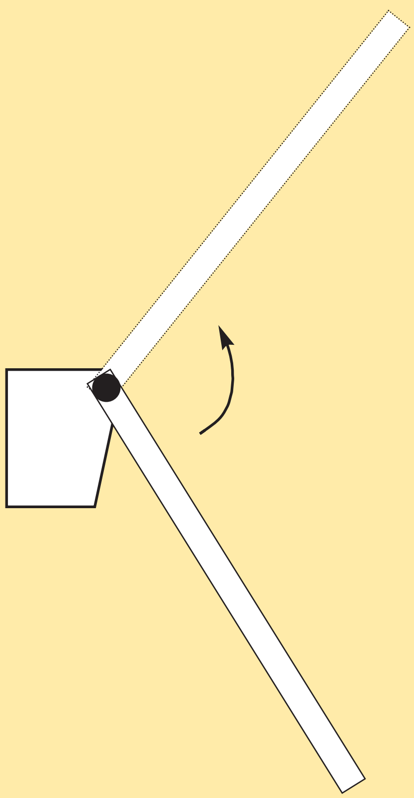
Determine whether each part in the table below has an acceptable size.

Design Length	Plus or Minus	Actual Length	O.K.?
4.734 in.	0.004 in.	4.741 in.	
10.812 in.	0.006 in.	10.808 in.	
32.56 in.	.02 in.	32.52 in.	
6.222 in.	.005 in.	6.226 in.	

Geometry (angles)

4

Use a protractor to find the measure of the angle through which this robot arm can move:

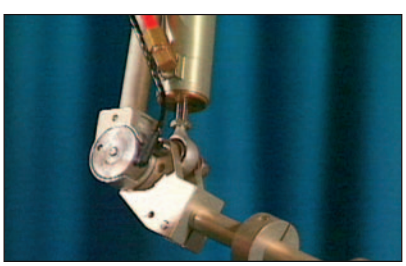


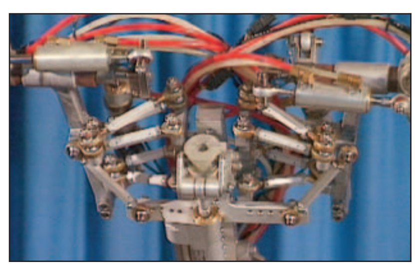
Statistics

5

The electric motors in a robot will operate for a long time before they break down, but not forever. The table below shows the length of time to failure for 10 test motors. (In each case, the duration has been rounded to the nearest thousand hours.) Find the mean, mode, median and range of these times.

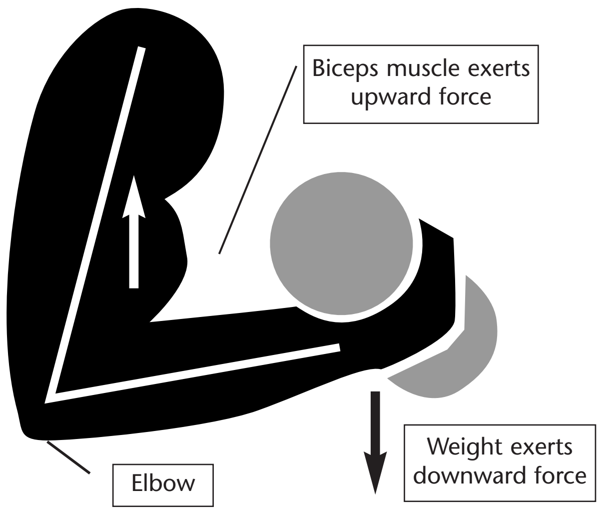
Motor #	Duration (thousands of hours)
1	85
2	77
3	86
4	83
5	95
6	85
7	88
8	61
9	79
10	80



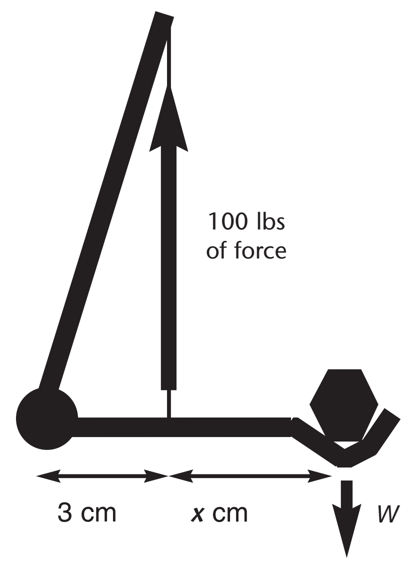


Investigation: Leverage

This diagram shows how the biceps muscle is used to lift a weight.

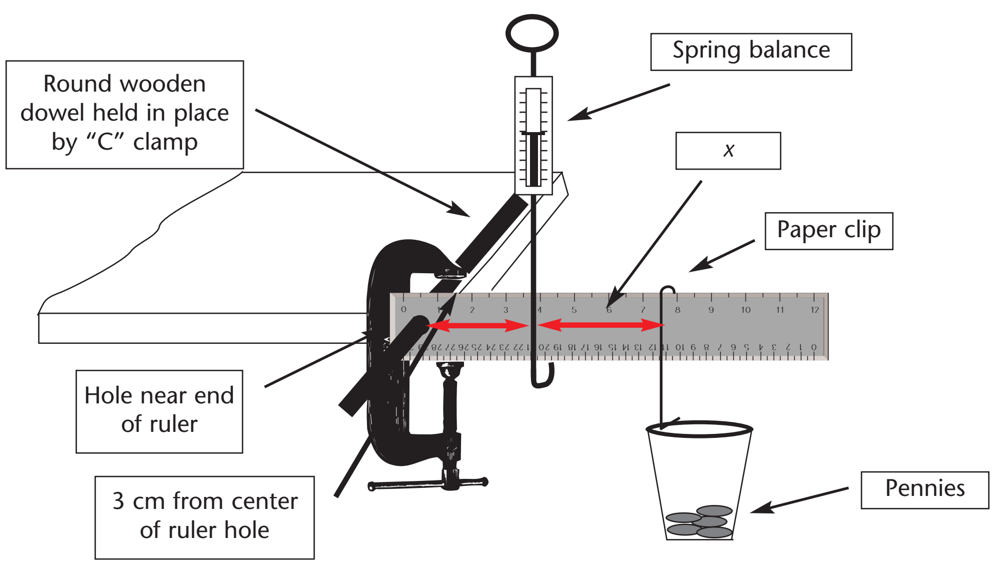


This diagram presents a model of the same situation.



In this investigation you will make a model of the arm and investigate the relationships among some of the variables in the above situation.

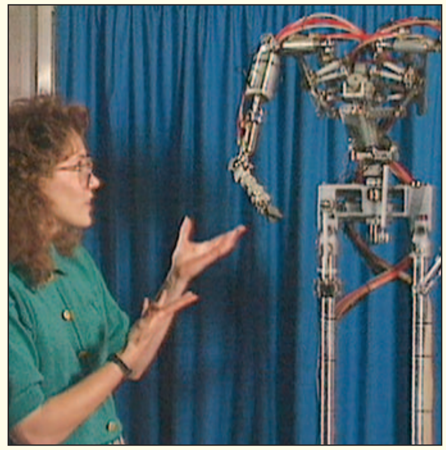
1. Configure your equipment as shown in the diagram on the next page.
2. Position the "weight" so that $x = 6$ centimeters.
3. Determine how many pennies you must add in order for the spring scale to read exactly halfway on its scale, with the ruler level.
4. Reposition the weight to a different value of x.
5. Again, determine how many pennies are needed for the spring scale to be at the same position as above (exactly halfway).
6. Repeat for several different values of x. Create a table to keep track of the data (value of "x" and "number of pennies" in each instance).
7. Graph the data, with "x" as the independent variable and "number of pennies" as the dependent variable.
8. Describe the characteristics of the graph. What happens to "number of pennies" as "x" increases?



Teaching Guidelines: Investigation: Leverage
Math Topics: Algebra (functions)

Materials

- One wooden or plastic ruler with a hole near one end
- A wooden dowel that just fits in the hole in the ruler
- One small C clamp
- One spring scale
- One heavy duty paper clip
- One binder clip
- A plastic cup (the type with a thickened rim)
- 200 pennies



Procedure:

This project should be done by students individually or in teams of two.

Distribute the handout and discuss it. Ensure that students understand the diagram. Review what they are being asked to do and ensure that they understand the assignment. Then have them begin.

Circulate as students work on the activity and assist as needed. Help them to determine just how they are going to investigate the questions asked, and help them work out how they are going to properly record their data.

Each student should prepare his or her own report on the procedure and results.

If you enjoyed this Futures Channel Movie, you will probably also like these:

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Testing the Robotic Hand, #1006	NASA engineer Larry Li has built a robot's hand that can catch a baseball—or recover an essential tool in the vacuum of space.
Searching for Water on Mars, #3001	If we can find water on Mars, then astronauts won't have to take it with them. But how do you find the water before you send a manned mission?