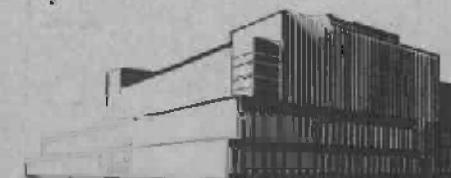


FOREST PRODUCTS LABORATORY'S TOUGHNESS TESTING MACHINE

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FOREST PRODUCTS LABORATORY
MADISON 5, WISCONSIN

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

In Cooperation with the University of Wisconsin

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THE FOREST PRODUCTS LABORATORY'S TOUGHNESS TESTING MACHINE¹,²

No two pieces of wood, even of the same species, are exactly alike. In studying the variability of wood it is observed that some pieces contain thick-walled cells and small cell spaces, others very thin-walled cells, large cell spaces and large pores or vessels, the amount of wood substance in a given volume occasionally varying as much as three to one in a single species. Since all wood substance has approximately the same density, the denser specimen will contain more wood substance than the lighter one. What is more logical, then, than to believe that the denser the piece (the more wood substance per unit volume) the higher will be its strength properties? Such, in general, is actually the case. Laws governing the relation of density to the different strength properties have been determined, and, in general, show that any increase in density is usually attended by more than a proportional increase in other properties.

But while density gives a good indication of the properties, it, nevertheless, has some important limitations. Thus the position in the tree for such species as hickory and ash is of great significance, the material from the butt of upland timber having very high tensile strength, and relatively low compressive strength for its weight, while higher in the tree the reverse is true. Other species, or these species when grown under different conditions, may not show this characteristic variation. There are many silvicultural conditions which probably influence somewhat the relation of density to strength. It is seldom, however, that all strength properties are influenced in the same way.

Toughness in wood, which is essential in many uses, is dependent on a combination of properties, or rather on the relation of tensile

¹The Civil Aeronautics Authority (Airworthiness Report 18, July 1940) approves the use of this machine as a means of determining the basic quality of wood to be used in aircraft construction.

²This report is one of a series of reports issued by the Forest Products Laboratory to aid the Nation's war program. Original report dated November 1941.

to compressive strength. When the tensile strength is abnormally high for a given density, it is quite common that the compressive strength will be somewhat low. On the other hand, when the tensile strength is abnormally low for its density, the compressive strength is not infrequently normal or above normal. It is significant, further, that relatively small changes in ratio of tensile to compressive strength have an important bearing on the failure in bending, and are accompanied by very large changes in toughness. In addition, incipient decay may have a very marked influence on toughness before its effect is indicated by density. Nor is density a criterion of other defects which have a pronounced effect upon the tensile strength. Thus it is seen that density cannot be depended upon to give a reliable criterion of toughness. When this property is of importance, therefore, some dependable means of determining it is essential. Such a means is provided by the toughness machine developed at the Forest Products Laboratory which offers a relatively simple method of obtaining the relation of compression to tensile strength, as will later be explained.

In brief, the inspection method which the Forest Products Laboratory now recommends for stock intended for exacting uses, particularly aircraft, provides for the testing of one or more specimens (preferably not less than four) from each piece under consideration. To be acceptable, the piece (1) must either meet a minimum toughness requirement established for the species in question, or if within a certain tolerance below the minimum must pass in addition the present specific gravity limitation; (2) must show a limited range in toughness values for all specimens from the same piece; and (3) must pass careful visual inspection. The object of limiting the range in toughness values for specimens from any one piece of stock is to guard against pieces which contain compression failures. Careful visual inspection is necessary to eliminate compression wood as well as diagonal and spiral grain, etc.

It should not be inferred that the Forest Products Laboratory Toughness Machine is recommended as a panacea for all inspection or selection difficulties. Its use is not practical or necessary in cases involving wood inspection where strength is not a prime requisite. In certain special instances, however, where safety, uninterrupted factory operations, or the like, are dependent on one or a few wooden pieces, the toughness machine should prove of great value. As a means of obtaining suitable airplane material its merit has been demonstrated by tests on continuous beams and also by the comparison of static strength values for structural members studied.

The toughness tests may be made on samples from the rough stock. If at this early stage a piece is found unsuitable for the purpose intended, the material has not only been kept practically intact to divert to other uses, but the time and effort involved in unnecessary machining and fabrication has been saved. Again, in many cases large quantities of high-grade lumber have been rejected for strength used because of stains which develop after purchase. Such stock, even though purchased at a premium, can usually be disposed of only at a sacrifice. If the toughness test were employed for selection, and treatment given to prevent further infection, much of this stock would no doubt be found satisfactory. These are but examples of possible economies which await the use of the toughness machine.

How the Toughness Tester Works

The toughness machine operates on the pendulum principle, but it differs radically from other types in that the load is applied to the specimen by means of a cable fastened around a drum mounted on the axis of the pendulum, as shown in the drawing, rather than by direct impact of pendulum and specimen. If the pendulum is raised to some initial position and allowed to swing freely, it will reach a like height on the opposite side except for a small loss due to friction. When a specimen is in the machine, the pendulum fails to swing to a like height on the opposite side by an amount representing the energy consumed in breaking the piece. Hence, in determining toughness it is only necessary to read the initial and the final angle of swing; after which, by reference to a table for the given weight position the toughness of the standard-sized specimen can be read directly.

Because of its relatively simple operation, technically-trained observers are unnecessary for the successful use of the machine.

Description of Machine

The toughness machine consists essentially of a frame supporting a pendulum, the whole being so arranged that a measured amount of the energy from the fall of the pendulum may be applied to a test specimen. The pendulum consists of a bar to which is bolted a weight adjustable to different positions, and carries at the upper end a drum or pulley whose center provides the axis of rotation. The toughness specimen

is tested as a beam with two vertical pins, adjustable as to span, acting as supports. The force is applied to the center of the specimen (in the standard test) by means of a flexible steel cable passing over the drum. A stationary graduated scale or dial and a vernier operated by the moving drum are provided for reading the angles through which the pendulum swings. The toughness values for specimens tested may be obtained directly from a table which can be readily prepared.

Adjustment and Use

The shaft on which the pendulum rotates must be level and concentric with the dial (g) (See Figure I), and the pendulum must swing in a vertical plane parallel to the longitudinal axis of the machine. The plane of the dial must be parallel to the plane in which the pendulum swings. These are fundamental adjustments which should be made at the time of manufacture, and should usually require no attention unless the machine has been disassembled or damaged. The dial is so constructed that it may be rotated slightly about its axis to allow adjustment for the zero of the vernier (h), should this be necessary.

The machine is so designed that the pendulum may be raised to any one of three initial angles, 30° , 45° , or 60° with the vertical and the weight adjusted to five different positions. The pendulum release trip operated by the foot lever can be inspected by removing the cover plate (r) on the trip housing. With the cover plates off, the trip can be readily removed and replaced so as to afford release from any one of the three initial angles desired. The various springs connected with the trip should be adjusted to afford easy operation.

There are two interrelated principal adjustments which must be made preparatory to testing, and which must be checked at intervals during testing work, namely, (1) the zero adjustment of dial, and (2) friction compensating adjustment. The procedure is as follows:

Zero adjustment of dial. Set the pendulum in motion with a small amplitude and let it swing until it comes to rest, the object being to insure its stopping in a truly vertical position. Adjust the zero of the vernier by means of the thumb-screw (j) to correspond to the zero on the dial.

Friction compensating adjustment. A practical method of correcting for friction is to increase the initial angle sufficiently so that

the final angle of free swing shall have exactly the nominal value. This is done by raising one end of the machine by means of the adjusting screws (a) which are provided for the purpose. To make the adjustment, operate the machine without a specimen, taking care that the stirrup is in its proper seat and the vernier adjusted to zero and in contact with the thumbscrew. If the pendulum, on being released by the trip and allowed to swing free, gives a final angle of exactly 30°, 45°, or 60°, as the case may be, the machine is in adjustment. If, on the other hand, the dial reading after operation is less than 30°, 45°, or 60°, as the case may be, the end of the machine must be raised by means of the adjusting screws provided, care being taken to keep the machine level laterally by advancing both screws the same amount. If the dial reading is more than 30°, 45°, or 60°, the end of the machine must be lowered.

After raising or lowering the end of the machine, the zero of the vernier should again be set to correspond to that of the dial. The machine should be operated as before without a specimen, and if the final angle does not read exactly 30°, 45°, or 60° as desired, the manipulations should be continued until the pendulum when released gives the desired final angle, and, on coming to rest in the vertical position, a zero dial reading. The initial angle will then exceed the nominal 30°, 45°, or 60° by a small reading which represents the friction compensation.

The cable is slack when the pendulum is in the initial position. Its amount of free play is adjusted by moving the specimen support plate (u), by means of the wheel (t), so that the pendulum applies the force when it swings to within about 15° of the vertical, the object being to produce complete failure by the time the downward swing is completed. With very tough material earlier contact should be provided.

Use of Toughness Machine

Size of Specimen

It is preferable, wherever possible, to use the standard test specimen, which is 5/8 by 5/8 by 10 inches tested over an 8-inch span, since no simple law has as yet been arrived at by which the data may be reduced to an absolute basis independent of variations in span and depth of specimen. A special table is provided, by means of which toughness, represented by the total work in inch-pounds expended by the pendulum in breaking the piece, can be read directly without computation. When the machine is used for acceptance tests, it is at least essential that the specimen be accurately cut to the same size as that upon which the minimum acceptance values have been established. The load should be applied to the tangential face grain side of the specimen.

In special cases, when it is necessary to depart from the standard size, the width only should be varied and this not to exceed about one-third the standard if comparison is to be made with standard pieces on a strictly proportional basis. Specimens of less than standard width should be tested with the full standard dimension (depth) in the direction of the pull.

Operation.

In the operation of the machine the position of the weight and initial angle of pendulum must be such that complete failure is obtained with a single drop. On the other hand, the pendulum should not swing too far after failure of the specimen. For the most satisfactory results there should preferably be a difference in initial and final angle of at least 10° for the average specimen.

Weight Positions.

In general, not more than five weight positions will be found on the standard machine. These will be sufficient to meet the ordinary requirements of use, although other machine capacities may be obtained by means of supplementary pendulum weights.

The weight positions provided are numbered from the lower end of the pendulum, the number of each position being stamped on the bar so as to appear immediately above the weight when bolted in place.

METHOD OF LOCATING POSITION OF HOLES
FOR ATTACHING SLIDING WEIGHT

A theoretical method of calculating the distance of the weight from the axis for the several machine capacities, when given the weight and measurement of the several parts; and a means of calculating the effect of the metal removed in boring the several holes is herein presented.

Calculations by this method show that the effect of the removal of the metal for the holes causes a maximum error of only about 0.2 percent. The effect of boring the holes can, therefore, be ignored.

The simplest method of locating the hole positions is therefore as follows:

1. Remove the cable from the drum, but replace the cable clips.
2. Measure the distance from the center of axis of rotation to the center of the pin at the end of the pendulum.

3. Support the pendulum (with the sliding weight) horizontally, letting the shaft at the axis of rotation serve as one fulcrum. Support the other end of the center of the end pin on a sensitive platform scale. The weight is then slid on the pendulum bar until the scale indicates the required reaction, as calculated from the desired machine constants and the length of moment arm as determined under 2 above. The position of the weight is then spotted on the bar with a special pointed center pin.

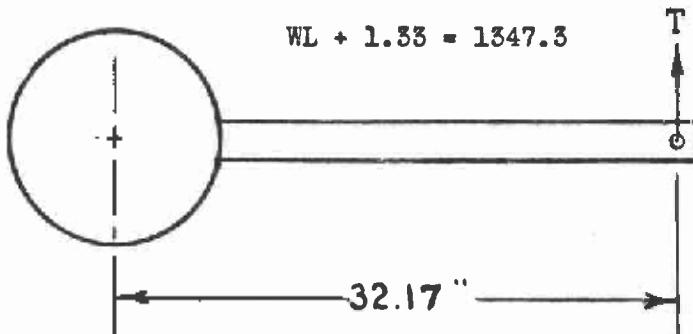
Empirical Method

Calculation of required reaction on scale, when sliding weight is in proper position to provide specified machine constants.

Extra moment due to unbored pendulum 1.53 inch-pounds.

Position 1.

$$WL = 1346 \text{ inch-pounds}$$



$$T_1 = \frac{1347.3}{32.17} = 41.88 \text{ pounds}$$

Position 2.

$$WL = 1222$$

$$T_2 = \frac{1223.3}{32.17} = 38.03 \text{ pounds}$$

Position 3.

$$WL = 1055$$

$$T_3 = \frac{1056.3}{32.17} = 32.83 \text{ pounds}$$

Position 4.

$$WL = 885$$

$$T_4 = \frac{886.3}{32.17} = 27.55 \text{ pounds}$$

Position 5.

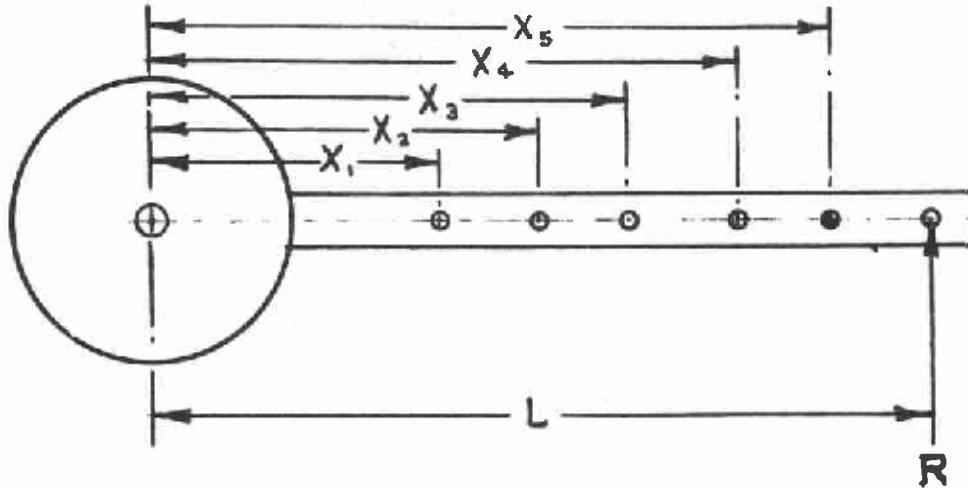
WL = 716

$$T_5 = \frac{717.3}{32.17} = 22.50 \text{ pounds}$$

The establishment of the specified machine constants by this empirical method then consists in sliding the weight on the pendulum bar until the scale indicates the required reaction, as computed above. The position of the weight is then spotted on the bar with a spiral pointed center pin.

A sample calculation follows. If desired the positions can be checked by measurements calculated from the theoretical method herein presented.

Determination of Positions of Sliding Weight
F. P. L. Toughness Machine



Calculation Method

1. Measure reaction R and distance L before boring holes in rod. Then $RL = \text{moment of rod and fixed attachments.}$

2. Let

$M_1, M_2, \text{ etc.} = \text{specified moment with sliding weight at } X_1,$
 $X_2, \text{ etc. (See page 11 for values of machine}$
 $\text{constants for different weight positions.)}$

W = weight of sliding weight.

Find $X_2 - X_1$ from the relation

$$W(X_2 - X_1) = M_2 - M_1$$

Find $X_3 - X_1$, $X_4 - X_1$, and $X_5 - X_1$, similarly.

Distances between holes are now known and all that remains is to find X_1 .

3. Let w = Weight of metal to be bored from one hole.

Then

$$WX_1 + RL - w(X_1 + X_2 + X_3 + X_4 + X_5) =$$

$$WX_1 + RL - w[5X_1 + (X_2 - X_1) + (X_3 - X_1) + (X_4 - X_1) + (X_5 - X_1)] = M_1$$

Whence X_1 is readily found.

Example:

Weight of sliding weight = 53.00 pounds

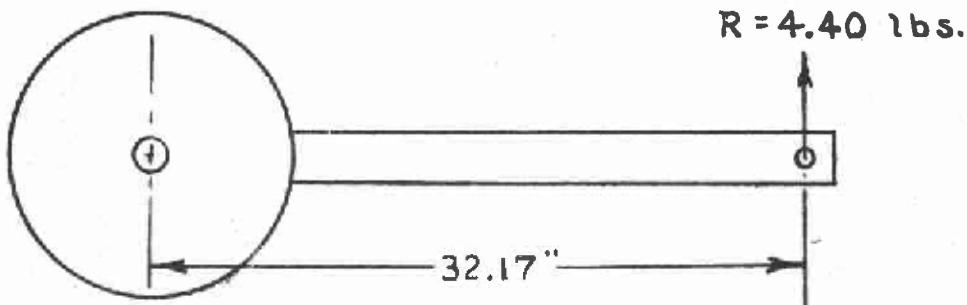
Weight of pin for sliding weight = 0.20 pounds

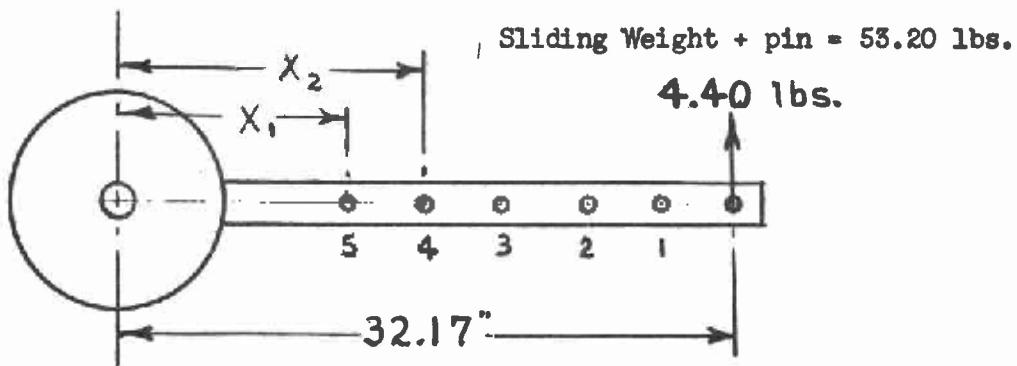
Weight of sliding weight and pin = 53.20 pounds

Weight of Pendulum including drum and cable clips, and end pin = 32.64 pounds.

Distance from center of rotation to center of end pin (L) = 32.17 inches.

Weight of reaction of pendulum horizontal, supported at other end by shaft, R = 4.40 pounds. (Sliding weight not included.)





$$M = 32.17 \times 4.40 = 141.55 \text{ inch-pounds.}$$

Machine Constants

Position	0	1	2	3	4	5
Capacity (Inch-Pounds)	1432	1346	1222	1055	885	716

$$X_2 - X_1 = \frac{885 - 716}{53.20} = \frac{169}{53.20} = 3.177$$

$$X_3 - X_1 = \frac{1055 - 716}{53.20} = \frac{339}{53.20} = 6.372$$

$$X_4 - X_1 = \frac{1222 - 716}{53.20} = \frac{506}{53.20} = 9.511$$

$$X_5 - X_1 = \frac{1346 - 716}{53.20} = \frac{630}{53.20} = 11.842$$

Metal bored from each hole (3/8 inch diameter hole in bar 1/2 inch thick) = .0157 pound.

$$716 = 53.20 X_1 + (32.17 \times 4.40) - .0157 (5X_1 + (X_2 - X_1) + (X_3 - X_1) + (X_4 - X_1) + (X_5 - X_1))$$

$$53.20 X_1 - .0785 X_1 = 716 - 141.55 + 0.49$$

$$53.12 X_1 = 574.94 \quad 5X_1 = 5 (10.82) = 54.10$$

$$X_1 = 10.82 \text{ inches} \quad .0157 \times 85.00 = 1.33$$

Computation of Results

Values have been tabulated from the solution of the following formula:

$$\text{Toughness (Work per specimen, inch-pounds)} = wl (\cos A_2 - \cos A_1)$$

where

w = weight of the pendulum in pounds

l = distance from the center of the supporting axis to the center of gravity of the pendulum

A_1 = initial angle (Since friction is compensated for in the machine adjustment, the initial angle may be regarded as exactly 30° , 45° , or 60° , as the case may be.)

A_2 = final angle the pendulum makes with the vertical after failure of the test specimen.

The product "wl" is a machine constant which has been adopted as standard for Forest Products Laboratory toughness machines, and is a part of the inherent design. The poise used has a weight of about 75 pounds. The values of wl for various positions of the weight are as follows:

<u>Position of the weight</u>	<u>Value of wl inch-pounds</u>
0	1,432
1	1,346
2	1,222
3	1,055
4	885
5	716

Description of Table

The table which has been prepared for convenience in obtaining toughness values from the final angle at failure is divided into three sections--the first for an initial angle of 60° , the second for 45° , and the third for 30° . In each section the work values are calculated for the different weight positions. Toughness values for position No. 0 may be obtained by multiplying the corresponding values for position No. 5 by 2. The table can be extended as necessity requires.

By means of the vernier provided, the angle may be read to minutes, while the table gives toughness values for tenths of a degree only. With standard specimens, therefore, the vernier need ordinarily be read only to the nearest tenth of a degree.

Example:

The following data were obtained on a 5/8-by 5/8-by 10-inch Sitka spruce specimen tested on an 8-inch span:

Weight in position No. 4
Initial angle, 45° (nominal)
Final angle, 29°05'

To find the toughness, turn to the table headed "Initial angle 45° plus friction". Read down the first column, headed "Final angle", until 29.1° (the nearest equivalent to 29°05') is reached. Opposite this value, and in the column headed "Position of weight No. 4", the figures 147.5 appear. The work required to break the specimen, and hence its toughness value, is therefore 147.5 inch-pounds.

Spruce specimens of standard size tested in accordance with the preceding instructions (load applied to the tangential face) are considered to represent spruce acceptable for use in aircraft construction if they have an average toughness value of at least 90 inch-pounds per specimen (75 inch-pounds if the specific gravity based on weight and volume of oven-dry wood is not less than 0.36). These acceptance values are to be applied to the average of four or more specimens and the range in individual test values should not exceed 1 to 2-1/2 under the acceptable among four specimens. Care should be taken to obtain enough specimens from each piece of material to be used so as to get a representative test of the member. In no case should less than two specimens from each end of a member spaced as widely apart as possible be considered as giving a fair value of the toughness of the member.

Minimum acceptance requirements for a number of species including spruce are given in the following tabulation:

Minimum acceptance requirements for aircraft woods based on tests¹
in the Forest Products Laboratory toughness machine

Species of wood	Size of specimen	Span	Minimum average acceptable toughness
			: Without specific gravity limitation
			: With specific gravity limitation
			: minimum specific gravity
			: minimum average specific gravity
			: minimum average toughness
			: minimum average toughness
	<u>Inches</u>	<u>Inches</u>	<u>Inch-pounds</u> <u>per specimen</u>
			<u>Inch-pounds</u> <u>per specimen</u>
White ash....	: 5/8 x 5/8 x 10	: 8	: 0.56 : 150 : 175
Yellow birch.	: 3/4 x 3/4 x 12	: 10	: .58 : 225 : 260
Douglas-fir..	: 5/8 x 5/8 x 10	: 8	: .45 : 95 : 115
White oak....	: 3/4 x 3/4 x 12	: 10	: .62 : 175 : 200
Sitka spruce.	: 5/8 x 5/8 x 10	: 8	: .36 : 75 : 90
Black walnut.	: 3/4 x 3/4 x 12	: 10	: .52 : 150 : 175

¹The load is to be applied to the tangential face of the specimen.

²Based on weight and volume of oven-dry wood.

³These values are to be applied to the average of 4 or more test specimens, and the range in individual test values used in arriving at the average should not exceed 1 to 2-1/2 among 4 specimens.

A number of testing machine manufacturers are prepared to furnish the Forest Products Laboratory toughness testing machine on order or complete blueprints necessary for the construction of this machine will upon request be released to any Madison, Wis., reproduction firm by the Laboratory.

INITIAL ANGLE 60° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
Degrees	w1= 1346	w1= 1222	w1= 1055	w1= 885	w1= 716
	Inch - pounds				
.1	675.1	611.0	527.5	442.4	358.1
.2	675.1	611.0	527.5	442.4	358.1
.3	675.1	611.0	527.5	442.4	358.1
.4	675.1	611.0	527.5	442.4	358.1
.5	675.1	611.0	527.5	442.4	358.1
.6	673.0	610.8	527.4	442.3	358.0
.7	675.0	610.8	527.4	442.3	358.0
.8	673.0	610.8	527.4	442.3	358.0
.9	673.0	610.8	527.4	442.3	358.0
1.0	672.8	610.7	527.3	442.2	358.0
1.1	672.8	610.7	527.3	442.2	358.0
.2	672.8	610.7	527.3	442.2	358.0
.3	672.7	610.6	527.2	442.1	357.9
.4	672.7	610.6	527.2	442.1	357.9
.5	672.7	610.6	527.2	442.1	357.9
.6	672.5	610.5	527.0	442.0	357.8
.7	672.5	610.5	527.0	442.0	357.8
.8	672.4	610.3	526.9	442.0	357.8
.9	672.4	610.3	526.9	442.0	357.8
2.0	672.3	610.2	526.8	441.9	357.7
2.1	672.1	610.1	526.7	441.8	357.6
.2	672.1	610.1	526.7	441.8	357.6
.3	672.0	610.0	526.6	441.7	357.5
.4	671.9	609.9	526.5	441.6	357.5
.5	671.7	609.7	526.4	441.5	357.4
.6	671.7	609.7	526.4	441.5	357.4
.7	671.6	609.6	526.3	441.4	357.3
.8	671.5	609.5	526.2	441.3	357.2
.9	671.3	609.4	526.1	441.2	357.2
3.0	671.2	609.2	526.0	441.2	357.1
3.1	671.1	609.1	525.9	441.1	357.0
.2	670.9	609.0	525.8	441.0	357.0
.3	670.8	608.9	525.7	440.9	356.9
.4	670.7	608.8	525.6	440.8	356.8
.5	670.5	608.6	525.5	440.7	356.7
.6	670.4	608.5	525.4	440.6	356.7
.7	670.3	608.4	525.3	440.5	356.6
.8	670.1	608.3	525.1	440.4	356.5
.9	670.0	608.2	525.0	440.4	356.5
4.0	669.9	608.0	524.9	440.3	356.4
4.1	669.6	607.8	524.7	440.1	356.2
.2	669.5	607.7	524.6	440.0	356.2
.3	669.3	607.5	524.5	440.0	356.1
.4	669.2	607.4	524.4	439.8	356.0
.5	669.0	607.2	524.2	439.6	355.9
.6	668.8	607.1	524.1	439.6	355.8
.7	668.5	606.8	523.9	439.4	355.7
.8	668.4	606.7	523.8	439.3	355.6
.9	668.1	606.4	523.6	439.1	355.5
5.0	668.0	606.3	523.5	439.0	355.4

INITIAL ANGLE 60° PLUS FRICTION

Final Angle	Position of Weight				
	1	2	3	4	5
w1= 1546	w1= 1222	w1= 1055	w1= 885	w1= 716	
Degrees	Inch - pounds				
.1	667.7	606.1	523.2	438.9	355.2
.2	667.6	606.0	523.1	438.8	355.2
.3	667.3	605.7	522.9	438.6	355.0
.4	667.2	605.6	522.8	438.5	355.0
.5	666.9	605.3	522.6	438.3	354.8
.6	666.6	605.1	522.4	438.1	354.7
.7	666.5	605.0	522.3	438.1	354.6
.8	666.2	604.7	522.1	437.9	354.5
.9	666.0	604.5	521.9	437.7	354.5
1.0	665.7	604.2	521.7	437.5	354.2
1.1	665.4	604.0	521.5	437.3	354.0
.2	665.3	603.9	521.3	437.3	354.0
.3	665.0	603.6	521.1	437.1	353.8
.4	664.7	603.4	520.9	436.9	353.7
.5	664.5	603.1	520.7	436.7	353.5
.6	664.2	602.9	520.5	436.6	353.4
.7	663.9	602.7	520.3	436.4	353.2
.8	663.7	602.4	520.1	436.2	353.1
.9	663.4	602.2	519.9	436.0	353.0
2.0	663.0	601.8	519.6	435.8	352.7
2.1	662.7	601.6	519.3	435.6	352.6
.2	662.5	601.3	519.1	435.4	352.5
.3	662.2	601.1	518.9	435.2	352.3
.4	661.9	600.8	518.7	435.0	352.2
.5	661.5	600.5	518.4	434.8	351.9
.6	661.2	600.2	518.2	434.6	351.8
.7	661.0	600.0	518.0	434.4	351.7
.8	660.6	599.6	517.7	434.2	351.4
.9	660.3	599.4	517.4	434.0	351.3
3.0	660.0	599.1	517.2	433.8	351.2
3.1	659.5	598.7	516.9	433.5	350.9
.2	659.4	598.5	516.7	433.4	350.8
.3	659.0	598.1	516.4	433.1	350.6
.4	658.7	597.9	516.2	432.9	350.4
.5	658.3	597.5	515.9	432.7	350.2
.6	658.0	597.3	515.7	432.5	350.1
.7	657.6	596.9	515.3	432.2	349.9
.8	657.2	596.5	515.0	432.0	349.7
.9	656.9	596.3	514.8	431.8	349.5
4.0	656.5	595.9	514.5	431.5	349.3
4.1	656.1	595.6	514.2	431.2	349.1
.2	655.7	595.2	513.9	431.0	348.9
.3	655.5	595.0	513.6	430.8	348.7
.4	655.0	594.8	513.5	430.5	348.5
.5	654.6	594.2	513.0	430.3	348.3
.6	654.2	593.9	512.7	430.0	348.1
.7	653.8	593.5	512.4	429.7	347.9
.8	653.4	593.1	512.1	429.5	347.7
.9	653.0	592.8	511.7	429.2	347.4
5.0	652.6	592.4	511.4	428.9	347.2

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INITIAL ANGLE 60° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
	wl= 1548	wl= 1222	wl= 1055	wl= 885	wl= 716
Degrees					
	Inch - pounds				
10.1	652.2	592.0	511.1	428.7	347.0
.2	651.8	591.7	510.8	428.4	346.8
.3	651.4	591.3	510.5	428.1	346.6
.4	651.0	590.9	510.2	427.9	346.4
.5	650.6	590.6	509.9	427.6	346.1
.6	650.1	590.1	509.4	427.5	345.9
.7	649.7	589.7	509.1	427.0	345.6
.8	649.5	589.5	508.8	426.7	345.4
.9	648.9	589.0	508.5	426.5	345.2
11.0	648.5	588.5	508.1	426.1	344.9
11.1	647.9	588.1	507.7	425.8	344.7
.2	647.5	587.7	507.4	425.6	344.5
.3	647.0	587.5	507.0	425.2	344.2
.4	646.6	586.9	506.7	425.0	344.0
.5	646.0	586.4	506.3	424.6	343.7
.6	645.6	586.0	505.9	424.3	343.5
.7	645.1	585.5	505.5	424.0	343.2
.8	644.7	585.2	505.2	423.7	343.0
.9	644.1	584.7	504.8	423.4	342.7
12.0	643.6	584.2	504.4	423.0	342.4
12.1	643.2	583.8	504.0	422.8	342.2
.2	642.7	583.5	503.6	422.4	341.9
.3	642.1	582.9	503.2	422.0	341.6
.4	641.7	582.5	502.9	421.8	341.4
.5	641.2	582.0	502.5	421.4	341.1
.6	640.6	581.5	502.0	421.1	340.8
.7	640.1	581.0	501.6	420.7	340.6
.8	639.6	580.5	501.2	420.4	340.3
.9	639.2	580.2	500.9	420.1	340.1
13.0	638.6	579.7	500.5	419.7	339.8
13.1	638.1	579.2	500.0	419.4	339.5
.2	637.5	578.7	499.6	419.0	339.2
.3	637.0	578.2	499.2	418.7	338.9
.4	636.5	577.8	498.8	418.3	338.6
.5	635.9	577.2	498.4	418.0	338.3
.6	635.4	576.7	497.9	417.6	338.1
.7	634.7	576.1	497.4	417.2	337.7
.8	634.2	575.6	497.0	416.8	337.4
.9	633.6	575.2	496.6	416.5	337.1
14.0	633.1	574.7	496.1	416.1	336.8
14.1	632.6	574.2	495.7	415.8	336.6
.2	631.9	573.6	495.2	415.5	336.2
.3	631.4	573.1	494.8	415.0	335.9
.4	630.8	572.6	494.5	414.6	335.6
.5	630.1	572.0	493.8	414.2	335.3
.6	629.6	571.5	493.4	413.8	335.0
.7	629.1	571.0	493.0	413.5	334.7
.8	628.4	570.4	492.4	413.0	334.3
.9	627.9	569.9	492.0	412.7	334.0
15.0	627.2	569.5	491.5	412.2	333.7

INITIAL ANGLE 60° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
	wl= 1548	wl= 1222	wl= 1055	wl= 885	wl= 716
Degrees					
	Inch - pounds				
15.1	626.6	568.8	491.1	411.9	335.4
.2	626.0	568.2	490.5	411.4	335.0
.3	625.4	567.7	490.1	411.1	332.8
.4	624.8	567.1	489.6	410.6	332.4
.5	624.1	566.5	489.1	410.2	332.0
.6	623.5	566.0	488.6	409.8	331.8
.7	622.9	565.4	488.1	409.4	331.4
.8	622.2	564.8	487.6	408.9	331.0
.9	621.5	564.2	487.1	408.5	330.7
16.0	621.0	563.7	486.6	408.2	330.4
16.1	620.3	563.1	486.1	407.7	330.0
.2	619.6	562.4	485.6	407.3	329.7
.3	619.0	561.8	485.1	406.8	329.5
.4	618.3	561.2	484.5	406.4	329.0
.5	617.6	560.6	484.0	405.9	328.6
.6	617.0	560.0	483.5	405.5	328.2
.7	616.3	559.4	482.9	405.1	327.9
.8	615.6	558.8	482.4	404.6	327.5
.9	614.9	558.2	481.9	404.2	327.2
17.0	614.3	557.6	481.4	403.7	326.8
17.1	613.6	557.0	480.8	403.5	326.5
.2	612.9	556.3	480.3	402.8	326.1
.3	612.2	555.7	479.8	402.4	325.7
.4	611.4	555.0	479.2	401.9	325.3
.5	610.8	554.4	478.6	401.4	324.9
.6	610.1	553.8	478.1	401.0	324.6
.7	609.4	553.2	477.6	400.5	324.2
.8	608.6	552.4	476.9	400.0	323.8
.9	607.9	551.8	476.4	399.6	323.4
18.0	607.3	551.2	475.9	399.1	323.1
18.1	606.5	550.5	475.2	398.6	322.7
.2	605.8	549.9	474.7	398.2	322.5
.3	605.0	549.1	474.1	397.6	321.9
.4	604.3	548.5	473.6	397.2	321.5
.5	603.5	547.8	472.9	396.6	321.1
.6	602.8	547.2	474.4	396.2	320.7
.7	602.0	546.4	471.8	395.7	320.3
.8	601.2	545.7	471.1	395.1	319.9
.9	600.5	545.1	470.6	394.7	319.5
19.0	599.7	544.4	470.0	394.2	319.1
19.1	598.9	543.6	469.3	393.6	318.6
.2	598.2	543.0	468.8	393.2	318.5
.3	597.4	542.3	468.2	392.7	317.9
.4	596.8	541.6	467.5	392.1	317.4
.5	595.8	540.8	466.9	391.6	317.0
.6	595.1	540.2	466.4	391.2	316.6
.7	594.5	539.5	465.8	390.6	316.2
.8	593.5	538.7	465.1	390.1	315.8
.9	592.7	538.0	464.5	389.6	315.4
20.0	591.9	537.3	463.9	389.0	314.9

INITIAL ANGLE 60° PLUS FRICTION

Final angle	Position of Weight				
	1 wl = 1546	2	3	4 wl = 885	5 wl = 716
Degrees Inch - pounds					
20.1	591.1	556.5	465.2	388.5	314.5
.2	590.3	555.8	462.6	388.0	314.1
.3	589.5	555.1	460.0	387.4	313.6
.4	588.7	554.5	451.3	386.9	313.2
.5	587.9	553.6	460.7	386.4	312.8
.6	587.1	532.9	480.1	385.9	312.3
.7	586.1	532.0	459.5	385.2	311.8
.8	585.3	531.3	458.7	384.7	311.4
.9	584.5	530.6	458.1	384.2	311.0
21.0	583.7	529.8	457.4	383.6	310.6
21.1	582.9	529.1	456.8	383.1	310.1
.2	581.9	528.2	456.0	382.5	309.6
.3	581.1	527.5	455.4	382.0	309.2
.4	580.3	526.8	454.8	381.4	308.8
.5	579.4	525.9	454.0	380.8	308.5
.6	578.6	525.2	453.4	380.3	307.8
.7	577.8	524.5	452.7	379.7	307.5
.8	576.8	523.6	452.0	379.1	306.9
.9	575.9	522.7	451.3	378.5	306.4
22.0	575.1	522.0	450.7	378.0	306.0
22.1	574.1	521.1	449.9	377.4	305.5
.2	575.3	520.4	449.5	376.8	305.0
.3	574.2	519.6	448.6	376.2	304.5
.4	571.4	518.7	447.8	375.6	304.0
.5	570.6	518.0	447.2	375.1	303.6
.6	569.7	517.1	446.4	374.4	303.1
.7	568.8	516.3	445.7	373.8	302.6
.8	567.9	515.5	445.1	373.5	302.2
.9	567.0	514.7	444.5	372.7	301.7
23.0	566.1	515.8	443.6	372.1	301.2
23.1	565.1	513.0	442.9	371.4	300.7
.2	564.2	512.1	442.1	370.8	300.2
.3	563.2	511.3	441.4	370.2	299.7
.4	562.4	510.5	440.8	369.7	299.2
.5	561.5	509.7	440.0	369.0	298.7
.6	560.5	508.8	439.5	368.4	298.2
.7	559.6	508.0	438.5	367.8	297.7
.8	558.7	507.1	437.8	367.2	297.2
.9	557.7	506.2	437.1	366.6	296.7
24.0	556.6	505.3	436.2	365.9	296.2
24.1	555.7	504.4	435.5	365.2	295.7
.2	554.8	503.6	434.7	364.8	295.2
.3	553.8	502.7	434.0	364.0	294.7
.4	552.9	501.8	433.5	363.4	294.2
.5	551.9	501.0	432.5	362.8	293.6
.6	550.9	500.0	431.7	362.1	293.1
.7	549.9	499.2	430.9	361.4	292.6
.8	549.0	498.3	430.2	360.8	292.1
.9	547.9	497.5	429.4	360.1	291.5
25.0	546.9	496.5	428.6	359.5	291.0

INITIAL ANGLE 60° PLUS FRICTION

Final angle	Position of Weight				
	1 wl = 1345	2 wl = 1222	3 wl = 1055	4 wl = 885	5 wl = 716
Degrees Inch - pounds					
25.1	546.0	495.6	427.9	358.9	290.5
.2	544.9	494.6	427.0	358.2	289.9
.3	544.0	493.8	426.3	357.5	289.4
.4	542.9	492.8	425.5	356.8	288.9
.5	542.0	492.3	424.7	356.2	288.3
.6	540.9	491.0	423.9	355.5	287.8
.7	539.9	490.1	423.1	354.9	287.3
.8	538.9	489.1	422.3	354.2	286.7
.9	537.9	488.3	421.6	353.6	286.2
26.0	536.9	487.3	420.7	352.9	285.6
26.1	535.8	486.3	419.9	352.1	285.1
.2	534.8	485.5	419.1	351.5	284.6
.3	533.8	484.5	418.3	350.8	284.0
.4	532.7	483.5	417.4	350.1	283.4
.5	531.6	482.5	416.6	349.4	282.8
.6	530.7	481.7	415.9	348.8	282.3
.7	529.6	480.7	415.0	348.1	281.8
.8	528.5	479.7	414.2	347.4	281.2
.9	527.4	478.7	413.5	346.7	280.6
27.0	526.4	477.8	412.5	346.0	280.0
27.1	525.3	476.8	411.6	345.2	279.5
.2	524.2	475.8	410.8	344.5	278.9
.3	523.1	474.8	409.9	343.8	278.3
.4	522.0	473.9	409.1	343.1	277.7
.5	521.0	472.9	408.3	342.4	277.2
.6	519.9	471.9	407.4	341.7	276.6
.7	518.8	470.9	406.6	341.0	276.0
.8	517.7	470.0	405.7	340.5	275.5
.9	516.7	469.0	404.9	339.6	274.9
28.0	515.4	467.9	403.9	338.8	274.2
28.1	514.4	466.9	403.1	338.1	273.7
.2	513.5	465.9	402.2	337.4	273.1
.3	512.2	464.9	401.4	336.7	272.5
.4	511.0	463.8	400.5	335.9	271.9
.5	509.9	462.9	399.6	335.2	271.3
.6	508.9	461.9	398.8	334.4	270.7
.7	507.6	460.8	397.8	333.7	270.1
.8	506.6	459.8	397.0	332.9	269.5
.9	505.5	458.8	396.1	332.2	268.9
29.0	504.5	457.7	395.2	331.4	268.3
29.1	503.2	456.8	394.5	330.7	267.7
.2	502.0	455.7	393.4	329.9	267.1
.3	500.9	454.7	392.5	329.2	266.5
.4	499.7	453.6	391.6	328.4	265.9
.5	498.6	452.6	390.7	327.7	265.3
.6	497.4	451.5	389.8	326.9	264.6
.7	496.2	450.4	388.8	326.1	264.0
.8	495.1	449.4	388.0	325.4	263.4
.9	495.9	448.3	387.1	324.6	262.8
30.0	492.7	447.2	386.1	323.8	262.1

INITIAL ANGLE 60° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
	w1= 1546	w1= 1222	w1= 1055	w1= 895	w1= 716
Degrees	Inch - pounds				
.01	491.6	446.2	385.3	323.1	261.6
.2	490.4	445.1	384.5	322.3	260.9
.5	489.2	444.0	383.4	321.5	260.5
.4	488.0	442.9	382.4	320.7	259.8
.5	486.8	441.8	381.5	319.9	259.0
.6	485.6	440.7	380.5	319.1	258.3
.7	484.5	439.8	379.7	318.4	257.8
.8	483.3	438.7	378.7	317.6	257.1
.9	482.1	437.6	377.8	316.8	256.5
51.0	480.9	436.5	376.8	316.0	255.8
.1	479.6	435.4	375.9	315.2	255.2
.2	478.4	434.3	374.9	314.5	254.5
.3	477.2	433.2	374.0	313.7	253.9
.4	476.0	432.1	373.0	312.9	253.3
.5	474.7	430.8	372.0	312.0	252.5
.6	473.4	429.7	371.0	311.2	251.9
.7	472.2	428.6	370.1	310.4	251.2
.8	471.0	427.6	369.1	309.6	250.6
.9	469.8	426.4	368.2	308.8	250.0
52.0	468.5	425.2	367.1	307.9	249.2
.1	467.3	424.1	366.2	307.1	248.6
.2	466.0	423.0	365.2	306.3	248.0
.3	464.8	421.9	364.3	305.5	247.5
.4	463.5	420.7	363.2	304.6	246.6
.5	462.3	419.6	362.3	303.8	245.9
.6	461.1	418.5	361.3	303.0	245.3
.7	459.7	417.3	360.5	302.2	244.6
.8	458.5	416.2	359.3	301.4	243.9
.9	457.2	415.0	358.3	300.5	243.2
53.0	455.9	413.9	357.3	299.7	242.6
.1	454.6	412.6	356.3	298.8	241.9
.2	453.4	411.5	355.3	298.0	241.2
.3	452.0	410.3	354.2	297.1	240.5
.4	450.7	409.1	353.2	296.2	239.8
.5	449.5	408.0	352.2	295.4	239.1
.6	448.1	406.8	351.2	294.5	238.4
.7	446.9	405.7	350.2	293.7	237.8
.8	445.6	404.5	349.2	292.9	237.1
.9	444.2	403.2	348.1	292.0	236.4
54.0	442.9	402.0	347.1	291.1	235.6
.1	441.7	400.9	346.1	290.3	235.0
.2	440.3	399.7	345.1	289.4	234.3
.3	439.0	398.5	344.0	288.5	233.6
.4	437.6	397.2	343.0	287.6	232.8
.5	436.3	396.0	341.9	286.8	232.1
.6	434.9	394.8	340.8	285.9	231.4
.7	433.6	393.6	339.8	285.0	230.7
.8	432.3	392.4	338.7	284.1	230.0
.9	431.0	391.3	337.8	283.3	229.3
55.0	429.7	390.0	336.7	282.4	228.6

INITIAL ANGLE 60° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
	w1= 1546	w1= 1222	w1= 1055	w1= 885	w1= 716
Degrees	Inch - pounds				
.1	428.2	388.7	335.6	281.5	227.8
.2	426.9	387.5	334.5	280.6	227.1
.3	425.5	386.2	333.5	279.7	226.4
.4	424.2	385.0	332.4	278.8	225.7
.5	422.8	383.8	331.4	277.9	225.0
.6	421.5	382.6	330.5	277.0	224.2
.7	420.1	381.4	329.2	276.1	223.5
.8	418.8	380.1	328.2	275.3	222.8
.9	417.3	378.8	327.0	274.3	222.0
56.0	416.0	377.6	326.0	273.4	221.3
.1	414.6	376.4	324.9	272.5	220.6
.2	413.3	375.1	323.9	271.6	219.9
.3	411.8	373.8	322.7	270.7	219.1
.4	410.4	372.6	321.7	269.8	218.4
.5	409.1	371.3	320.6	268.9	217.7
.6	407.6	370.0	319.4	267.9	216.9
.7	406.3	368.8	318.4	267.0	216.2
.8	404.8	367.4	317.2	266.1	215.4
.9	403.4	366.2	316.2	265.2	214.7
57.0	402.0	364.9	315.0	264.2	213.9
.1	400.6	363.6	313.9	263.3	213.1
.2	399.1	362.3	312.8	262.3	212.4
.3	397.8	361.1	311.7	261.5	211.6
.4	396.5	359.7	310.6	260.5	210.9
.5	395.0	358.5	309.5	259.6	210.1
.6	393.5	357.2	308.4	258.6	209.4
.7	392.0	355.8	307.2	257.6	208.6
.8	390.7	354.6	306.1	256.8	207.8
.9	389.2	353.3	305.0	255.8	207.1
58.0	387.7	351.9	303.8	254.8	206.5
.1	386.2	350.6	302.7	253.8	205.5
.2	384.9	349.3	301.6	253.0	204.8
.3	383.4	348.0	300.4	252.0	204.0
.4	381.9	346.7	299.3	251.0	203.2
.5	380.4	345.3	298.1	250.0	202.4
.6	378.9	344.0	297.0	249.1	201.6
.7	377.5	342.6	295.8	248.1	200.8
.8	376.0	341.3	294.6	247.1	200.0
.9	374.5	339.9	293.5	246.1	199.3
59.0	373.0	338.6	292.3	245.2	198.5
.1	371.5	337.3	291.2	244.2	197.7
.2	370.1	335.9	290.0	243.2	196.9
.3	368.6	334.6	288.8	242.3	196.1
.4	367.1	333.2	287.7	241.3	195.3
.5	365.6	331.9	286.5	240.3	194.5
.6	364.1	330.5	285.4	239.3	193.7
.7	362.7	329.2	284.2	238.4	192.9
.8	361.2	327.8	283.0	237.4	192.2
.9	359.7	326.5	281.9	236.4	191.4
40.0	358.1	325.0	280.6	235.4	190.5

INITIAL ANGLE 60° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
wl= 1346	wl= 1222	wl= 1065	wl= 885	wl= 716	

Degrees	Inch-pounds				
.1	366.6	328.7	278.5	238.4	188.7
.2	355.1	322.3	278.5	233.4	188.9
.3	353.6	321.0	277.1	232.4	188.2
.4	352.0	319.5	276.9	231.4	187.3
.5	350.5	318.2	274.7	230.4	186.5
.6	349.1	316.8	273.5	229.4	185.7
.7	347.4	315.4	272.3	228.4	184.9
.8	346.0	314.0	271.1	227.4	184.1
.9	344.5	312.7	270.0	226.4	183.3
41.0	342.9	311.2	268.7	225.4	182.4
.1	341.4	309.9	267.5	224.4	181.6
.2	339.8	308.4	266.3	223.3	180.8
.3	338.3	307.1	265.1	222.3	180.0
.4	336.7	305.6	263.8	221.3	179.1
.5	335.2	304.3	262.7	220.3	178.3
.6	333.6	302.8	261.4	219.1	177.5
.7	332.0	301.3	260.1	218.2	176.6
.8	330.5	300.0	259.0	217.2	175.8
.9	328.9	298.5	257.7	216.2	175.0
42.0	327.3	297.0	256.5	215.1	174.1
.1	326.8	295.7	255.3	214.1	173.3
.2	324.2	294.2	264.0	213.1	172.5
.3	322.5	292.8	252.8	212.0	171.6
.4	321.1	291.4	251.6	211.0	170.8
.5	319.4	290.0	250.3	210.0	170.0
.6	317.8	288.5	249.1	208.9	169.1
.7	316.2	287.0	247.8	207.8	168.2
.8	314.6	285.6	246.5	206.6	167.4
.9	313.0	284.1	245.3	205.7	166.5
43.0	311.5	282.8	244.1	204.7	165.7
.1	309.9	281.3	242.8	203.7	164.9
.2	308.3	279.8	241.6	202.6	164.0
.3	306.7	278.4	240.3	201.6	163.2
.4	305.0	276.9	239.0	200.6	162.3
.5	303.4	275.4	237.6	199.4	161.4
.6	301.8	274.0	236.5	198.4	160.6
.7	300.2	272.5	235.3	197.3	159.7
.8	298.6	271.0	234.0	196.2	158.9
.9	297.0	269.6	232.7	195.2	158.0
44.0	295.2	268.0	231.3	194.0	157.1
.1	293.6	266.5	230.1	193.0	156.2
.2	292.0	265.0	228.8	191.9	155.3
.3	290.4	263.6	227.5	190.8	154.5
.4	288.8	262.1	226.3	189.8	153.6
.5	287.1	260.6	225.0	188.7	152.8
.6	285.4	259.0	223.6	187.6	151.8
.7	283.8	257.6	222.4	186.6	151.0
.8	282.2	256.1	221.1	185.5	150.1
.9	280.4	254.6	219.7	184.3	149.2
45.0	278.8	253.1	218.6	183.2	148.3

INITIAL ANGLE 60° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
wl= 1346	wl= 1222	wl= 1055	wl= 885	wl= 716	
Degrees	Inch-pounds				
.1	277.2	261.6	217.2	182.2	147.5
.2	275.4	250.0	215.6	181.0	146.5
.3	273.8	248.5	214.6	180.0	145.7
.4	272.2	247.1	213.3	178.9	144.8
.5	270.4	245.6	211.9	177.8	143.9
.6	268.8	244.0	210.7	176.7	143.0
.7	267.1	242.4	209.3	175.5	142.1
.8	265.6	241.0	208.0	174.5	141.2
.9	263.7	239.4	206.7	173.3	140.3
45.0	262.1	237.9	205.4	172.3	139.4
.1	260.3	236.3	204.0	171.1	138.5
.2	258.6	234.7	202.7	170.0	137.6
.3	257.0	233.3	201.4	168.9	136.7
.4	255.2	231.7	200.0	167.8	135.8
.5	253.6	230.2	198.7	166.7	134.9
.6	251.9	228.6	197.4	165.5	134.0
.7	250.1	227.0	196.0	164.4	133.1
.8	248.4	225.4	194.6	163.2	132.1
.9	246.8	224.0	193.4	162.2	131.3
47.0	245.0	222.4	192.0	161.0	130.4
.1	243.3	220.8	190.6	159.9	129.4
.2	241.5	219.2	189.3	158.7	128.5
.3	239.9	217.7	188.0	157.7	127.6
.4	238.1	216.2	186.6	156.5	126.7
.5	236.4	214.6	185.2	155.4	125.8
.6	234.6	213.0	183.9	154.2	124.8
.7	232.9	211.4	182.5	153.1	123.9
.8	231.1	209.8	181.1	151.9	123.0
.9	229.4	208.2	179.8	150.8	122.0
48.0	227.6	206.6	178.4	149.6	121.1
.1	225.9	205.0	177.0	148.5	120.2
.2	224.1	203.4	175.6	147.3	119.3
.3	222.6	201.9	174.3	146.2	118.3
.4	220.6	200.5	172.9	145.0	117.4
.5	218.9	199.7	171.5	143.9	116.5
.6	217.1	197.1	170.2	142.7	115.5
.7	215.4	195.5	168.8	141.6	114.6
.8	213.6	193.9	167.4	140.4	113.7
.9	211.9	192.3	166.0	139.3	112.7
49.0	210.1	190.7	164.7	138.1	111.8
.1	208.3	189.0	163.2	136.9	110.8
.2	206.5	187.4	161.8	135.7	109.9
.3	204.8	185.9	160.5	134.6	108.9
.4	203.0	184.3	159.1	133.4	108.0
.5	201.1	182.6	157.6	132.2	107.0
.6	199.4	181.0	156.2	131.0	106.1
.7	197.6	179.4	154.9	129.9	106.1
.8	195.9	177.8	153.5	128.7	104.2
.9	194.0	176.1	152.0	127.5	103.2
50.0	192.2	174.5	150.6	126.3	102.3

INITIAL ANGLE 60° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
	wl = 1546	wl = 1222	wl = 1055	wl = 885	wl = 716
Degrees					
	Inch - pounds				
.50.1	190.5	172.8	149.2	125.1	101.3
.2	188.6	171.2	147.8	124.0	100.5
.3	186.8	169.6	146.4	122.8	99.4
.4	185.0	167.9	144.9	121.6	98.4
.5	183.2	166.3	143.6	120.4	97.5
.6	181.5	164.6	142.1	119.2	96.5
.7	179.8	163.0	140.7	118.0	95.5
.8	177.7	161.3	139.3	116.8	94.5
.9	175.9	159.7	137.9	115.6	93.6
51.0	174.1	158.0	136.4	114.4	92.6
51.1	172.3	156.4	135.0	115.3	91.7
.2	170.4	154.7	133.6	112.0	90.7
.3	168.5	153.0	132.1	110.8	89.7
.4	166.8	151.4	130.7	109.6	88.7
.5	164.9	149.7	129.2	108.4	87.7
.6	163.0	148.0	127.8	107.1	86.7
.7	161.3	146.4	126.4	106.0	85.8
.8	159.4	144.7	124.9	104.8	84.8
.9	157.5	143.0	123.4	103.5	83.8
52.0	155.8	141.4	122.1	102.4	82.9
52.1	153.9	139.7	120.6	101.1	81.9
.2	152.0	138.0	119.1	99.9	80.9
.3	150.1	136.2	117.6	98.7	79.9
.4	148.2	134.5	116.1	97.4	78.9
.5	146.5	132.9	114.8	96.3	77.9
.6	144.6	131.2	113.3	95.0	76.9
.7	142.7	129.5	111.8	93.8	75.9
.8	140.8	127.8	110.3	92.5	74.9
.9	138.9	126.1	108.9	91.3	73.9
53.0	137.0	124.4	107.4	90.1	72.9
53.1	135.2	122.7	105.9	88.8	71.9
.2	133.3	121.0	104.4	87.6	70.9
.3	131.4	119.3	103.0	86.4	69.9
.4	129.5	117.5	101.5	85.1	68.9
.5	127.6	115.8	100.0	85.9	67.9
.6	125.7	114.1	98.5	82.8	66.9
.7	123.8	112.4	97.1	81.4	65.9
.8	122.0	110.7	95.6	80.2	64.9
.9	120.1	109.0	94.1	78.9	63.9
54.0	118.2	107.3	92.6	77.7	62.9
54.1	116.5	105.6	91.1	76.4	61.9
.2	114.4	103.9	89.7	75.2	60.9
.3	112.4	102.0	88.1	75.9	59.8
.4	110.5	100.3	86.6	72.6	58.8
.5	108.6	98.6	85.1	71.4	57.8
.6	106.8	96.9	85.7	70.2	56.8
.7	104.9	95.2	82.2	69.9	55.8
.8	102.8	93.4	80.6	67.6	54.7
.9	101.0	91.6	79.1	66.4	53.7
55.0	99.1	89.9	77.6	65.1	52.7

INITIAL ANGLE 60° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
	wl = 1546	wl = 1222	wl = 1055	wl = 885	wl = 716
Degrees					
	Inch - pounds				
.55.1	97.1	88.1	76.1	65.8	51.6
.2	95.2	86.4	74.6	62.8	50.6
.3	93.3	84.7	73.1	61.3	49.6
.4	91.5	82.8	71.5	60.0	48.6
.5	89.4	81.1	70.0	58.7	47.6
.6	87.5	79.4	68.6	57.5	46.6
.7	85.5	77.6	67.0	56.2	45.5
.8	83.6	75.9	65.5	54.9	44.5
.9	81.6	74.0	63.9	53.6	43.4
56.0	79.7	72.5	62.5	52.4	42.4
56.1	77.7	70.5	60.9	51.1	41.5
.2	75.8	68.9	59.4	49.8	40.3
.3	73.8	67.0	57.8	48.5	39.2
.4	71.9	65.3	56.5	47.2	38.2
.5	69.9	63.4	54.8	45.9	37.2
.6	68.0	61.7	55.3	44.7	36.2
.7	66.0	59.9	51.7	45.4	35.1
.8	64.1	58.2	50.2	42.1	34.1
.9	62.1	56.5	48.6	40.8	35.0
57.0	60.0	54.5	47.1	39.5	31.9
57.1	58.2	52.8	45.6	38.2	30.9
.2	56.1	51.0	44.0	38.9	29.9
.3	54.1	49.1	42.4	35.6	28.8
.4	52.2	47.4	40.9	34.3	27.8
.5	50.2	45.6	39.5	33.0	26.7
.6	48.2	43.7	37.8	31.7	25.6
.7	46.3	42.0	36.3	30.4	24.6
.8	44.3	40.2	34.7	29.1	25.6
.9	42.3	38.4	33.1	27.8	22.5
58.0	40.3	36.5	31.5	26.5	21.4
58.1	38.2	34.7	30.0	25.1	20.5
.2	36.3	33.0	28.5	23.9	19.3
.3	34.3	31.2	26.9	22.6	18.5
.4	32.3	29.5	25.3	21.2	17.2
.5	30.3	27.5	23.7	19.9	16.1
.6	28.3	25.7	22.2	18.6	15.0
.7	26.3	23.8	20.6	17.3	14.0
.8	24.2	22.0	19.0	15.9	12.9
.9	22.2	20.2	17.4	14.6	11.8
59.0	20.2	18.3	15.8	13.8	10.7
59.1	18.2	16.5	14.2	11.8	9.7
.2	16.2	14.7	12.7	10.6	8.6
.3	14.1	12.8	11.1	9.5	7.5
.4	12.1	11.0	9.5	8.0	6.4
.5	10.1	9.2	7.9	6.6	5.4
.6	8.1	7.5	6.5	5.5	4.5
.7	6.1	5.5	4.7	4.0	3.2
.8	4.0	3.7	3.2	2.7	2.1
.9	2.0	1.8	1.6	1.3	1.1
60.0	0.0	0.0	0.0	0.0	0.0

INITIAL ANGLE 45° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
wl= 1348	wl= 1422	wl= 1065	wl= 885	wl= 716	

Degrees	Inch - pounds				
	.1	.2	.3	.4	.5
.1	394.3	357.9	309.0	259.2	209.8
.2	394.3	357.9	309.0	259.2	209.8
.3	394.3	357.9	309.0	259.2	209.8
.4	394.3	357.9	309.0	259.2	209.8
.5	394.3	357.9	309.0	259.2	209.8
.6	394.2	357.8	308.9	259.1	209.7
.7	394.2	357.8	308.9	259.1	209.7
.8	394.2	357.8	308.9	259.1	209.7
.9	394.2	357.8	308.9	259.1	209.7
1.0	394.0	357.7	308.8	259.0	209.6
1.1	394.0	357.7	308.8	259.0	209.6
.2	394.0	357.7	308.8	259.0	209.6
.3	393.9	357.6	308.7	258.9	209.6
.4	393.9	357.5	308.7	258.9	209.6
.5	393.9	357.5	308.7	258.9	209.6
.6	393.8	357.4	308.6	258.8	209.5
.7	393.8	357.4	308.6	258.8	209.5
.8	393.6	357.3	308.5	258.7	209.4
.9	393.6	357.3	308.5	258.7	209.4
2.0	393.5	357.2	308.4	258.6	209.4
2.1	393.4	356.9	308.3	258.5	209.3
.2	393.4	356.9	308.3	258.5	209.3
.3	393.2	356.9	308.1	258.4	209.2
.4	393.1	356.8	308.0	258.4	209.1
.5	392.9	356.7	307.9	258.3	209.1
.6	392.9	356.7	307.9	258.3	209.1
.7	392.8	356.6	307.8	258.2	209.0
.8	392.7	356.4	307.7	258.1	208.9
.9	392.6	356.3	307.6	258.0	208.8
3.0	392.4	356.2	307.5	257.9	208.8
3.1	392.3	356.1	307.4	257.8	208.7
.2	392.1	355.9	307.3	257.7	208.6
.3	392.0	355.8	307.2	257.6	208.6
.4	391.9	355.7	307.1	257.6	208.5
.5	391.7	355.6	307.0	257.5	208.4
.6	391.6	355.5	306.9	257.4	208.3
.7	391.5	355.3	306.8	257.3	208.3
.8	391.3	355.2	306.7	257.2	208.2
.9	391.2	355.1	306.6	257.1	208.1
4.0	391.1	355.0	306.5	257.0	208.1
4.1	390.8	354.7	306.2	256.9	207.9
.2	390.7	354.6	306.1	256.8	207.8
.3	390.5	354.5	306.0	256.7	207.8
.4	390.4	354.4	305.9	256.6	207.7
.5	390.1	354.1	305.7	256.4	207.6
.6	390.0	354.0	305.6	256.3	207.5
.7	389.7	353.7	305.4	256.1	207.3
.8	389.6	353.6	305.3	256.1	207.3
.9	389.5	353.4	305.1	255.9	207.1
5.0	389.2	353.3	305.0	255.8	207.1

INITIAL ANGLE 45° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
wl= 1348	wl= 1222	wl= 1065	wl= 885	wl= 716	
Degrees	Inch - pounds				
.1	388.9	353.0	304.8	255.6	206.9
.2	388.8	352.9	304.7	255.5	206.8
.3	388.5	352.6	304.5	255.3	206.7
.4	388.4	352.5	304.3	255.3	206.6
.5	388.1	352.3	304.1	255.1	206.5
.6	387.8	352.0	303.9	254.9	205.3
.7	387.7	351.9	303.8	254.8	205.3
.8	387.4	351.7	303.6	254.6	205.1
.9	387.2	351.4	303.4	254.5	205.0
6.0	386.9	351.2	303.2	254.3	205.8
6.1	386.6	350.9	303.0	254.1	205.7
.2	386.5	350.8	302.9	254.0	205.6
.3	386.2	350.6	302.7	253.8	205.5
.4	385.9	350.3	302.5	253.7	205.3
.5	385.7	350.1	302.2	253.5	205.2
.6	385.4	349.8	302.0	253.3	205.1
.7	385.1	349.6	301.8	253.1	204.9
.8	384.9	349.3	301.6	253.0	204.8
.9	384.6	349.1	301.4	252.8	204.6
7.0	384.2	348.7	301.1	252.6	204.4
7.1	383.9	348.5	300.9	252.3	204.3
.2	383.7	348.2	300.7	252.2	204.1
.3	383.4	348.0	300.4	252.0	204.0
.4	383.1	347.8	300.2	251.8	203.8
.5	382.7	347.4	299.9	251.5	203.6
.6	382.4	347.1	299.7	251.4	203.5
.7	382.2	346.9	299.5	251.2	203.3
.8	381.8	346.5	299.2	250.9	203.1
.9	381.5	346.3	299.0	250.7	203.0
8.0	381.2	346.0	298.8	250.6	202.8
8.1	380.8	345.7	298.4	250.3	202.6
.2	380.6	345.4	298.2	250.1	202.5
.3	380.2	345.1	297.9	249.9	202.3
.4	379.9	344.8	297.7	249.7	202.1
.5	379.5	344.5	297.4	249.4	201.9
.6	379.2	344.2	297.2	249.2	201.8
.7	378.8	343.8	296.9	249.0	201.5
.8	378.4	343.5	296.6	248.7	201.3
.9	378.1	343.2	296.3	248.5	201.2
9.0	377.7	342.9	296.0	248.3	201.0
9.1	377.3	342.6	295.7	248.0	200.8
.2	376.9	342.1	295.4	247.7	200.5
.3	376.7	341.9	295.2	247.6	200.4
.4	376.3	341.5	294.9	247.3	200.2
.5	375.9	341.2	294.6	247.0	200.0
.6	375.4	340.8	294.2	246.8	199.8
.7	375.0	340.4	293.9	246.5	199.5
.8	374.6	340.1	293.6	246.2	199.3
.9	374.2	339.7	293.3	246.0	199.2
10.0	373.8	339.3	293.0	246.7	199.0

INITIAL ANGLE 45° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
wl= 1346	wl= 1222	wl= 1056	wl= 885	wl= 718	

INITIAL ANGLE 45° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
wl= 1346	wl= 1222	wl= 1056	wl= 885	wl= 718	

Degrees Inch - pounds

.1	373.4	339.0	292.6	245.4	198.7
.2	373.0	338.6	292.3	245.2	198.5
.3	372.6	338.2	292.0	244.9	198.2
.4	372.2	337.9	291.7	244.6	198.0
.5	371.8	337.5	291.4	244.4	197.8
.6	371.3	337.0	291.0	244.0	197.5
.7	370.9	336.6	290.6	243.8	197.3
.8	370.5	336.3	290.3	243.5	197.1
.9	370.1	335.9	290.0	243.2	196.9
11.0	369.5	335.4	289.6	242.9	196.6
11.1	369.1	335.1	289.3	242.6	196.4
.2	368.7	334.7	288.9	242.3	196.2
.3	368.2	334.2	288.5	242.0	196.0
.4	367.8	333.8	288.2	241.7	195.7
.5	367.2	333.3	287.8	241.4	195.4
.6	366.8	333.0	287.5	241.1	195.2
.7	366.3	332.5	287.0	240.8	194.9
.8	365.9	332.1	286.7	240.5	194.7
.9	365.4	331.6	286.3	240.1	194.4
12.0	364.8	331.1	285.9	239.8	194.1
12.1	364.4	330.6	285.6	239.5	193.9
.2	363.9	330.3	285.1	239.2	193.6
.3	363.3	329.8	284.7	238.8	193.3
.4	362.9	329.4	284.4	238.5	193.1
.5	362.4	328.9	284.0	238.2	192.8
.6	361.9	328.5	283.6	237.8	192.5
.7	361.3	328.0	283.1	237.5	192.2
.8	360.8	327.5	282.7	237.1	191.9
.9	360.4	327.1	282.4	236.9	191.7
13.0	359.8	326.6	282.0	236.5	191.4
13.1	359.3	326.1	281.6	236.1	191.2
.2	358.8	325.6	281.1	235.8	190.9
.3	358.2	325.2	280.7	235.4	190.6
.4	357.7	324.7	280.3	235.1	190.3
.5	357.1	324.2	279.9	234.7	190.0
.6	356.6	323.7	279.5	234.4	189.7
.7	356.0	323.1	278.9	233.9	189.4
.8	356.4	322.6	278.5	233.6	189.1
.9	356.9	322.1	278.1	233.2	188.8
14.0	356.3	321.6	277.7	232.9	188.5
14.1	355.8	321.1	277.2	232.5	188.2
.2	355.1	320.5	276.7	232.1	187.9
.3	352.6	320.0	276.3	231.7	187.6
.4	352.0	319.5	275.9	231.4	187.3
.5	351.4	318.9	275.3	230.9	186.9
.6	350.8	318.4	274.9	230.6	186.6
.7	350.3	317.9	274.5	230.2	186.4
.8	349.6	317.3	274.0	229.8	186.0
.9	349.1	316.8	273.5	229.4	185.7
15.0	348.4	316.2	273.0	229.0	185.4

Degrees Inch - pounds

.1	347.0	315.7	272.6	226.6	185.1
.2	347.2	315.1	272.1	226.2	184.7
.3	346.6	314.5	271.6	227.8	184.4
.4	346.0	314.0	271.1	227.4	184.1
.5	345.3	313.4	270.6	226.9	183.7
.6	344.8	312.9	270.2	226.6	183.4
.7	344.1	312.3	269.6	226.2	183.1
.8	343.4	311.7	269.1	225.7	182.7
.9	342.7	311.1	268.6	225.3	182.3
16.0	342.2	310.5	268.2	224.9	182.1
16.1	341.5	310.0	267.6	224.5	181.7
.2	340.9	309.4	267.1	224.0	181.3
.3	340.2	308.8	266.6	223.6	181.0
.4	339.5	308.2	266.1	223.1	180.6
.5	338.8	307.6	265.6	222.7	180.3
.6	338.2	306.9	265.0	222.3	179.9
.7	337.5	306.3	264.5	221.6	179.5
.8	336.8	305.7	263.9	221.4	179.2
.9	336.1	305.1	263.4	220.9	178.8
17.0	335.5	304.5	262.9	220.5	178.5
17.1	334.8	303.9	262.4	220.0	178.1
.2	334.1	303.3	261.8	219.6	177.9
.3	333.4	302.7	261.3	219.2	177.4
.4	332.6	301.9	260.7	218.6	177.0
.5	332.0	301.3	260.1	218.2	176.6
.6	331.3	300.7	259.6	217.7	176.3
.7	330.6	300.1	259.1	217.3	175.9
.8	329.8	299.4	258.5	216.8	175.5
.9	329.1	298.8	257.9	216.3	175.1
18.0	328.5	298.1	257.4	215.9	174.8
18.1	327.7	297.4	256.8	215.4	174.3
.2	327.0	296.8	256.2	214.9	174.0
.3	326.2	296.1	255.6	214.4	173.5
.4	325.5	295.5	255.1	213.9	173.2
.5	324.7	294.7	254.5	213.4	172.8
.6	324.0	294.1	253.9	213.0	172.4
.7	323.2	293.4	253.3	212.4	172.0
.8	322.4	292.7	252.7	211.9	171.5
.9	321.7	292.0	252.1	211.5	171.2
19.0	320.9	291.3	251.5	210.9	170.7
19.1	320.1	290.6	250.9	210.4	170.3
.2	319.4	290.0	250.3	210.0	170.0
.3	318.6	289.2	249.7	209.4	169.5
.4	317.8	288.5	249.1	208.9	169.1
.5	317.0	287.8	248.4	208.4	168.7
.6	316.4	287.2	247.9	207.9	168.3
.7	315.5	286.4	247.3	207.4	167.9
.8	314.7	285.7	246.6	206.9	167.5
.9	313.9	285.0	246.0	206.3	167.0
20.0	313.1	284.2	245.4	205.8	166.6

INITIAL ANGLE 45° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
	w1= 1346	w1= 1222	w1= 1055	w1= 865	w1= 716

Degrees	Inch - pounds				
.1	512.5	285.5	244.7	205.3	166.2
.2	511.5	282.8	244.1	204.7	165.7
.3	510.7	282.0	245.5	204.2	165.3
.4	509.9	281.5	242.8	205.7	164.9
.5	509.1	280.6	242.2	205.1	164.4
.6	508.5	279.8	241.6	202.6	164.0
.7	507.3	279.0	240.8	202.0	163.5
.8	506.5	278.2	240.2	201.5	163.1
.9	505.7	277.5	239.6	200.9	162.7
21.0	504.9	276.8	238.9	200.4	162.2
.1	504.1	276.0	238.5	199.9	161.8
.2	503.2	275.2	237.6	199.3	161.3
.3	502.4	274.4	236.9	198.7	160.9
.4	501.5	273.7	236.3	198.2	160.4
.5	500.6	272.9	235.6	197.6	159.9
.6	299.8	272.1	234.9	197.0	159.5
.7	298.8	271.5	234.2	196.4	159.0
.8	298.0	270.5	233.6	195.9	158.8
.9	297.1	269.7	232.8	195.3	158.1
22.0	296.3	268.9	232.2	194.7	157.6
.1	295.4	268.1	231.5	194.1	157.1
.2	294.5	267.4	230.8	195.6	156.7
.3	293.6	266.5	230.1	195.0	156.2
.4	292.7	265.6	229.3	192.3	155.7
.5	291.8	264.9	228.7	191.8	155.3
.6	290.9	264.1	228.0	191.2	154.8
.7	290.0	263.2	227.2	190.6	154.3
.8	289.2	262.5	226.6	190.1	153.8
.9	288.2	261.6	225.9	189.4	153.3
23.0	287.5	260.8	225.1	189.0	152.8
.1	286.5	259.9	224.4	188.2	152.5
.2	285.4	258.0	223.6	187.6	151.8
.3	284.4	258.2	222.9	187.0	151.3
.4	283.6	257.5	222.3	186.4	150.9
.5	282.7	256.6	221.5	185.8	150.4
.6	281.8	255.7	220.8	185.2	149.9
.7	280.8	254.9	220.1	184.6	149.4
.8	279.9	254.0	219.3	183.9	148.9
.9	278.9	253.2	218.6	183.5	148.4
24.0	277.8	252.2	217.7	182.6	147.8

INITIAL ANGLE 45° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
	w1= 1346	w1= 1222	w1= 1055	w1= 885	w1= 716
Degrees	Inch - pounds				
.1	267.2	242.6	209.4	175.6	142.2
.2	266.1	241.6	208.6	174.9	141.6
.3	265.2	240.7	207.8	174.5	141.1
.4	264.1	239.7	207.0	173.6	140.5
.5	263.2	238.9	206.2	173.0	140.0
.6	262.1	237.9	205.4	172.5	139.4
.7	261.2	237.1	204.7	171.6	138.9
.8	260.1	236.1	203.8	170.9	138.4
.9	259.1	235.2	203.1	170.5	137.9
26.0	258.1	234.2	202.2	169.6	137.5
.1	257.0	233.5	201.4	168.9	136.7
.2	256.0	232.4	200.6	168.5	136.2
.3	255.0	231.4	199.8	167.6	135.7
.4	255.9	230.5	199.0	166.9	135.1
.5	252.8	229.5	198.1	166.2	134.5
.6	251.9	228.6	197.4	165.5	134.0
.7	250.8	227.6	196.5	164.8	133.4
.8	249.7	226.7	195.7	164.1	132.9
.9	248.6	225.7	194.8	163.4	132.3
27.0	247.6	224.7	194.0	162.7	131.7
.1	246.5	223.7	195.2	162.0	131.1
.2	245.4	222.8	192.3	161.5	130.6
.3	244.3	221.8	191.5	160.6	130.0
.4	245.3	220.8	190.6	159.9	129.4
.5	242.2	219.8	189.8	159.2	128.8
.6	241.1	218.8	188.9	158.5	128.3
.7	240.0	217.9	188.1	157.8	127.7
.8	238.9	216.9	187.3	157.0	127.1
.9	237.9	215.9	186.4	156.3	126.6
28.0	236.7	214.8	185.5	155.5	125.9
.1	235.6	213.8	184.6	154.8	125.3
.2	234.5	212.9	183.8	154.1	124.8
.3	233.4	211.9	182.9	153.4	124.2
.4	232.2	210.8	182.0	152.6	123.5
.5	231.1	209.8	181.1	151.9	123.0
.6	230.1	208.8	180.3	151.2	122.4
.7	228.8	207.7	179.3	150.4	121.8
.8	227.8	206.7	178.5	149.7	121.2
.9	226.7	205.8	177.7	149.0	120.6
29.0	225.5	204.7	176.7	148.2	120.0
.1	224.4	203.7	175.9	147.5	119.4
.2	225.2	202.6	174.9	146.7	118.7
.3	222.1	201.6	174.1	146.0	118.2
.4	220.9	200.5	173.1	145.2	117.5
.5	219.8	199.5	172.3	144.5	117.0
.6	218.8	198.4	181.5	143.8	116.8
.7	217.4	197.5	170.4	142.9	115.7
.8	216.3	196.4	169.5	142.2	115.1
.9	215.1	195.3	168.6	141.4	114.5
30.0	213.9	194.2	167.6	140.6	113.8

Z M 39719 F

INITIAL ANGLE 45° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
	wl= 1346	wl= 1282	wl= 1055	wl= 885	wl= 718
Degrees					
.1	212.8	195.2	166.8	159.9	115.2
.2	211.6	192.1	165.8	159.1	112.6
.3	210.4	191.0	164.9	158.5	111.9
.4	209.2	189.9	165.9	157.5	111.3
.5	208.0	188.8	165.0	156.7	110.7
.6	206.8	187.7	162.0	135.9	110.0
.7	205.7	166.7	161.2	135.2	109.4
.8	204.5	185.6	160.2	134.4	108.8
.9	203.3	184.5	159.3	153.6	108.1
31.0	202.1	183.4	159.3	132.8	107.5
31.1	200.8	182.3	157.4	132.0	106.9
.2	199.6	181.2	156.4	151.2	106.2
.3	198.4	180.1	155.5	130.4	105.6
.4	197.2	179.0	154.5	129.6	104.9
.5	195.9	177.8	153.5	128.7	104.2
.6	194.7	176.7	152.5	127.9	103.6
.7	193.4	175.6	151.6	127.1	102.9
.8	192.2	174.5	150.6	126.3	102.3
.9	191.0	173.4	149.7	125.6	101.6
32.0	189.7	172.2	148.6	124.7	100.9
32.1	188.5	171.1	147.7	125.9	100.5
.2	187.3	170.0	146.7	123.1	99.6
.3	186.0	168.9	145.8	122.5	99.0
.4	184.7	167.6	144.7	121.4	98.3
.5	183.5	166.5	143.8	120.6	97.6
.6	182.3	165.4	142.8	119.8	97.0
.7	180.9	164.2	141.8	118.9	96.3
.8	179.7	163.1	140.8	118.1	95.6
.9	178.4	161.9	139.8	117.2	94.9
33.0	177.2	160.8	138.8	116.4	94.5
33.1	175.8	159.6	137.8	115.6	93.5
.2	174.6	158.5	136.8	114.8	92.9
.3	173.3	157.5	135.8	113.9	92.2
.4	171.9	156.0	134.7	115.0	91.5
.5	170.7	154.9	133.8	112.2	90.8
.6	169.3	155.7	132.7	111.5	90.1
.7	168.1	152.6	131.8	110.5	89.5
.8	166.8	151.4	130.7	109.6	88.7
.9	165.4	150.2	129.7	108.7	88.0
34.0	164.1	149.0	128.6	107.9	87.5
34.1	162.9	147.9	127.6	107.1	86.7
.2	161.5	146.6	126.6	106.2	85.9
.3	160.2	145.4	125.5	105.3	85.2
.4	158.8	144.2	124.5	104.4	84.5
.5	157.5	143.0	123.4	103.5	83.8
.6	156.2	141.7	122.4	102.6	83.1
.7	154.8	140.5	121.5	101.8	82.4
.8	153.5	139.3	120.3	100.9	81.6
.9	152.3	138.2	119.3	100.1	81.0
35.0	150.9	137.0	118.5	99.2	80.5

INITIAL ANGLE 45° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
	wl= 1346	wl= 1222	wl= 1055	wl= 885	wl= 718
Degrees					
.1	149.4	155.8	117.1	98.2	79.5
.2	148.1	134.4	116.0	97.5	78.8
.3	146.7	155.2	115.0	96.4	78.1
.4	145.4	132.0	113.9	95.6	77.4
.5	144.0	130.7	112.9	94.7	76.6
.6	142.7	129.5	111.8	93.8	75.9
.7	141.5	128.5	110.6	92.9	75.2
.8	140.0	127.1	109.7	92.0	74.5
.9	138.5	125.7	108.6	91.0	73.7
36.0	137.2	124.5	107.5	90.2	73.0
.1	155.8	128.3	106.4	89.5	72.5
.2	134.5	122.1	105.4	88.4	71.6
.3	133.0	120.7	104.2	87.4	70.8
.4	131.7	119.5	105.2	86.5	70.0
.5	130.3	118.3	102.1	85.6	69.5
.6	128.8	116.9	101.0	84.7	68.5
.7	127.5	115.7	99.9	83.8	67.8
.8	126.0	114.4	98.7	82.8	67.0
.9	124.7	113.1	97.7	81.9	66.5
37.0	123.2	111.8	96.5	81.0	65.5
.1	121.8	110.6	95.5	80.1	64.8
.2	120.3	109.2	94.3	79.1	64.0
.3	119.0	108.0	93.5	78.2	63.3
.4	117.5	106.7	92.1	77.2	62.5
.5	116.2	105.5	91.0	76.4	61.8
.6	114.7	104.1	89.8	75.4	61.0
.7	113.2	102.8	88.7	74.4	60.2
.8	111.9	101.5	87.7	73.5	59.5
.9	110.4	100.2	86.5	72.6	58.7
38.0	108.9	98.9	85.5	71.6	57.9
.1	107.4	97.5	84.2	70.6	57.2
.2	106.1	96.5	85.1	69.7	56.4
.3	104.6	94.9	82.0	68.7	55.7
.4	103.1	93.6	80.8	67.8	54.9
.5	101.6	92.3	79.8	66.8	54.1
.6	100.2	90.9	78.5	65.8	53.3
.7	98.7	89.6	77.5	64.9	52.5
.8	97.2	88.2	76.2	63.9	51.7
.9	95.7	86.9	75.0	62.9	50.9
39.0	94.2	85.5	73.8	61.9	50.1
.1	92.8	84.2	72.7	61.0	49.5
.2	91.3	82.8	71.5	60.0	48.6
.3	89.8	81.5	70.4	59.0	47.8
.4	88.3	80.2	69.2	58.0	47.0
.5	86.8	78.8	68.0	57.1	46.2
.6	85.3	77.5	66.9	56.1	45.4
.7	83.9	76.1	65.7	55.1	44.6
.8	82.4	74.8	64.6	54.1	43.8
.9	80.9	73.4	63.4	53.2	43.0
40.0	79.5	72.0	62.1	52.1	42.2

Z M 39720 F

INITIAL ANGLE 45° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
	wl= 1348	wl= 1222	wl= 1056	wl= 886	wl= 716

Degrees	Inch - pounds				
40.1	77.8	70.6	61.0	51.1	41.4
.2	76.3	69.3	59.8	50.2	40.6
.3	74.8	67.9	58.7	49.2	39.8
.4	73.2	66.6	57.4	48.1	39.0
.5	71.8	65.1	56.2	47.2	38.2
.6	70.3	63.8	55.1	46.2	37.4
.7	68.7	62.3	53.8	45.1	36.5
.8	67.2	61.0	52.6	44.2	35.7
.9	65.7	59.6	51.5	43.2	35.0
41.0	64.1	58.2	50.2	42.1	34.1
41.1	62.6	56.8	49.1	41.1	33.3
.2	61.0	55.4	47.8	40.1	32.4
.3	59.5	54.0	46.6	39.1	31.7
.4	57.9	52.5	45.4	38.0	30.8
.5	56.4	51.2	44.2	37.1	30.0
.6	54.8	49.7	42.9	36.0	29.8
.7	53.2	48.3	41.7	34.9	28.3
.8	51.7	46.9	40.5	34.0	27.5
.9	50.1	45.5	39.2	32.9	26.6
42.0	48.5	44.0	38.0	31.9	25.8
42.1	47.0	42.6	36.8	30.9	25.0
.2	45.4	41.2	35.6	29.8	24.1
.3	43.8	39.7	34.3	28.8	23.3
.4	42.3	38.4	33.1	27.8	22.5
.5	40.7	36.9	31.9	26.7	21.6
.6	39.0	35.4	30.6	25.7	20.8
.7	37.4	34.0	29.3	24.6	19.9
.8	35.8	32.5	28.1	23.5	19.1
.9	34.2	31.0	26.6	22.5	18.2
43.0	32.7	29.7	25.6	21.5	17.4
43.1	31.1	28.2	24.4	20.4	16.5
.2	29.5	26.8	23.1	19.4	15.7
.3	27.9	26.3	21.8	18.3	14.8
.4	26.3	25.8	20.6	17.3	14.0
.5	24.6	22.4	19.3	16.2	13.1
.6	23.0	20.9	18.0	15.1	12.2
.7	21.4	19.4	16.8	14.1	11.4
.8	19.8	18.0	15.5	13.0	10.5
.9	18.2	16.5	14.2	11.9	9.7
44.0	16.4	14.9	12.8	10.8	8.7
44.1	14.8	13.4	11.6	9.7	7.9
.2	13.2	12.0	10.5	8.7	7.0
.3	11.6	10.5	9.1	7.6	6.1
.4	10.0	9.0	7.6	6.5	5.3
.5	8.3	7.6	6.5	5.5	4.4
.6	6.6	6.0	5.2	4.3	3.5
.7	5.0	4.5	3.9	3.3	2.6
.8	3.4	3.1	2.6	2.2	1.8
.9	1.6	1.5	1.3	1.1	.9
45.0	0.0	0.0	0.0	0.0	0.0

Z M 39721 F

INITIAL ANGLE 30° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
<u>wl = 1346 wl = 1222 wl = 1055 wl = 885 wl = 716</u>					
Degrees Inch - pounds					
.1	180.4	163.7	141.4	118.6	96.0
.2	180.4	163.7	141.4	118.6	96.0
.3	180.4	163.7	141.4	118.6	96.0
.4	180.4	163.7	141.4	118.6	96.0
.5	180.4	163.7	141.4	118.6	96.0
.6	180.3	163.6	141.3	118.5	95.9
.7	180.3	163.6	141.3	118.5	95.9
.8	180.3	163.6	141.3	118.5	95.9
.9	180.3	163.6	141.3	118.5	95.9
1.0	180.1	163.5	141.2	118.4	95.8
1.1	180.1	163.5	141.2	118.4	95.8
.2	180.1	163.5	141.2	118.4	95.8
.3	180.0	163.4	141.0	118.3	95.8
.4	180.0	163.4	141.0	118.3	95.8
.5	180.0	163.4	141.0	118.3	95.8
.6	179.8	163.2	140.9	118.2	95.7
.7	179.8	163.2	140.9	118.2	95.7
.8	179.7	163.1	140.8	118.1	95.6
.9	179.7	163.1	140.8	118.1	95.6
2.0	179.6	163.0	140.7	118.0	95.5
2.1	179.4	162.9	140.6	117.9	95.5
.2	179.4	162.9	140.6	117.9	95.5
.3	179.3	162.8	140.5	117.9	95.4
.4	179.2	162.8	140.4	117.8	95.3
.5	179.0	162.5	140.3	117.7	95.3
.6	179.0	162.5	140.3	117.7	95.3
.7	178.9	162.4	140.2	117.6	95.2
.8	178.8	162.5	140.1	117.5	95.1
.9	178.6	162.1	140.0	117.4	95.0
5.0	176.5	162.0	139.9	117.3	95.0
3.1	176.4	161.9	139.8	117.2	94.9
.2	176.2	161.8	139.7	117.1	94.8
.3	176.1	161.7	139.6	117.1	94.8
.4	176.0	161.5	139.5	117.0	94.7
.5	177.8	161.4	139.4	116.9	94.6
.6	177.7	161.3	139.5	116.8	94.5
.7	177.6	161.2	139.1	116.7	94.5
.8	177.4	161.0	139.0	116.6	94.4
.9	177.3	160.9	138.9	116.5	94.3
4.0	177.2	160.8	138.8	116.4	94.3
4.1	176.9	160.6	138.6	116.5	94.1
.2	176.8	160.4	138.5	116.2	94.0
.3	176.6	160.3	138.4	116.1	94.0
.4	176.5	160.2	138.3	116.0	93.9
.5	176.2	159.9	138.1	115.8	93.8
.6	176.1	159.8	138.0	115.7	93.7
.7	175.8	159.6	137.8	115.6	93.5
.8	175.7	159.5	137.7	115.5	93.5
.9	175.4	159.2	137.5	115.3	93.3
5.0	175.3	159.1	137.4	115.2	93.3

INITIAL ANGLE 30° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
<u>wl = 1346 wl = 1222 wl = 1055 wl = 885 wl = 716</u>					
Degrees Inch - pounds					
.1	175.0	158.8	137.1	115.0	93.1
.2	174.9	158.7	137.0	114.9	93.0
.3	174.8	158.5	136.8	114.8	92.9
.4	174.5	158.4	136.7	114.7	92.8
.5	174.2	158.1	136.5	114.5	92.7
.6	175.9	157.9	136.3	114.3	92.5
.7	175.8	157.8	136.2	114.2	92.5
.8	175.5	157.5	136.0	114.0	92.3
.9	175.3	157.3	135.8	113.9	92.2
6.0	173.0	157.0	135.6	113.7	92.0
6.1	172.7	156.8	135.3	113.5	91.9
.2	172.6	156.7	135.2	113.4	91.8
.3	172.3	156.4	135.0	113.5	91.7
.4	172.0	156.2	134.8	113.1	91.5
.5	171.8	155.9	134.6	112.9	91.4
.6	171.5	155.7	134.4	112.7	91.2
.7	171.2	155.4	134.2	112.5	91.1
.8	171.0	155.2	134.0	112.4	91.0
.9	170.7	154.9	133.8	112.2	90.8
7.0	170.3	154.6	133.4	111.9	90.6
7.1	170.0	154.5	133.2	111.7	90.5
.2	169.8	154.1	133.0	111.6	90.5
.3	169.5	153.8	132.8	111.4	90.2
.4	169.2	153.6	132.6	111.2	90.0
.5	168.8	153.2	132.3	111.0	89.8
.6	168.5	153.0	132.1	110.8	89.7
.7	168.3	152.7	131.9	110.6	89.5
.8	167.9	152.4	131.6	110.3	89.3
.9	167.6	152.1	131.3	110.2	89.2
8.0	167.3	151.9	131.1	110.0	89.0
8.1	166.9	151.5	130.8	109.7	88.8
.2	166.7	151.5	130.6	109.5	88.7
.3	166.3	150.9	130.3	109.3	88.5
.4	166.0	150.7	130.1	109.1	88.3
.5	165.6	150.3	129.8	108.8	88.1
.6	165.3	149.9	129.5	108.7	88.0
.7	164.9	149.7	129.2	108.4	87.7
.8	164.5	149.5	128.9	108.1	87.5
.9	164.2	149.1	128.7	107.9	87.4
9.0	165.8	148.7	128.4	107.7	87.2
9.1	165.4	148.3	128.1	107.4	86.9
.2	165.0	148.0	127.8	107.1	86.7
.3	162.8	147.7	127.5	107.0	86.6
.4	162.3	147.4	127.2	106.7	86.4
.5	161.9	147.0	126.9	106.4	86.2
.6	161.5	146.6	126.6	106.2	85.9
.7	161.1	146.3	126.3	105.9	85.7
.8	160.7	145.9	126.0	105.6	85.5
.9	160.3	145.5	125.6	105.4	85.3
10.0	159.9	145.2	125.3	105.1	85.1

INITIAL ANGLE 30° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
<i>Degrees</i> Inch - pounds					
.1	159.5	144.8	125.0	104.8	84.9
.2	159.1	144.4	124.7	104.6	84.7
.3	158.7	144.1	124.4	104.3	84.4
.4	158.3	143.7	124.1	104.1	84.2
.5	157.9	143.3	123.7	103.8	84.0
.6	157.4	142.8	123.3	103.4	83.7
.7	157.0	142.5	123.0	103.2	83.5
.8	156.6	142.1	122.7	102.9	83.3
.9	156.2	141.7	122.4	102.6	83.1
11.0	155.6	141.3	122.0	102.3	82.8
11.1	155.2	140.9	121.6	102.0	82.6
.2	154.8	140.5	121.3	101.8	82.4
.3	154.3	140.0	120.9	101.4	82.1
.4	153.9	139.7	120.6	101.1	81.9
.5	153.3	139.2	120.2	100.8	81.6
.6	152.9	138.8	119.8	100.5	81.4
.7	152.4	138.3	119.4	100.2	81.1
.8	152.0	138.0	119.1	99.9	80.9
.9	151.4	137.5	118.7	99.5	80.6
12.0	150.9	137.0	118.3	99.2	80.3
12.1	150.5	136.6	117.9	98.9	80.1
.2	150.0	136.1	117.5	98.6	79.8
.3	149.4	135.6	117.1	98.2	79.5
.4	149.0	135.3	116.8	97.9	79.3
.5	148.5	134.8	116.4	97.6	79.0
.6	147.9	134.3	115.9	97.2	78.7
.7	147.4	133.8	115.5	96.9	78.4
.8	146.9	133.3	115.1	96.5	78.1
.9	146.5	132.9	114.8	96.3	77.9
13.0	145.9	132.5	114.4	95.9	77.6
13.1	145.4	132.0	113.9	95.6	77.4
.2	144.8	131.5	113.5	95.2	77.1
.3	144.3	131.0	113.1	94.8	76.8
.4	143.8	130.5	112.7	94.5	76.5
.5	143.2	130.0	112.2	94.1	76.2
.6	142.7	129.5	111.8	93.8	75.9
.7	142.0	128.9	111.3	93.5	75.6
.8	141.5	128.4	110.9	93.0	75.3
.9	140.9	127.9	110.5	92.6	75.0
14.0	140.4	127.4	110.0	92.3	74.7
14.1	139.9	127.0	109.6	91.9	74.4
.2	139.2	126.5	109.1	91.5	74.1
.3	138.7	125.9	108.7	91.1	73.8
.4	138.1	125.4	108.2	90.8	73.5
.5	137.4	124.8	107.7	90.3	73.1
.6	136.9	124.3	107.3	90.0	72.8
.7	136.4	123.8	106.9	89.6	72.6
.8	135.7	123.2	106.3	89.2	72.2
.9	135.2	122.7	105.9	88.8	71.9
15.0	134.5	122.1	105.4	88.4	71.6

INITIAL ANGLE 30° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
<i>Degrees</i> Inch - pounds					
15.1	155.9	121.6	105.0	88.0	71.3
.2	133.3	121.0	104.4	87.6	70.9
.3	132.7	120.5	104.0	87.2	70.6
.4	132.1	119.9	105.5	86.8	70.3
.5	131.4	119.3	105.0	86.4	69.9
.6	130.8	118.8	102.5	86.0	69.6
.7	130.2	118.2	102.0	85.6	69.3
.8	129.5	117.5	101.5	85.1	68.9
.9	128.8	116.9	101.0	84.7	68.5
16.0	128.3	116.4	100.5	84.3	68.3
16.1	127.6	115.8	100.0	83.9	67.9
.2	126.9	115.2	99.5	83.4	67.5
.3	126.3	114.6	99.0	83.0	67.2
.4	125.6	114.0	98.4	82.6	66.8
.5	124.9	113.4	97.9	82.1	66.5
.6	124.5	112.8	97.4	81.7	66.1
.7	123.6	112.2	96.8	81.2	65.7
.8	122.9	111.6	96.3	80.8	65.4
.9	122.2	111.0	95.8	80.3	65.0
17.0	121.6	110.3	95.3	79.9	64.7
17.1	120.9	109.7	94.7	79.5	64.3
.2	120.2	109.1	94.2	79.0	64.0
.3	119.5	108.5	93.7	78.6	63.6
.4	118.7	107.8	93.0	78.0	63.2
.5	118.1	107.2	92.5	77.6	62.8
.6	117.4	106.6	92.0	77.2	62.5
.7	116.7	105.9	91.5	76.7	62.1
.8	115.9	105.2	90.8	76.2	61.7
.9	115.2	104.6	90.5	75.7	61.3
18.0	114.6	104.0	89.8	75.3	61.0
18.1	113.8	103.3	89.1	74.8	60.5
.2	113.1	102.6	88.6	74.3	60.2
.3	112.5	101.9	88.0	73.8	59.7
.4	111.6	101.3	87.5	73.5	59.4
.5	110.8	100.6	86.8	72.8	58.9
.6	110.1	100.0	86.5	72.4	58.6
.7	109.3	99.2	85.7	71.8	58.2
.8	108.5	98.5	85.0	71.5	57.7
.9	107.8	97.9	84.5	70.9	57.4
19.0	107.0	97.1	83.9	70.5	56.9
19.1	106.2	96.4	83.2	69.8	56.5
.2	105.5	95.8	82.7	69.4	56.2
.3	104.7	95.1	82.1	68.8	55.7
.4	103.9	94.3	81.4	68.5	55.3
.5	103.1	93.6	80.8	67.8	54.9
.6	102.4	93.0	80.5	67.5	54.5
.7	101.6	92.3	79.8	66.8	54.1
.8	100.8	91.5	79.0	66.5	53.6
.9	100.0	90.8	78.4	65.7	53.2
20.0	99.2	90.1	77.7	65.2	52.8

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INITIAL ANGLE 30° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
wl= 1346	wl= 1222	wl= 1055	wl= 885	wl= 716	
Degrees	Inch - pounds				
.20.1	98.4	89.5	77.1	64.7	52.4
.2	97.6	88.6	76.5	64.1	51.9
.3	96.8	87.9	75.8	63.6	51.5
.4	96.0	87.1	75.2	63.1	51.1
.5	95.2	86.4	74.6	62.6	50.6
.6	94.4	85.7	74.0	62.0	50.2
.7	93.4	84.8	73.2	61.4	49.7
.8	92.6	84.1	72.6	60.9	49.5
.9	91.8	83.5	71.9	60.3	48.8
21.0	91.0	82.6	71.3	59.8	48.4
.21.1	90.2	81.9	70.7	59.3	48.0
.2	89.3	81.0	69.9	58.7	47.5
.3	88.4	80.3	69.3	58.1	47.1
.4	87.6	79.5	68.7	57.8	46.6
.5	86.7	78.7	67.9	57.0	46.1
.6	85.9	78.0	67.5	56.4	45.7
.7	84.9	77.1	66.0	55.8	45.2
.8	84.1	76.4	65.9	55.3	44.8
.9	83.2	75.5	65.2	54.7	44.3
22.0	82.4	74.8	64.6	54.1	43.8
.22.1	81.4	73.9	63.8	55.5	45.3
.2	80.6	73.2	63.2	53.0	42.9
.3	79.7	72.3	62.5	52.4	42.4
.4	78.8	71.5	61.7	51.8	41.9
.5	77.9	70.7	61.1	51.2	41.5
.6	77.0	69.9	60.3	50.6	41.0
.7	76.0	69.0	59.6	50.0	40.5
.8	75.3	68.3	59.0	49.5	40.0
.9	74.5	67.5	58.2	48.8	39.5
23.0	73.4	66.6	57.5	48.2	39.1
.23.1	72.4	65.7	56.8	47.6	38.5
.2	71.5	64.9	56.0	47.0	38.0
.3	70.5	64.0	55.3	46.4	37.5
.4	69.7	63.3	54.6	45.8	37.1
.5	68.8	62.4	53.9	45.2	36.6
.6	67.8	61.6	53.2	44.6	36.1
.7	66.9	60.7	52.4	44.0	35.6
.8	66.0	59.9	51.7	43.4	35.1
.9	65.0	59.0	51.0	42.7	34.6
24.0	65.9	58.0	50.1	42.0	34.0
.24.1	65.0	57.2	49.4	41.4	33.5
.2	62.1	56.3	48.6	40.8	33.0
.3	61.1	55.5	47.9	40.2	32.5
.4	60.2	54.6	47.2	39.5	32.0
.5	59.2	53.8	46.4	38.9	31.5
.6	58.2	52.8	45.6	38.2	30.9
.7	57.2	51.9	44.8	37.6	30.4
.8	56.3	51.1	44.1	37.0	29.9
.9	55.2	50.1	43.3	36.5	29.4
25.0	54.3	49.2	42.5	35.7	28.9

INITIAL ANGLE 30° PLUS FRICTION

Final angle	Position of Weight				
	1	2	3	4	5
wl= 1346	wl= 1222	wl= 1055	wl= 885	wl= 716	
Degrees	Inch - pounds				
.25.1	53.3	48.4	41.8	35.0	28.4
.2	52.2	47.4	40.9	34.5	27.8
.3	51.3	46.6	40.2	33.7	27.5
.4	50.2	45.6	39.3	35.0	26.7
.5	49.3	44.7	38.6	32.4	26.2
.6	48.2	43.7	37.8	31.7	25.6
.7	47.3	42.9	37.0	31.1	25.1
.8	46.2	41.9	36.2	30.3	24.6
.9	45.2	41.1	35.4	29.7	24.1
26.0	44.2	40.1	34.6	29.0	23.5
.26.1	43.1	39.1	33.8	28.5	22.9
.2	42.1	38.2	33.0	27.7	22.4
.3	41.1	37.3	32.2	27.0	21.8
.4	40.0	36.3	31.3	26.5	21.5
.5	38.9	35.3	30.5	25.6	20.7
.6	38.0	34.5	29.7	25.0	20.2
.7	36.9	33.5	28.9	24.2	19.6
.8	35.8	32.5	28.1	23.5	19.1
.9	34.7	31.5	27.2	22.8	18.5
27.0	33.7	30.5	26.4	22.1	17.9
.27.1	32.6	29.6	25.5	21.4	17.3
.2	31.5	28.6	24.7	20.7	16.8
.3	30.4	27.6	23.8	20.0	16.2
.4	29.3	26.6	23.0	19.3	15.6
.5	28.3	25.7	22.2	18.6	15.0
.6	27.2	24.7	21.3	17.9	14.5
.7	26.1	23.7	20.5	17.2	13.9
.8	25.0	22.7	19.6	16.5	13.8
.9	24.0	21.2	18.8	15.7	12.7
28.0	22.8	20.7	17.8	15.0	12.1
.28.1	21.7	19.7	17.0	14.2	11.5
.2	20.6	18.7	16.1	13.5	11.0
.3	19.5	17.7	15.3	12.8	10.4
.4	18.3	16.6	14.3	12.0	9.7
.5	17.2	15.6	13.5	11.5	9.2
.6	16.2	14.7	12.7	10.6	8.6
.7	14.9	13.6	11.7	9.8	8.0
.8	13.9	12.6	10.9	9.1	7.4
.9	12.8	11.6	10.0	8.4	6.8
29.0	11.6	10.5	9.1	7.6	6.2
.29.1	10.5	9.5	8.2	6.9	5.6
.2	9.3	8.4	7.3	6.1	4.9
.3	8.2	7.5	6.4	5.4	4.4
.4	7.0	6.4	5.5	4.6	3.7
.5	5.9	5.4	4.6	3.9	3.2
.6	4.7	4.3	3.7	3.1	2.5
.7	3.5	3.2	2.7	2.5	1.9
.8	2.4	2.2	1.9	1.6	1.3
.9	1.2	1.1	.9	.8	.6
30.0	0.0	0.0	0.0	0.0	0.0

DIAGRAMMATIC SKETCH OF F.P.L. TOUGHNESS TESTING MACHINE

ZM 44 3F

