THE GOLFWORKS®

Instructions For:
Auditor MOI Speed Match System
Code: **GM1023**

GOLF CLUB MOMENT OF INERTIA MEASURING INSTRUMENT & MOI MATCHING SYSTEM

070206 OPERATION MANUAL
Version 1.1

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PART-1 SETUP AND INSTALLATION

KEYBOARD FUNCTIONS

ZERO Sets current value as the tare weight. Futures measurements will be shown as the difference to the tare weight. Tare weight can be reset by rebooting the machine. Useful for comparing gripped vs non-gripped MOI values etc.

RESET Clears the current measurement and starts the next measurement cycle. Holding Reset while the display is showing the average will clear memory of the previous 5 values.

MODE Unit selector and converter. Holding Mode displays the average value of the past 5 readings.

(+) Changes selected value incrementally. Used to input calibration values, club weight and balance point when in Moi matching mode and calibration.

→ Moves indicator from left to right; used during calibration and MOI matching.

Set Save input values to memory.

i □ Unit and Function indicator

Specifications

Max weight load	750 grams
Maximum moment load Factor*	6
Maximum radius of gyration**	40 inches
Minimum radius of gyration**	25 Inches
Resolution	1/1000
Maximum measurable MOI	5000 Kg.Cm^2
Minimum measurable MOI***	0.005 % TI*
Accuracy	+/- 0.5%
Operating Temperature range	-20~60 C°
AC/DC adapter	9V 500Ma

* Club balance point divided by the club total weight.(Inches and ounces or grams and mm)

** Club balance point must be between 40 and 25 inches measured from the end of the grip cap.

*** given as a percentage of the tare inertia of the system

First time operation:
Upon unpacking the Auditor MOI Speed Match its box. Do not operate the machine straight away.

1) The machine should be installed first on a wobble free, flat and level surface. The machine should be placed away from ventilation vents, direct exposure to sun light and other sources of heat and draft.

2) The machine should be placed away from potential sources of electromagnetic interference such as bench grinders, micro wave ovens etc...

3) Level the machine as accurately as possible using the built in bubble level or a carpenter spirit level for greater accuracy. If the Auditor MOI Speed match is not properly leveled, inertia measurements will be inaccurate.

4) To prevent damaging the spring damped beam the following precautions should be taken.

* Do Not overload the beam. Only measure conventional golf clubs of standard weight; club length must not exceed 48 inches.

* Do not override the side stops that restrict the beam amplitude. Greater Angles will stress the spring, resulting in premature failure.

* When loading a club in the measuring fixture avoid excessive force to prevent twisting the beam.

6) An MOI calibration stick is provided with the machine to ensure the instrument is functioning correctly.

* Do not disassemble the calibration stick end weight.
* Always tighten the two rods correctly to maintain the correct length for the stick.

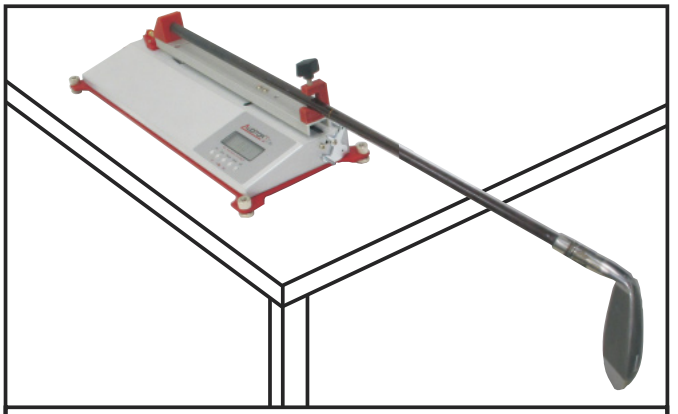
*Do not drop the calibration stick. If the end weight is marred, the MOI calibration value will be affected as a result of the change in geometry of the end weight.

* Do not bend the calibration stick and Store properly.

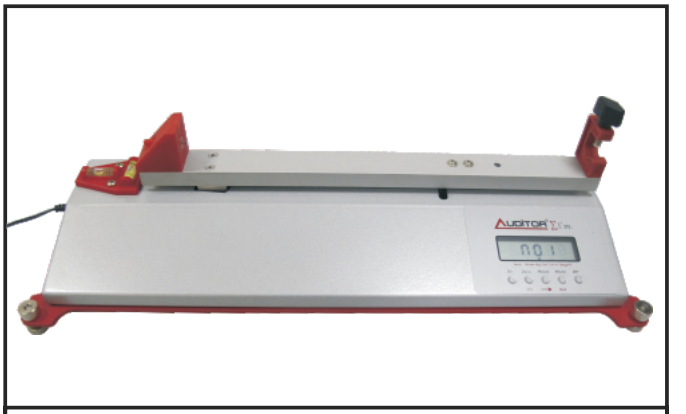
* Do not use the calibration stick for calibrating frequency analyzers, swing weight scales etc..

Calibration stick
Individually calibrated. Refer to value on stick before calibrating the Auditor MSM.

PART-2 INSTRUMENT & CALIBRATION CHECK

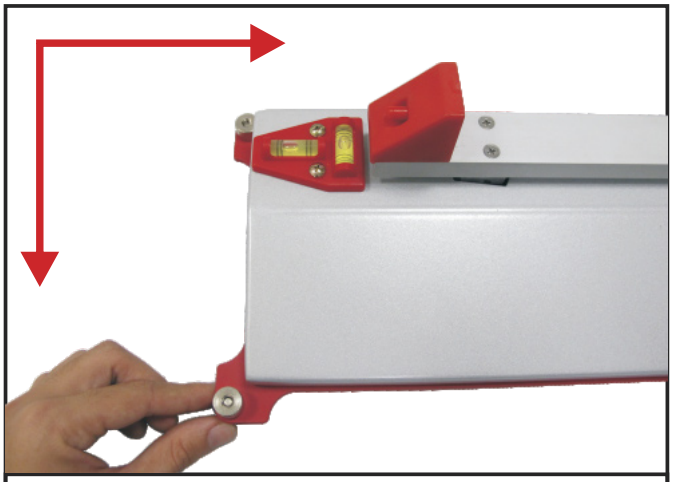


Locate the Auditor MSM on a work surface near the edge to facilitate the mounting and un-mounting of golf clubs. Enough clearance should be provided for the longer clubs.

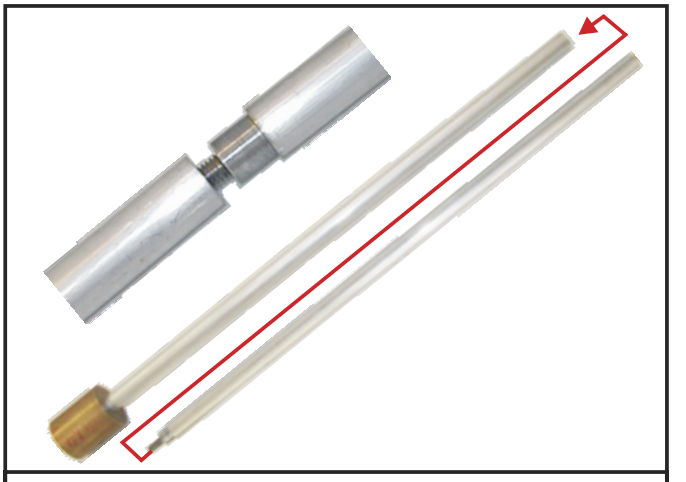


MOI
● ON

Plug in the power supply and turn the instrument to ON. The Caption MOI will show on the Display.



Level the Auditor MSM as accurately as possible using the built in bubble level. Leveling the instrument is done by dialing the leveling feet.



Assemble the calibration stick and tighten the two rod sections together. The Calibration value is inscribed on it for easy reference.

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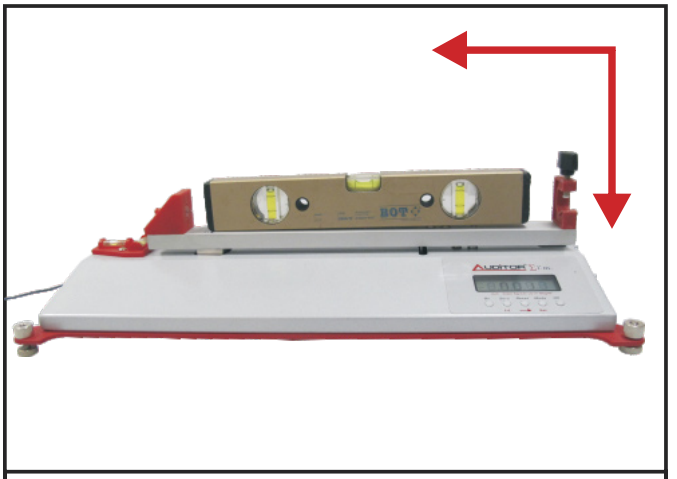
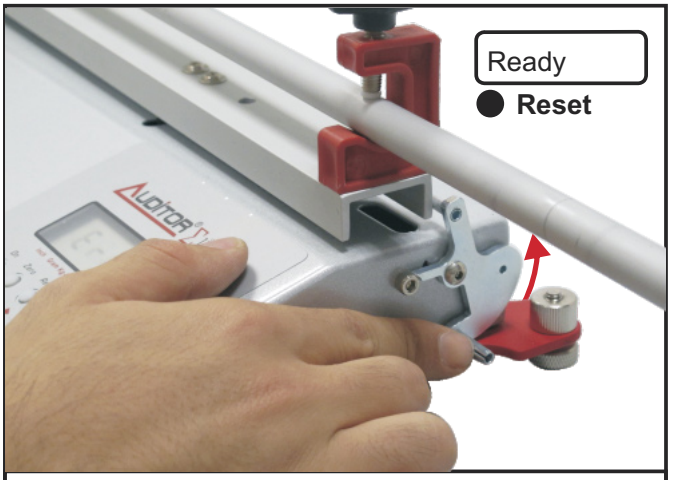
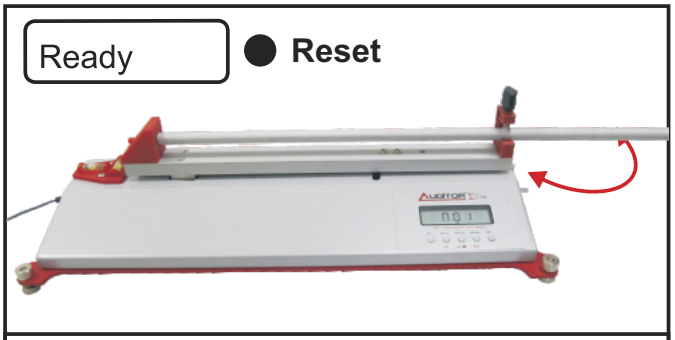


To improve the instrument's accuracy, the use of a precision spirit level is recommended. Leveling must be done both along and across the beam.



Mount the calibration stick on the Auditor MSM and push the trigger as far as it will go. Release the trigger and press the reset button.

PART-2.1 INSTRUMENT & CALIBRATION CHECK



The Calibration stick will oscillate gently for 3 cycles before the measured MOI value is displayed. Note the value mentally and press the reset button to take a second and a third reading.

The MOI measurement is in $Kg.Cm^2$ by default. $Slug.Ft^2$ and $lbs.Ft^2$ are also available; press MODE to toggle between the 3 different units.

Example

1) Mount the calibration stick on the instrument and initiate the count cycle.

RESET	2.580.0
RESET	2.580.5
RESET	2.581.5

The difference between the three consecutive readings Maxima and minima is less then 0.05% of the calibration value. When all three readings are within 1% of the calibration value the instrument is setup correctly and does not require calibration.

Important Note:
The oscillations imparted to the beam decays over time due to gravity and air friction. This introduces small errors into the measured inertia values. A maximum of three counts taken at the beginning of the cycle and at short interval are sufficient.

When placing a club on the beam it is not necessary to secure the club with the thumb screw as long as the club's toe points towards the ground and does not wobble during oscillation.

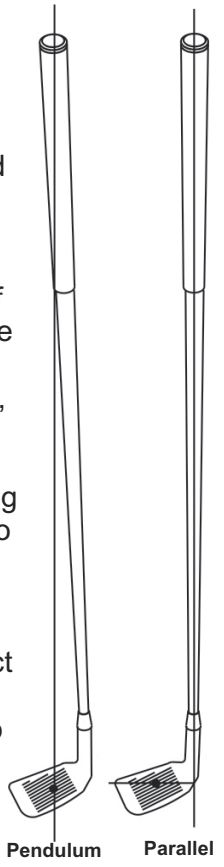
POSITIONING THE GOLF CLUB

For those club-makers familiar with MOI measurements using the pendulum method, the golf club lays on a plane controlled by the club head center of gravity. This, in fact, shortens the effective pendulum length which is not taken into account when calculating the inertia of the golf club using the standard pendulum equation, since the balance point of the club is measured parallel to the shaft centerline and not parallel to the pendulum plane.

This small error in the effective pendulum length, results in a MOI slightly larger then the true MOI. The effective pendulum length and experimental errors can add up to 2~3% of the effective MOI.

When measuring the MOI of a golf club using the direct method on the Auditor MSM, the golf club lies parallel to the principal inertia axis, with the club head balance point parallel to it. This fact must be taken into account when comparing MOI results gathered using the two methods.

It must be noted that when measuring the MOI using the direct method on the Auditor MSM, the reduction in golf club length due to shaft bending under load will also result in small experimental errors.



PART-3 COMPARING THE MOI OF 2 CLUBS

Mount the 1st club on the beam and take an MOI reading. Press **ZERO** to tare the displayed value and remove the club. Mount the 2nd club on the instrument and take a measurement. The reading is the MOI difference between the two clubs.

Example

1) Mount the 1st club on the instrument and initiate the count cycle.

RESET	2.300.0	ZERO

2) Remove the 1st club and mount the 2nd club on the instrument and initiate the count cycle.

RESET	0056.0

The display shows the MOI difference between the two clubs.
The MOI of club 2 = 2300 + 56 = 2356

3) To measure more clubs after the second club, press Zero, mount the 3rd club on the instrument and initiate the count cycle.

RESET	0044.0

Note that the MOI displayed is not the difference between club 3 and club 1, nor is it the difference between club 3 and 56. The value displayed is the MOI difference between Club 2 and Club 3.
Hence, The MOI of Club 3 = 2356 + 44* = 2400

This allows you to measure the MOI of a set of clubs and the MOI difference between each club without requiring external calculations.

ERR DU

This error occurs when the MOI difference between the two clubs is very small and thus exceeds the resolution of the instrument

*The displayed MOI difference is positive if the measured value is larger than the tare value and negative if the measured value is smaller.

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It must be noted that the tare value MOI (ZERO) cannot equal the calibration MOI. This causes a divide by zero error and the solution cannot be resolved. When the error occurs the instrument must be re-started. To clear the tare value.

PART-3.1 MOI MATCHING OF A SET OF CLUBS

Step-1

MODE	On	NOIn

Do not release the Mode button until the function is initiated

Step-2

MODE	F nOI	MODE	00000

Step-3
Mount the favorite club on the Auditor MSM. When done, push the trigger until it reaches a stop, and release the trigger. Press **RESET** to start the count cycle.

1639.5

Step-4

MODE	NOI 2	MODE	00000

Mount the club that needs MOI matching on the instrument, and initiate a count cycle.

RESET	00000	1638.1	MODE
N LOC	MODE	00.00	

Inch

Use the **ZERO** and the **RESET** key to enter the Distance in inches from the grip end to where additional weight can be added or removed from the club head. For this example additional weight can be located 32 inches from the grip down the shaft.

32.00	MODE	0.40

Gram

In this example an MOI match between the favorite club and the club that needs matching requires that 0.40 grams be added 32 inches from the grip end.

Step-5
To match additional clubs to the favorite club MOI repeat **step-4.** If you wish to terminate the MOI matching mode turn the instrument to **OFF**

PLEASE NOTE:
1) The Standard units for when in MOI matching mode are $Kg.Cm^2$, Grams and inches. It is not possible to convert to $Lb.In^2$ or ounces.

2) The **reset** key can be used any time during a measuring cycle to Interrupt the cycle or to re-take a 2nd measurement for verification purposes. Pressing the mode key will automatically save the last measurement to memory for further computations.

Natch

When one of the clubs to be MOI matched has the same Moi as the favorite golf club the caption "Match" will appear on the display. Press **MODE** to resume MOI matching another club in the set.

ENTERING THE MASS LOCATION (Inches only)
To input the distance from the grip end to where additional **can be added or removed from the club head use the ZERO** and the **RESET** key as follows:

ZERO (+)	Each press will increment the active digit by one from 1-9
RESET-->	Each press will activate the next digit to the right.

PART-4 AUDITOR MSM CALIBRATION

The Auditor MSM requires calibration at regular intervals. The procedure assumes that the instrument is properly leveled. Prior to calibration, ensure that the instrument is still, since outside factors such as wind draft may interfere with the calibration. The calibration stick should be inspected and the calibration value known before initiating the procedure.

Step-1 Hold down **Reset** & **Mode** simultaneously while pressing the **On** button. Do not release the **Reset** and **Mode** buttons until LASEr is displayed.

RESET	MODE	On	LASEr

Step-1.2

Press the MODE button to skip the laser alignment steps.

MODE	Cal p1

Step-2

MODE	00000

Step-3 Use the trigger to initiate a count cycle (**Do not place the calibration stick on the beam**)

Step-3.1

RESET	00000	0.2660
RESET	00000	0.2660
RESET	00000	0.2660

All three readings should yield the same result +/- 1.
If the results do not agree. Repeat **step 3** through 4.
If the results agree, proceed to next step.

Step-4

MODE	CAL P2

Step-5 Place the calibration stick on the beam.

Step-6

MODE	00000

Step-7 Push trigger until it stops and release

Step 7.1

RESET	00000	1.3037
RESET	00000	1.3038
RESET	00000	1.3040

All three readings should yield the same result +/- 3.
If the results do not agree. Repeat **Step 7**.
If the results agree proceed to next step.

Step-8

MODE	C nOI
MODE	2580.0

This is the calibration stick value as set at the factory. If the calibration stick value matches the value displayed, press **Mode** To finish. The instrument will shut down and restart automatically. If the calibration value does not match the value stated on the calibration stick, proceed to the next step.

Step-8.1

MODE	C nOI
MODE	2580.0

If the Instrument MOI calibration value and the calibration stick value do not match, proceed as follows:

ZERO (+)	Each press will increment the active digit by one from 0 to 9
RESET-->	Each press will activate the next digit to the right.

Enter the MOI calibration stick value as written on the Calibration stick.

Step-9

MODE	NOI

The instrument will shut down and restart automatically.

Step-10

With the calibration stick still on the beam, push the trigger until it stops and release.

RESET	00000	2579.5
RESET	00000	2580.0
RESET	00000	2580.5

All three readings should yield the same result within 1%. The Auditor MSM is now calibrated.

You may wish to continue working or you can turn off the instrument. The settings will not be lost.

Remark

During the calibration procedure, it is not possible to skip between settings and the procedure must be followed exactly as directed.

If a step is missed, the calibration procedure must be repeated all over again.

PART-5 ALIGNING THE LASER

The Auditor MSM is shipped with the laser already aligned. However there are instances where re-aliging the laser must be carried out to restore the accuracy of the MOI measurements taken. This procedure is recommended when:

1- The MOI measurements taken are not very repeatable. Before initiating the procedure, you need to check that the measuring methodology used is as described in the previous sections. Also check that the MOI instrument is leveled correctly.

2- The beam is suspected to be out of alignment.

3- The “bad run” error message appears to persist after several attempts to measure the MOI of a golf club.

Step-1.1 In order to align the laser you will need the small M4 Allen wrench provided with the instrument.

Step-1.2 Before aligning the laser the Auditor MSM should be placed on a sturdy, wobble free work top and leveled as accurately as possible. Aligning the laser while the instrument is not level will introduce large measuring errors. A spirit level or digital level indicator will help greatly.

Step-2 (Reset Mode) must be pressed down simultaneously and hold while pressing the **On** button. Do not release the **zero & reset** mode buttons for at least **5** seconds until LASEr is displayed.

RESET	MODE	On	Laser

Step-2.1

Locate the laser aligning screw on the back of the instrument opposite the LCD display. Turn the screw gently counter-clockwise 2~3 turns maximum until solid arrows appear on the LCD.

Step-2.2

The arrows indicate that the laser is not shuttered. Now turn the adjustment screw clockwise about 2 turns until the arrows on the display start flashing intermittently. **Stop turning!** The flashing arrows indicate that the laser is not shuttered.

Flashing arrows

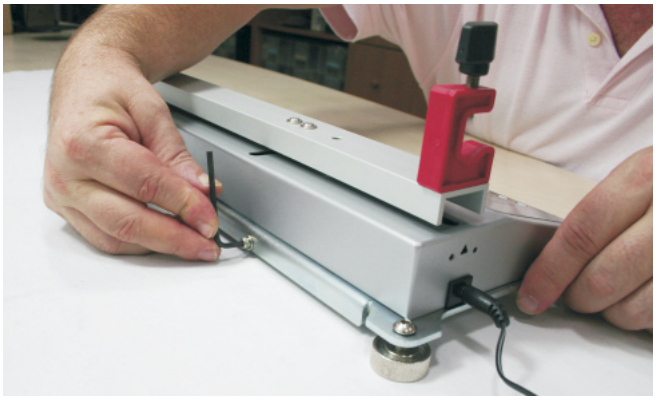
Step-2.3

With the arrows flashing turn the adjustment screw an additional 1/4 turn gently until the arrows disappear, noting that the beam should be **motionless**. The laser is now aligned. Press the **Off** button and restart the instrument.

Please note:

1-The laser alignment procedure requires that the beam be held motionless. A very small oscillation may be tolerated. Holding the beam in alignment during the procedure with items such as sticky tape is counterproductive, and will lead to large measuring errors.

2-The screw driven alignment platen on which the laser is mounted has been finely adjusted to offer a moderate amount of resistance when sliding. Loosening / tightening the platen screws is not recommender.

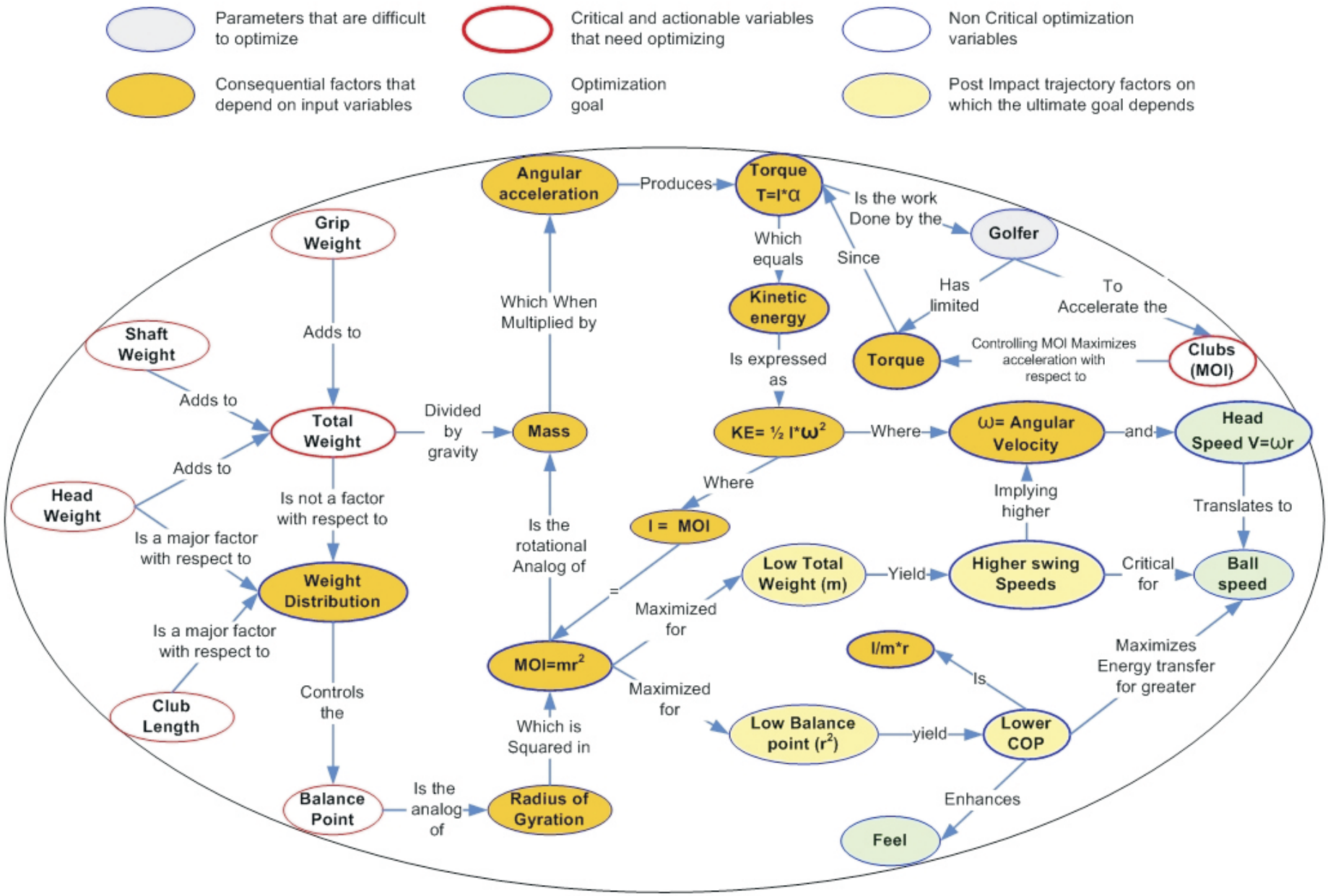


Step 2.1 Turn adjustment screw counter clockwise from 3 O’clock to 9 O’clock until solid arrows appear on the LCD. A max of 2~3 turns is sufficient

Step 2.2 Turn adjustment screw clockwise from 9 O’clock to about 2 O’clock until arrows start flashing.

Step 2.3 Turn screw an additional 1/4 turn or until the arrows disappear. The beam should be motionless. Turn the instrument to OFF when done and back to ON again. The laser is now aligned.

GOLF CLUB MOMENT OF INERTIA "MOI"



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