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سایت آموزش مهندسی مکانیک ایران

Golf Ball Speed Analysis Apparatus

ENGR 196 Honors Project, Dec. 2001

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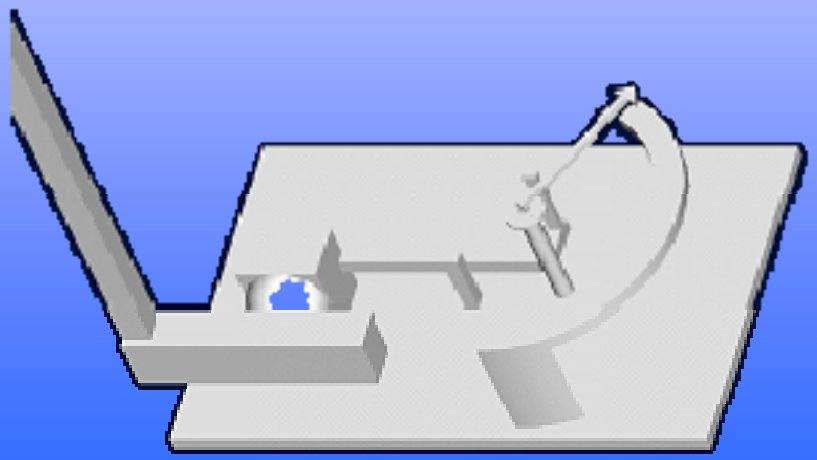


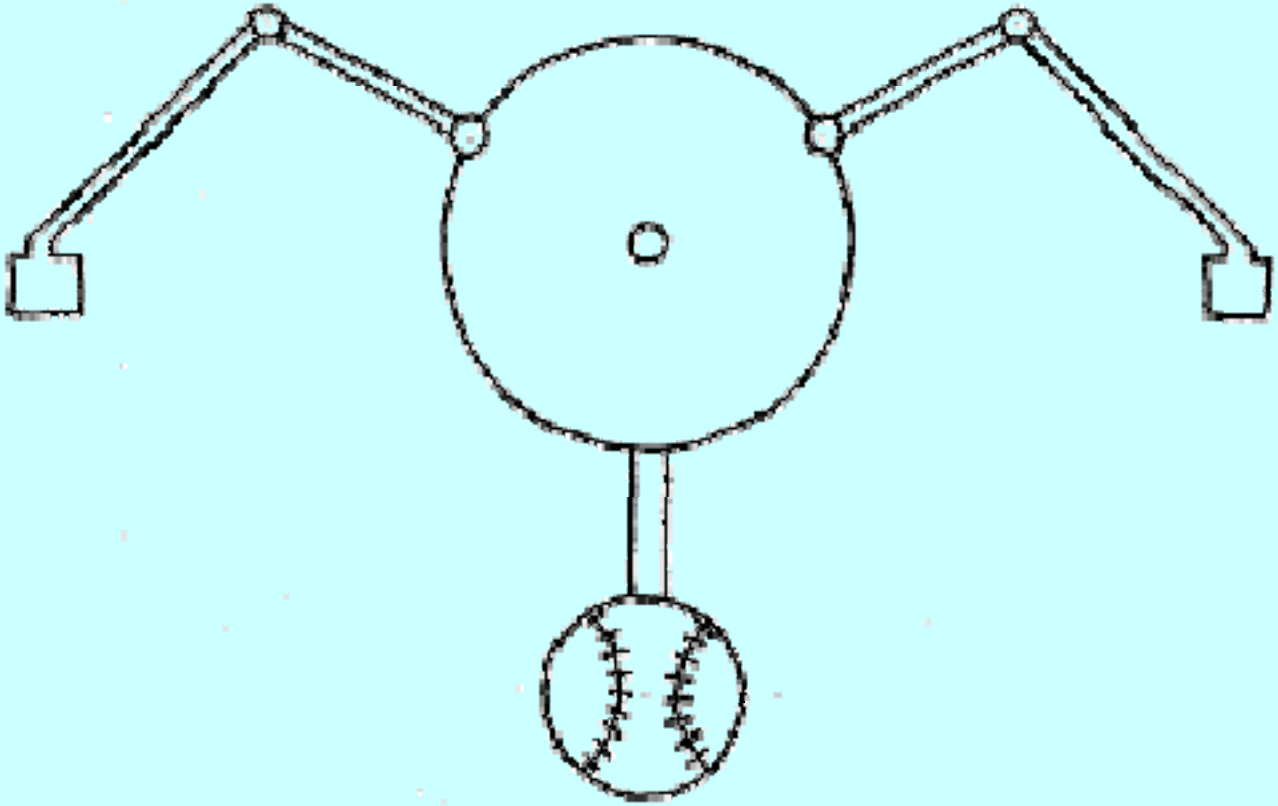
Outline of Presentation

- Original Intent
- 1st conceptual design
- Flaws in 1st design
- 2nd conceptual design
- Flaws in 2nd design
- Motion of apparatus
- Final design
- Changes to final design
- Components
- Animation at 30°
- Animation at 25°
- Graphs of acceleration, velocity, forces, and position
- Limitations
- Possible Improvements

Original Intent of Project

- Find speed of baseball after being hit by a bat.
- Slow the measuring apparatus down.
- Design apparatus to have relatively no vibration.

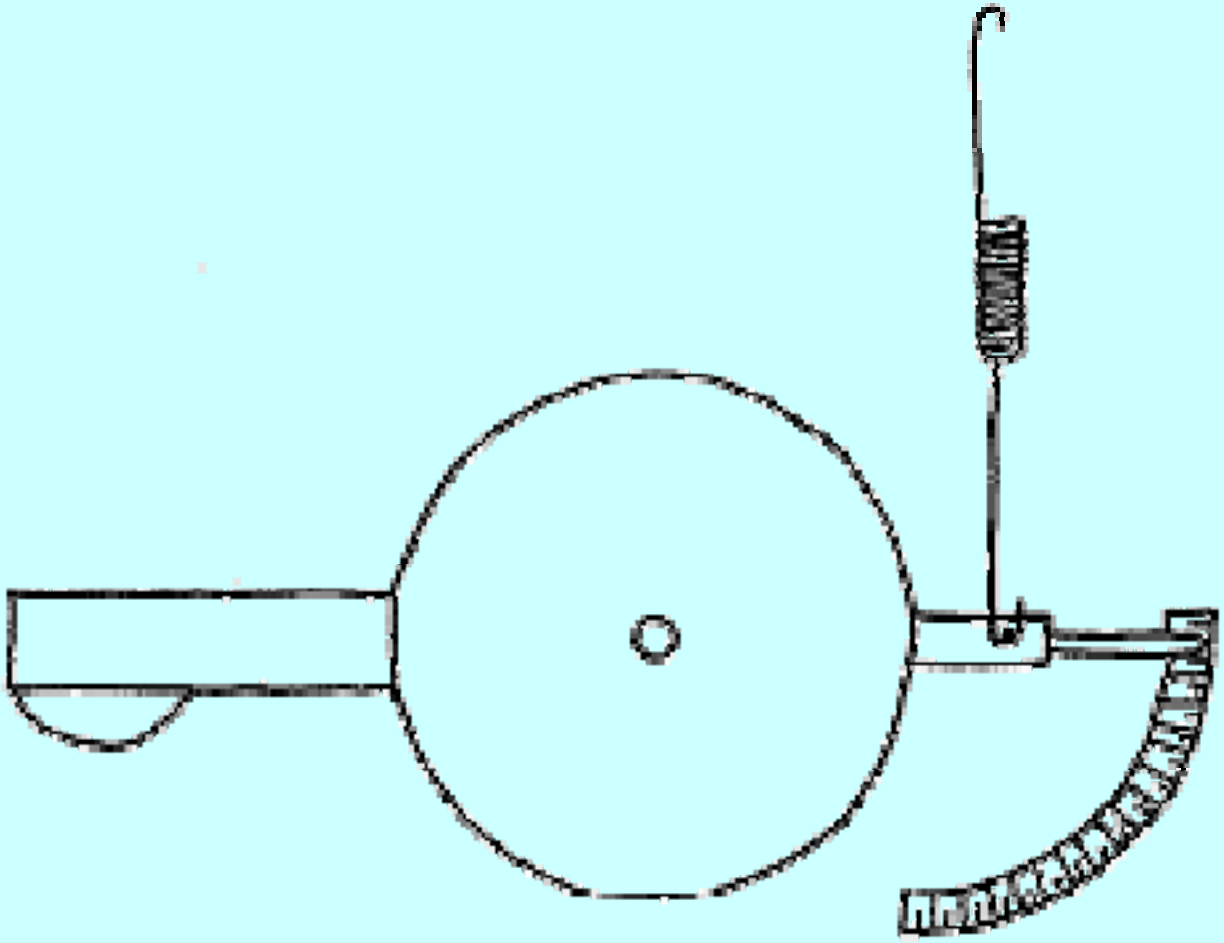
1st Design



Flaws in 1st Design

- The parts would have to be big to with stand speed.
- The arms used to slow the mechanism down may fly apart.
- The joints would not be pin joints, instead they would have to pivot.

2nd Design



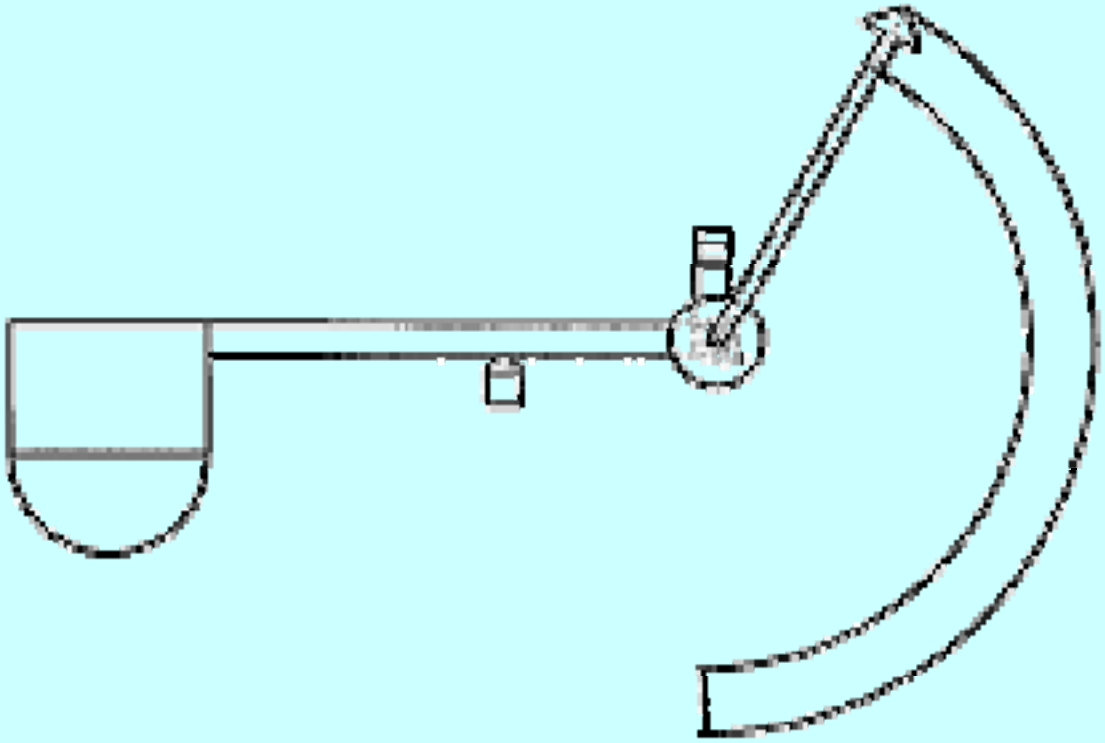
Flaws In Second Design

- The spring would have a large recoil velocity.
- The recoil velocity could injure the player or break his equipment.
- The parts would have to be rigid and strong for their size.

Motion of Apparatus

- Forces applied by the putter to the ball.
- Ball arm pivots on center shaft, while arrow indicates speed of initial impact.
- Spring attached to ball arm counteracts the initial impact of the putter.
- Ball returns to initial position.

Final Design



Changes In Final Design

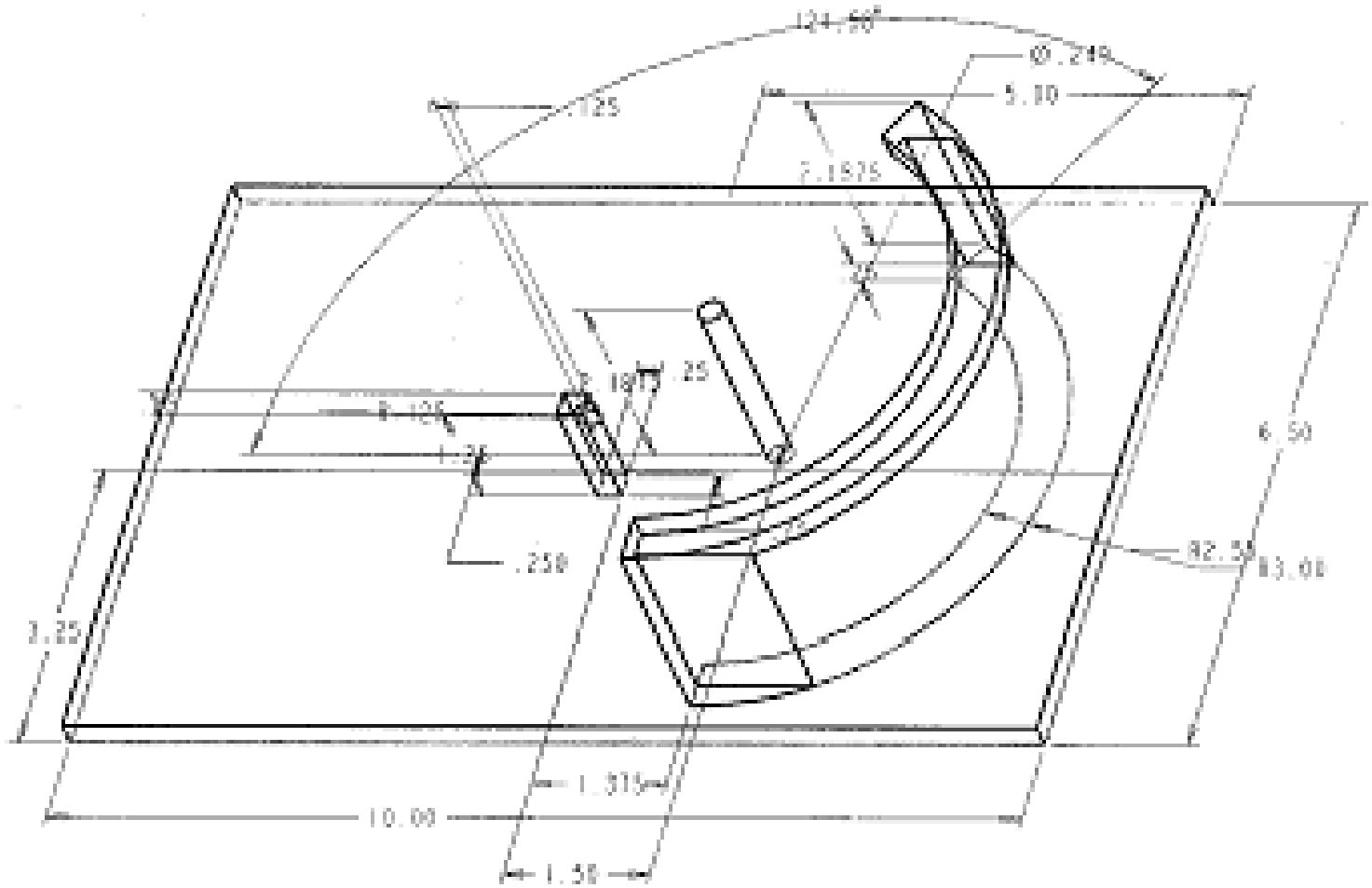
(Throughout Process)

- Removed the spring from the shaft.
- Connected arrow to the ball-arm.
- Added half-sphere to the stop.

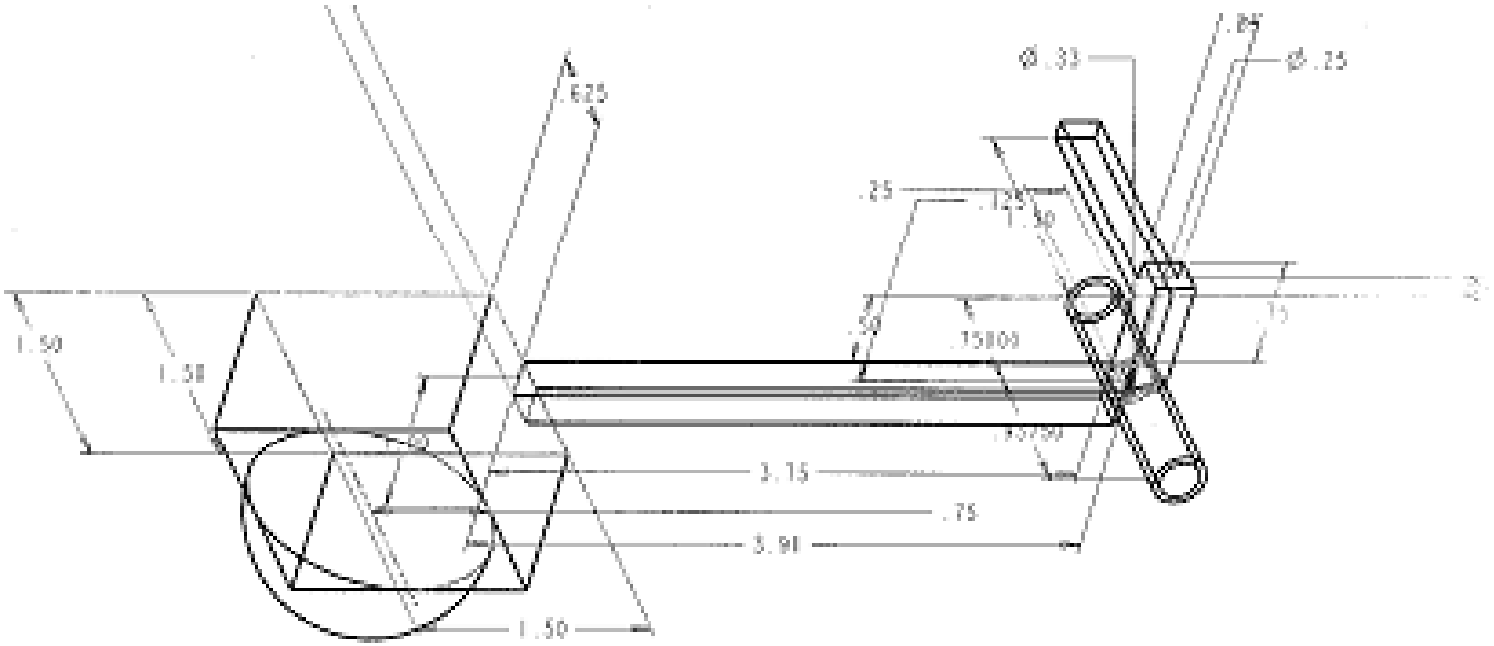
Components of Final Design

- Base Feature
- Ball-Arm
- Top Retainer
- Indicator Arrow
- Putter
- Spring (Removed from final assembly do to complications in Pro Mechanica).

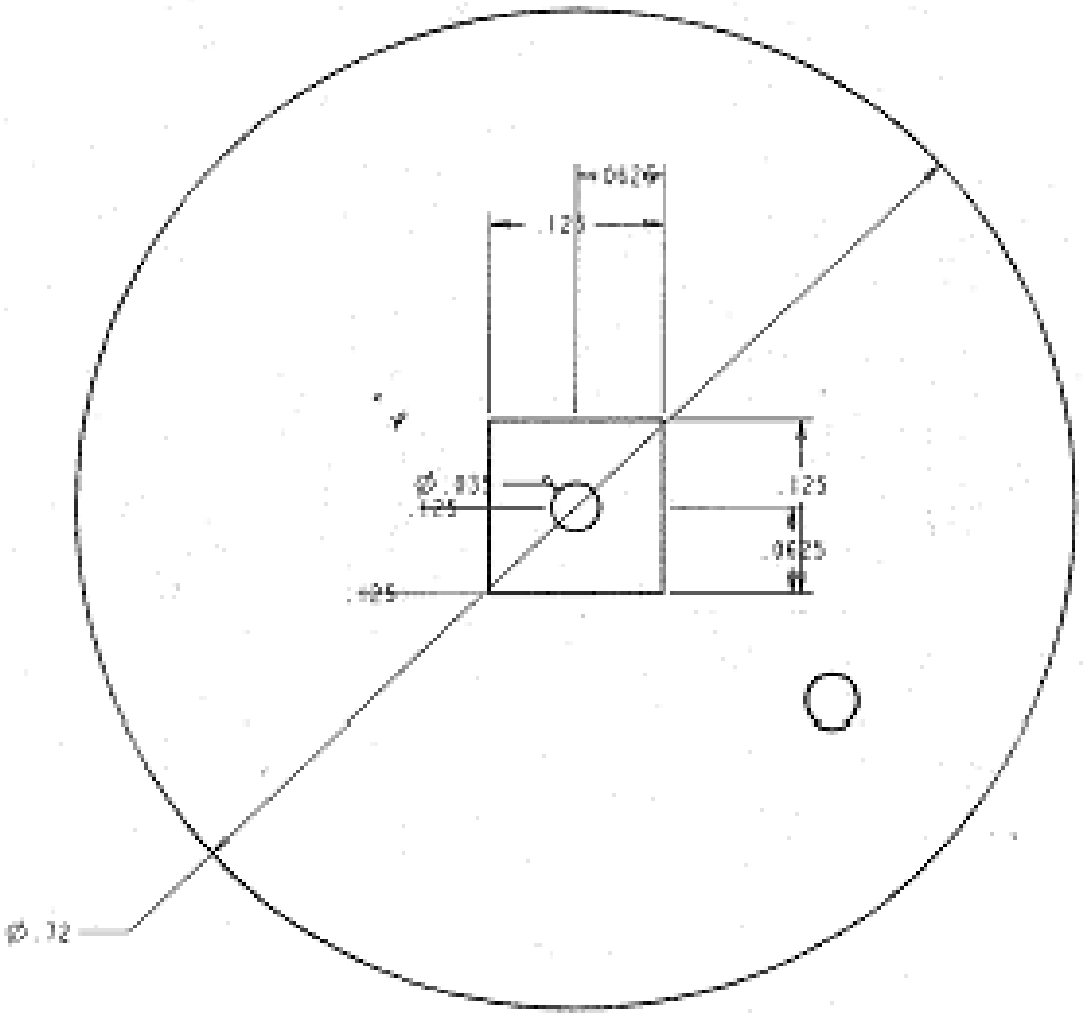
Base Feature



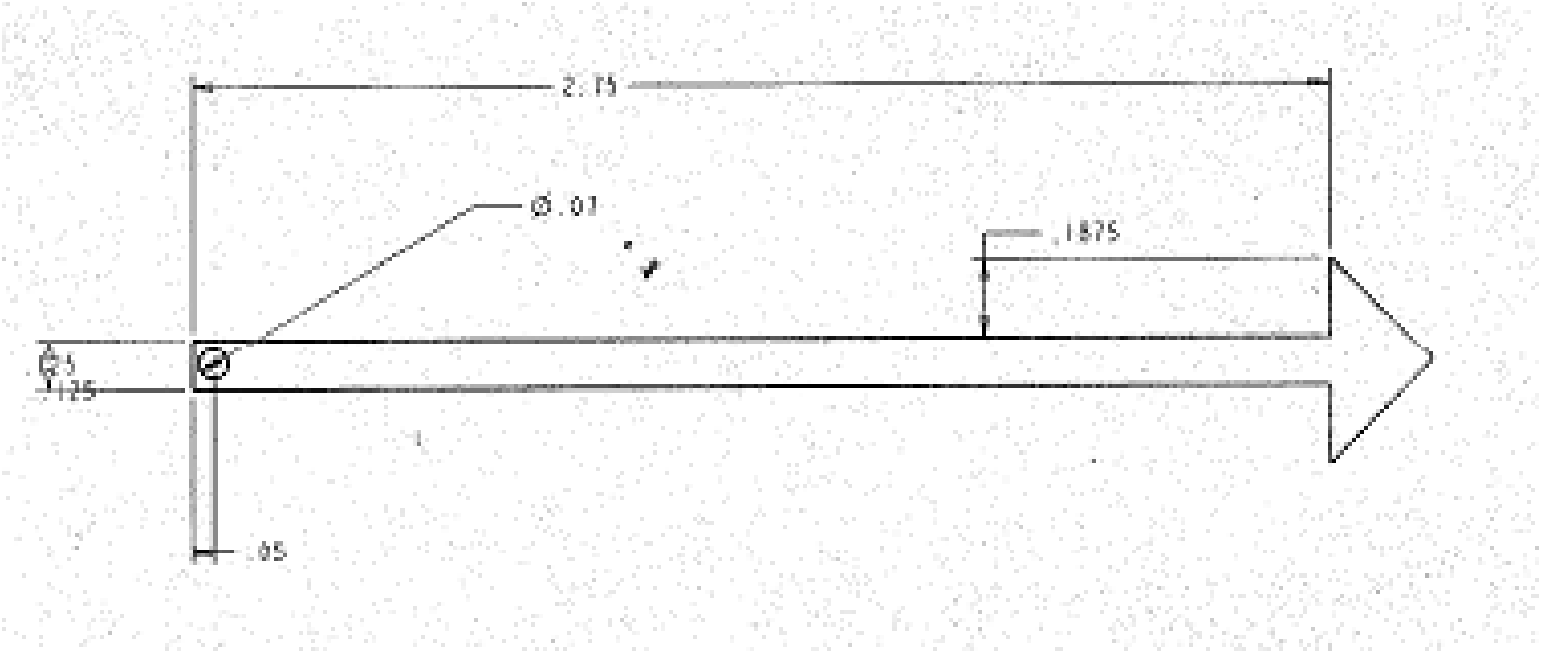
Ball-Arm



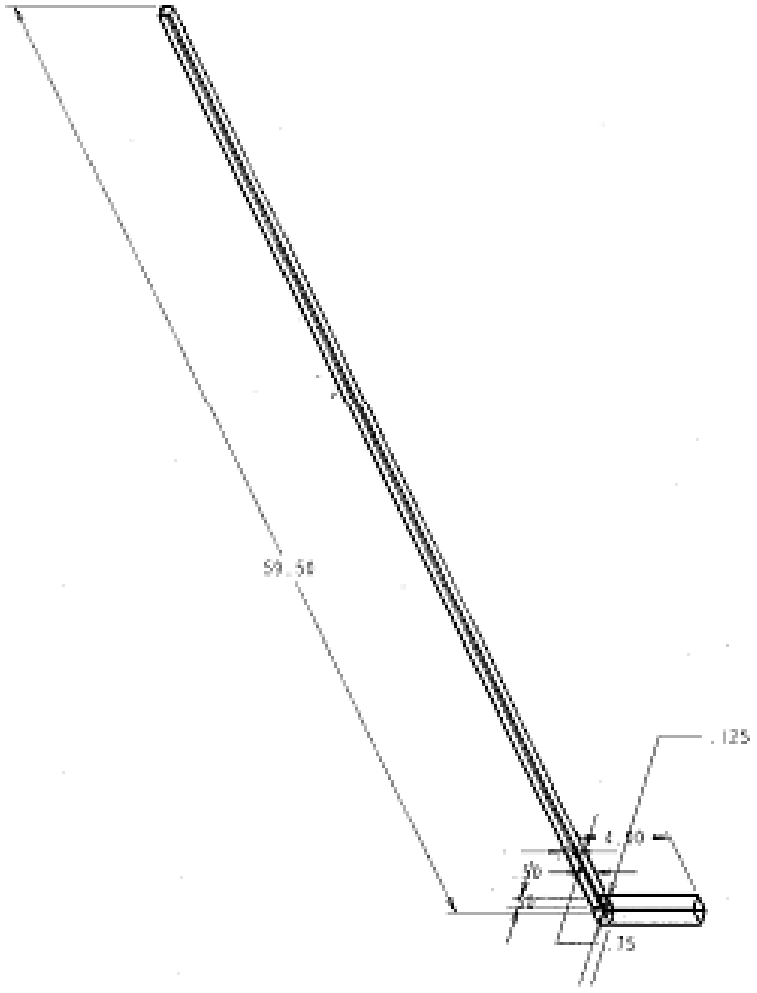
Top Retainer



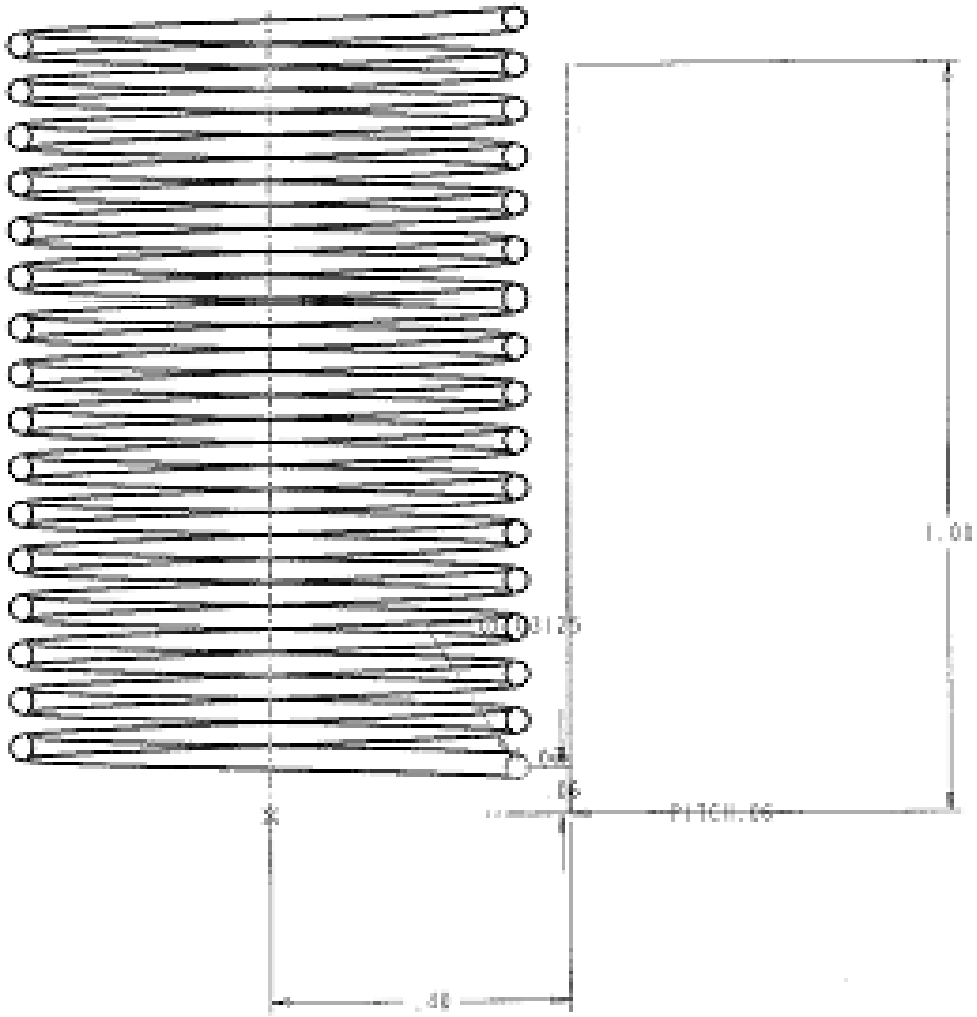
Indicator Arrow



Putter



Spring



Assembly

- Aligned center axis of base feature with center axis of the ball-arm.
- Mated the ball-arm, indicator arrow, and top retainer.

Initial Conditions

Putter

- $Angle_1$ = 0.5236 radians
- Velocity = 0.17244 radians per second

- $Angle_2$ = 0.4363 radians
- Velocity = 0.17244 radians per second

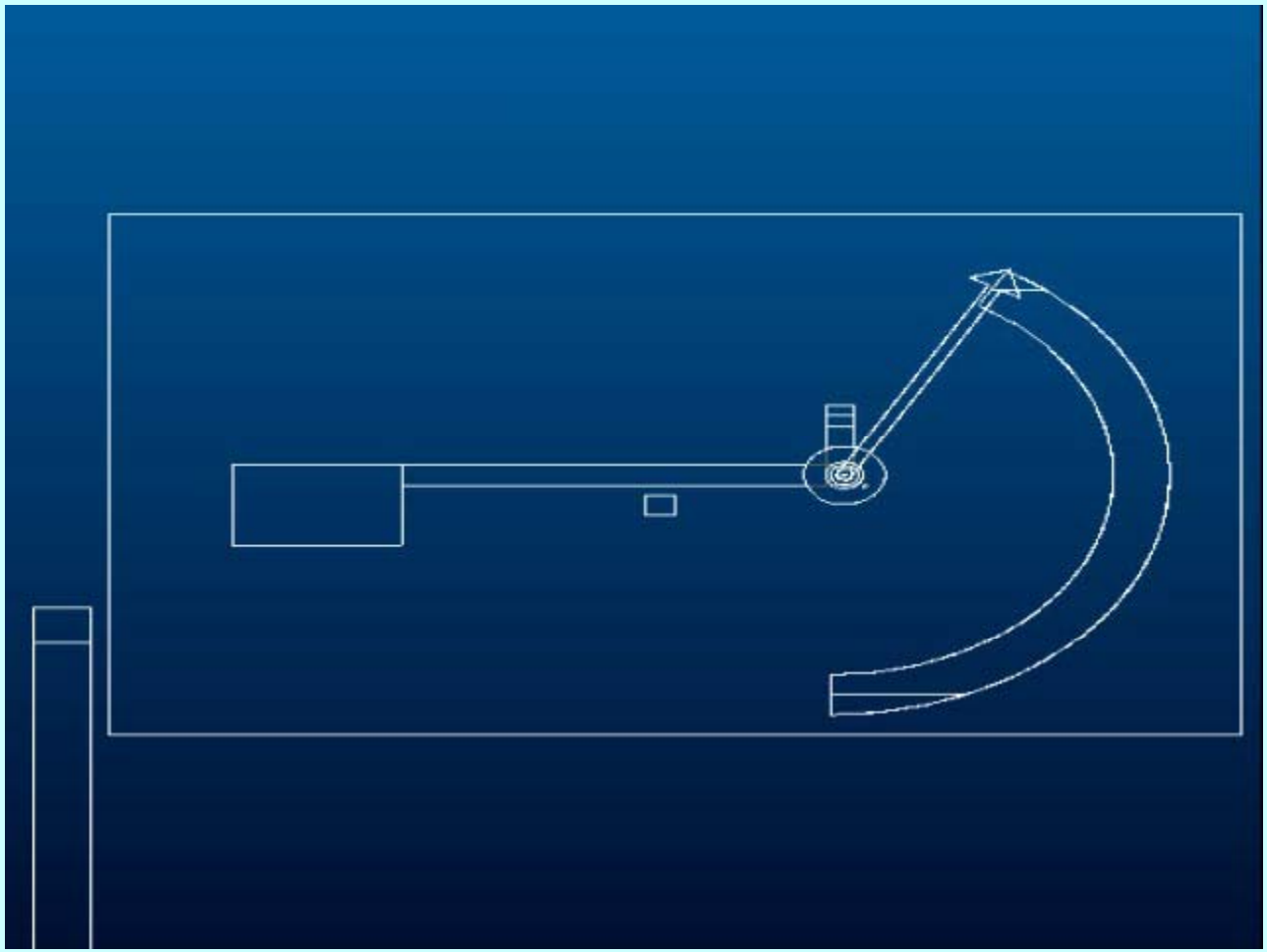
Ball arm

- $Angle_1$ = 0 radians
- Velocity = 0 radians per second

- $Angle_2$ = 0 radians
- Velocity = 0 radians per second

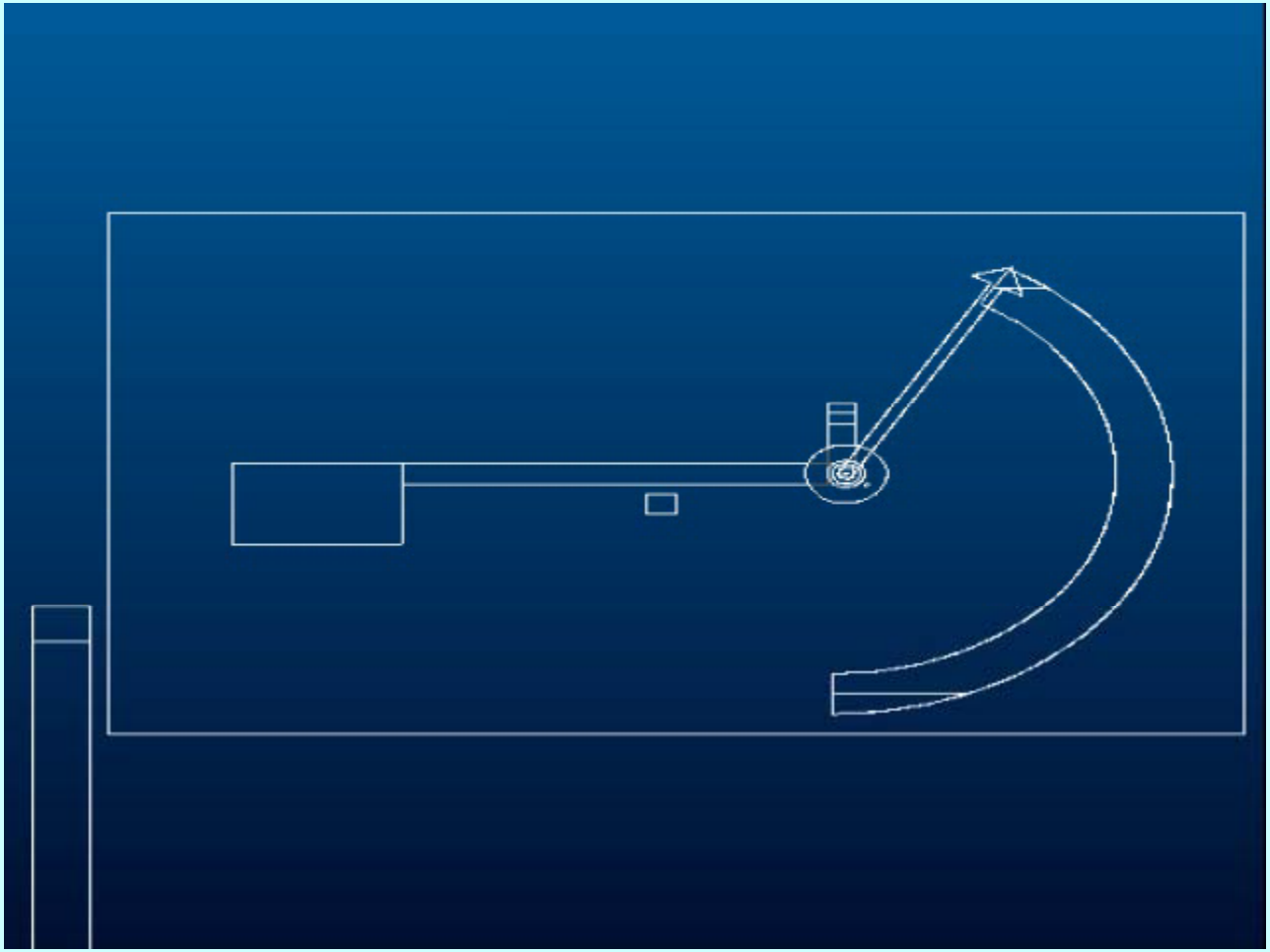
Animation at 30º

(click on image)



Animation at 25º

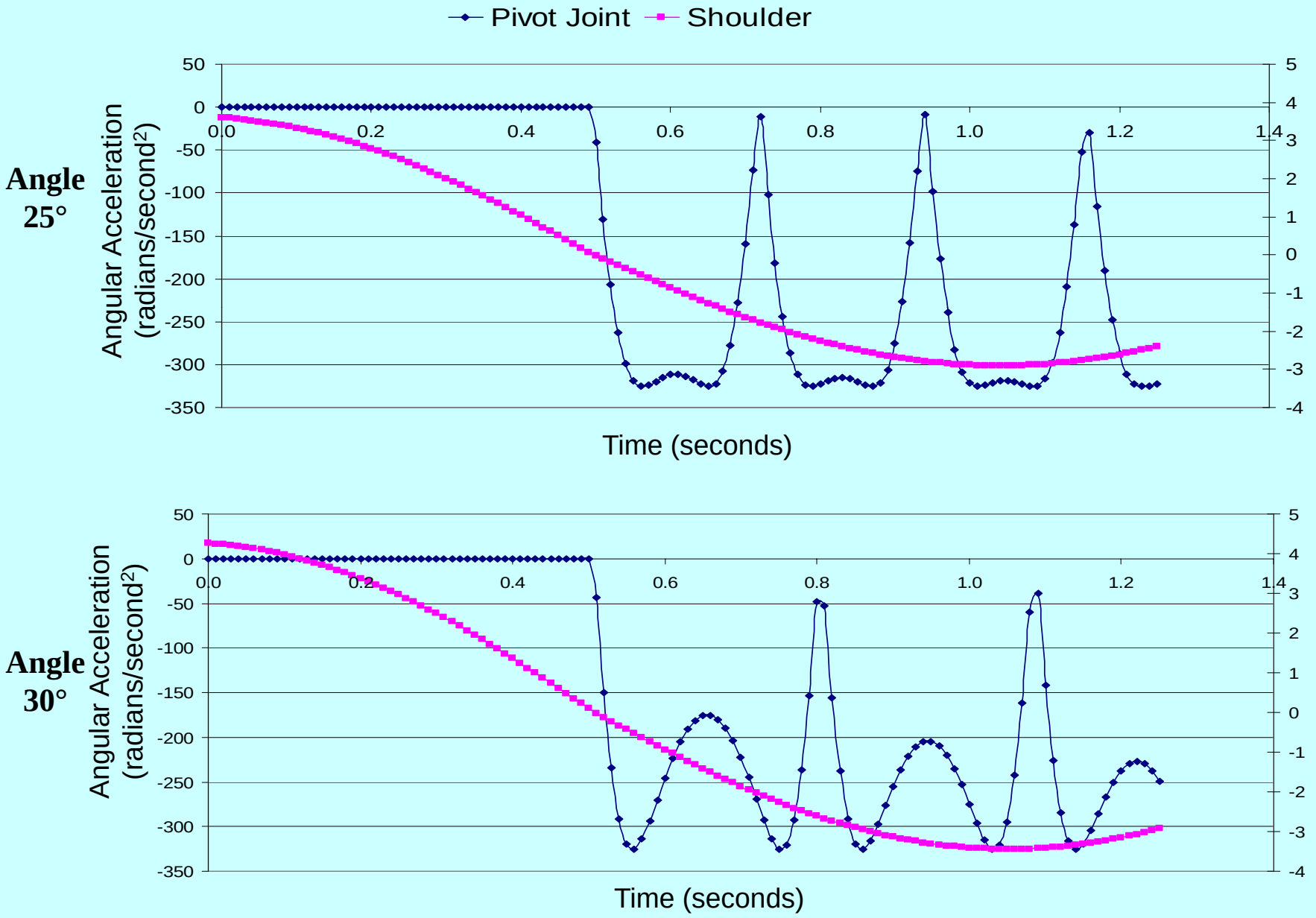
(click on image)



Results

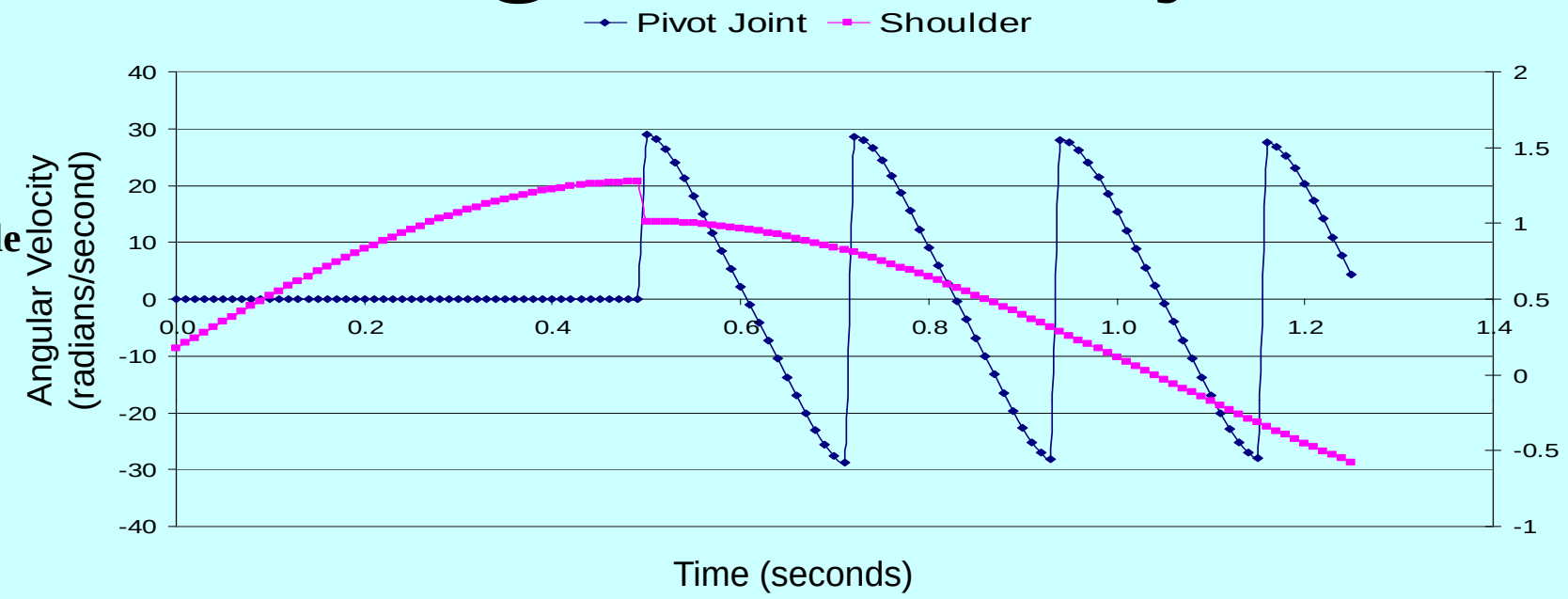
- Angular Acceleration
- Angular Velocity
- Joint Force
- Joint Torque
- Shoulder Force
- Shoulder Torque
- Point Acceleration
- Point Position
- Point Velocity

Angular Acceleration

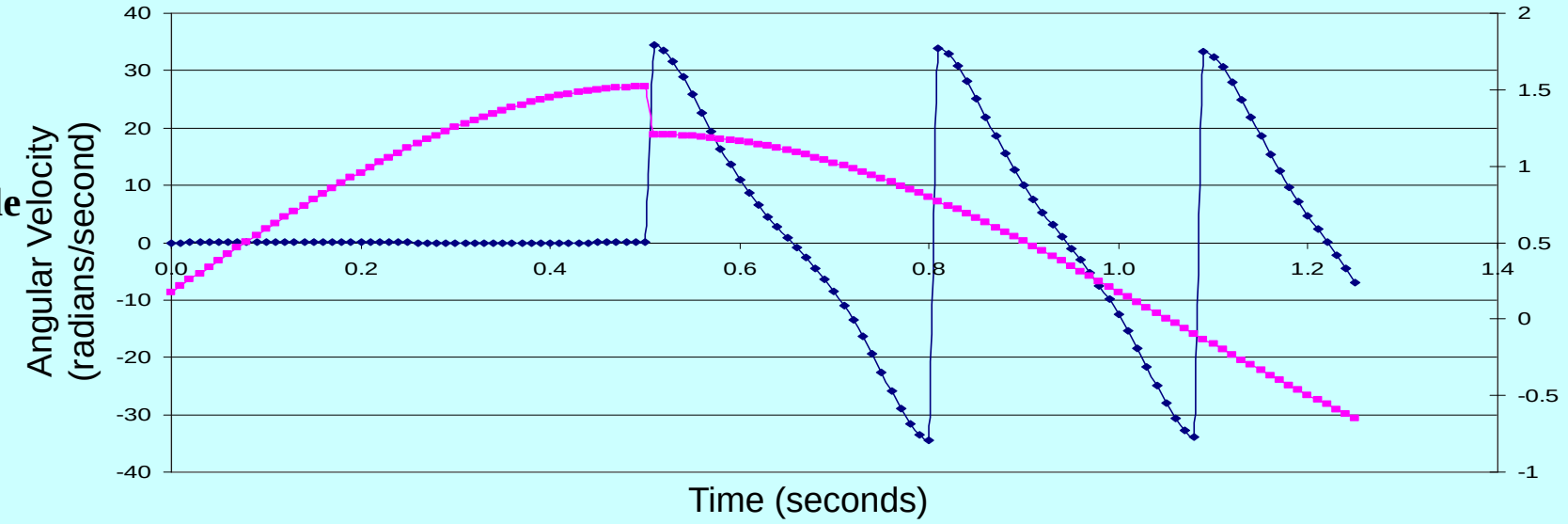


Angular Velocity

Angle 25°

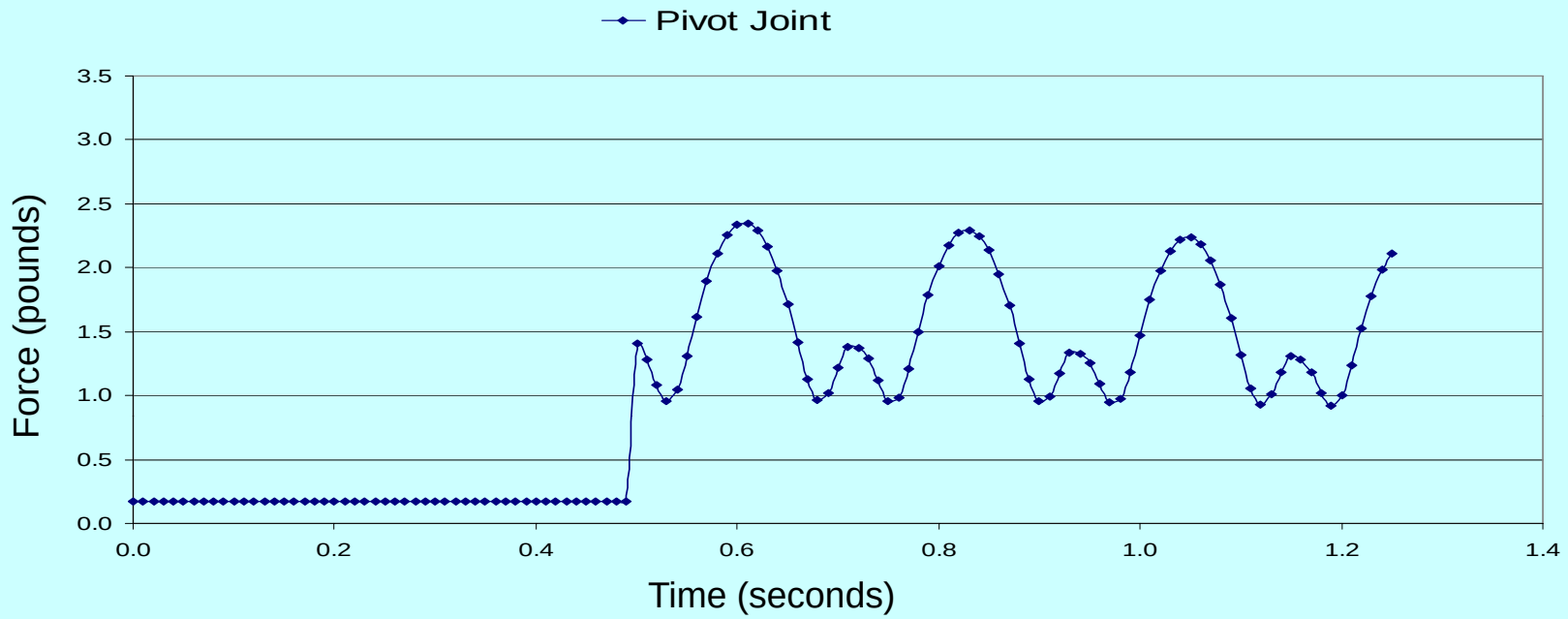


Angle 30°

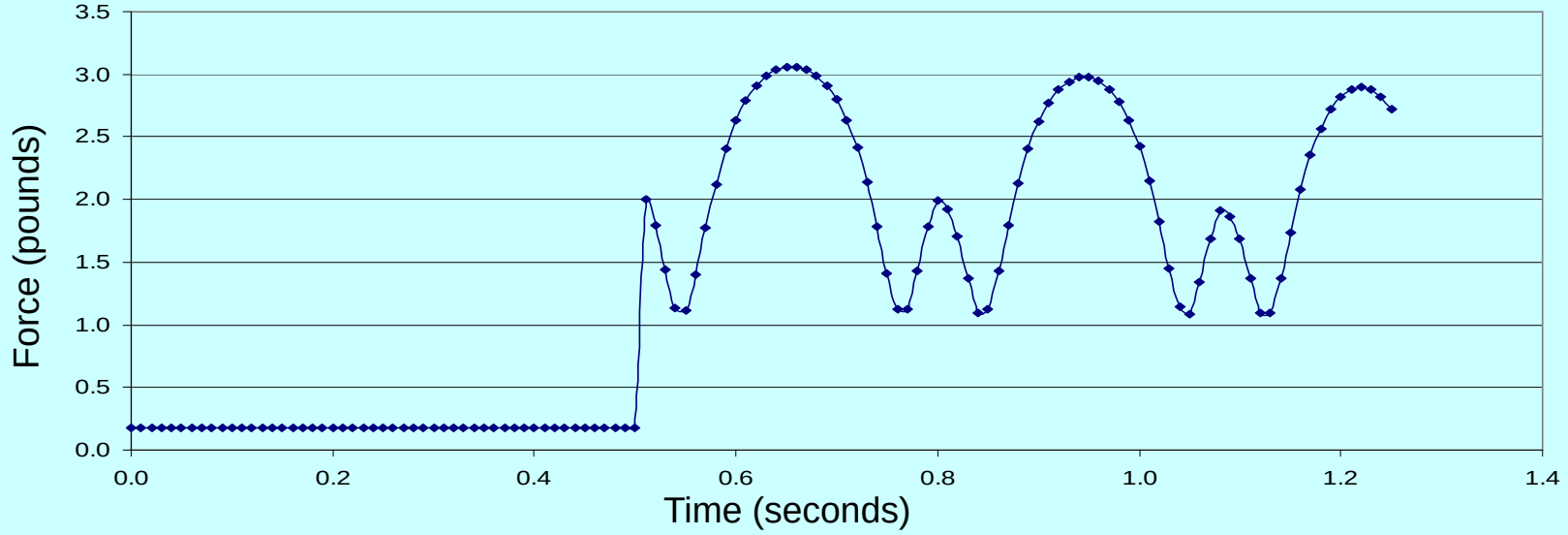


Joint Force

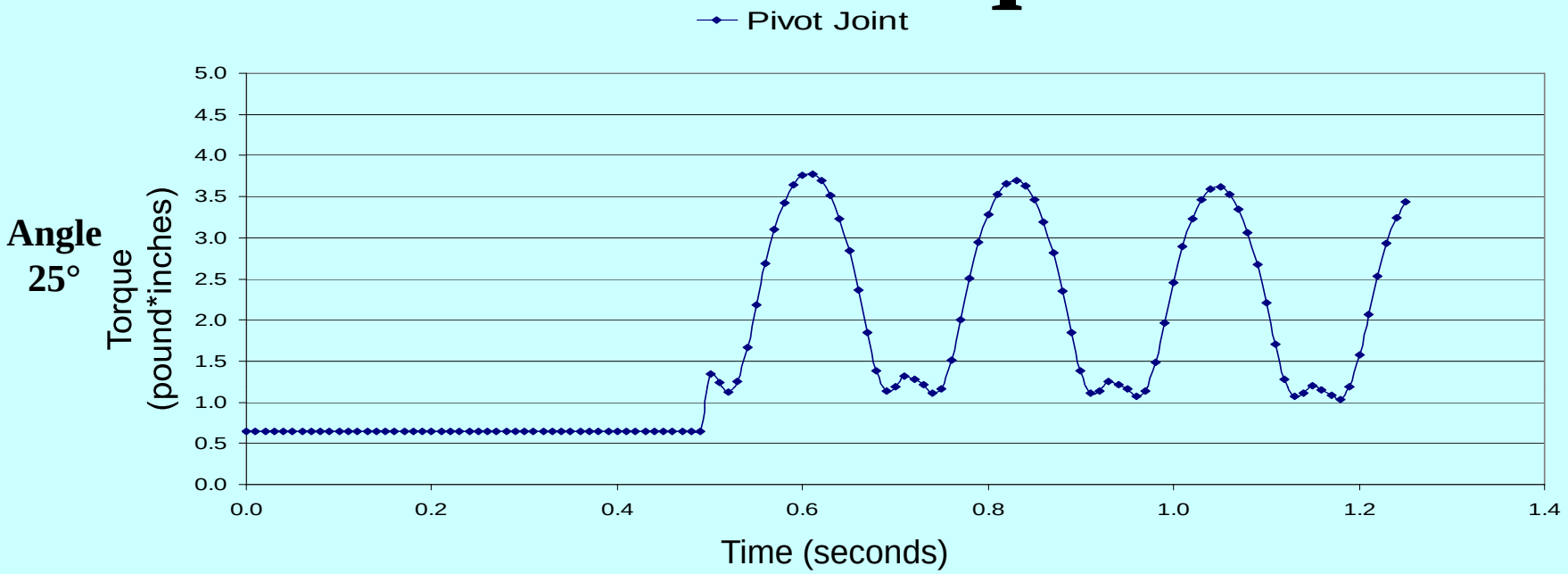
Angle 25°

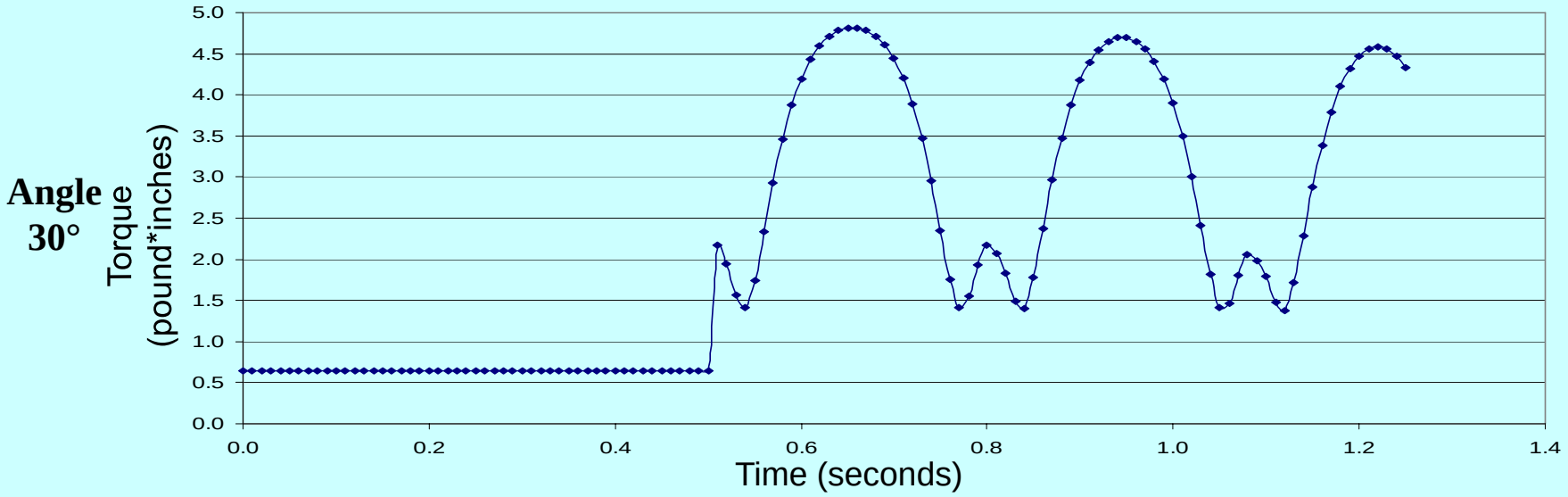


Angle 30°



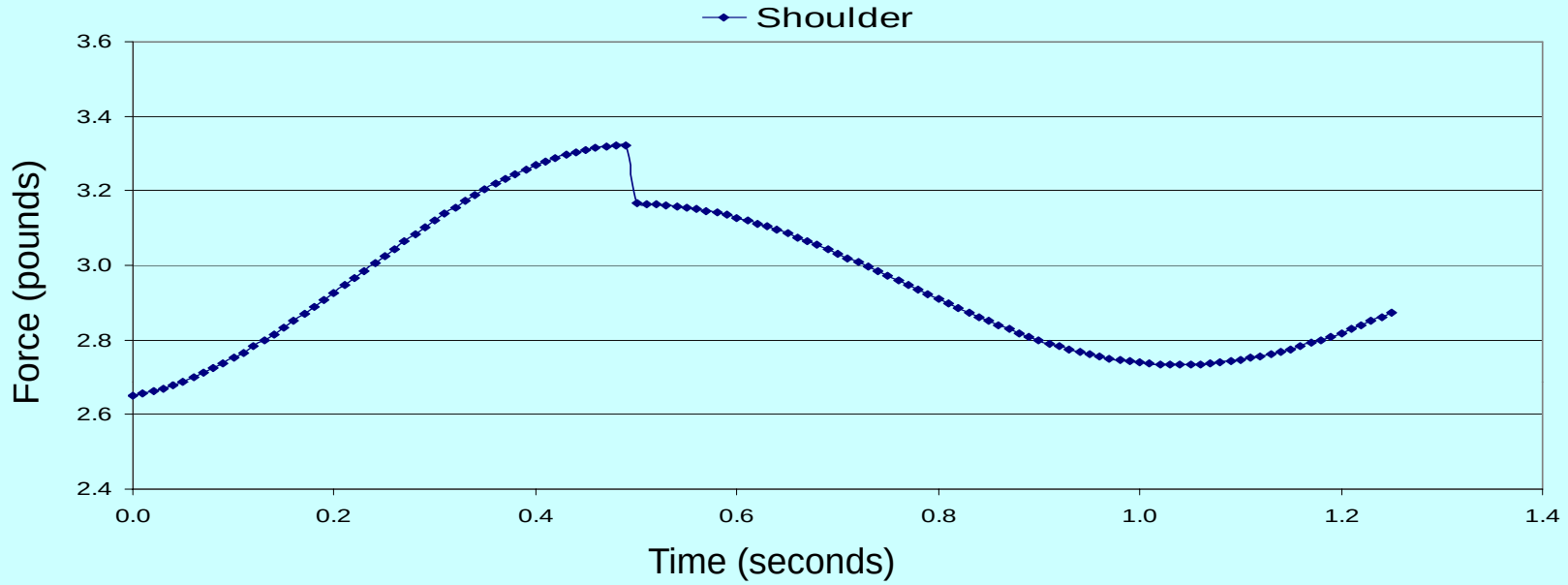
Joint Torque



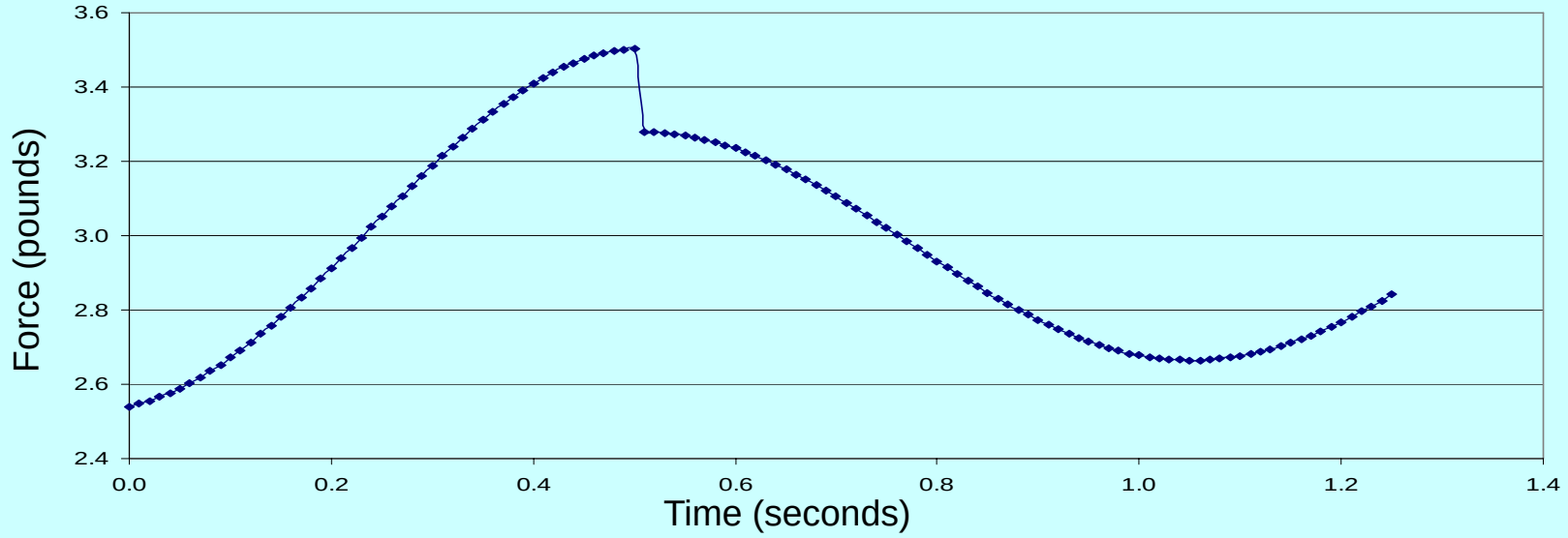


Shoulder Force

Angle 25°

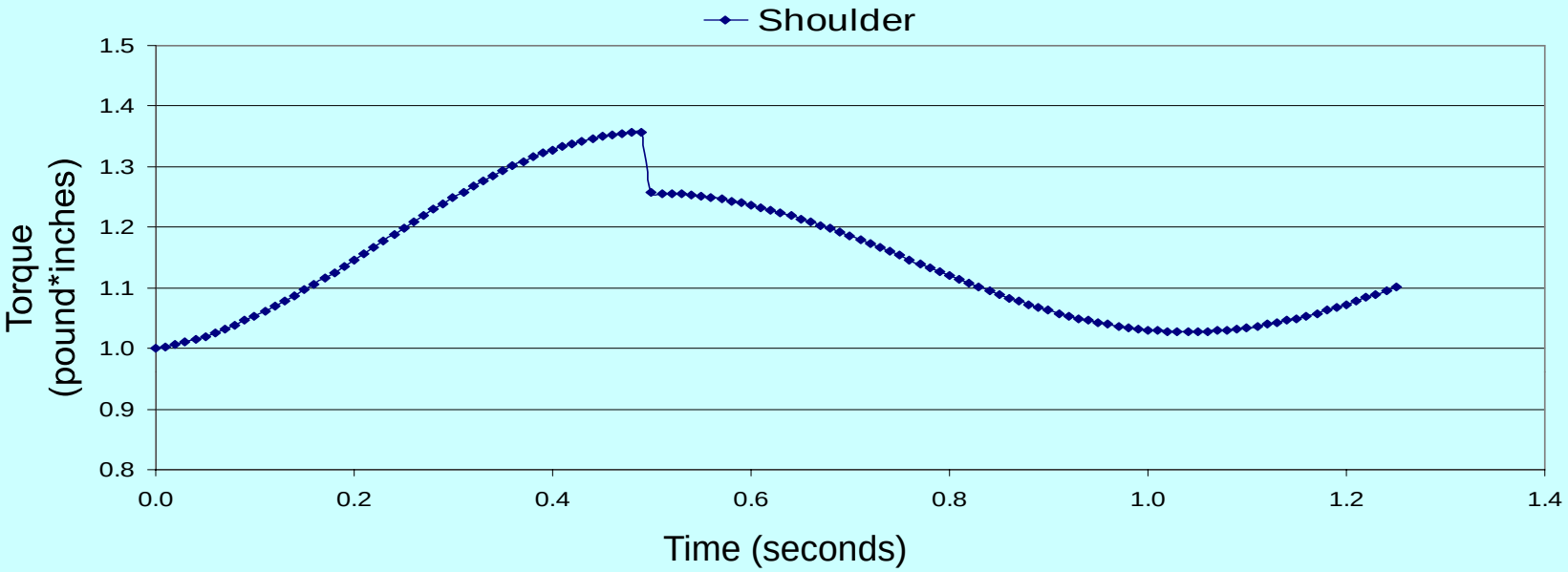


Angle 30°

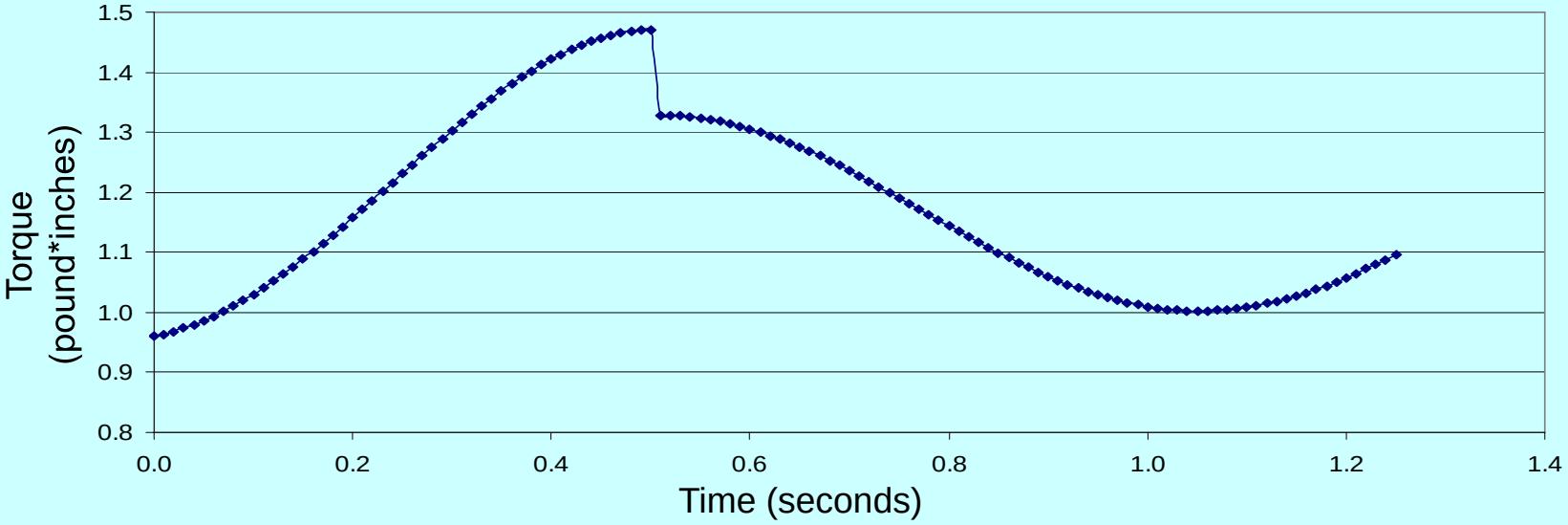


Shoulder Torque

Angle 25°

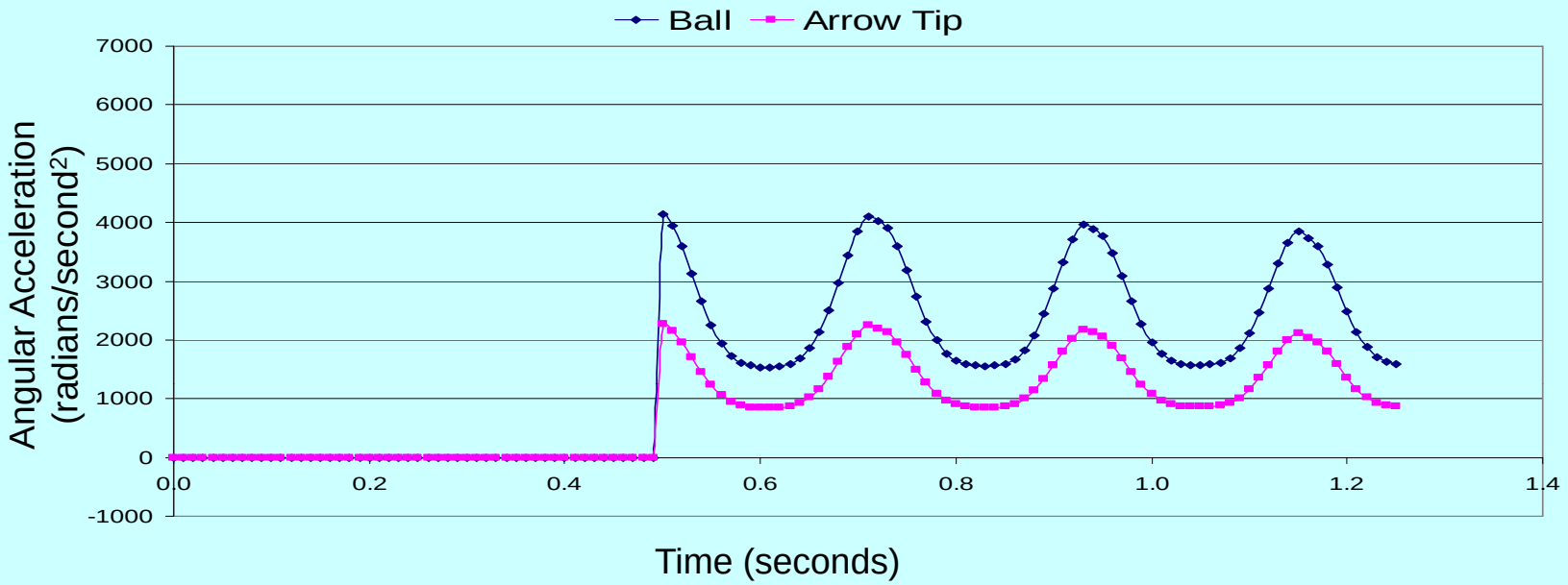


Angle 30°

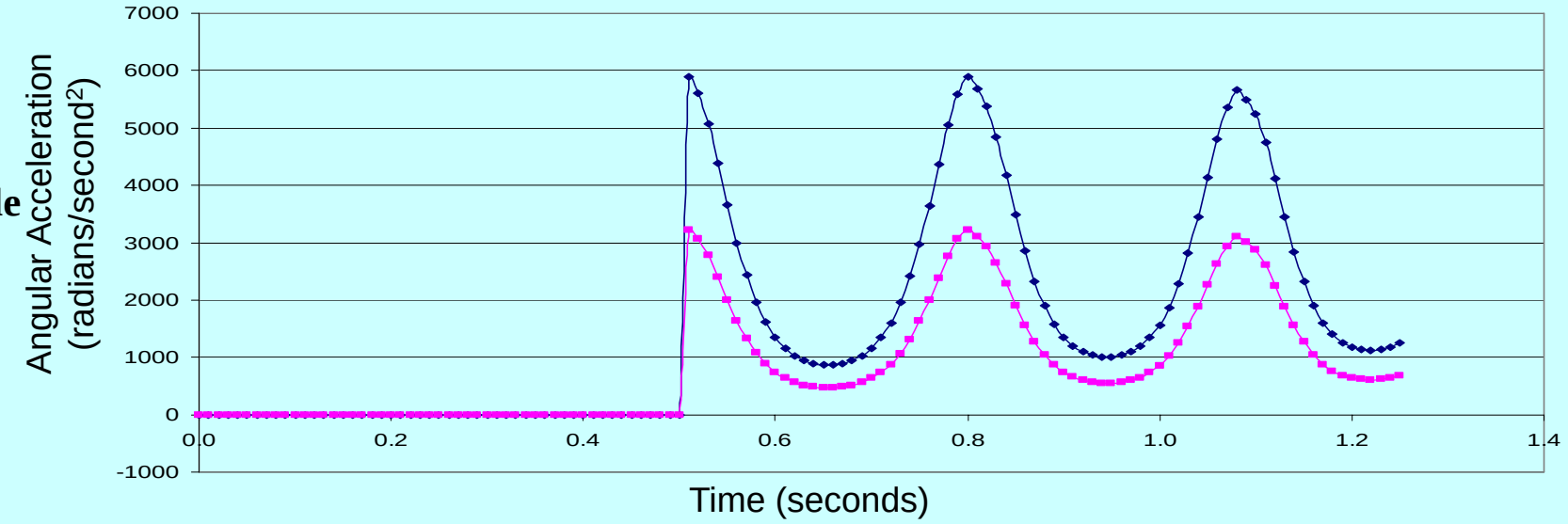


Point Acceleration

Angle 25°

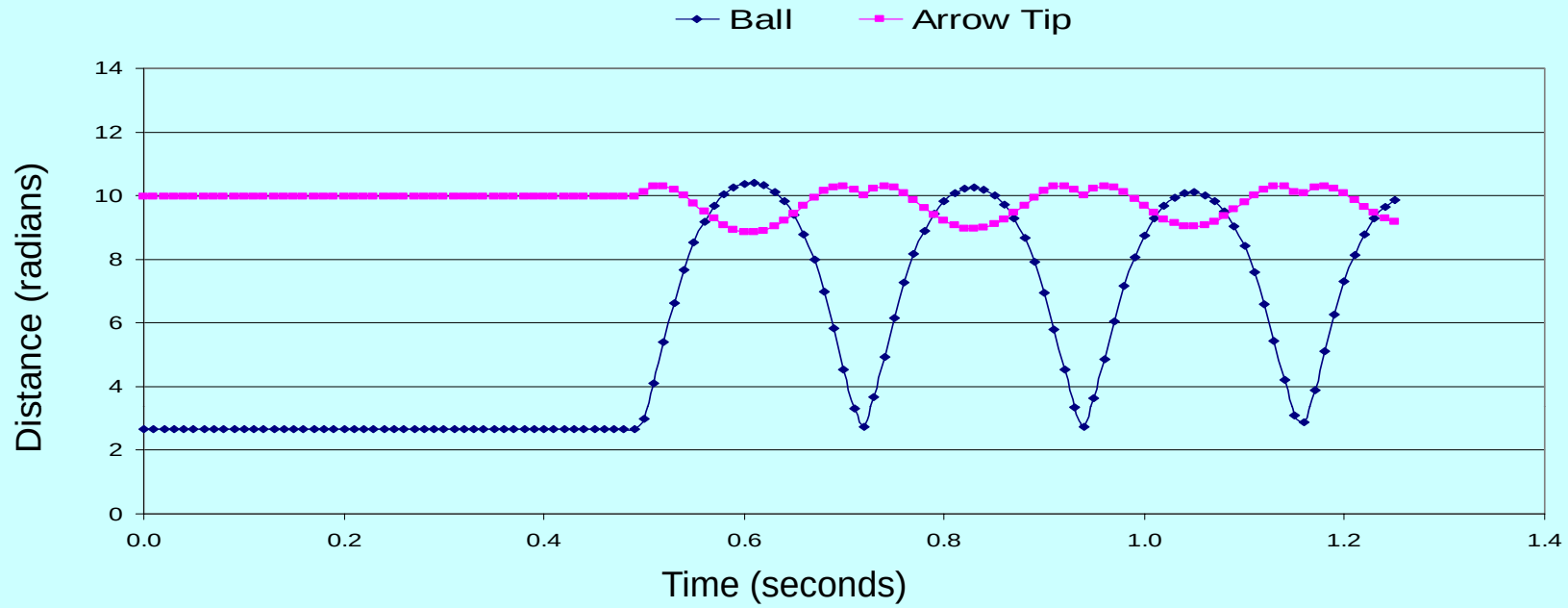


Angle 30°

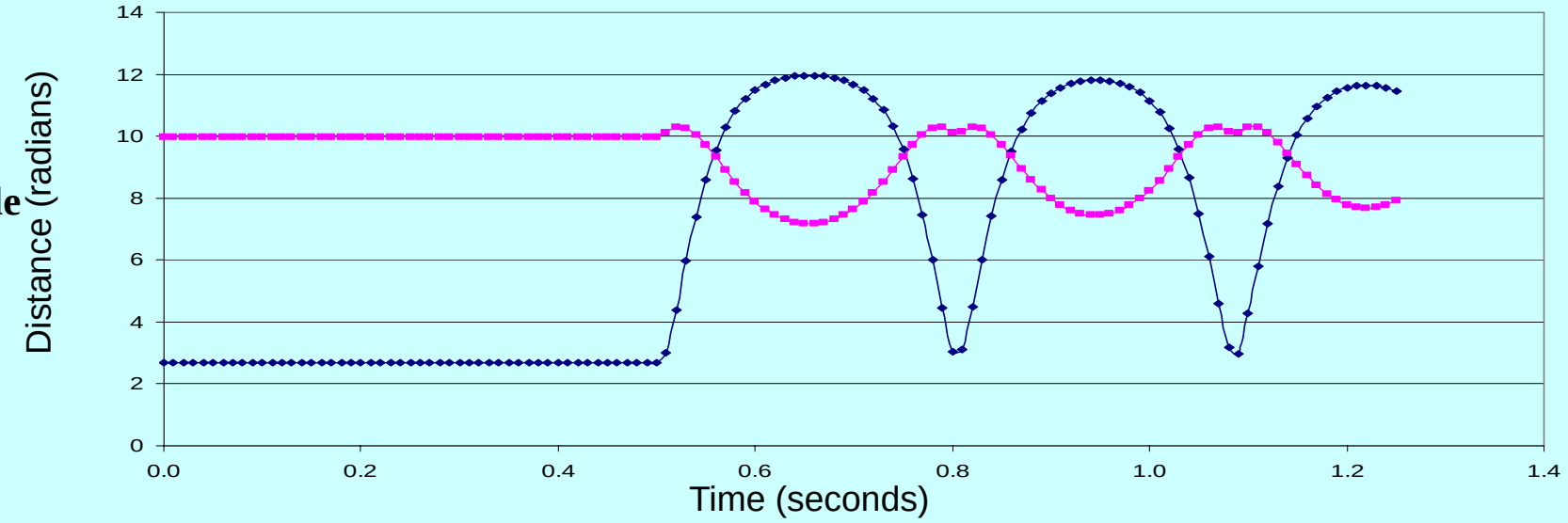


Point Position

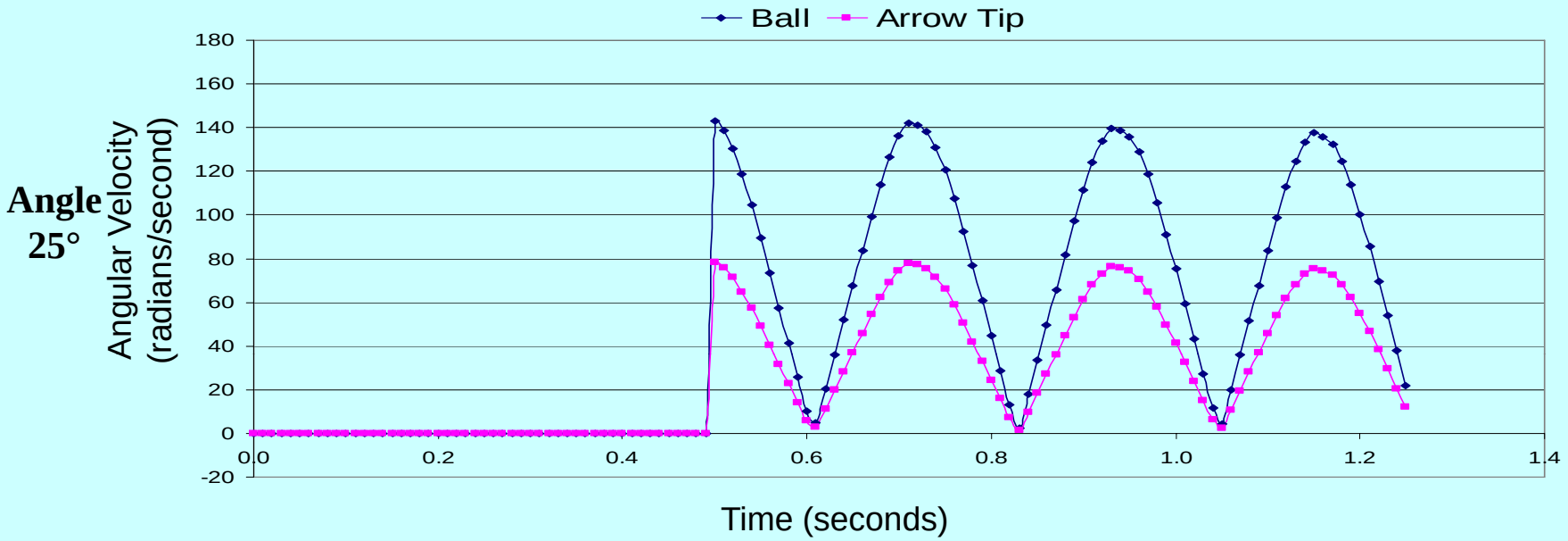
Angle 25°

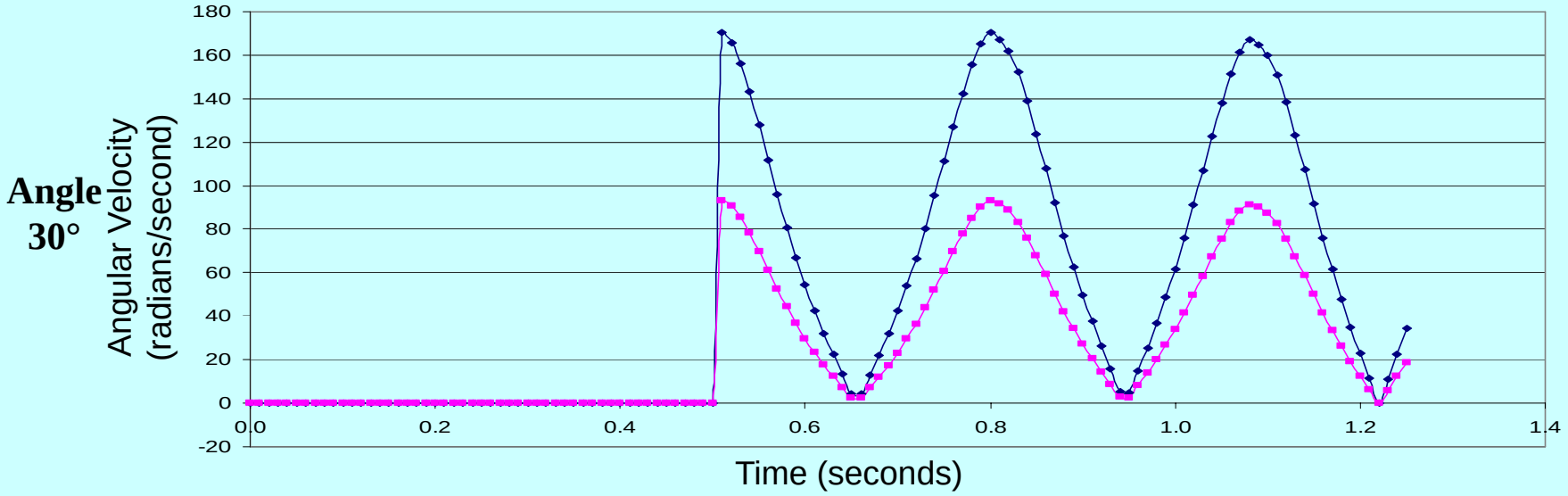


Angle 30°



Point Velocity





Limitations

- Scale is not calibrated.
- Indicator arrow does not help golfer find velocity, distance, or force.
- Linear spring may affect results.
- Ball-arm hits support for scale.
- Motion never stops.

Possible Improvements

- Different source of resistance.
- Move support for scale.