

# Experiment 09: Angular momentum

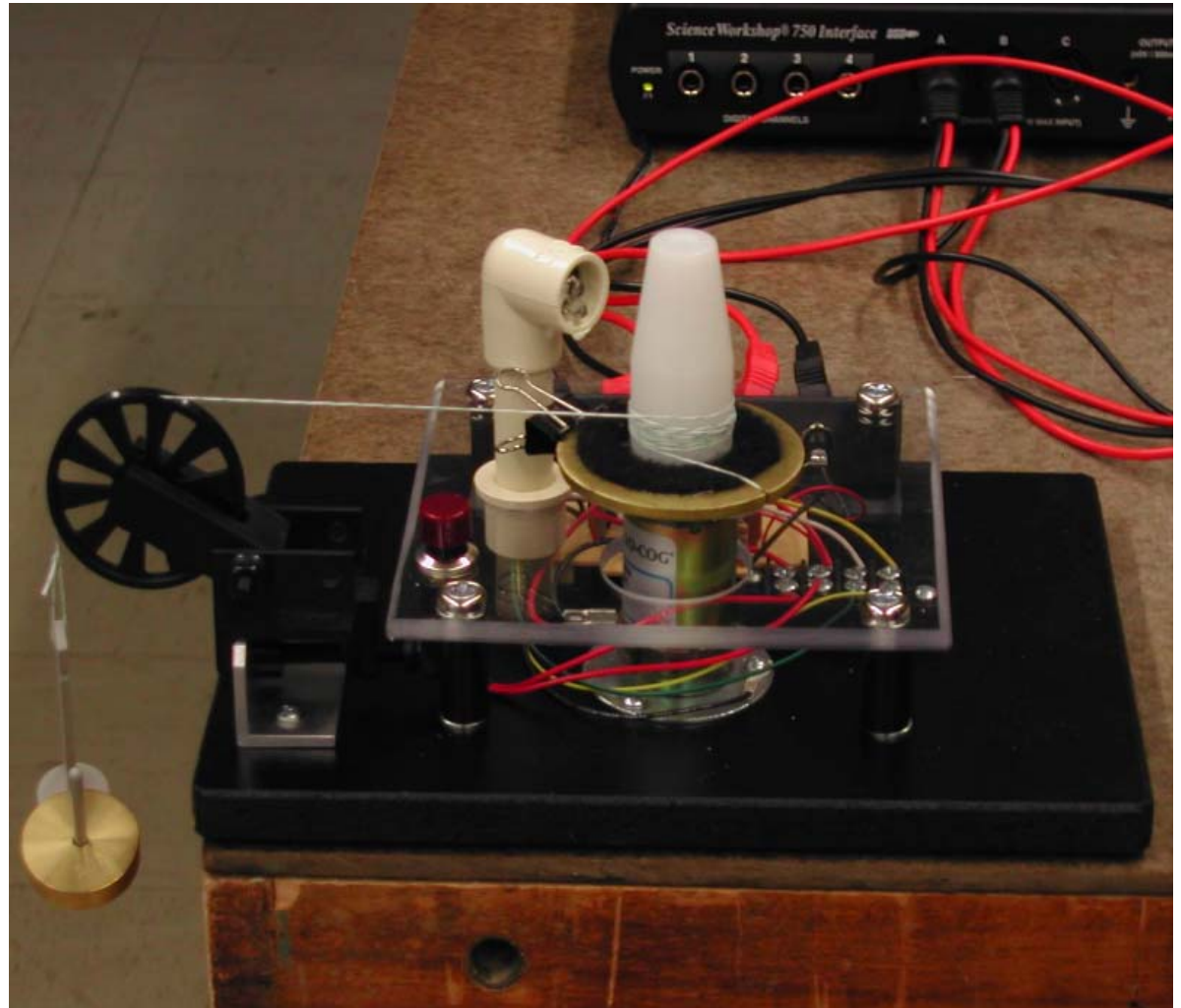


# Goals

- Investigate conservation of angular momentum and kinetic energy in rotational collisions.
- Measure and calculate moments of inertia.
- Measure and calculate non-conservative work in an inelastic collision.

# Apparatus

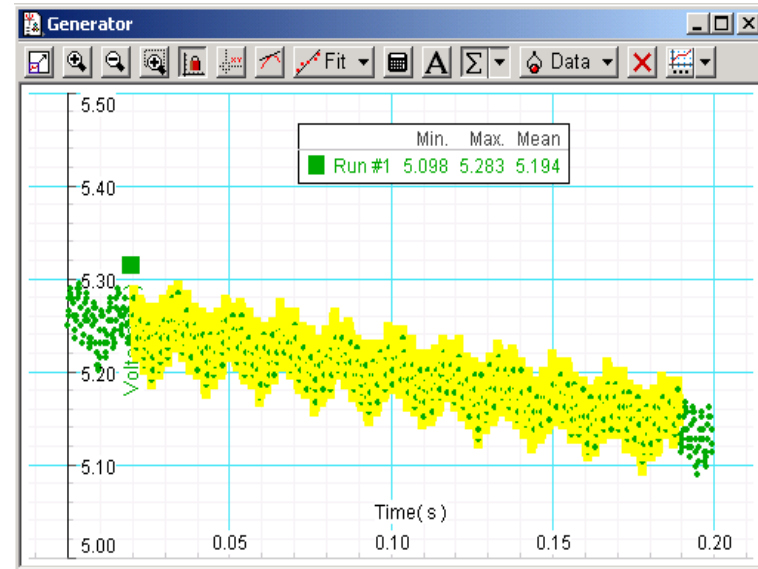
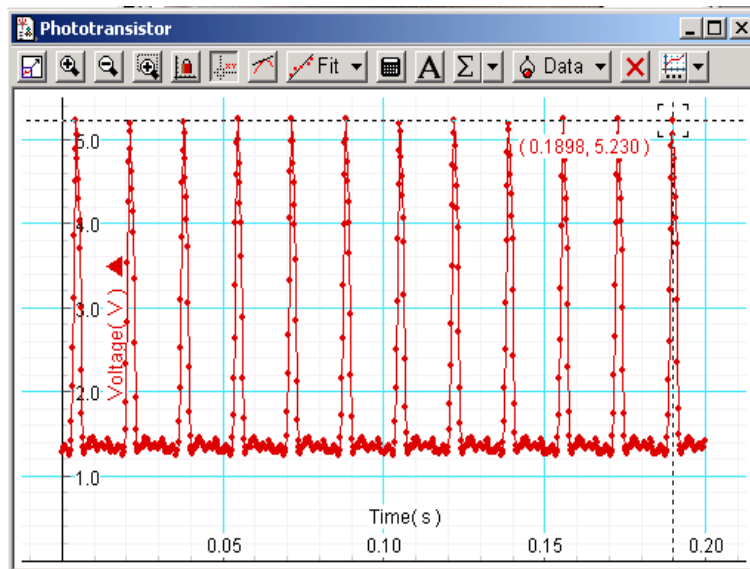
- ❑ Connect output of phototransistor to channel A of 750.
- ❑ Connect output of tachometer generator to channel B of 750.
- ❑ Connect power supply.
- ❑ Red button is pressed: Power is applied to motor.
- ❑ Red button is released: Rotor coasts: Read output voltage using DataStudio.



- ❑ Use black sticker or tape on white plastic rotor for generator calibration.

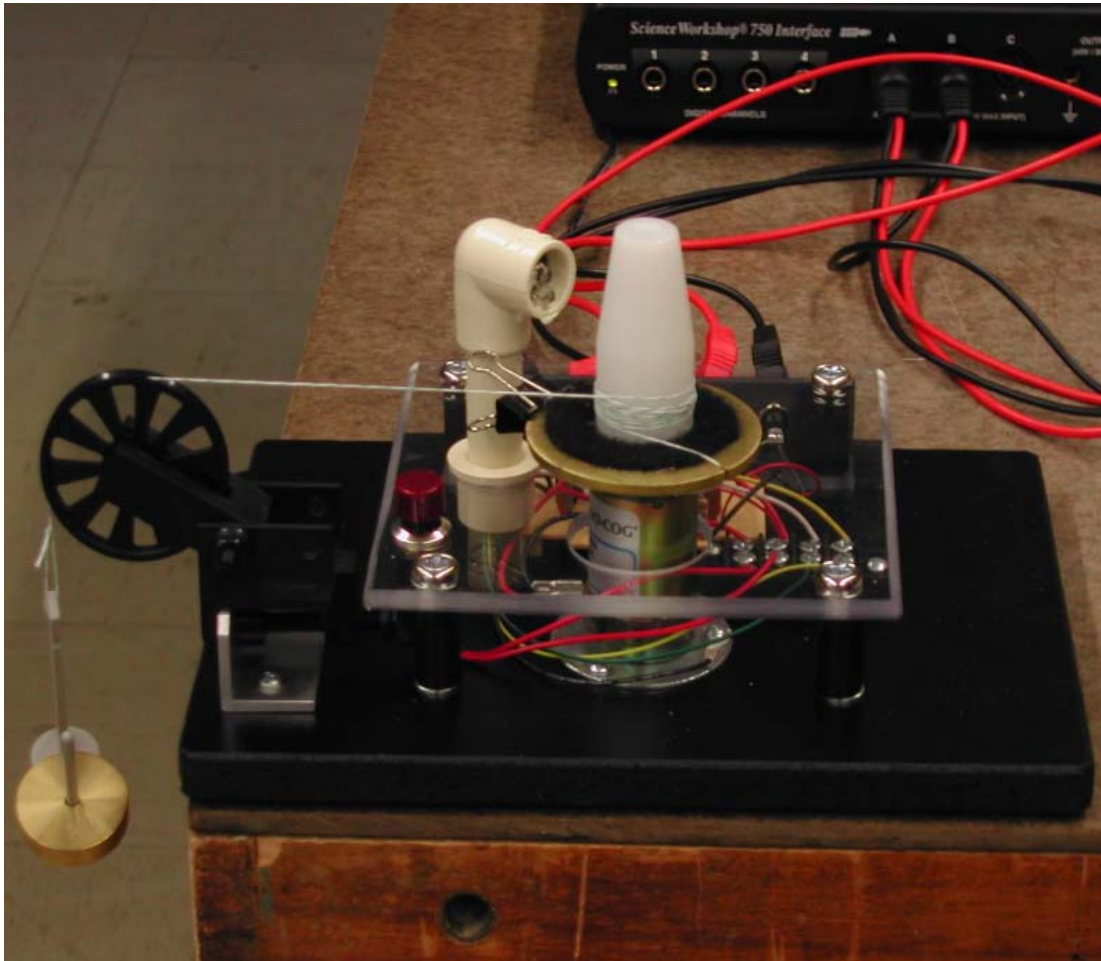
# Calibrate tachometer-generator

- Spin motor up to full speed, let it coast. Measure and plot voltages for 0.25 s period. Sample Rate: 5000 Hz, and Sensitivity: Low.



- Time 10 periods to measure  $\omega$ .
- Then calculate  $\omega$  for 1 V output.
- Average the output voltage over the same 10 periods.

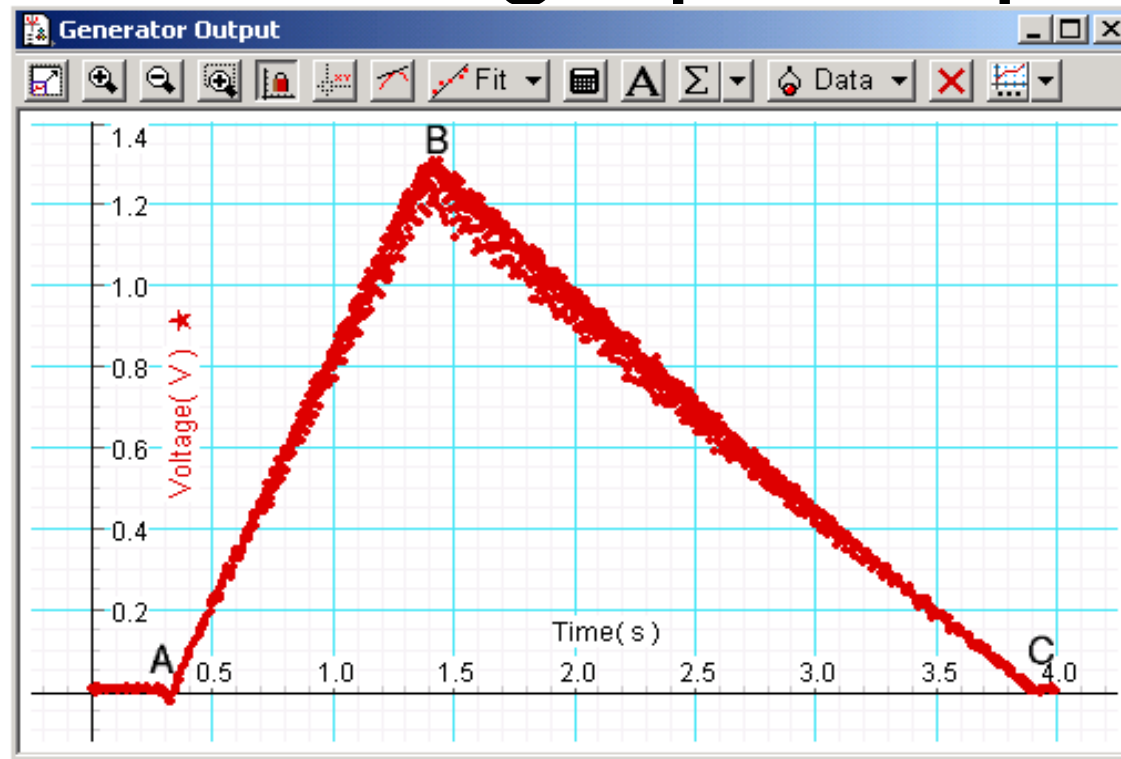
# Measure rotor $I_R$



- ❑ Plot only the generator voltage for rest of experiment.
- ❑ Use a 55 gm weight to accelerate the rotor.
- ❑ Settings:
  - Sensitivity: Low
  - Sample rate 500 Hz.
  - Delayed start: None
  - Auto Stop: 4 seconds

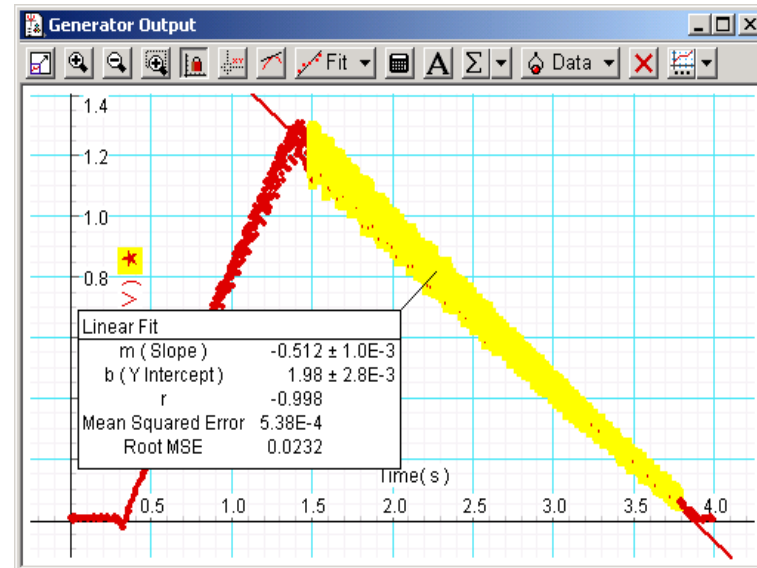
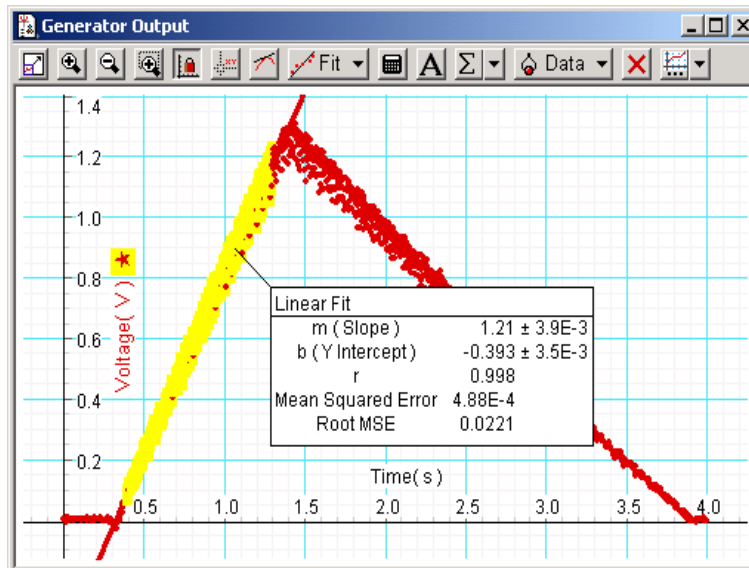
- ❑ Start DataStudio and let the weight drop.

# Understand graph output to



- Generator voltage while measuring  $I_R$ . What is happening:
  1. Along line A-B ?
  2. At point B ?
  3. Along line B-C ?
- How do you use this graph to find  $I_R$  ?

# Measure $I_R$ results



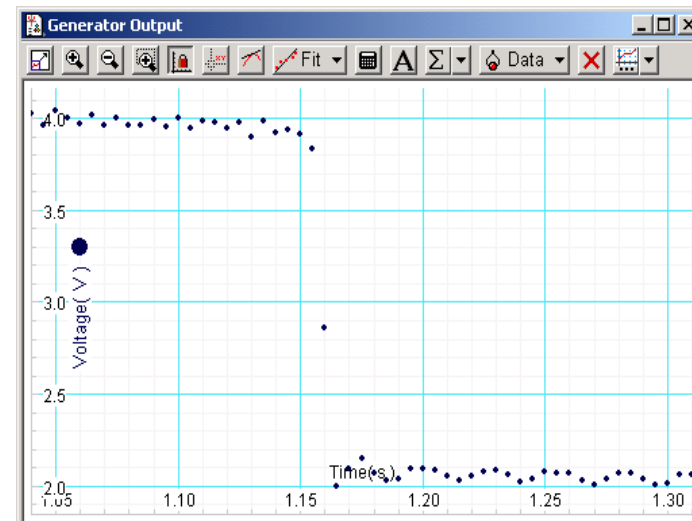
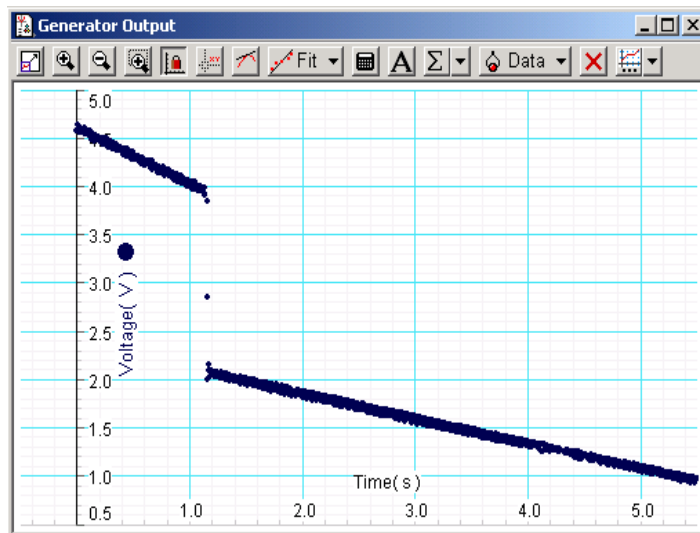
□ Measure and record  $\alpha_{up}$  and  $\alpha_{down}$ .

□ For your report, calculate  $I_R$ :

$$\tau_f = I_R \alpha_{down} \quad I_R = \frac{mr(g - r\alpha_{up})}{\alpha_{up} - |\alpha_{down}|}$$

# Fast collision

Sensitivity	Sample Rate	Delayed Start	Auto Stop
Low	200 Hz	1 sec	Falls below 0.5V

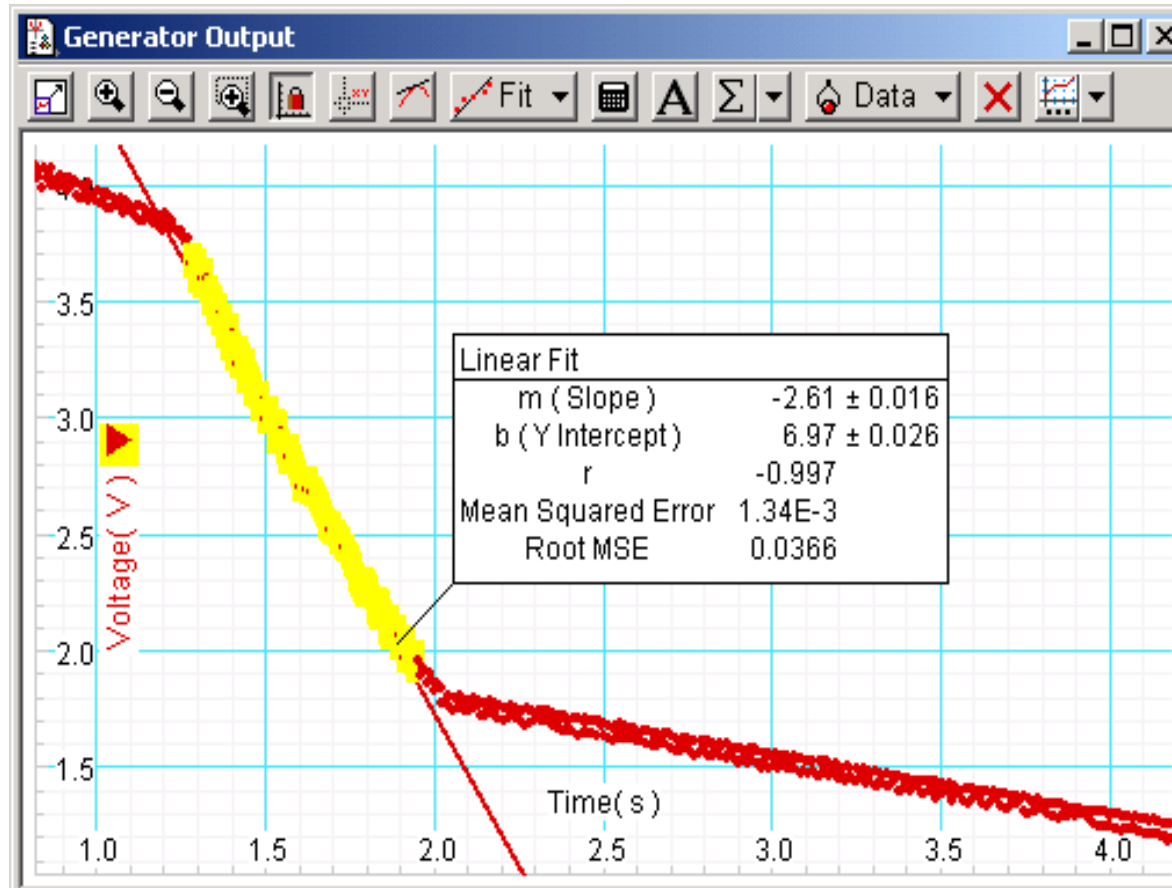


Find  $\omega_1$  (before) and  $\omega_2$  (after), estimate  $\delta t$  for collision.

Calculate 
$$I_w = \frac{1}{2} m \omega (r_o^2 + r_i^2)$$



# Slow collision



- Find  $\omega_1$  and  $\omega_2$ , measure  $\delta t$ , fit or measure to find  $a_c$ .
- Keep a copy of your results for the homework problem.