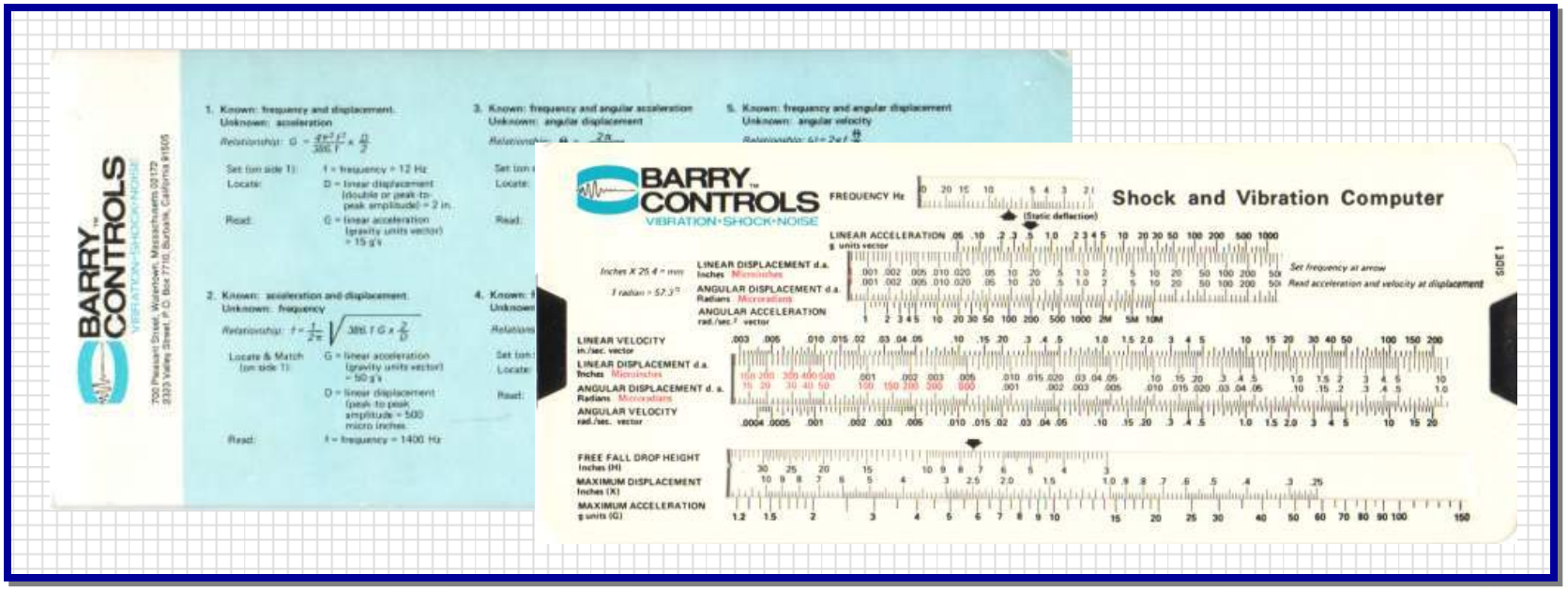
BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

SLIDE RULE IS HELPFUL TOOL FOR BASIC APPLICATIONS TO FIND UNKNOWNS WHERE SOME CONDITIONS ARE KNOWN.



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 1:

- KNOWN: Frequency and Displacement
- UNKNOWN: Acceleration

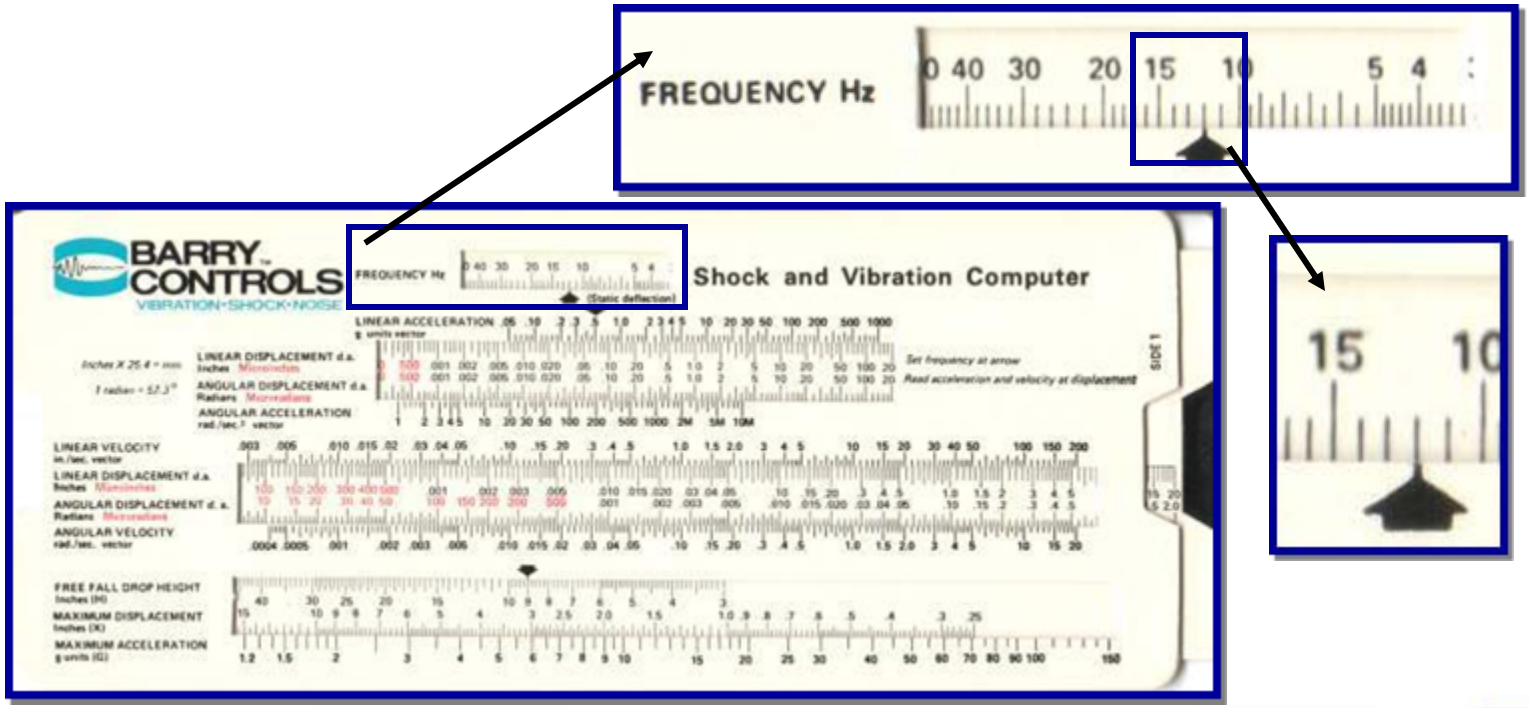
RELATIONSHIP: $G = \frac{4\pi^2 f^2}{386.1} \times \frac{D}{2}$

- Exercise
  - Set (on side 1): f = frequency = 12 Hz
  - Locate: D = linear displacement (double or peak-to-peak amplitude) = 2 inches
  - Read: G = linear acceleration (gravity units vector) = 15 g's

BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 1b: On Side 1

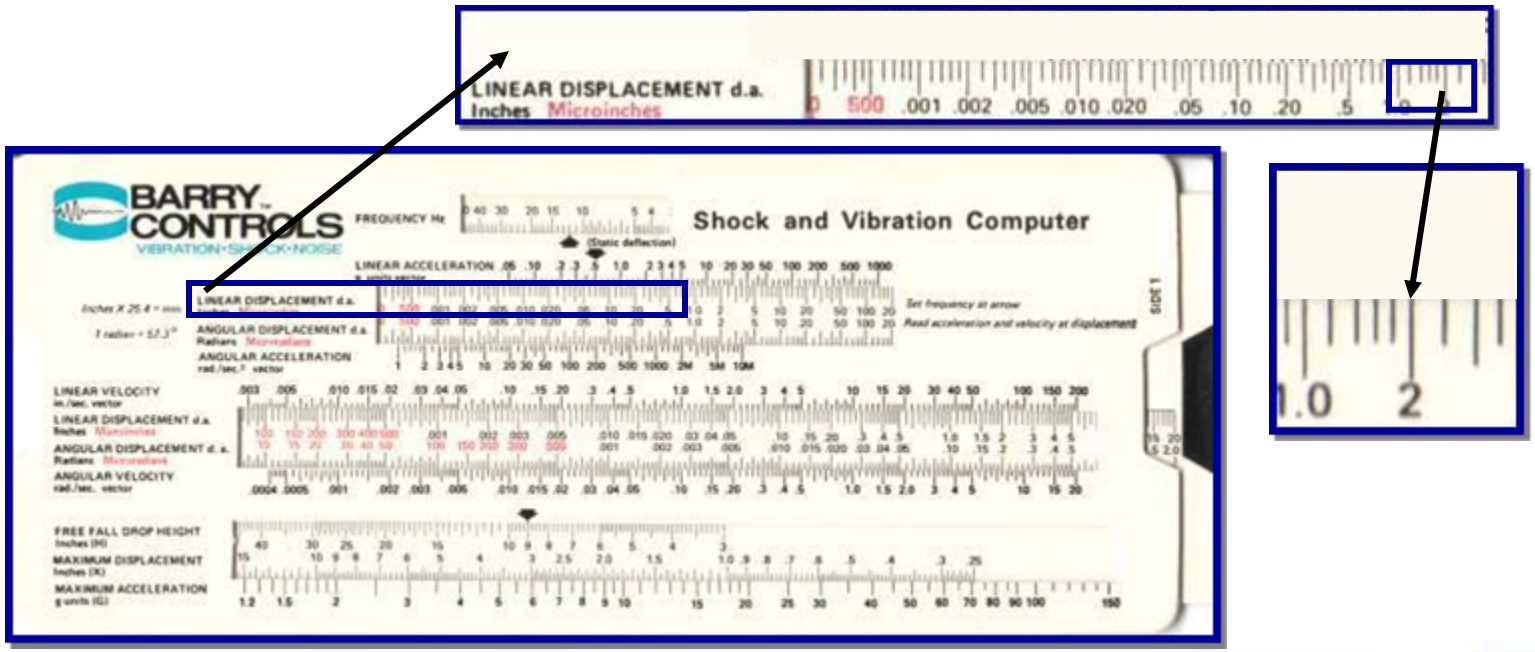
- Set: f = frequency = 12 Hz



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 1c:

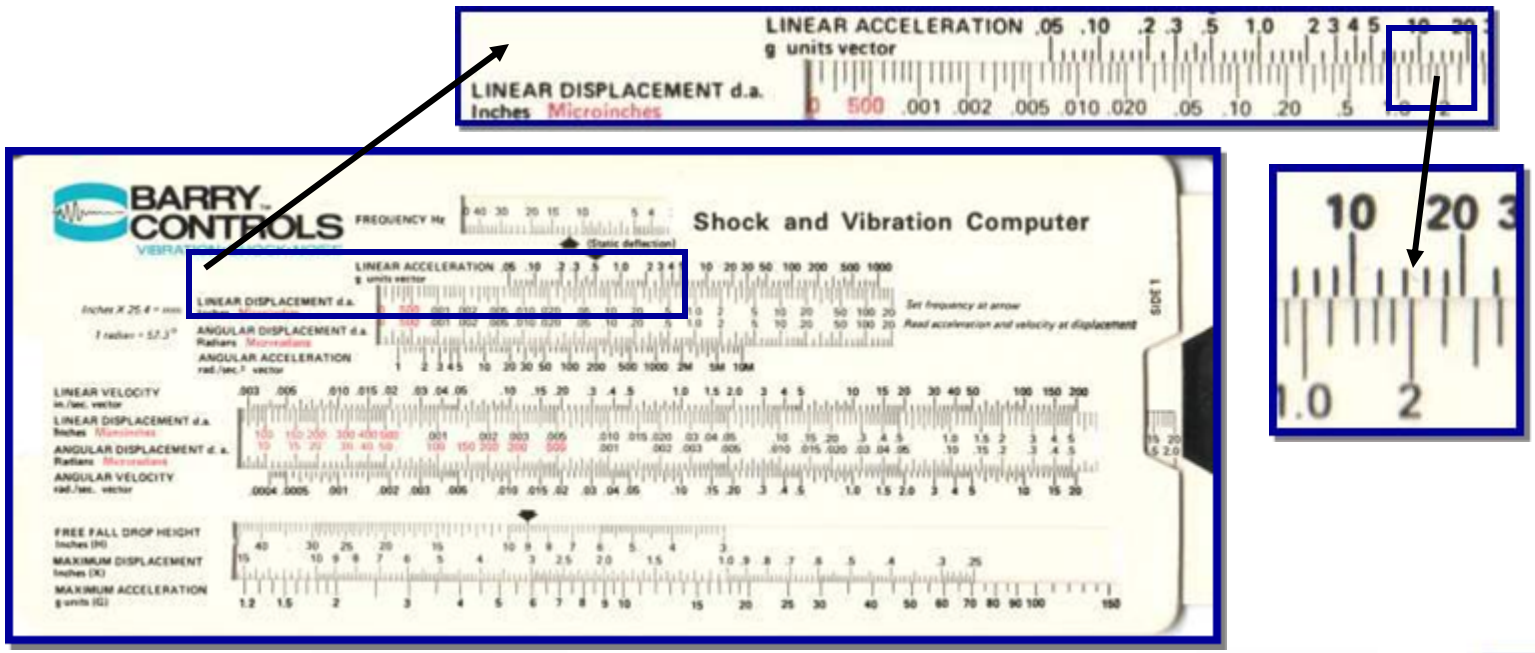
- Locate: D = linear displacement (double or peak-to-peak amplitude) = 2 inches



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 1d:

- Read: G = linear acceleration (gravity units vector) = 15 g's



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 2:

- KNOWN: Acceleration and Displacement
- UNKNOWN: Frequency

$$\textbf{RELATIONSHIP:}\quad f = \frac{1}{2\pi}\sqrt{386.1\ G \times \frac{2}{D}}$$

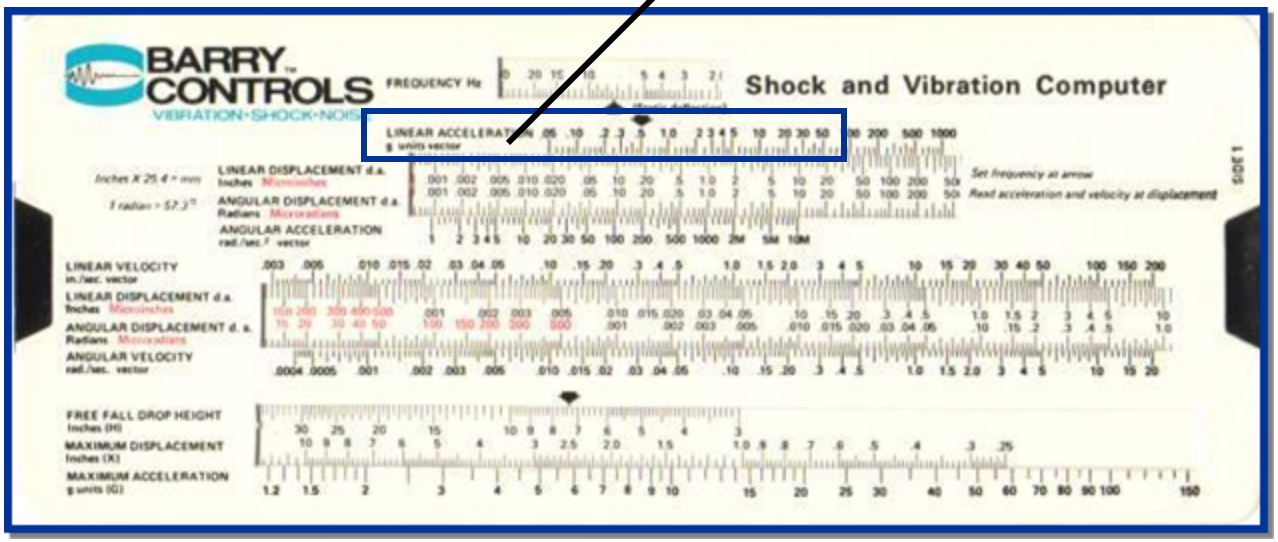
- Exercise:
  - Locate and Match: G = linear acceleration (gravity units vector) = 50 g's

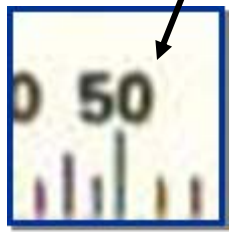
    D = linear displacement (peak-to-peak amplitude) = 500 micro inches
  - Read: f = frequency = 1400 Hz

BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 2b: On Side 1

- Locate: G = linear acceleration (gravity units vector) = 50 g's

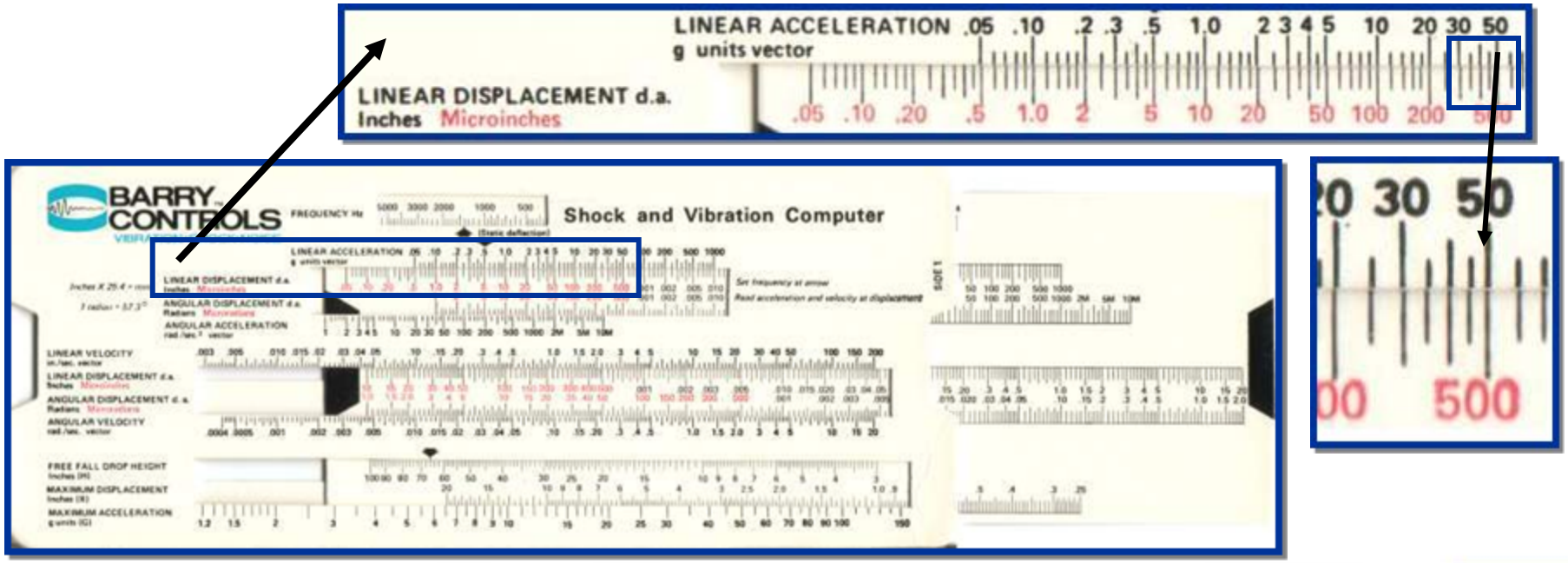




BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 2c:

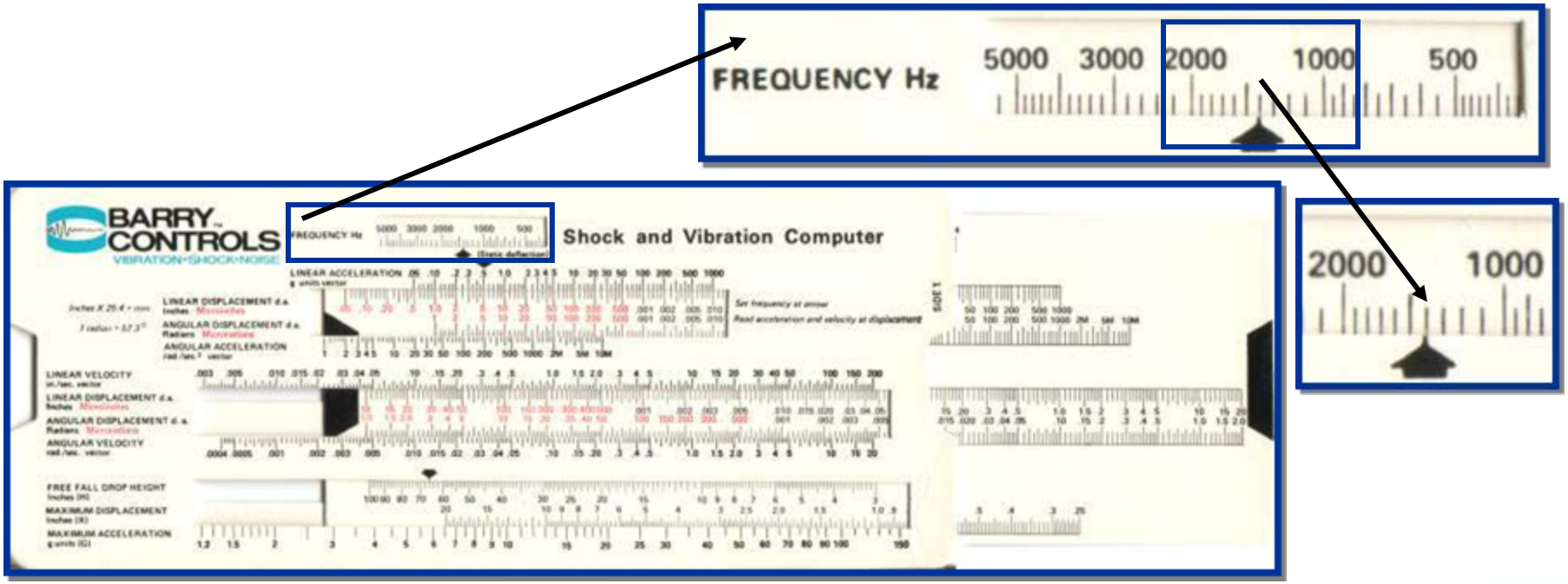
- Match: D = linear displacement (peak-to-peak amplitude) = 500 micro inches



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 2d:

- Read: f = frequency = 1400 Hz



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 6:

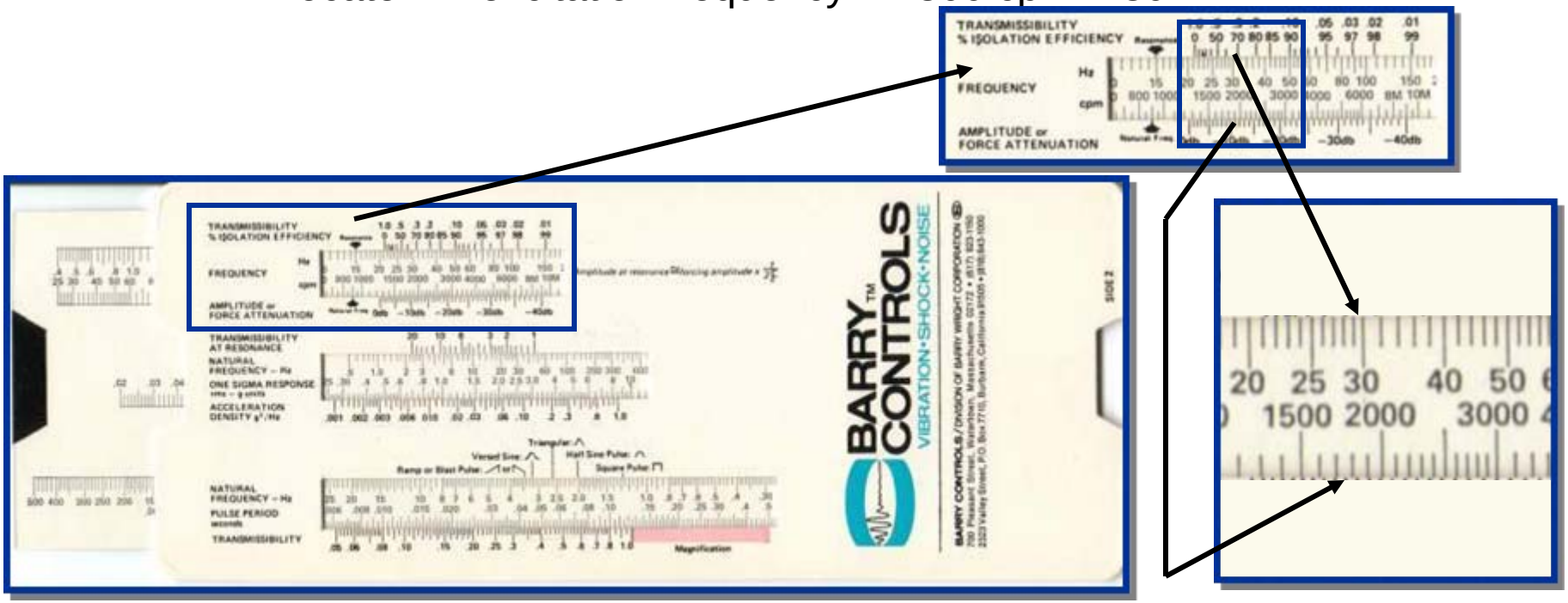
- KNOWN: Suspension Weight, Excitation Frequency and Desired Attenuation of Excitation by Suspension
- UNKNOWN: Suspension Natural Frequency

- Exercise
  - Locate (on side 2): f = excitation frequency = 1800 cpm = 30 Hz
  - Match: attenuation = -10db
    transmissibility = .316
    Isolation efficiency = 68.4%
  - Read: fn = natural frequency = 900 cpm = 15 Hz

BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 6b: <u>On Side 2</u>

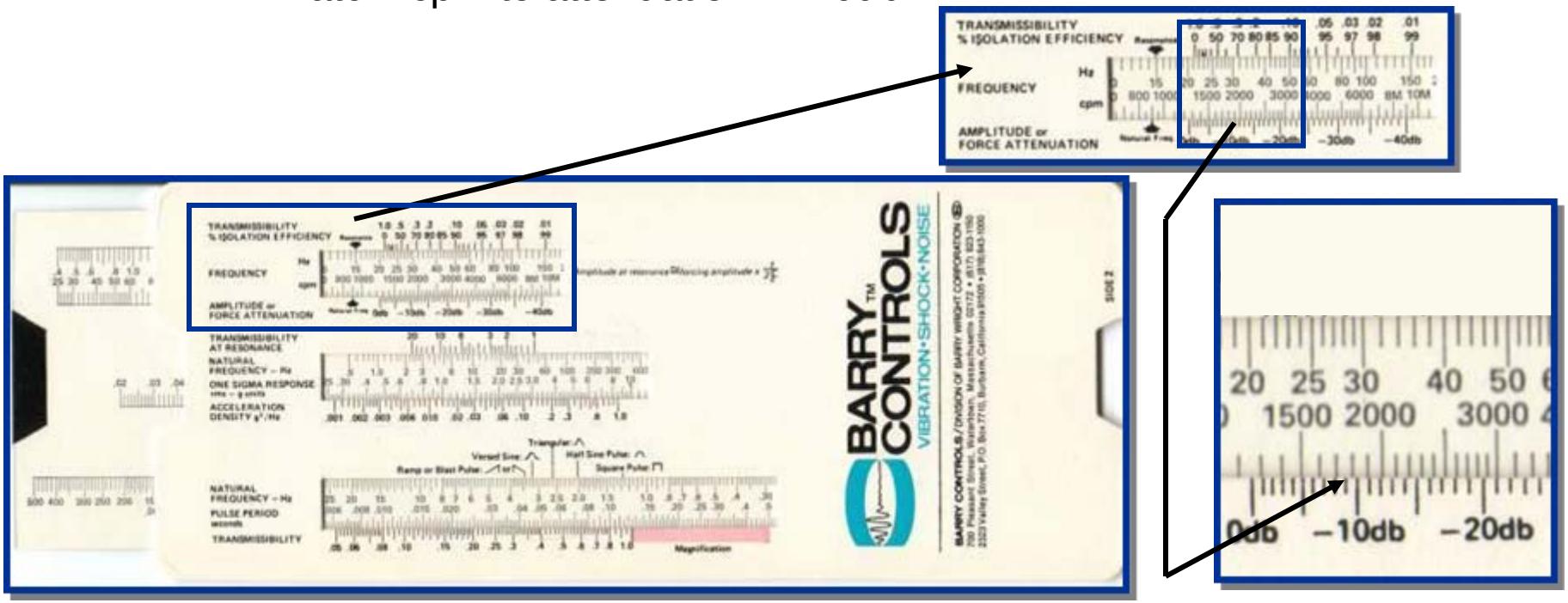
- Locate: f = excitation frequency = 1800 cpm = 30 Hz



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 6c:

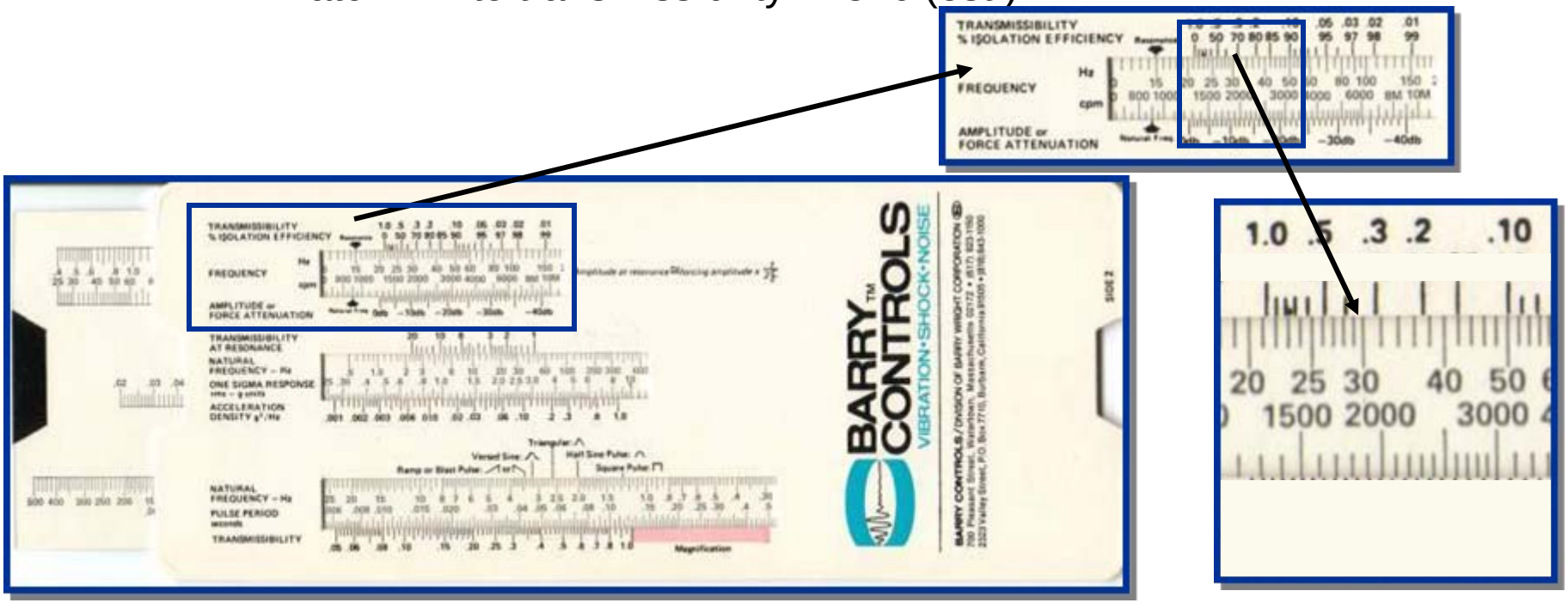
- Match: cpm to attenuation = -10db



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 6d:

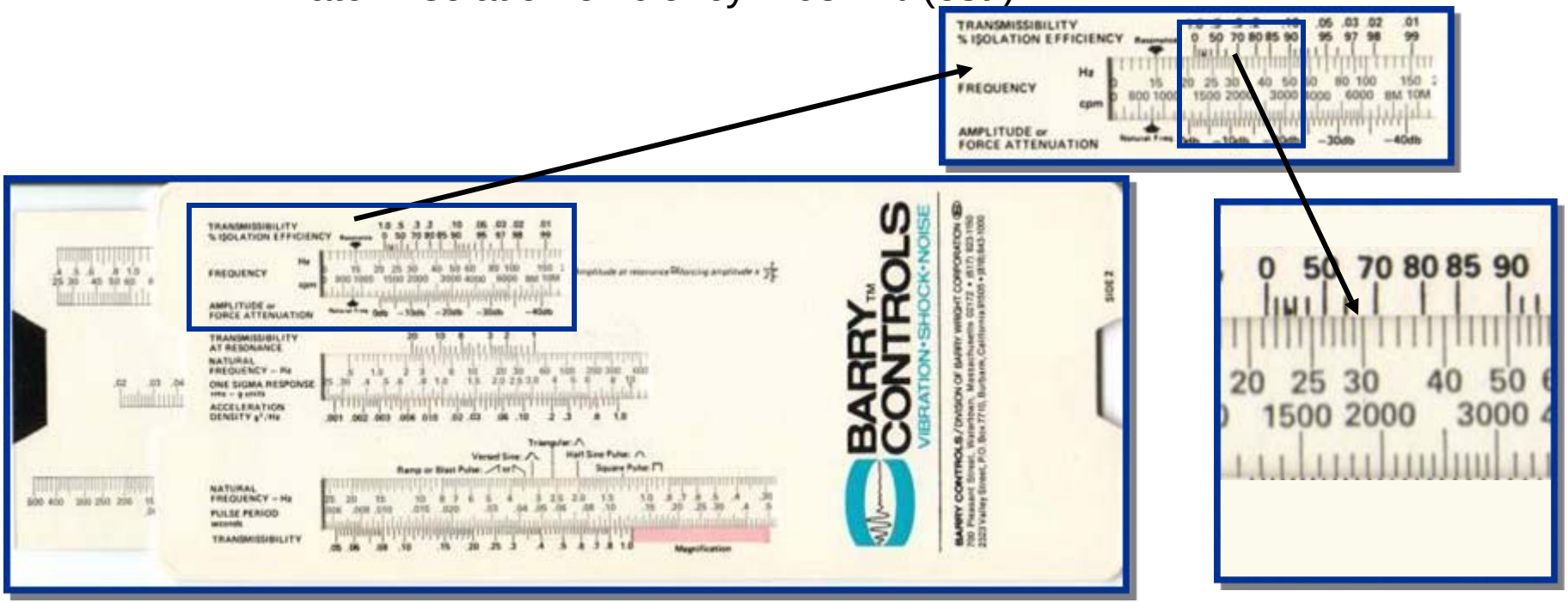
- Match: Hz to transmissibility = .316 (est.)



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 6e:

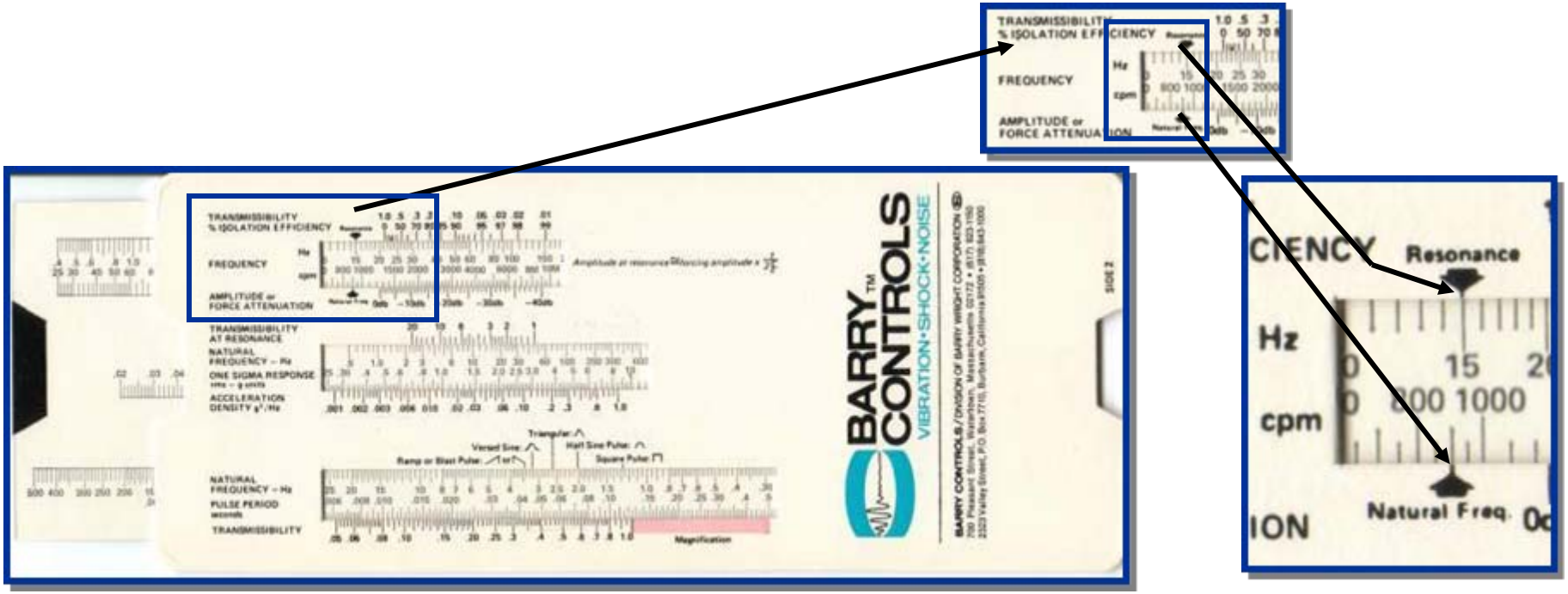
- Match: Isolation efficiency = 68.4% (est.)



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 6f:

- Read: fn = natural frequency = 900 cpm = 15 Hz = resonance



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 8:

- KNOWN: Drop Height and Acceleration Level Permitted
- UNKNOWN: Package Clearance Requirements and Suspension Natural Frequency

$$\text{Relationship: } X = \frac{2h}{G_T}$$

- This relationship shows the deflection required for a linear, undamped isolation system to attenuate to an acceleration level when a rigid package with that isolation system is dropped from a given height on a rigid, massive platform.

BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

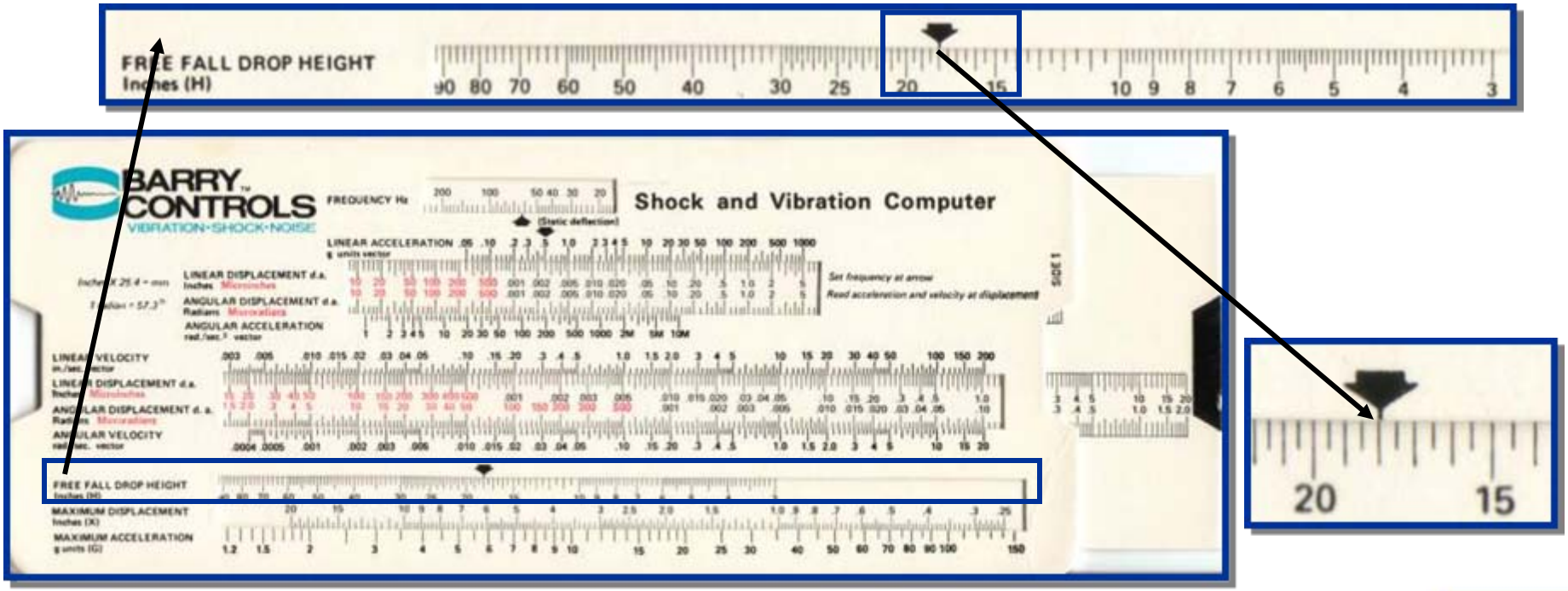
EXERCISE 8 (cont.):

- Exercise:
  - Set (on side 1): H = free-fall drop height = 18 in.
  - Locate: G = maximum acceleration = 20 g units
  - Read: X = maximum displacement =1.8 in.
  - Set: X/G = static deflection = .09 inch
  - Read: fn = natural frequency = 10.4 Hz

BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 8b: On Side 1

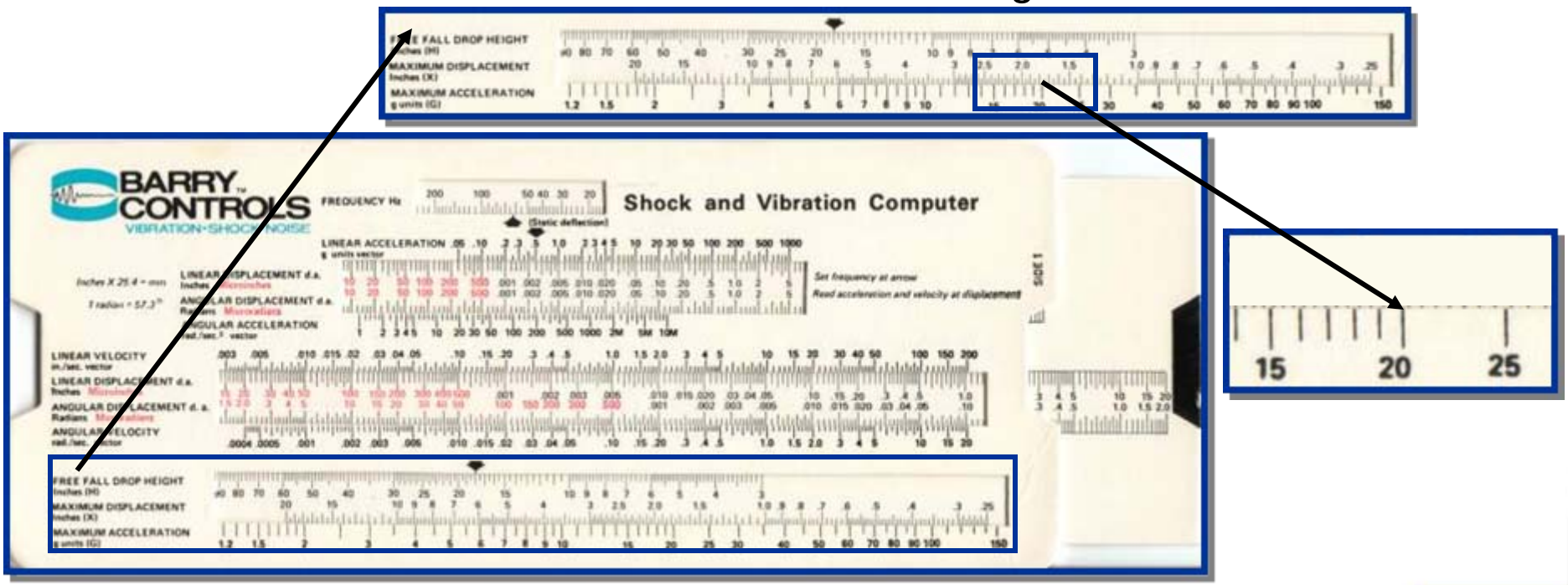
- Set: H = free-fall drop height = 18 in.



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 8c:

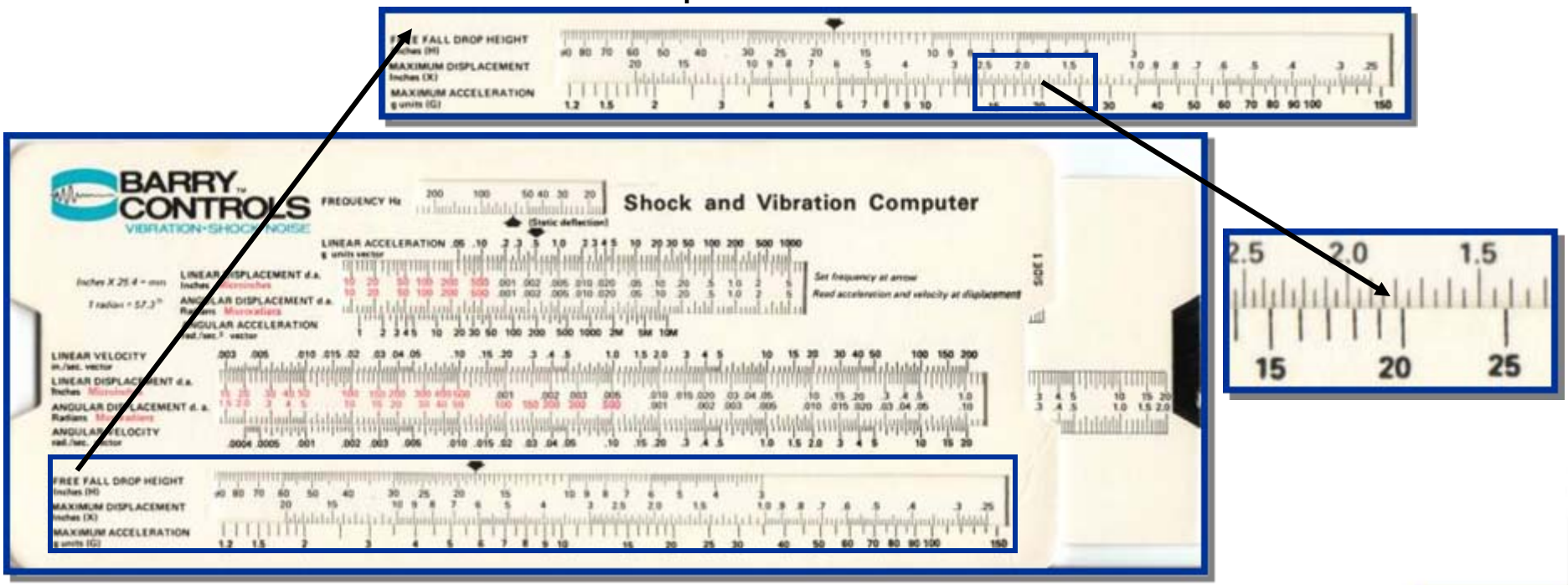
- Locate: G = maximum acceleration = 20 g units



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 8d:

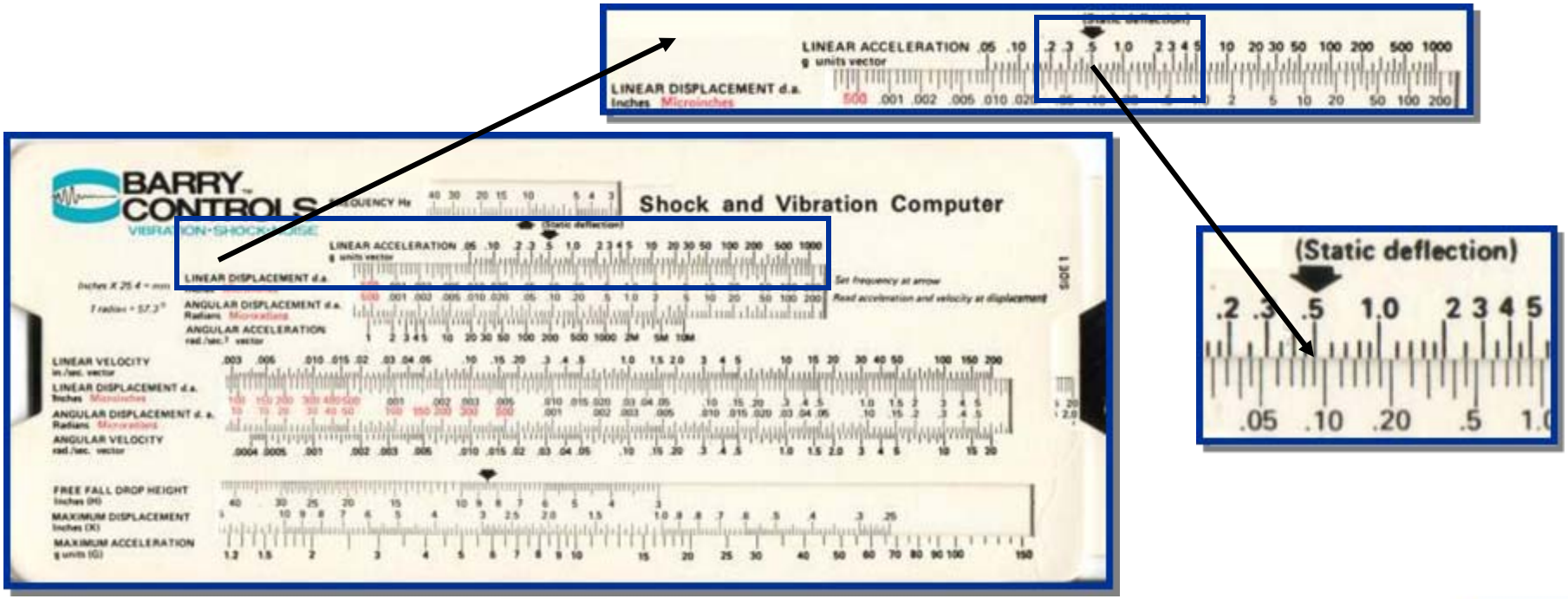
- Read: X = maximum displacement =1.8 in.



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 8e:

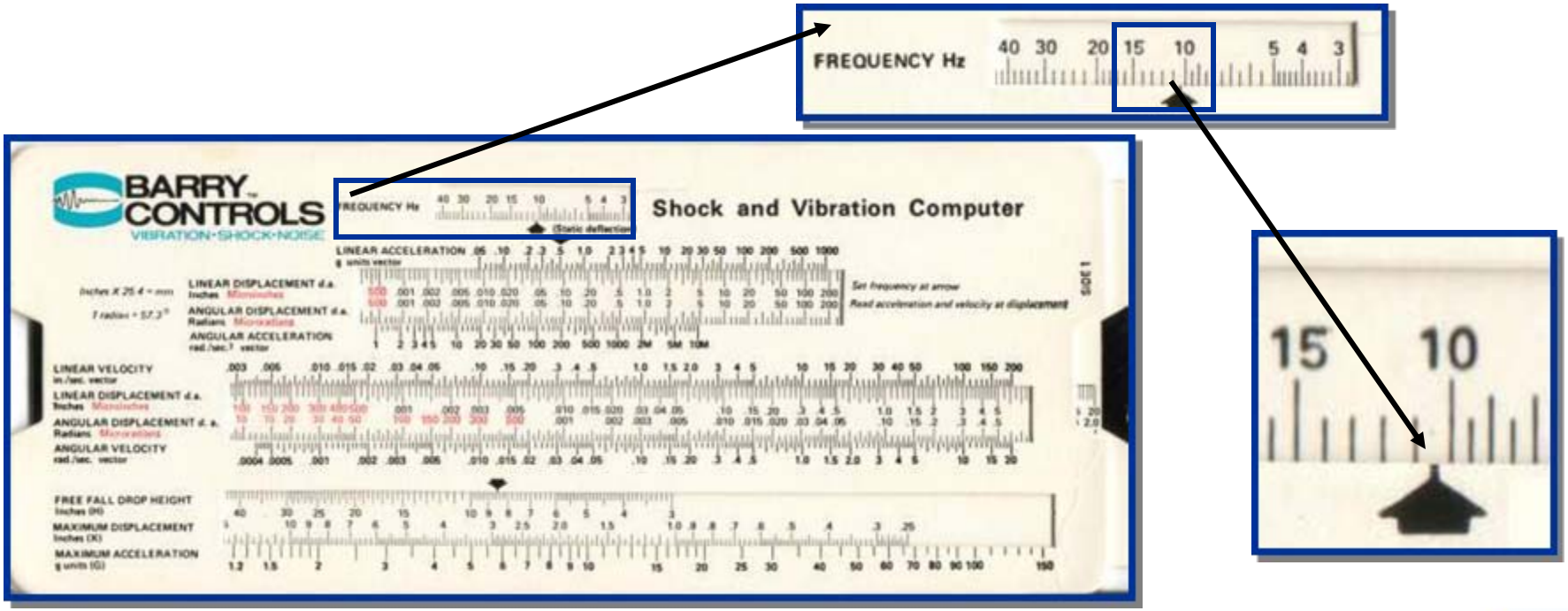
- Set: X/G = static deflection = .09 inch



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 8f:

- Read: fn = natural frequency = 10.4 Hz



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 9:

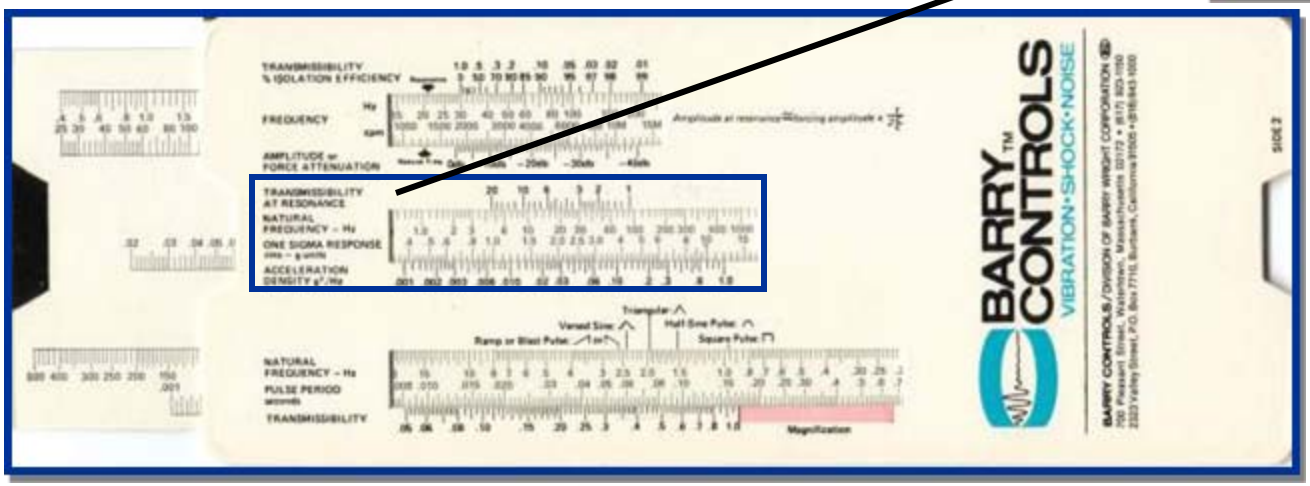
- KNOWN: Natural Frequency, Transmissibility at Resonance
- UNKNOWN: System Response to Random Vibration

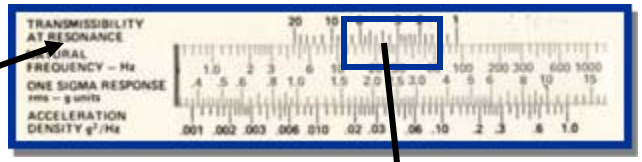
- Exercise:
  - Match (on side 2): fn = natural frequency of system = 30 Hz to Q = transmissibility at resonance = 3
  - Locate: G = power spectral density of random input = .06 G^2/Hz
  - Read: σ = one sigma response of system = 2.95 g ^{RMS}

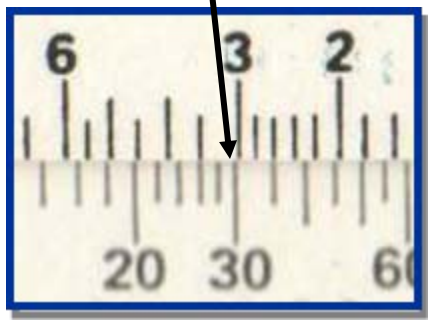
BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 9b: On Side 2

- Match: fn = natural frequency of system = 30 Hz
  to Q = transmissibility at resonance = 3



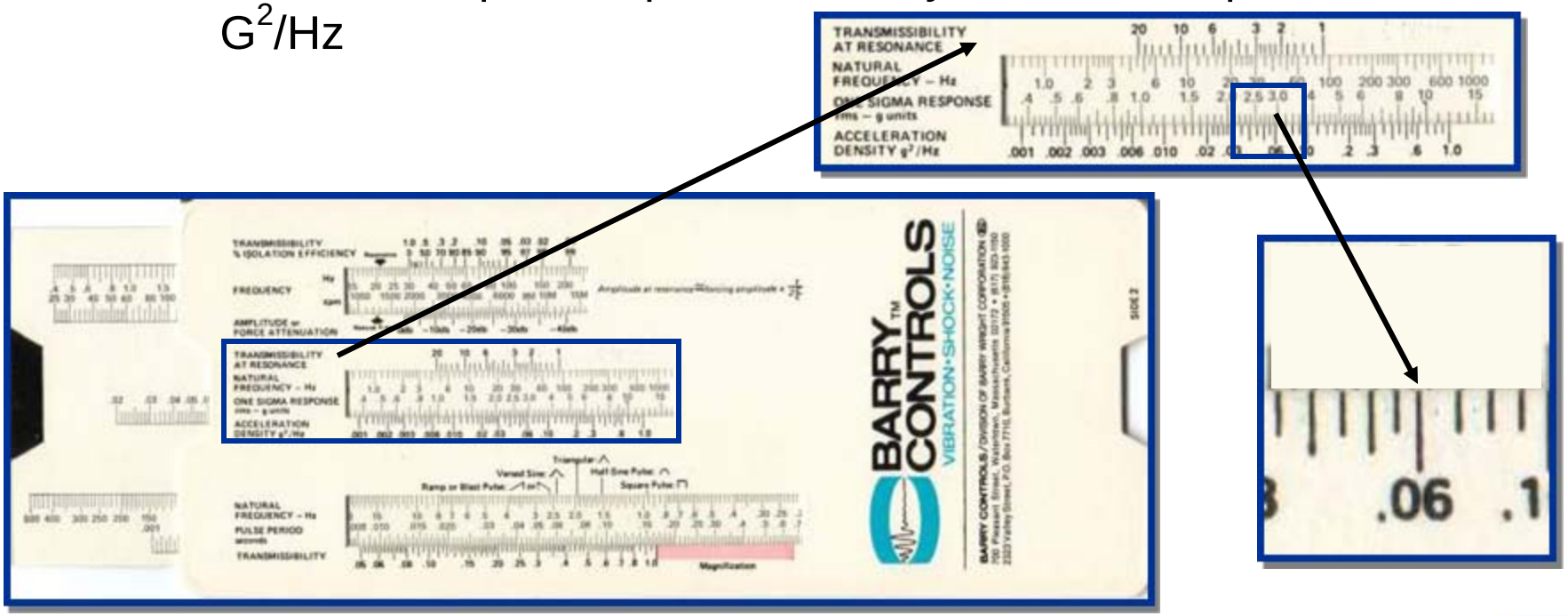




BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 9c:

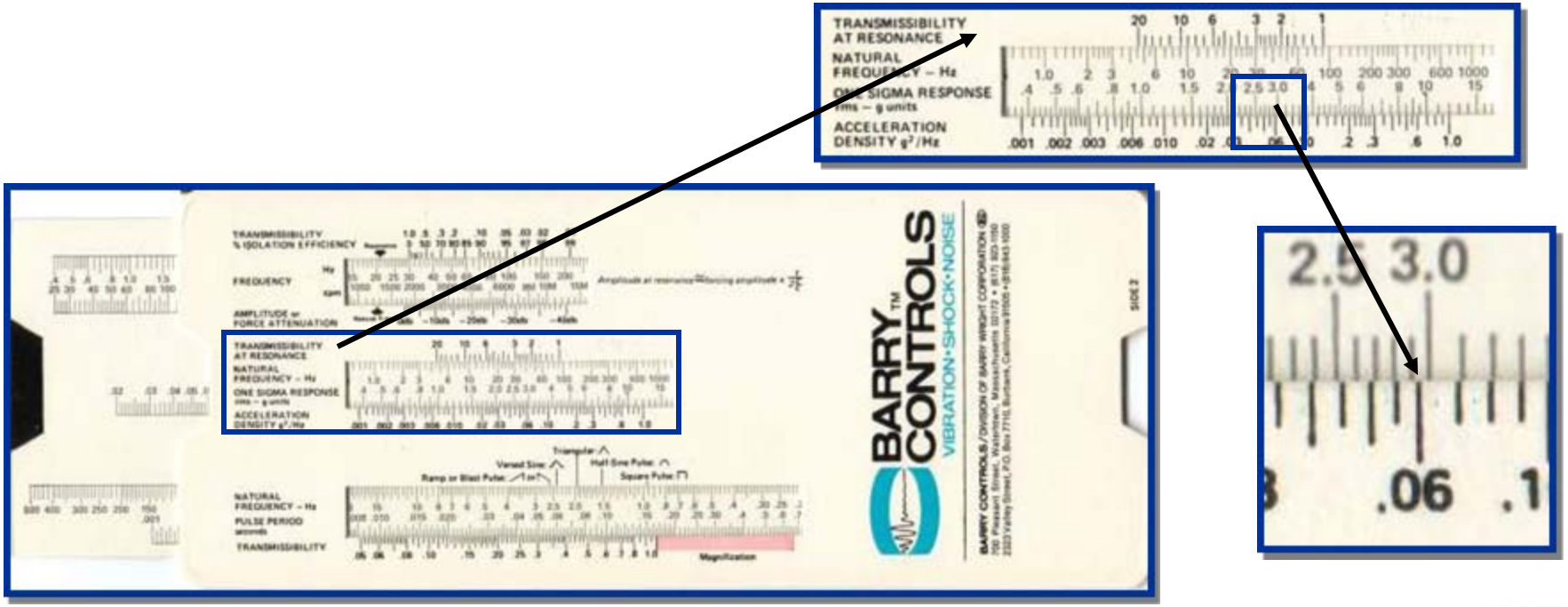
- Locate: G = power spectral density of random input = .06 G^2/Hz



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 9d:

- Read: σ = one sigma response of system = 2.95 g ^{RMS}



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 9e:

- For multiples of σ (sigma), multiply response by the desired multiple.

  Example: 3 sigma = 3(2.95) = 8.85g ^{RMS}

BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 10:

- KNOWN: Natural Frequency of System, Shock Pulse Shape and Duration
- UNKNOWN: Transmissibility of an Undamped System to a Shock Pulse Input

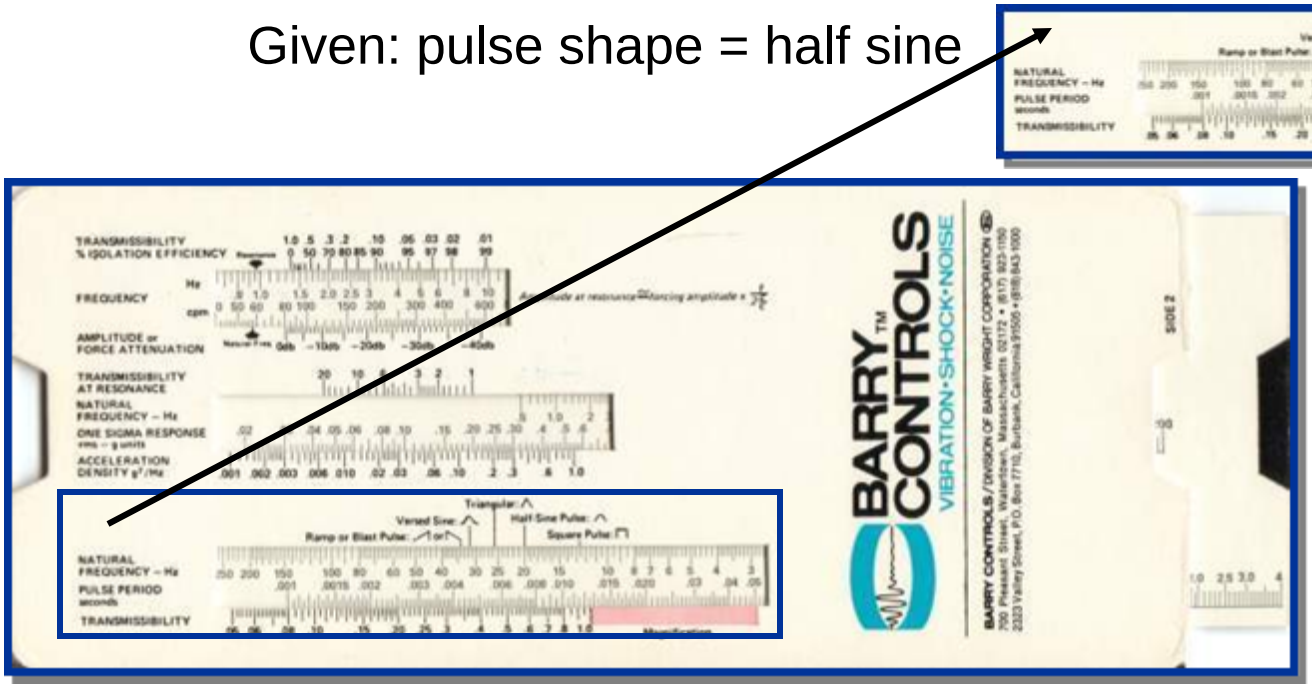
- Exercise:
  - Match (on side 2): fn = natural frequency of system = 20 Hz
  - Given: pulse shape = half sine
  - Locate: t = pulse period = .011 seconds
  - Read: Q = transmissibility of system = 0.88

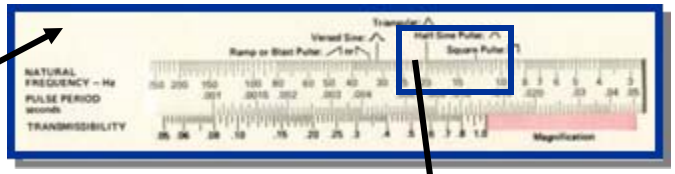
BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

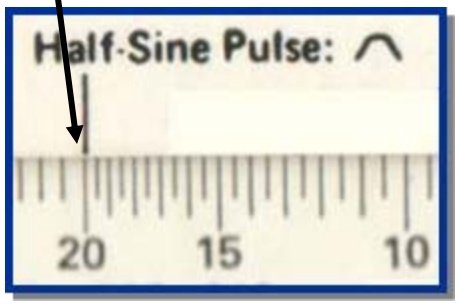
EXERCISE 10b: On Side 2

- Match: fn = natural frequency of system = 20 Hz

  Given: pulse shape = half sine



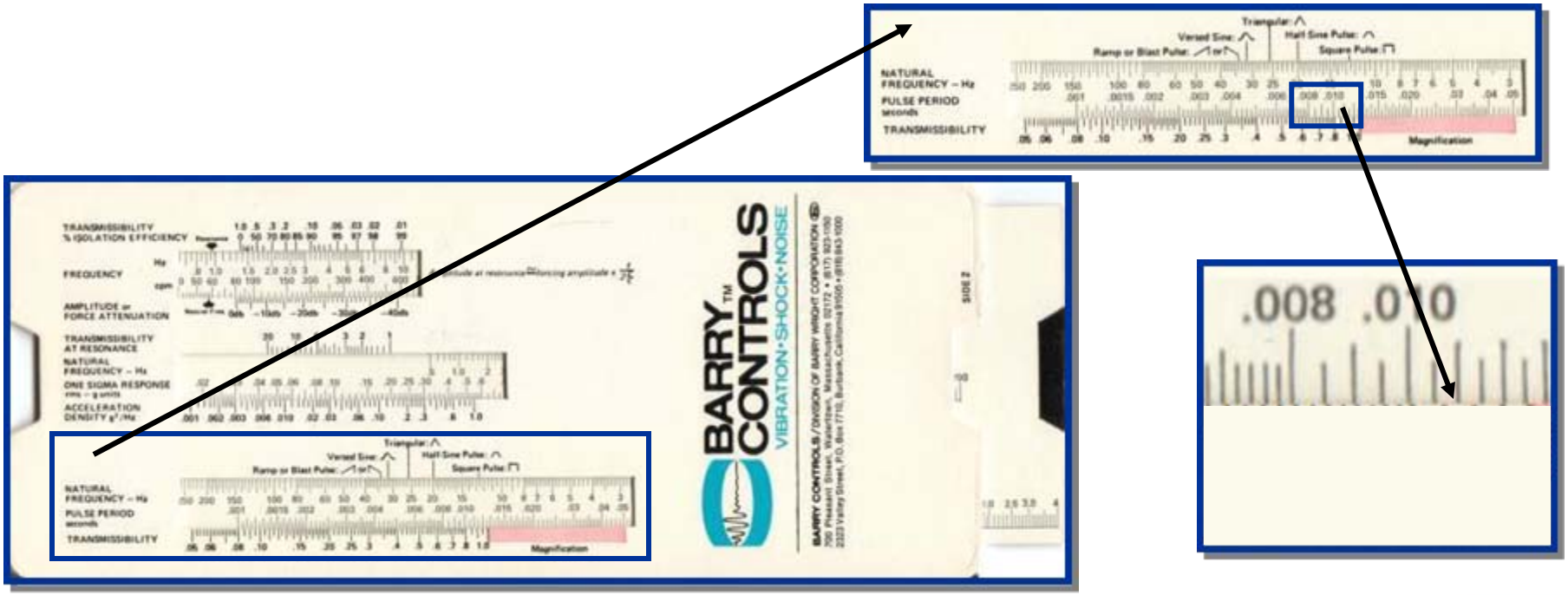




BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 10c:

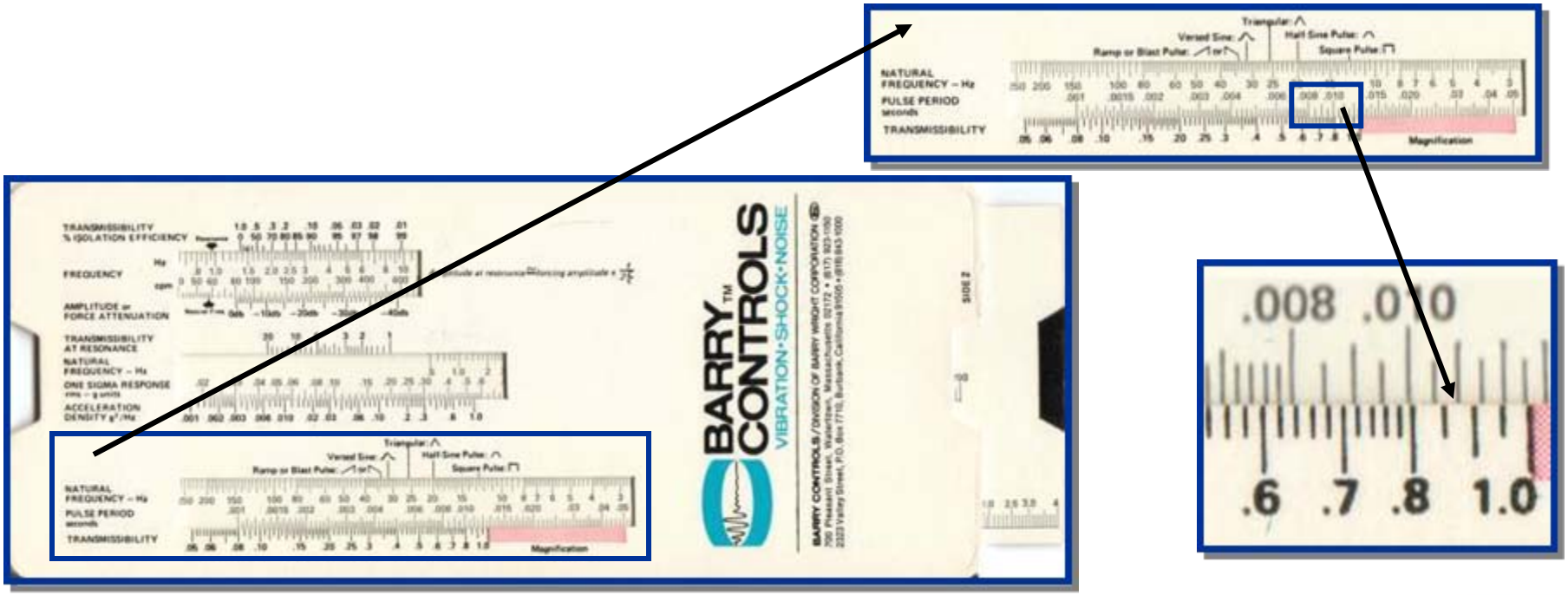
- Locate: t = pulse period = .011 seconds



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 10d:

- Read: Q = transmissibility of system = 0.88



BARRY CONTROLS SHOCK AND VIBRATION SLIDE RULE

EXERCISE 10e:

- This calculator exercise assumes sufficient deflection available in system to permit isolation. If system “bottoms” (snubs), calculator will not give correct results.