Blood Properties and Flow Measurement Homework Solution
BE-382, Winter '08-'09, Dr. C. S. Tritt

1. The relationship between yield stress and hematocrit given in the slideshow is $\tau_0 = (Hct - 0.04)^3$ (note that while it is not explicitly stated, the factional (rather than percent) hematocrit must be used in this equation for results that are consistent with the given statement that τ_0 is about 0.04 dyne/cm^2 under normal conditions (a hematocrit of about 42% or 0.42). So, $\tau_0 = (0.30 - 0.04)^3 = 0.018$ dyne/cm^2.

   The relationship between apparent Newtonian viscosity and hematocrit given in the slideshow is $\eta_N = \eta_P(1.00 + 2.50Hct + 7.35Hct^2)$. In this case it is clear from the slide that *Hct* should be in factional terms, but the constant, η_P, is not defined. However, the given viscosity of 3.05 cp at a *Hct* of 0.40 requires that η_P be 0.9603 cp. Using this value in the equation above (really a Matlab function I wrote to implement it), gives $\eta_N = 2.32$ at a *Hct* of 0.30.

2. From the slide show, take “typical” blood properties to be 3.00 cp (0.0030 N·s/m^2) and 1.056 g/cm^3 (1056 kg/m^3). See the attached spreadsheet for the solution to this problem. The flow is laminar (N_Re = 1992) and the pressure drop is 322 Pa.

3. a) Pneumotachometer – based on statements in slide show (a type of calibrated resistance flow meter and, a.k.a., a Fleisch pneumotachometer)

   b) Many possibilities including a calibrated resistance, a rotary vane or turbine flow meter or a rotameter.

   c) Either a laser Doppler, ultrasonic or an electromagnetic flow meter, see slide show.

   d) Rotameter – based on statement in slide show (also if you search “anesthesia machine” on Google images, you’ll see they all use rotameters).