PHY 2811 (2009)

Solution of Exp.1 prelab questions

(1) **Equation of motion:**

$$v - v_t = -\frac{m}{b}\frac{dv}{dt} \qquad [1]$$

Initial condition:

At time $t = 0$, the water drop velocity is labeled as v_0.

Case 1: $v_0 < v_t$

Let $y = v_t - v$

Then $y = \frac{-m}{b}\frac{dy}{dt}$ or $\frac{dy}{y} = \frac{-b}{m}dt$ (Note: y must be ≥ 0.)

The result is $\text{Log } y\Big|_{y(t=0)}^{y(t)} = \frac{-b}{m}t$ or $y = y_0 e^{\frac{-b}{m}t}$

$$v = v_t - (v_t - v_0)e^{\frac{-b}{m}t} = v_t + (v_0 - v_t)e^{\frac{-b}{m}t} \qquad (\text{for } v_0 < v_t)$$

Case 2: $v_0 > v_t$

Let $y = v - v_t$.

Then $y = \frac{-m}{b}\frac{dy}{dt}$ or $\frac{dy}{y} = \frac{-b}{m}dt$

The result is $\text{Log } y\Big|_{y(t=0)}^{y(t)} = \frac{-b}{m}t$ or $y = y_0 e^{\frac{-b}{m}t}$

$$v = v_t + (v_0 - v_t)e^{\frac{-b}{m}t} \qquad (\text{for } v_0 > v_t)$$

So we have only one result: $v = v_t + (v_0 - v_t)e^{\frac{-b}{m}t}$.

(2) $RS = \frac{2}{3}r^3\rho g$

SI units: $(10^{-3}\text{m})(73 \times \frac{10^{-5}\text{N}}{10^{-2}\text{m}}) = \frac{2}{3}r^3(10^3\frac{\text{kg}}{\text{m}^3})(9.8\frac{\text{m}}{\text{s}^2})$

CGS units: $(0.1\text{ cm})(73\frac{\text{dyn}}{\text{cm}}) = \frac{2}{3}r^3(1\frac{\text{g}}{\text{cm}^3})(980\frac{\text{cm}}{\text{s}^2})$

$\therefore\ r = 2.2$ mm