#1

Need to Show your own data

Should have general agreement w/ Known curve

Uncertainty in measurements will lead to imperfect fit, but should generally be ok.

Plastic balls in water should depart from the curve the most as the sides of the container tend to interfere - and the spheres tend to move toward the wall.

#2

Car

High Reynolds # so drag is

$$F_D = \tfrac{1}{2}\rho U^2 \underbrace{A\ C_D}_{\text{must Come from Data}}$$

Power

$$P = \cancel{\quad} = F U = \tfrac{1}{2}\rho U^{3} A C_D$$

Force × Velocity

Cube.

thus Power at 75 mph will be

$$\frac{(75)^3}{55^3} \approx 2.5 \text{ times greater at high Speed.}$$

Take $C_D A \approx 0.55\,m^2$ which seems a common value

$$P_{55} = 5\ kW \approx 7\ Hp$$

$$P_{75} = 12\ kW \approx 16\ Hp$$

#3

Thunderstorm.

to hold a sphere aloft

$$mg = \text{Drag Force.}$$

$$\rho_{ice} \frac{4}{3}\pi R^3 \cdot g = \frac{1}{2}\rho U^2 \underbrace{\pi R^2}_{A} \cdot C_D$$

$$\frac{\rho_{ice} \frac{8}{3} R g}{\rho_{Air} \; C_D} = U^2$$

Need to estimate parameters and Solve for U

$\rho_{ice} \cong 900 \ kg/m^3$

$R = 0.021 \ m$

$g = 9.8 \ m/s^2$

$\rho_{air} = 1.2 \ kg/m^3$

$C_D \approx 0.5$ as a guess

So

$\boxed{U = 29 \frac{m}{s}}$ or . 65 mph

seems reasonable based on Storm wind speeds

Now check that C_D is consistent.

$$Re = \frac{\rho U D}{\mu} = \frac{(1.2)(29)(0.042)}{1.8 \times 10^{-5}}$$

$$\approx 8 \times 10^{4}$$

guess looks good when I compare to plot of measured drag coeff.

#4

fit should be quite good, depending on how much care you take when doing the experiment. Generally you will ~~[illegible]~~ likely find that the data sits higher than under ideal conditions due to your tubes not being perfectly straight.

#5

$L = 50\ ft = 15.2\ m$

$D = \frac{1}{2}\ in = 0.0127\ m$

$L/D = 1200$

$Q = 6.31 \times 10^{-5}\ m^3/s$

$A = 1.26 \times 10^{-4}\ m^2$

$u = 0.5\ m/s$

$$Re = \frac{\rho u D}{\mu} = \frac{(1000)(0.5)(0.0127)}{0.001} = 6350$$

$f = 0.035$ (approx. from Moody)

$$\Delta P = \frac{1}{2} \rho u^2 \frac{L}{D} f$$

$$= \underline{5250\ Pa}$$

#6

Same problem, only difficulty that f is unknown.

So guess $f \approx 0.03$

$\Delta P = 50\ \text{psi} = 344\ \text{kPa}$

$\Delta P = \frac{1}{2}\rho u^2 \frac{L}{D} f$

$$u^2 = \frac{\Delta P}{\frac{1}{2}\rho \frac{L}{D} f} = \frac{344000}{\frac{1}{2}(1000)(1200)\,0.03} = 19$$

$u = 4.4\ \text{m/s}$

Compute $Re = \frac{\rho u D}{\mu} = \frac{(1000)(4.4)(0.0127)}{0.001} = 55 \times 10^3$

From Moody $f \approx 0.02$ at $Re \approx 5.5 \times 10^4$

So

$$u^2 = \frac{344000}{\frac{1}{2}(1000)(1200)(0.02)} = 33.25\ ;\ u = 5.7\ \text{m/s}$$

Now $Re = \frac{\rho u D}{\mu} = 7 \times 10^4$ Solution seems close enough.

$$Q = u\frac{\pi D^2}{4} = \boxed{721\ \frac{\text{mL}}{\text{s}}}$$

#7

$L = 0.03\ m$

$D = 40 \times 10^{-6} m$

$Q = 10 \frac{mL}{hr} = 2.8 \times 10^{-9} \frac{m^3}{s}$

Resistance $R = \frac{128 \mu L}{\pi D^4}$ (Can use this since Re is small)

$R = 4.77 \times 10^{14}$

$\Delta P = QR = 1.3 \times 10^6\ Pa$

$= 1300\ kPa = \underline{\underline{13 \text{ atmospheres}}}$

Force = P · Area Syringe

$= (1.3 \times 10^6\ Pa)\left(\pi (0.0145)^2 / 4\right)$

$\boxed{F = 214\ N}$