300 points for 3 problems, 100 points for each problem

I. Virgo Cluster

1. From table above, we have $\sum_i \frac{d_i}{s_i^2} = 56.1082$ and $\sum_i \frac{1}{s_i^2} = 3.5485$, so:

$$d_{avg} = \frac{56.1082}{3.5485} \text{ Mpc} = 15.81 \text{ Mpc} \qquad \textbf{(30\%)}$$

2. The uncertainty (rms):

$$s_d = \sqrt{\frac{1}{\sum_i \frac{1}{s_i^2}}} = \sqrt{\frac{1}{3.5485}} \text{ Mpc} = 0.53 \text{ Mpc}$$

$$d_{Virgo} = 15.81 \pm 0.53 \text{ Mpc} \qquad \textbf{(10\%)}$$

3. Hubble constant

$$H_0 = \frac{v}{d_{avg}} = \frac{1136 \text{ km/s}}{15.81 \text{ Mpc}} = 71.9 \text{ km/sec/Mpc} \qquad \textbf{(15\%)}$$

Uncertainty:

$$s_{H_0} = \frac{s_d}{d_{avg}} H_0 = \frac{0.53}{15.81} \times 71.85 = 0.0335 \times 71.85 = 2.4 \text{ km/sec/Mpc} \qquad \textbf{(15\%)}$$

Hubble constant: $H_0 = 72 \pm 2 km/\text{sec}/Mpc$ **(5%)**

4. Hubble time:

$$H_0^{-1} = \frac{1}{H_0} = \frac{1}{71.85 \text{ km/sec/Mpc}} \times 3.086 \times 10^{10} \text{ km/Mpc} = 4.29 \times 10^{17} \text{sec} = 13.6 \text{ Gyr} \qquad \textbf{(20\%)}$$

Uncertainty is 3.35% which is 0.45 Gyr. **(5%)**