













- If we were to take the log of each observation, and tabulate the data, then the median would equal the mean: the logs are normally distributed.
  - The geometric mean is the antilog of the average of these logs.
  - The geometric standard deviation is the antilog of the standard deviation of the logs.









- Statistical parameters
  - Population mean =  $\mu$
  - Sample mean =  $\overline{x}$
  - Population  $\sigma_n$  versus sample  $\sigma_{n\text{-}1}$







- · Calibration is used to reduce error.
  - Calibration of direct-reading instruments: use NBS standard samples or gas concentrations or generate known concentration.
- Calibration can limit measurement error: an estimate of exposure at time of measurement.
- Calibration does not reduce sampling error: an estimate of the true exposure experienced by population.



space.



















## Flow Rate Calibration (Orifice Meter)

 Orifice meter: a disk inside a duct or tube. The pressure drop can measure the flow rate across the disk. Critical orifice can be used to generate a known flow: operate at high suction, and measure flow. Then flow does not need calibration.







![](_page_14_Figure_0.jpeg)

![](_page_14_Figure_1.jpeg)

![](_page_15_Figure_0.jpeg)

![](_page_15_Figure_1.jpeg)

![](_page_16_Figure_0.jpeg)

![](_page_16_Figure_1.jpeg)

![](_page_17_Figure_0.jpeg)

![](_page_17_Figure_1.jpeg)

![](_page_18_Figure_0.jpeg)

![](_page_18_Figure_1.jpeg)

## **Dynamic Calibration Systems**

 Problems with this approach: temperature dependence; Actual concentration may not be known [you may not be at saturation]; Very high concentrations are generated [safety and fire concerns possible]; Stability of test gas may be a problem with some chemicals.

## **Dynamic Calibration Systems**

 Use a syringe pump. A syringe pump is a gear – driven device that can pump liquid into an air stream at a constant rate.
These pumps can be calibrated, and can inject small volumes of gas or liquid. So long as pump rate is known and constant, and liquid evaporates completely, this works well.

![](_page_20_Figure_0.jpeg)

![](_page_20_Figure_1.jpeg)

![](_page_21_Figure_0.jpeg)

![](_page_21_Figure_1.jpeg)