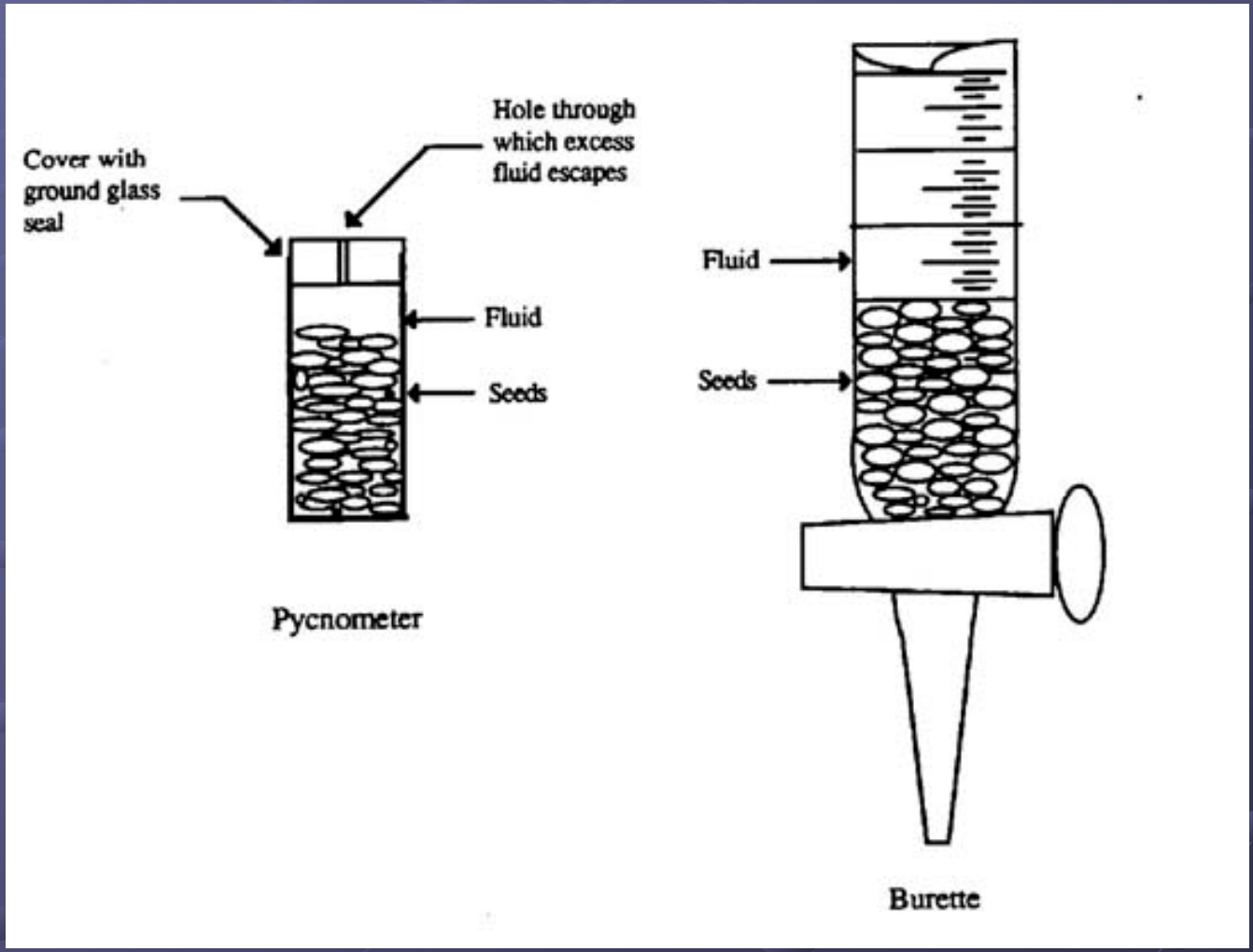
Volume Measurement

experimentally measured by liquid/gas displacement



Grains and smaller seeds → pycnometer or sp. gravity bottles or graduate burettes

$$V_s = \frac{[W_{pf} - W_p] - [W_{pfs} - W_{ps}]}{\rho_f}$$

Wpf – Wp = mass of fluid contained in pycnometer
Wpfs – Wps = mass of fluid in pycnometer when it also contains solids

Graduated burette : vol. of particle > 10 x the graduation

Source of error:

– air bubbles

– low surface tension liquid should be used, e.g. alcohol, toluene and tetrachloroethylene

large particles: use beaker with water

– Determine the mass of beaker and water

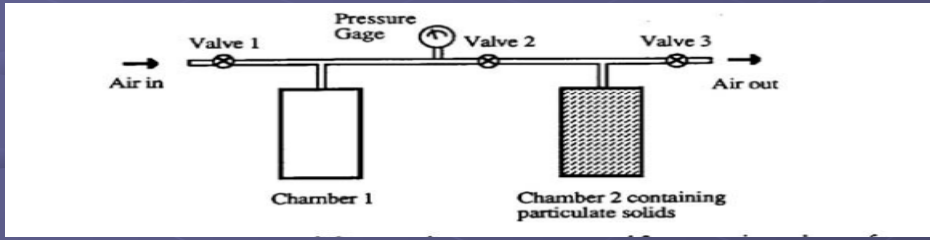
– Object is immersed so that it will not touch the sides or bottom of the container

$$V_s = \frac{\text{Buoyant Force}}{\text{Density of Water}} = \frac{W_{bws} - W_{bw}}{\rho_w}$$

Volume of particulate solids

- air comparison pycnometer
- gas pycnometer

$$PV_a = \frac{MRT}{n}$$



If R, T and n are constant

$M_3=M_1+M_2$

$P_3(V_1+V_2+V_3)= P_1V_1+P_2(V_2-V_s)$

$V_s(P_3-P_2)=V_2(P_3-P_2) – V_1(P_1-P_3)$

$V_s=$

If $P_2=0$

$V_s =$

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- **Sources of error:**

– Air does not follow the ideal gas law

– Equalization of pressure in chambers 1 and 2 is not isothermal

– Tubing volume was not taken into account

– Error in pressure measurement

– Penetration of air/gas into the kernel / particle interior

Helium (used in gas pycnometers)

- 20% of air spaces in the interior of corn kernels
- 30% of air spaces in the interior of wheat kernels
- 52% of air spaces in the interior of sorghum kernels

Volume and surface area estimation

– using similarity to geometric solids

– formulas are in Appendix C*

– more complex geometries may better describe the actual shape of agric./bio-materials (Example 2.3)

– computer vision systems: used for quick estimation of volume and surface areas

Surface area measurement

Fruits, vegetables and larger objects, e.g. egg

– peeling: material is carefully peeled and the peel is traced

–Coating: for materials that can not be peeled

Small materials, e.g. seeds and grains

– coating with metal powder

–surface area estimated by determining the increase in weight per unit surface area for plastic cylinders or spheres after being coated in the same manner as seeds

Radius of Curvature

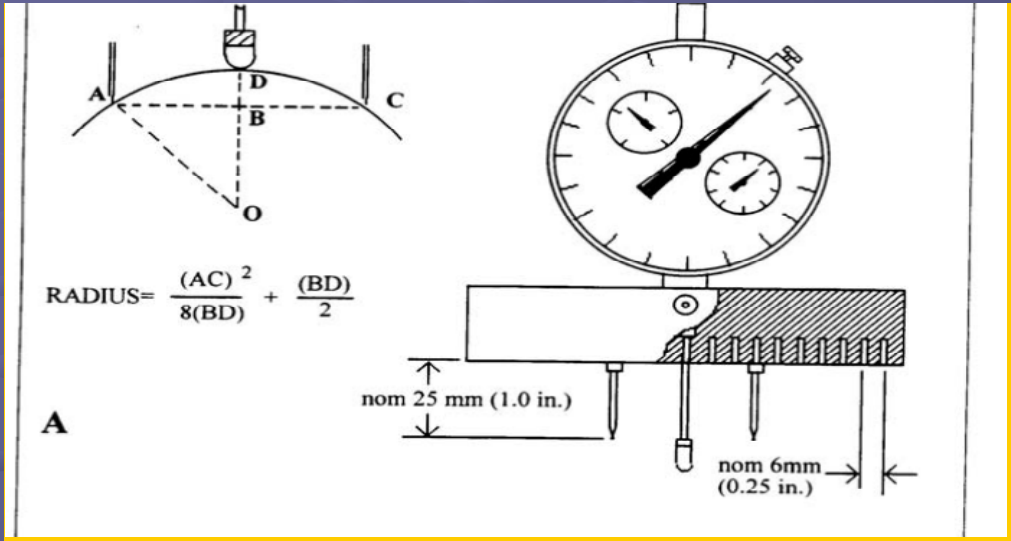
-Sharpness of curvature will determine how objects will roll

- Greater contact stresses develop in surfaces of ag./bio-materials when their surfaces are more sharply rounded

- Radius of a circle having an arc which coincides with the curve at that point.

- There is a minimum and maximum radius of curvature when all points on the surface are considered.

Radius of curvature meter for large objects



Radius of curvature for a small object

$$R_1 \simeq H/2$$

$$R_1' \simeq \frac{H^2 + L^2/4}{2H}$$

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