

with the kidneys secreting substances which should not be lost from the body. The determination of density (specific gravity) is almost always performed during a urinalysis.

Several techniques are used for the determination of density. The method used will depend on the *type of sample* and on the level of *precision* desired for the measurement. For example, devices have been constructed for determinations of the density of urine, that permit a quick, reliable, routine determination. In general, a density determination will involve the determination of the mass of the sample with a balance, but the method used to determine the volume of the sample will differ from situation to situation. Several methods of volume determination are explored in this experiment.

For *solid* samples, different methods may be needed for the determination of the volume, depending on whether or not the solid is regularly shaped. If a solid has a *regular shape* (e.g., cubic, rectangular, cylindrical), the volume of the solid may be determined by geometry:

For a cubic solid, volume = (edge)³

For a rectangular solid, volume = length × width × height

For a cylindrical solid, volume = $\pi \times (\text{radius})^2 \times \text{height}$

If a solid does *not* have a regular shape, it may be possible to determine the volume of the solid from Archimedes' principle, which states that an insoluble, non-reactive solid will *displace* a volume of liquid equal to its own volume. Typically, an irregularly shaped solid is added to a liquid in a volumetric container (such as a graduated cylinder) and the *change* in liquid level determined.

For liquids, very precise values of density may be determined by pipeting an exact volume of liquid into a sealable weighing bottle (this is especially useful for highly volatile liquids) and then determining the mass of liquid that was pipeted. A more convenient method for routine density determinations for liquids is to weigh a particular volume of liquid as contained in a graduated cylinder.

Safety Precautions

- Protective eyewear approved by your institution must be worn at all time while you are in the laboratory.
- The unknown liquids may be flammable, and their vapors may be toxic. Keep the unknown liquids away from open flames, and do not inhale their vapors. Dispose of the unknown liquids as directed by the instructor.
- Dispose of the metal samples in the container designated for their collection. Do not put into the trash container.

Apparatus/Reagents Required

Unknown liquid sample, unknown metal sample, sodium chloride