percentage error occurs when the smallest amount is being measured. Thus, the rule of thumb for measuring liquids in graduates is that a graduate should be used having a capacity *equal to or just exceeding* the volume to be measured.

According to Goldstein and Mattocks (2), based on a deviation of 1 mm from the mark and an allowable error of 2.5%, the smallest amounts that should be measured in cylindrical graduates having the stated internal diameters are as follows:

GRADUATE CYLINDER SIZE (ML)	INTERNAL DIAMETER (CM)	DEVIATION IN ACTUAL VOLUME (ML)	MINIMUM VOLUME MEASURABLE (ML)
5	0.98	0.075	3.00
10	1.18	0.109	4.36
25	1.95	0.296	11.84
50	2.24	0.394	15.76
100	2.58	0.522	20.88

For a 5% error, the minimum volumes measurable would be one-half of those stated. It is apparent that for accuracy, one should not use a graduate when the measurement would use only the bottom portion of the scale.

In using graduates, the pharmacist pours the liquid into the graduate slowly, observing the level. In measuring viscous liquids, adequate time must be allowed for the liquid to settle in the graduate, as some may run slowly down the inner sides of the graduate. It is best to attempt to pour such liquids toward the center of the graduate, avoiding contact with the sides. In emptying the graduate of its measured contents, adequate drain time should be allowed.

When pouring liquids from bottles, good pharmaceutical technique is to keep the label on the bottle facing up; this avoids the possibility of any errant liquid running down over the label as the bottle is righted after use. The bottle orifice should be wiped clean after each use.

REFERENCES

1. Ansel HC. Pharmaceutical Calculations. 13th Ed. Baltimore, MD: Lippincott Williams & Wilkins, 2010.
2. Goldstein SW, Mattocks AM. How to measure accurately. J Am Pharm 1951;23:421.