



## TP 2.1

### Minimum cue tip friction required for no-slip horizontal impact

supporting:

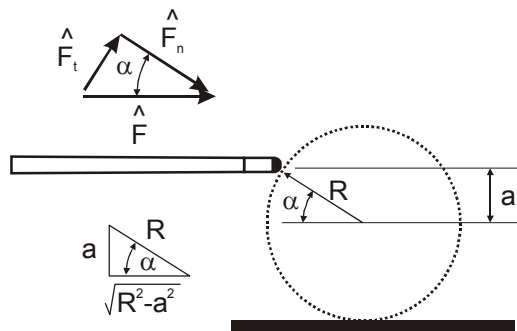
“The Illustrated Principles of Pool and Billiards”

<http://billiards.colostate.edu>

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ball size:             $D := 2.25 \cdot \text{in}$              $R := \frac{D}{2}$



Horizontal impulse between the cue stick and cue ball:

$$F'$$

Normal impulse (perpendicular to the ball):

$$F'_n = F' \cdot \cos(\alpha) \tag{1}$$

Tangential impulse (tangent to the ball):

$$F'_t = F' \cdot \sin(\alpha) \tag{2}$$

On the verge of slip, using Equation 1:

$$F'_t = \mu \cdot F'_n = \mu \cdot (F' \cdot \cos(\alpha)) \quad (3)$$

Equating Equations 2 and 3 gives:

$$\mu = \frac{\sin(\alpha)}{\cos(\alpha)} = \tan(\alpha) = \frac{a}{\sqrt{R^2 - a^2}}$$

Typical values:

$$\mu(a) := \frac{a}{\sqrt{R^2 - a^2}} \quad \mu(0.6 \cdot \text{in}) = 0.63$$
$$\mu\left(\frac{9}{16} \cdot \text{in}\right) = 0.577$$