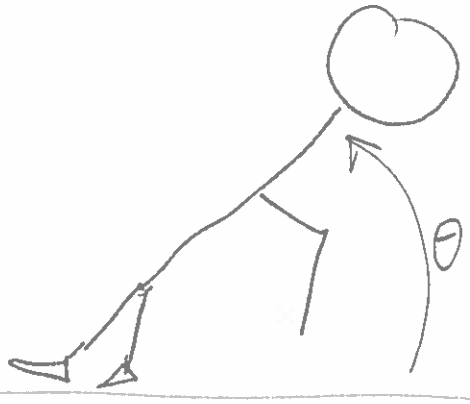
Short-track speed skating

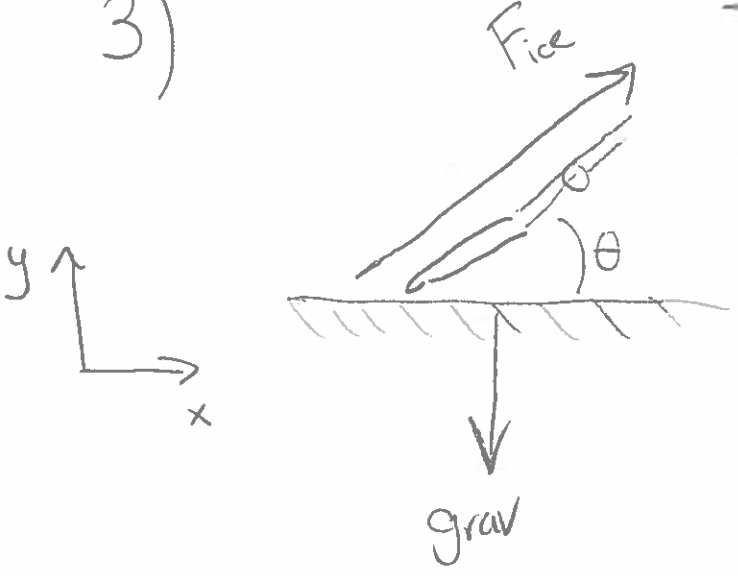
1) Radius of curvature $R \sim 13\ m$

2)



$\theta \approx 35^\circ$, rough guess

3)



4)

force	x	y
grav	0	$-mg$
ice	$+F_{ice}\cos\theta$	$+F_{ice}\sin\theta$
total	$+ma_x$	$+ma_y = 0$

$\rightarrow F_{ice}\sin\theta = mg \rightarrow F_{ice} = \frac{mg}{\sin\theta}$

5) Ice's horizontal force pushes skaters toward center of the curve.

$$F_{ice}\cos\theta = ma_x = \left(\frac{mg}{\sin\theta}\right)\cos\theta$$

6) Centripetal acceleration is

$$a_c = \frac{v^2}{R} \quad \text{toward center of curve}$$

So, we have two expressions for acceleration toward the center of the curve, in the x-direction.

$$m a_x = \left(\frac{mg}{\sin\theta}\right)\cos\theta$$

$$\rightarrow \boxed{a_x = \left(\frac{g}{\sin\theta}\right)\cos\theta}$$

And

$$a_c = \frac{v^2}{R}$$

7) Setting them equal

$$\frac{v^2}{R} = \frac{g}{\sin\theta}\cdot\cos\theta$$

$$v = \sqrt{gR\,\frac{\cos\theta}{\sin\theta}}$$

$$= \sqrt{\left(9.8\,\frac{m}{s^2}\right)(13\,m)\left(\frac{\cos 35^\circ}{\sin 35^\circ}\right)}$$

$$\simeq \underline{13\,\frac{m}{s}}$$

8) At this speed, one lap of $L = 111\,m$ would take

$$t = \frac{L}{v} = \frac{111\,m}{13\,m/s} \simeq 8\,s$$

9) Hmm... Real time is $\simeq 9\,s$. Close enough!