2018B F=ma Exam: Problem 14

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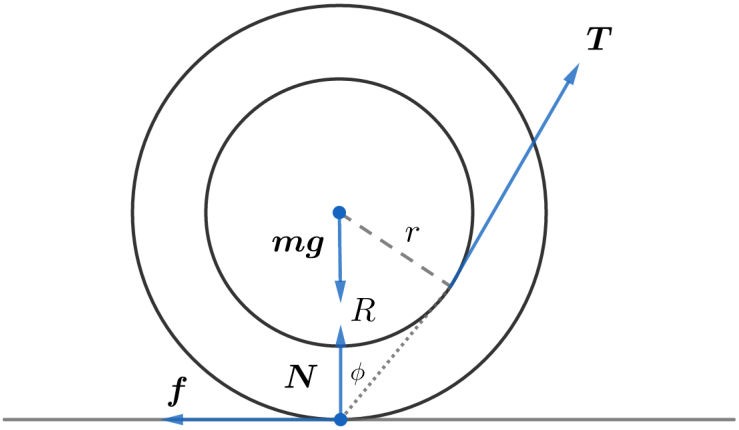

Since the spool will slip without rotating, the net torque on it must be zero:

$$\tau_{net} = 0$$

Let's choose the contact point with the ground as our axis such that only the tension from the string contributes to torque (since the lines of all other forces go through the contact point). Then it is clear that the line of the string must also intersect with the axis. Hence,

$$\sin\phi = \frac{r}{R}$$

$$\phi = \arcsin\frac{r}{R}$$

so

$$\theta = 90^\circ - \phi = 90^\circ - \arcsin\frac{3}{4} \approx 41.4^\circ$$

and the answer is $\boxed{\text{B}}$.