Focus the problem
Draw a picture of the situation including ALL the information given in the problem.

\[ m = 75 \text{ kg} \]

\[ \theta = 9.0^\circ \]

5.0 m = \( r \)

Question(s): What is the problem asking you to find?

What is the work done by friction and average frictional force

Approach: Outline the approach you will use.

Use conservation of energy with work done by friction as the only non-conservative external work

Describe the physics
Draw physics diagram(s) and define ALL quantities uniquely.

Initial

\[ y_i = 5.0 \text{ m} \]

\[ v_i = 0 \text{ m/s} \]

\[ F_f \]

\[ W_f, \quad F_f \]

Final

\[ y_f = 0 \text{ m} \]

\[ v_f = 9.0 \text{ m/s} \]

Which of your defined quantities is your target variable(s)?

Quantitative relationships: Write equations you will use to solve this problem.

\[ W = \int F \cdot dr \]

\[ W_{ext} = \Delta K + \Delta U \]

\[ \frac{1}{2} mv^2 \]

\[ U_g = mgH \]
**PLAN the SOLUTION**
Construct Specific Equations (Same Number as Unknowns)

Find \( \langle F_x \rangle \)
\[
W_f = \int S \, F_x \, dr = \langle F_x \rangle \Delta r \cos \theta
\]
Since \( \theta = -1 \), \( \Delta r = \frac{1}{4} \pi r \)
\[
W_f = \langle F_x \rangle \frac{1}{2} \pi r
\]
\[
\langle F_x \rangle = -\frac{2W_f}{\pi r}
\]

\( \text{(1)} \)

Find \( W_f \)
\[
W_f = \Delta k + \Delta U = K_f - K_i + U_f - U_i
\]
\[
W_f = \frac{1}{2} m V_f^2 - m g y_i
\]

\( \text{(2)} \)

**EXECUTE the PLAN**
Calculate Target Quantity(ies)

\( \text{(2)} \)
\[
W = \frac{1}{2} (75 \text{ kg})(9.0 \text{ m/s})^2 - \frac{1}{2} (75 \text{ kg})(9.8 \text{ m/s}^2)(5.0 \text{ m})
\]
\[
= -640 \text{ J}
\]

\( \text{(1)} \)
\[
\langle F_x \rangle = \frac{(2)(640 \text{ J})}{11 \text{ (5.0 m)}} = 81 \text{ N}
\]

**EVALUATE the ANSWER**
Is Answer Properly Stated?

Yes, in Joules and Newtons

Is Answer Unreasonable?

This is a Force of about 18 pounds
So it seems reasonable

Is Answer Complete?

Yes

(extra space if needed)

Check Units

For \( \text{(2)} \)
\[
\frac{\text{[m]}(\text{L})^2}{(\text{T})^2} - \frac{\text{[m]}(\text{L})^2(\text{L})}{(\text{T})^2} = \text{ J ok}
\]

For \( \text{(1)} \)
\[
\frac{\text{[m]}(\text{L})^2}{(\text{T})^2(\text{L})} = \frac{\text{[m]}(\text{L})}{(\text{T})^2} = \text{ J ok}
\]