SHOW ALL WORK!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

The block, as shown in the drawing, is launched up the incline with an initial velocity of \( v_0 = 4.00 \text{ m/s} \). A very weak spring with \( k = 20.0 \text{ N/m} \) is placed on the top of the incline a distance 1.00 m from the block. The block hits the spring, compresses it and stops. (No energy is lost when the block hits the spring.)

(a) What is the maximum compression of the spring?
(b) The spring launches the block back. What will be the velocity of the block when it is again 1.00 m from the spring (at its initial position)?

\[ \mu_k = 0.24 \]
\[ \mu_s = 0.30 \]
\[ l = 1.00 \text{ m} \]
\[ m = 2.00 \text{ kg} \]
\[ k = 20 \text{ N/m} \]

\( a) \) Energy at \( A \):
\[ E_A = \frac{1}{2} mv_0^2 \]

Energy at \( B \):
\[ E_B = \frac{1}{2} kx^2 + mg(l+x)\sin \theta \]

Work done by friction force:
\[ W = f_k(l+x) = \mu_k mg \cos \theta (l+x) \]

Since no energy is lost when block hits the spring:
\[ E_A = E_B + W \]

\[ \frac{1}{2} mv_0^2 = \frac{1}{2} kx^2 + mg(l+x)\sin \theta + \mu_k mg \cos \theta (l+x) \]

\( \text{(2 pts) } (2 \text{ pts) } (4 \text{ pts) } (2 \text{ pts) } \quad (10 \text{ pts) } \)

\( \text{or } \frac{1}{2} mv_0^2 = \frac{1}{2} kx^2 + mg(l+x)\sin \theta + \mu_k mg l \cos \theta \)
$(1/2)kx^2 + mg(\sin \theta + \mu_k \cos \theta)x + mgl(\sin \theta + \mu_k \cos \theta) - \frac{1}{2}mv_0^2 = 0$

Let $a = \frac{1}{2}k = 20.00$

$b = mg(\sin \theta + \mu_k \cos \theta) = 13.89$ (or $b' = mg \sin \theta = 9.81$)*

$c = mgl(\sin \theta + \mu_k \cos \theta) - \frac{1}{2}mv_0^2 = -2.11$

Then:

$$ax^2 + bx + c = 0$$ (1 pt)

$$x_{1/2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$ (2 pts)

$$x = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$ (1 pt)

$$= 1.38 \cdot 10^{-1} \text{ m (or } 1.82 \cdot 10^{-1} \text{ m})$$ (1 pt)

b) Conservation of energy law:

$$E_a' = E_a - 2W$$, where $E_a'$ - energy of the block when it's back at the initial position.

$$\frac{mv_{12}^2}{2} = \frac{mv_0^2}{2} - 2 \mu_k mg \cos \theta (x + x)$$ (2 pts)

(or $\frac{mv_{12}^2}{2} = \frac{mv_0^2}{2} - 2 \mu_k mg \cos \theta \cdot l$)*

Therefore:

$$v' = \sqrt{v_0^2 - 4 \mu_k mg \cos \theta (x + x)}$$ (2 pts)

$$= 2.59 \text{ m/s (or } 2.80 \text{ m/s})$$ (1 pt)

If static friction was evaluated at the top - 2 bonus pts.

+ - if announcement was taken into account,
- No penalty for either solution.