A block is attached to a horizontal spring and oscillates back and forth on a frictionless surface with a frequency of \( f = 3.00 \text{ Hz} \). The amplitude of this motion is \( 0.00 \times 10^{-2} \text{ m} \). Assume \( t_i = 0 \) and is the instant the block is at the equilibrium position moving to the left.

A. \( 8 \text{ pts.} \) Write expressions \( x(t) = A \sin (\omega t + \phi) \) and 
\( v(t) = A \omega \cos (\omega t + \phi) \) filling in the values of \( A, \omega, \) and \( \phi \) (the initial phase).

\[
x(t) = (2.00 \times 10^{-2} \text{ m}) \cos (6 \pi t + \pi)
\]

\[
v(t) = (0.36 \text{ m/s}) \cos (6 \pi t + \pi)
\]

\[
\omega = 2 \pi f = 2 \pi \times 3.00 \text{ Hz} = 6 \pi \text{ rad/s}
\]

\[
A = 2.00 \times 10^{-2} \text{ m}
\]

\[
x(t_i) = x(0) = -A \Rightarrow \phi = \pi
\]

\[
v(t_i) = 0 \Rightarrow -A \omega \Rightarrow \phi = \pi
\]

\[
\text{Since } \omega = \sqrt{\frac{k}{m}}
\]

\[
\frac{F}{m} = \omega^2 m = (6 \pi \text{ rad/s})^2 (0.36 \text{ m/s}^2)
\]

B. \( 5 \text{ pts.} \) What is the total mechanical energy (ME) of the block-spring system?

\[
\text{ME}_{\text{tot}} = \frac{1}{2} m v_{\text{max}}^2 = \frac{1}{2} m (0.36 \text{ m/s})^2 = 0.330 \text{ J}
\]

C. \( 15 \text{ pts.} \) Suppose the block, at the moment it reaches its maximum velocity to the left splits in half with only one of the halves remaining attached to the spring. What are the amplitude and frequency of the resulting oscillations?

\[
\text{NEW} = \frac{2}{0.36 \text{ m/s}} = 4.24 \text{ m/s}
\]

\[
\frac{m}{2} g = 1.77 \text{ N/m} \Rightarrow \omega = \sqrt{\frac{1.77 \text{ N/m}}{0.36 \text{ kg}}} = 36.4 \text{ rad/s}
\]

\[
\frac{\omega}{2 \pi} = 5.8 \text{ Hz}
\]

D. \( 16 \text{ pts.} \) Suppose, instead of splitting at the position of maximum velocity to the left, the block now splits when it is at the extreme position in the left. What are the amplitude and frequency of the resulting motion?

\( A = 6.00 \times 10^{-2} \text{ m} \) AS BEFORE

\( \frac{\omega}{2 \pi} = 5.8 \text{ Hz} \) FROM C

E. \( 15 \text{ pts.} \) Describe in words what would happen to the period of oscillation if a second block identical to the first block were dropped on the first block at either of its extreme positions.

A WOULD STAY THE SAME

\[
T_{\text{new}} = \frac{\omega_{\text{new}}}{2 \pi} = \frac{1}{2 \pi} \sqrt{\frac{k}{m}} = \frac{F_{\text{old}}}{F_{\text{new}}}
\]

THerefore The Period \( T = \frac{1}{5} \) gets longer.