14) An object of mass $m$ moving horizontally with a certain speed has a kinetic energy of 0.0124 J. The object collides with a horizontal spring and compresses it by 0.800 m before it is brought to rest. What is the spring constant of this spring?

A) 0.315 N/m
B) 0.0388 N/m
C) 0.194 N/m
D) 0.0235 N/m
E) 0.150 N/m

**Use conservation of energy**

\[
E_i = E_f \\
E_i = \frac{1}{2} k x^2 \quad \Rightarrow \quad k = \frac{2 E_i}{x^2} \\
E_i = 2 \left(0.0124\right) \] 

\[
0.0388 \text{ N/m} 
\]

15) A golf club exerts an average force of 1000 N on a 0.045-kg golf ball which is initially at rest. The club is in contact with the ball for 1.8 ms. What is the speed of the golf ball as it leaves the tee?

A) 30 m/s
B) 45 m/s
C) 40 m/s
D) 35 m/s
E) 50 m/s

**Use Impulse-Momentum Theorem**

\[
I = \Delta p \\
F_{avg} \Delta t = m(V_f - V_i) \\
F_{avg} \Delta t = m \left( \frac{1000}{0.0018} \right) \\
V_f = \frac{F_{avg} \Delta t}{m} \\
V_f = \frac{40 \text{ m/s}}{0.045} 
\]

16) A 2.00-g bullet hits and becomes embedded in a 5.00-kg wood block which is hanging from a 1.20-m long string. This causes the block to swing through an arc of 3.50°. What was the speed of the bullet before it hit the block?

A) 524 m/s
B) 789 m/s
C) 262 m/s
D) 25.3 m/s
E) 16.7 m/s

**Use conservation of momentum**

\[
F_0 = F_1 \\
m_1 V_0 + m_2 V_0 = (m_1 + m_2) V_1 \\
V_1 = \left(\frac{m_1 + m_2}{m_1}\right) V_0 - \left(\frac{m_2}{m_1}\right) V_0 \\
V_0 = \left(\frac{m_1 + m_2}{m_1}\right) \sqrt{\frac{2 \Delta E}{m_1}} \\
V_0 = \left(\frac{m_1 + m_2}{m_1}\right) \sqrt{\frac{2 \Delta E}{m_1}} \\
= \left(\frac{2 + 5000}{2}\right) \sqrt{\frac{2 (4.81) (1.2) (1 - \cos 3.5\degree)}{2}} \\
= 5.24 \text{ m/s} 
\]

17) A railroad car of mass $m$ and speed $v$ collides and sticks to an identical railroad car that is initially at rest. After the collision, the kinetic energy of the system

A) is one third as much as before.
B) is one fourth as much as before.
C) is one quarter as much as before.
D) is half as much as before.
E) is the same as before.

**Use conservation of momentum**

\[
P_i = P_f \\
v m + 0 = 2 m V_f \\
V_f = \frac{v}{2} \\
k_i = \frac{1}{2} m v^2 \\
k_f = \frac{1}{2} (m + m) V_f^2 = m \left(\frac{v}{2}\right)^2 \\
= \frac{1}{4} m v^2 \\
= \frac{1}{2} k_i 
\]

**Use conservation of energy**

\[
E_i = E_f \\
E_i = \frac{1}{2} m v^2 \\
E_f = \frac{1}{2} \left( m + m \right) V_f^2 = m \left(\frac{v}{2}\right)^2 \\
= \frac{1}{4} m v^2 \\
= \frac{1}{2} k_i 
\]

**Diagram**

\[
h = L - L \cos Q \\
= L (1 - \cos Q) 
\]