Answer on Question 58429, Physics, Mechanics, Relativity

Question:

A small glider is placed against a compressed spring at the bottom of an air track that slopes 40° above the horizontal. The glider has a mass of $0.090\ kg$. The spring has a $k = 640\ N/m$ and negligible mass. When the spring is released, the glider travels a maximum distance of $1.80\ m$ along the air track before sliding back down. Before reaching this maximum distance, the glider losses contact with the spring. What distance was the spring originally compressed? When the glider has traveled along the track $0.80\ m$ from its initial position against the compressed spring, is still in contact with the spring? What is the kinetic energy of the glider at this point?

Solution:

a) We can find the original distance by which the spring is compressed from the law of conservation of energy (As the glider leaves the spring, it receives some part of the potential energy of the spring. On the top of the track there is only the glider's potential energy remains):

$$\frac{1}{2}kx^2 = mgh,$$

here, k is the spring constant, x is the original distance by which the spring is compressed, m is the mass of the glider, g is the acceleration due to gravity, h is the height of the track.

Let's find the height of the track from the geometry:

$$sin\theta = \frac{h}{l},$$

$$h = lsin\theta,$$

here, l is the maximum distance travelled by the glider, θ is the angle of inclination of the track.

Then, we can substitute h into the previous formula and find x:

$$\frac{1}{2}kx^2 = mglsin\theta,$$

$$x^2 = \frac{2mglsin\theta}{k},$$

$$x = \sqrt{\frac{2mglsin\theta}{k}} = \sqrt{\frac{2 \cdot 0.09\ kg \cdot 9.8\ ms^{-2} \cdot 1.8\ m \cdot sin\ 40^{\circ}}{640\ \ N/m}} = 0.056\ m.$$

Therefore, the glider loses the contact with the spring after $0.056\ m$ or $5.6\ cm$.

b) As we can see, the glider loses the contact with spring after $5.6\ cm$, so it not in contact with the spring at point $0.80\ m$.

c) The kinetic energy of the glider at point $0.80\ m$ is equal to the potential energy of the spring minus the potential energy of the glider at point $0.80\ m$:

$$KE = \Delta PE = \frac{1}{2}kx^2 - mglsin\theta =$$
$$= \frac{1}{2} \cdot 640 \frac{N}{m} \cdot (0.056\ m)^2 - 0.09\ kg \cdot 9.8\ ms^{-2} \cdot 0.8\ m \cdot sin40^{\circ}$$
$$= 1.003\ J - 0.45\ J = 0.553\ J.$$

Answer:

a) $0.056\ m$

b) As we can see, the glider loses the contact with spring after $5.6\ cm$, so it not in contact with the spring at point $0.80\ m$.

c) $KE = 0.553\ J$.