

PHYS:1200 Physics of Everyday Experience

Review questions and exercises for Lecture 9 (M-8)

1. Describe the conversion of kinetic energy into potential energy and vice-versa as a ball is thrown upward and then falls back to the ground.
2. Describe the motion of a roller coaster ride in terms of the concepts of work and energy.
3. Is energy stored in a compressed or stretched spring?
4. What is the difference between static and kinetic friction?
5. An object moves in a circular path with constant speed. Is its velocity constant?
6. A child swings a ball attached to a string in a circle at a constant speed. Is the ball accelerating and if so what force provides this acceleration?
7. How does the centripetal acceleration of an object change when either its speed or the radius of the circle change?
8. What provides the centripetal force that allows a car to go around a curve?
9. What force is required to keep a 4 kg object in a circular path of radius 2 meters if its speed is 5 m/s. What must be the direction of this force?
10. A mass of 3 kg is attached to a string of length 3 m. If the string can provide a maximum tension force of 6 N, what is the maximum speed that the mass can be swung in a circle before the string breaks?

Solutions (Try to answer the questions before looking at the solutions.)

1. To throw a ball straight up you must give it some kinetic energy (KE). As it rises its kinetic energy decreases and its potential energy (PE) increases. At the very top its KE = 0, and its PE is a maximum = mgh, where h is how high it went. As it comes down, its PE decreases and its KE increases. At any point in its motion KE + PE = constant.
2. Work must be done by a motor to bring the cars to the top of the first hill. The work that is done on the cars is stored as PE. As the cars come down the first hill, their KE increases and their PE decreases. The cars then use their KE to bring them up the next hill. As the cars rise their KE decreases and PE increases.
3. Work must be done to either stretch or compress a spring. This work is stored in the spring as elastic potential energy.
4. A minimum amount of force is needed to get an object to move. The friction in this case is called static friction. Once a large enough force acts on it to overcome the maximum friction force, it begins to move. While it is moving, the friction force is called kinetic friction.
5. The velocity of an object in circular motion is constantly changing direction, so the object is accelerating.
6. The ball is accelerating and the force that provides the acceleration is the tension in the string.
7. $a_c = v^2 / R$. If v increases a_c increases; if R increases, a_c decreases.
8. On a level curve, the required centripetal force is provided by friction.
9. $F_c = m v^2 / R \rightarrow F_c = 4 \text{ kg } (5 \text{ m/s})^2 / 2 \text{ m} = 4(25)/2 = 50 \text{ N}$.
10. $F_c = T = m v^2 / R = 3 v^2 / 3 < 6 \text{ N} \rightarrow$ to keep the string from breaking $v^2 < 6 \text{ N}$, so for the string not to break v must be less than $\sqrt{6}$.