Course Name : Physics – I
Course # PHY 107

Notes-8 : Work and Energy : Part-II

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Topics to be studied

- Work-Energy Theorem and the Conserrvation Law
- Gravitational Force: Weight
- Elastic Force: Ideal Spring
- The total energy conservation law
- Work done by Frictional forces: Energy Loss
- Conservation Law of Energy including froctional forces.
- Examples

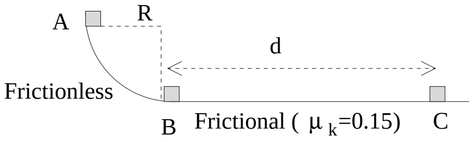
Short Summary: Previous Lecture

From the previous analysis and derivation it is clear that:

- The total energy is conserved if and only if the force on the body is a derivative of a scalar function.
- The scalar function is known as the 'Potential Energy'.
- Therefore, the system is called a 'Conservative System', and the corresonding force is called the conservative force.
- The work done (that is, the integral) is Path independent, and is given by the Net Change in Potential energy.
- In short we can say that: if the work done is path independent then it also implies that the force is conservative and also the total energy is conserved.
- If any of three properties is NOT satisfied, then all are violated, and hence the tptal energy is NOT conserved or Work is path dependent, or the force is not conservative.

Problem:

A block of mass $m = 0.125\,\mathrm{kg}$ slides down a track as shownn in the figure below. The trach is frictionless from A to B, but frictional from B to C with $\mu_k = 0.15$. The block is released from rest at A amd slides down to reach at B with speed v_B, and continue to move. But it stops due to friction and stops at C. The radius of the circular path is $25.0\,\mathrm{cm}$.



- At what speed the block reaches point B?
- Find the distance d from B to C.
- If the mass is doubled, will the previous two answers be different? Explain or show calculation.

(a) Note here that gravitational force, *i.e.* weight of an object is the ONLY force on here. Since it is a conservative force. and so the total energy is conserved. Therefore, by the Conservation Law of Total Energy, we can find:

$$
\begin{aligned}
K_B + U_B &= K_A + U_A \Longrightarrow \frac{1}{2} m v_B^2 + 0 = 0 + mgR \ , \\
\therefore \ v_B &= \sqrt{2gR} = \sqrt{2 \times 9.80 \times 0.250}\,\mathrm{m/s} = 2.21\,\mathrm{m/s}.
\end{aligned}
$$

(b) From B to C the distance is d, and Work is done by the frictional force. Hence by Work-Energy Theorem,

$$
\begin{aligned}
\Delta K &= 0 - \frac{1}{2} m v_B^2 = W_f = f_k d \cos 180^\circ = -\mu_k m g d \ , \\
\therefore \ d &= \frac{v_B^2}{2\mu_k g} = \frac{(2.21)^2}{2 \times 0.15 \times 0.25}\,\mathrm{m} = 0.997\,\mathrm{m} \ .
\end{aligned}
$$

(c) The previous two results do not depend on mass. So doubling the mass will not change the previous two results.