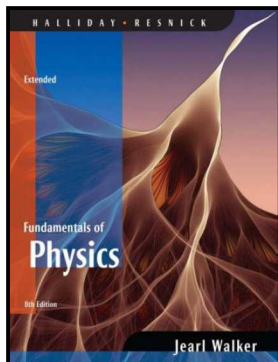


Workshop Physics

1017 - 311

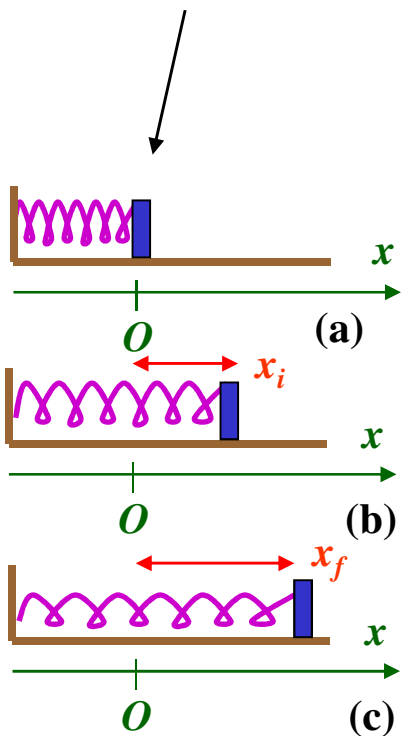
University Physics I

Week 7 : Day 1



The Work Done by a Spring

Equilibrium Position –
position where there is
no net force...



We will use the expression $W_s = \int_{x_i}^{x_f} F(x)dx = \int_{x_i}^{x_f} -kx dx = -k \int_{x_i}^{x_f} x dx$.

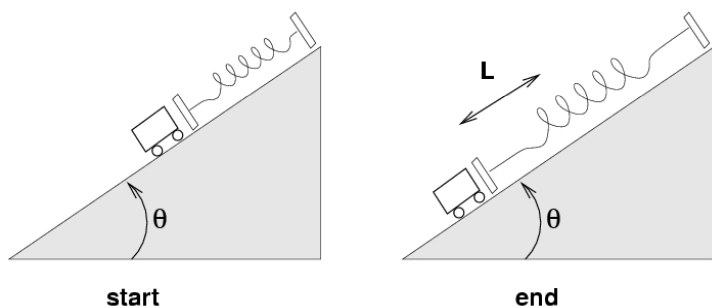
$$W_s = -k \left[\frac{x^2}{2} \right]_{x_i}^{x_f} = \frac{kx_i^2}{2} - \frac{kx_f^2}{2}.$$

Quite often we start with a relaxed spring ($x_i = 0$) and we either stretch or compress the spring by an amount x ($x_f = \pm x$). In this case $W_s = -\frac{kx^2}{2}$.

Activity – The Work Done by a Spring

□ Analyze System

- Draw a FBD (no friction)



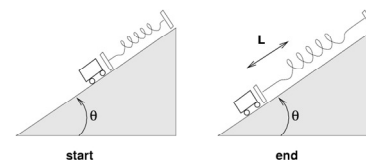
- What is work done by gravity?
- What is work done by spring?

The Work done by a Spring

Equipment.

Rods, clamps, cart, track, spring, rule, set of standard weights, graph paper.

The set-up



A cart of mass M is placed on a ramp tilted at angle θ . It is attached to a spring of force constant k , which is initially at its rest length (the “start” position). We hold the cart in the “start” position for a moment, then release it. The cart rolls down the ramp a distance L before coming to a momentary halt. It then starts back up the ramp, pulled by the spring.

Theory

Use concepts of work and the work-kinetic energy theorem to derive an equation for the displacement L , in terms of M , θ , k and g . Ignore friction for the moment...

- How much work is done by gravity as the cart rolls?
- How much work is done by the spring as the cart rolls?
- What is the cart's kinetic energy just as it reaches its lowest point on the ramp?
- Write an equation, which gives the distance L in terms of other quantities.

Prediction

Set up a track so that it is tilted at an angle of about 10° . Measure the tilt angle θ (use trigonometry). Measure the mass M of the cart. Determine the uncertainties in both these quantities. Now choose a spring.

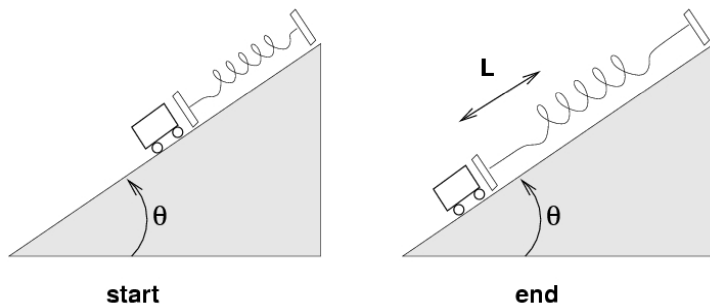
Your job:

- Determine the spring constant, k , and the uncertainty (just as you did in week 5).
- Use the values of M , k and θ in your equation to predict the displacement down the ramp, L , for your spring. Calculate the uncertainty in L .

Analysis – The Work Done by a Spring

□ Analyze System

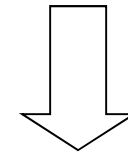
- Draw a FBD (no friction)



- What is work done by gravity?
- What is work done by spring?

$$W_g = -mgL \sin \theta$$

$$W_s = +\frac{1}{2}kL^2$$



$$L = \frac{2mg}{k} \sin \theta$$