Wednesday, May 1/13
Physics 112/111

1. Lab - The Explosion (Change in Momentum) - 2 Days Late
2. Check: Page 245, PP # 22-25
3. Gravitational Potential Energy
4. Textbook: Page 250, PP # 27, 29 (L1 - Also Do #28) HW P2
5. Work-Gravitational Potential Energy Theorem
6. Textbook: Page 254, PP # 30-33 HW P2

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7. Hooke's Law
8. Textbook: Page 258, PP # 35-37
7. Elastic Potential Energy
8. Textbook: Page 261, PP #38-40

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9. Quiz - Topics
10. Investigation 6-A Force and Spring Extension (Page 255)

Period 2

Potential Energy
(Page 247)

Reminder: Potential energy is the energy stored by an object due to its position or condition.

For all forms of potential energy, there is **no absolute zero position or condition**. Only changes in potential energy are measured. You must establish a reference line or zero line to determine potential energy of an object.

Gravitational Potential Energy

Gravitational potential energy is the potential energy an object has because of its position above Earth's surface.

$$\boxed{\Delta E_g = mg\Delta h}$$

$E_{gi} = mgh_i$

$\Delta E_g = mg(h_f - h_i)$

$E_{gf} = mgh_f$

ΔE_g -> change in gravitational potential energy (J)
m -> mass (kg)
g -> magnitude of acceleration due to gravity (m/s^2)
Δh -> change in height (m)

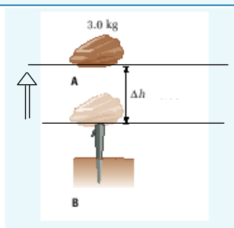
↳ position (vertical)

continued

MODEL PROBLEM

Calculating Gravitational Potential Energy

You are about to drop a 3.0 kg rock onto a tent peg. Calculate the gravitational potential energy of the rock after you lift it to a height of 0.68 m above the tent peg.

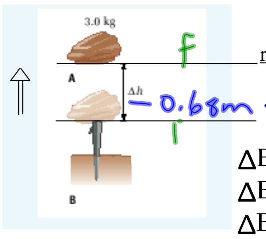


reference level -> E_g = 0 J, h = 0 m

must be stated

$\Delta E_g = mg\Delta h$
$\Delta E_g = mg(h_f - h_i)$
$\Delta E_g = (3.0 \text{ kg})(9.80 \text{ m/s}^2)(0.68 \text{ m} - 0 \text{ m})$
$\Delta E_g = 20 \text{ J}$

$\boxed{E_{gf} = 20 \text{ J}}$



reference level -> E_g = 0 J, h = 0 m

$\Delta E_g = mg\Delta h$
$\Delta E_g = mg(h_f - h_i)$
$\Delta E_g = (3.0 \text{ kg})(9.80 \text{ m/s}^2)(0 - (-0.68 \text{ m}))$
$\Delta E_g = 20 \text{ J}$

$\boxed{E_{gf} = 0 \text{ J}}$

Textbook: Page 250, PP # 27, 29 + L1 do #28

Work-Gravitational Potential Energy Theorem
(Page 251)

$W = \Delta E_g$

$W = E_{gf} - E_{gi}$

$W = mgh_f - mgh_i$

$Fd = mgh_f - mgh_i$

* include a zero line

$W = Fd = \Delta E_g = E_{gf} - E_{gi} = mgh_f - mgh_i$

Textbook: Page 254, PP # 30-33

Period 4

Hooke's Law
(Page 256)

When a force causes a spring to stretch or compress, the spring exerts a force in a direction that will return it to its original length. The force that the spring exerts is called the <u>restoring force</u> and it is equal in magnitude to the applied force that stretches or compresses the spring and acts in a direction opposite to the applied force.

<u>Physics</u>
McGraw-Hill
Page 255 ✓

<u>Hooke's Law</u>: The restoring force is directly proportional to the extension or compression of a spring.

<u>Restoring Force vs Extension</u>

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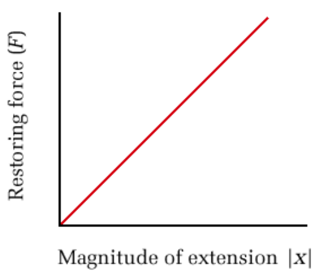


Figure 6.21 The relationship between the restoring force and the extension of a spring is linear.

$y = mx + b$

slope   y-intercept

$\boxed{F = mx}$

$m = \frac{F}{x} \rightarrow \frac{N}{m}$

<u>Hooke's Law - Restoring Force</u>

$\boxed{F = -kx}$

F -> restoring force (N)
k -> spring constant (N/m)
x -> elongation or compression (m)

<u>Hooke's Law - Applied Force</u>

$\boxed{F_A = kx}$

F_A -> applied force (N)
k -> spring constant (N/m)
x -> elongation or compression (m)

* Spring constant = force constant

elastic limit

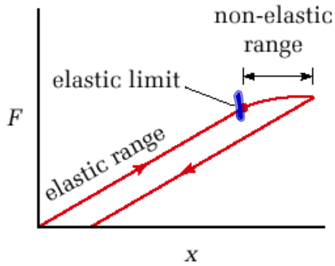
$F_A = kx$ | $\cancel{F_A\ kx}$

Before | After

elastic limit.

PHYSICS FILE

A *perfectly elastic* material will return precisely to its original form after being deformed, such as stretching a spring. No real material is perfectly elastic. Each material has an elastic limit, and when stretched to that limit, will not return to its original shape. The graph below shows that when something reaches its elastic limit, the restoring force does not increase as rapidly as it did in its elastic range.



MODEL PROBLEM

Hooke's Law in an Archery Bow

A typical compound archery bow requires a force of 133 N to hold an arrow at "full draw" (pulled back 71 cm). Assuming that the bow obeys Hooke's law, what is its spring constant?

$F_A = 133N$

$x = 71cm = 0.71m$

$K = ?$

$F_A = Kx$

$K = \frac{F_A}{x}$

$K = \frac{133N}{0.71m}$

$K = 1.9 \times 10^2 \frac{N}{m}$

ws

Textbook: Page 258, PP # 35-37

Elastic Potential Energy

(Page 254)

Many objects can stretch, compress, bend or change shape in some way. If an object can return to its original condition, it is said to be elastic. Since the object can undergo motion when the force causing the change in condition or state is removed, there must be stored energy due to its condition. This form of stored energy is called spring or elastic potential energy.

Restoring Force vs Extension (or Compression)

(Page 258)

The area under a Hooke's Law graph gives the amount of elastic potential energy stored in a spring (or any elastic substance).

Restoring Force vs. Extension or Compression

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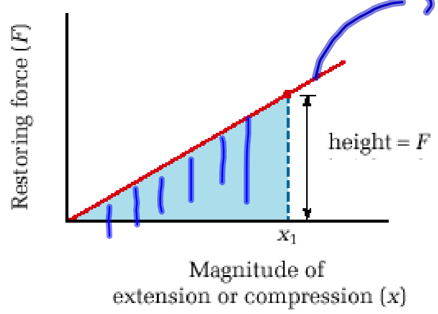
slope = k (spring constant)



Area = elastic potential energy

Figure 6.22 The triangular area under the Hooke's law graph gives you the amount of elastic potential energy stored in the spring at any amount of extension.

$$A = \frac{1}{2}(\text{base})(\text{height})$$

$$A = \frac{1}{2}xF$$

$$A = \frac{1}{2}Fx$$

* $F = kx$

$$A = \frac{1}{2}(kx)x$$

$$A = \frac{1}{2}kx^2$$

$$\boxed{E_e = \frac{1}{2}kx^2}$$

Assumption

perfectly elastic material

Ee -> elastic potential energy (J)
k -> spring constant (N/m)
x -> extension or compression (m)

MODEL PROBLEM

Elastic Potential Energy of a Spring

A spring with spring constant of 75 N/m is resting on a table.

(a) If the spring is compressed a distance of 28 cm, what is the increase in its potential energy?

(b) ~~What force~~ must be applied to hold the spring in this position?

$k = 75\ \frac{N}{m}$

$x = 0.28\ m$

$E_e = ?$

a) $E_e = \frac{1}{2}kx^2$

$E_e = \frac{1}{2}(75)(0.28)^2$

$E_e = 2.9\ J$

ws

b) $F_A = kx$

$F_A = (75)(0.28)$

$F_A = 21\ N$

$\vec{F}_A = +21\ N$

ws

→ ℓuu

Textbook: Page 261, PP #38-40