Announcements 27 Apr 09

- **Online homework grade**
  - Only 10 best scores are kept for grades posted in SPARK
- **Homework #11**
  - Written homework due now
  - Online homework due tomorrow by 8 am
  - Problem 11.10:
    - Assume mass of the person = 68 kg
    - Power expended to ride a bicycle at a speed of 15 km/h = 480 J/s (i.e. 480 W)
    - 1 gram of gasoline corresponds to an energy of 44 kJ
- **Written homework #12 due on Monday**
- **Exam 3**
  - **Date change to Wednesday May 6** (7 to 9 pm)

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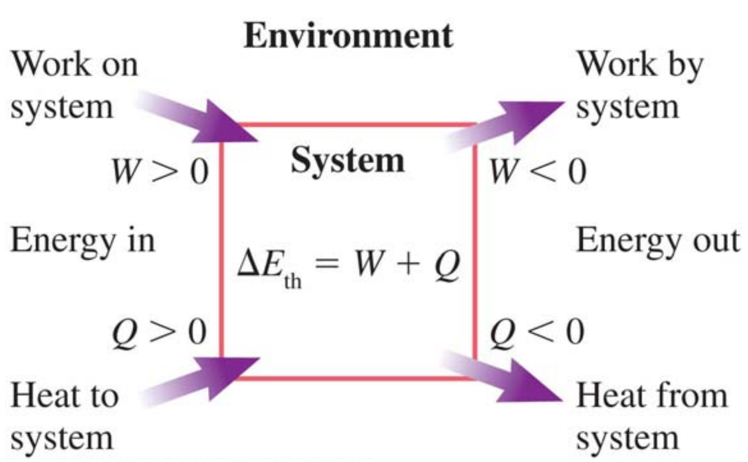
First law of thermodynamics For systems in which only the thermal energy changes, the change in thermal energy is equal to the energy transferred into or out of the system as work W and/or heat Q:

$$\Delta E_{th} = W + Q \tag{11.14}$$



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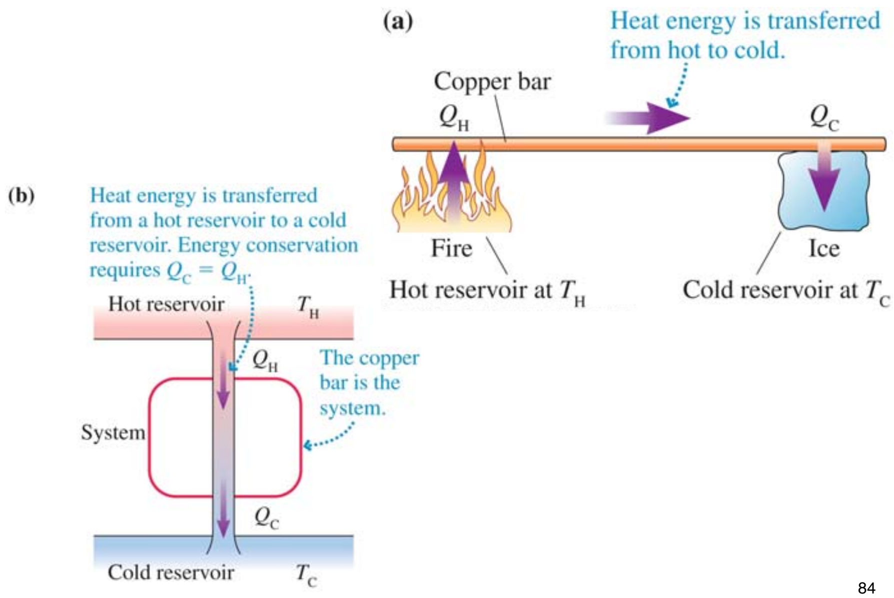
Energy Transfers

Energy is always transferred from a hot reservoir to a cold reservoir



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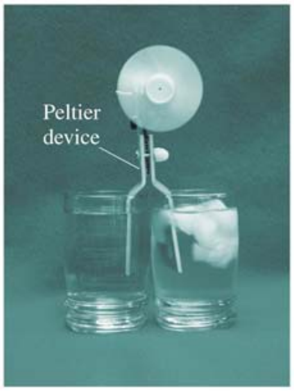
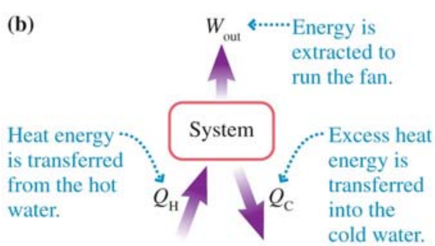
Heat Engines

Some of the energy transferred from the hot reservoir to the cold reservoir can be converted to other forms (e.g. electrical energy to run a small fan)

DEMO: Peltier device





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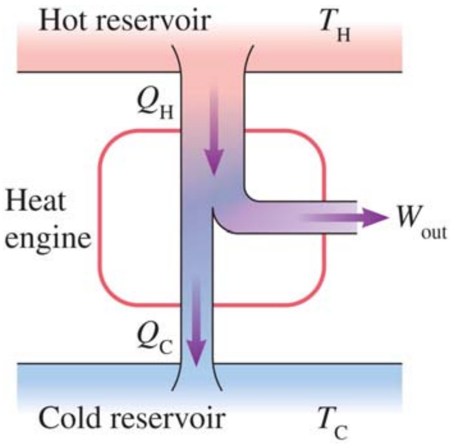
Heat Engines



Efficiency to do useful work W_{out}

$$e = \frac{\text{what you get}}{\text{what you had to pay}} = \frac{W_{out}}{Q_H} = \frac{Q_H - Q_C}{Q_H}$$

$$e_{max} = 1 - \frac{T_C}{T_H} \qquad (11.16)$$

Theoretical maximum efficiency of a heat engine

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Geothermal Efficiency

At the Geysers geothermal power plant in northern California, electricity is generated by using the temperature difference between the 15 °C surface and 240 °C rock deep underground. What is the maximum possible efficiency? What happens to the energy that is extracted from the steam that is not converted to electricity?

$$e = 1 - \frac{T_C}{T_H} = 1 - \frac{273 + 15}{273 + 240} = 0.439 = 43.9\%$$

Convert temperatures to Kelvin!

The energy that is not converted to electricity ends up as heat transfer to the surface (i.e. the temperature of the surface will increase)

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Chapter 14
Oscillations

Topics:

- Equilibrium, restoring forces, and oscillation
- Mathematical description of oscillatory motion
- Energy in oscillatory motion
- ~~Damped oscillations~~
- Resonance

Sample question:

The gibbon will swing more rapidly and move more quickly through the trees if it raises its feet. How can we model the gibbon's motion to understand this observation?

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Oscillations examples

There are many situations in life where we have periodic motion or oscillations
What do we mean by periodic motion?

Examples: swings, pendulum like in a clock, heart beat, waves of all sorts, vibrational motion of molecules and atoms or any other situation where we have similar types of motion

Whenever we have motion that repeats itself over and over again we have what we call **Periodic Motion** or **oscillations**

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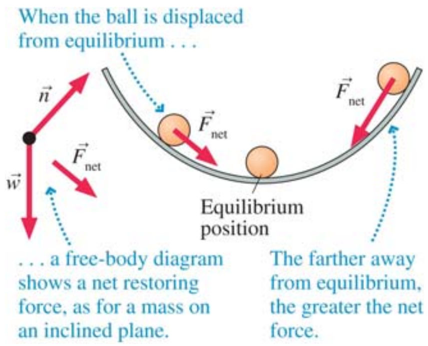
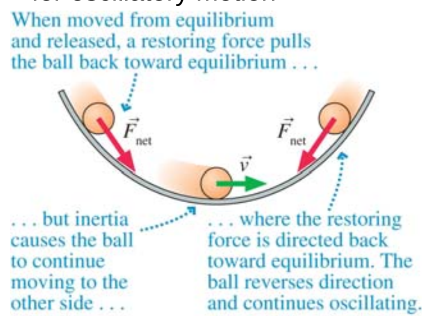
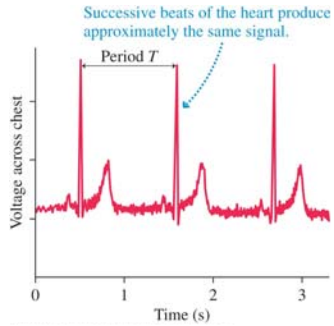
Equilibrium and Oscillation

Restoring force is responsible for oscillatory motion





DEMO: ball inside
loop-the-loop



Oscillations properties

DEMOS: Pendulum
Mass connected to a spring

Main characteristics of oscillations:

Amplitude A
= max displacement from equilibrium point

Period T
= time to complete one full cycle

Frequency $f = 1 / T$
= number of cycles per second

Unit of frequency: ***Hertz***
1 Hz = 1 cycle / s = 1 s^{-1}

Period dependence on the amplitude

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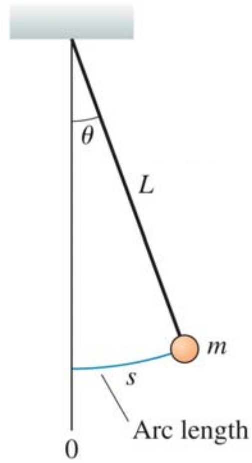
How does the period of a pendulum change if its amplitude (max displacement s) is doubled?

A. The period doubles.
B. The period halves.
C. The period stays the same.



Period dependence on the amplitude

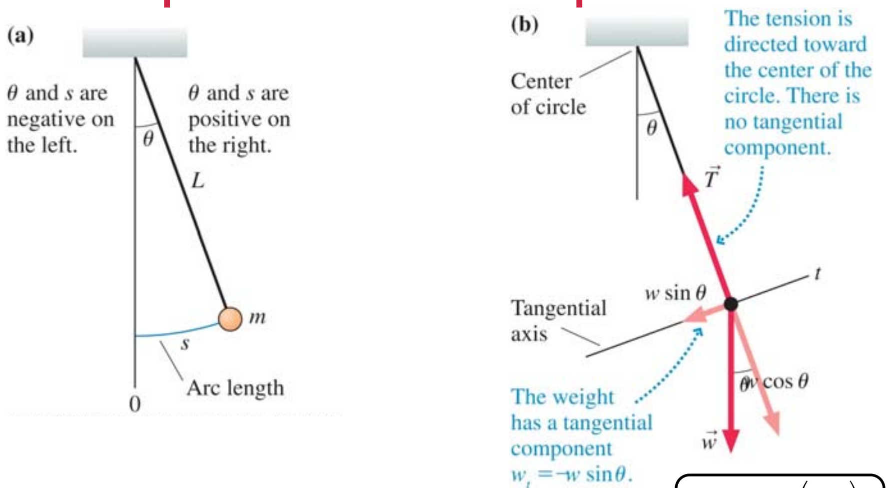
DEMOS: Pendulum with timer
Mass connected to a spring with timer

How does the period of oscillation change when the amplitude increases?

The period of oscillation does not depend on the amplitude!

Why?

Period dependence on the amplitude



$$\left(F_{net}\right)_t = -\left(\frac{mg}{L}\right)s$$

Restoring force magnitude grows with displ. s :

➔ acceleration increases with increased distance s resulting in the same amount of time needed to travel greater distance

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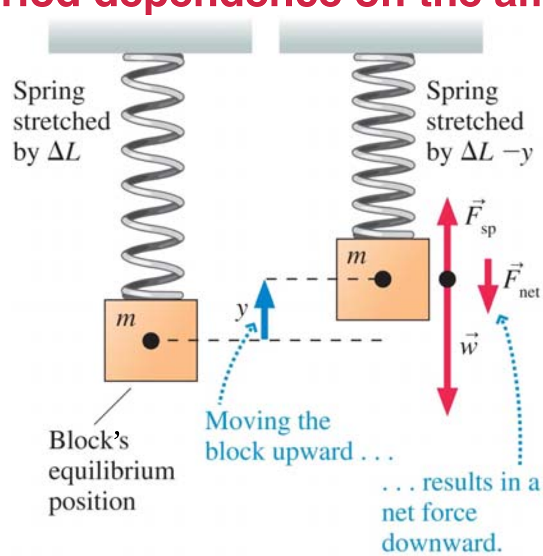
Period dependence on the amplitude



$$\left(F_{net}\right)_y = -ky$$

k = spring constant

Restoring force magnitude grows with displacement y from equilibrium position ➔ acceleration increases with y

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