Lecture 19
(Force and Potential Energy, Potential Energy Diagrams)

Physics 160-01 Fall 2012

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Conservation of Mechanical Energy

- The work-energy theorem can be written as:

$$W_{Other} = \Delta KE + \Delta U_{Gravity} + \Delta U_{Elastic}$$

- And if there are no “other” forces doing work, then:

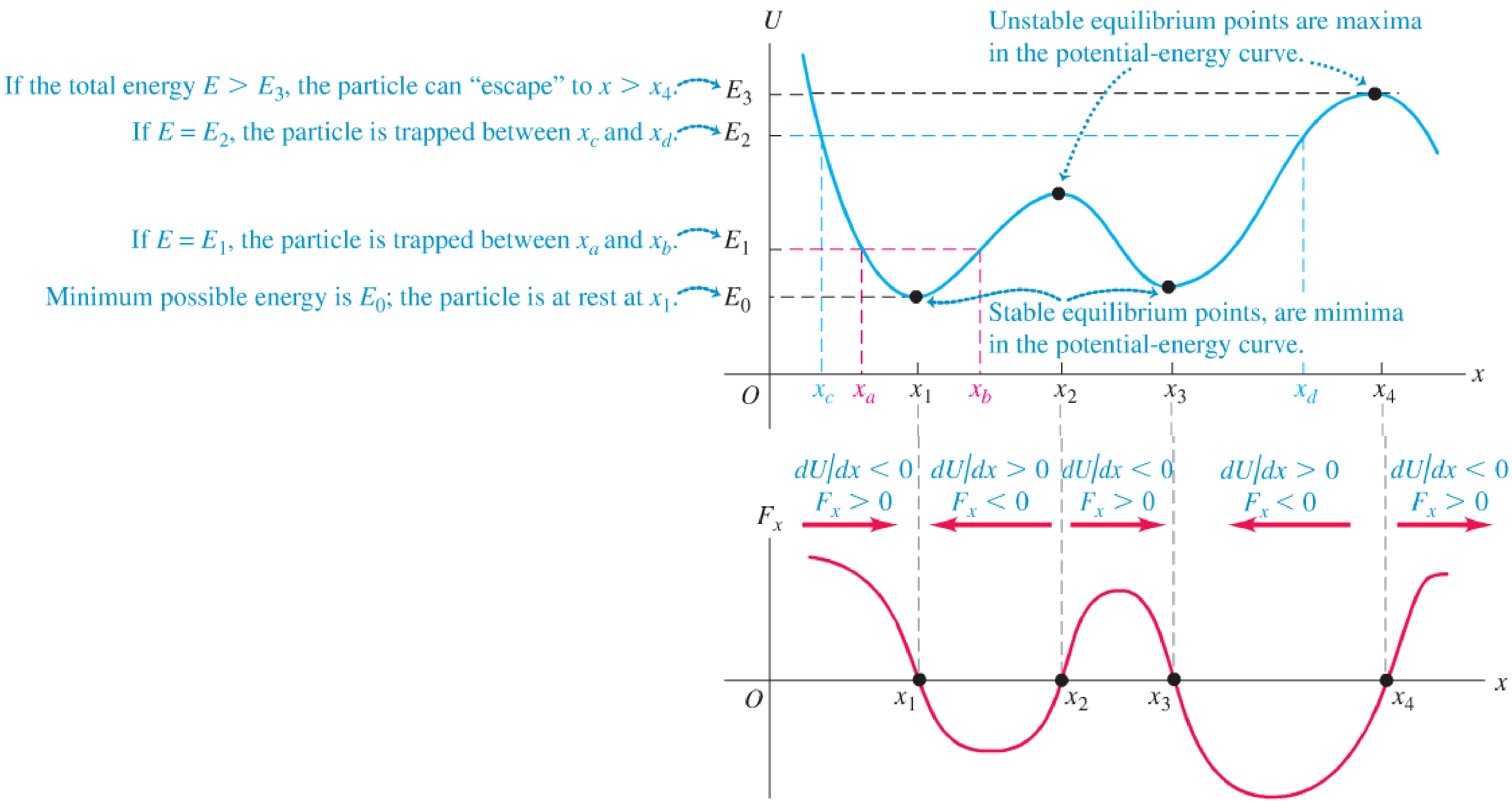
$$0 = \Delta KE + \Delta U_{Gravity} + \Delta U_{Elastic}$$

$$\Delta E = 0$$

$$E = KE + U_{Gravity} + U_{Elastic}$$

Energy Graphs

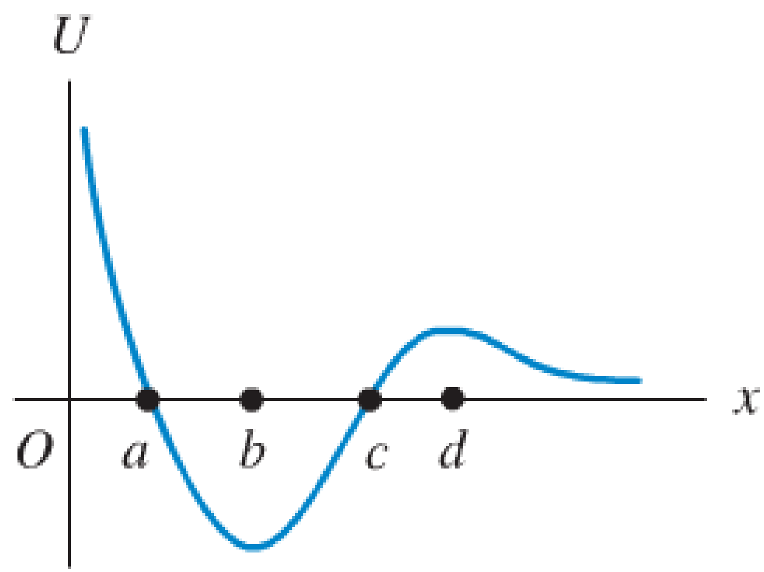
- One can learn a lot about the behavior of an object, just by looking at a graph of its potential and total mechanical energies.



Problem 7.38

7.38. A marble moves along the x-axis. The potential-energy function is shown in Fig. 7.28. (a) At which of the labeled x-coordinates is the force on the marble zero? (b) Which of the labeled x-coordinates is a position of stable equilibrium? (c) Which of the labeled x-coordinates is a position of unstable equilibrium?

Figure 7.28 Exercise 7.38.



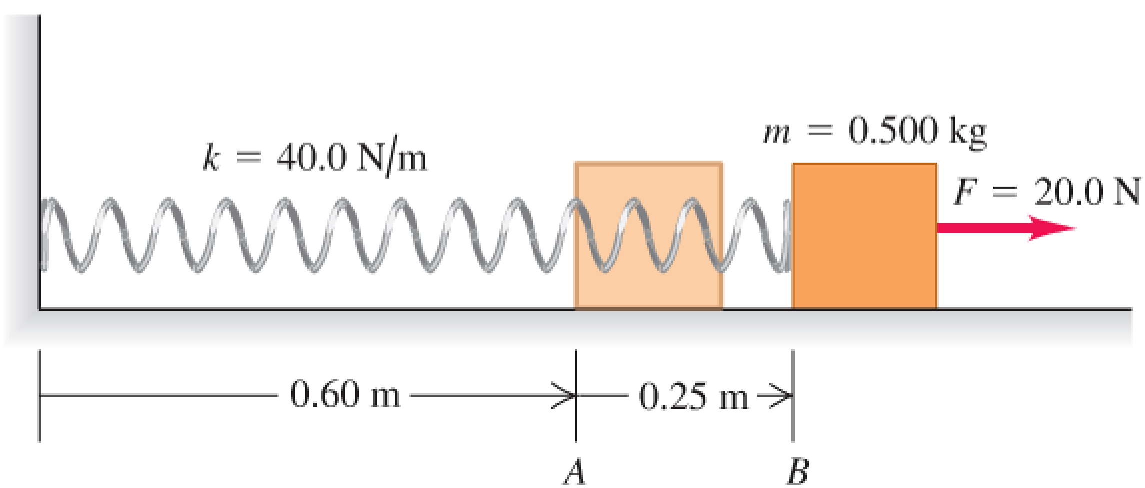
Problem 7.73

7.73. A wooden block with mass 1.50 kg is placed against a compressed spring at the bottom of an incline of slope 30.0° (point A). When the spring is released, it projects the block up the incline. At point B, a distance of 6.00 m up the incline from A, the block is moving up the incline at 7.00 m/s and is no longer in contact with the spring. The coefficient of kinetic friction between the block and the incline is $\mu_k = 0.50$. The mass of the spring is negligible. Calculate the amount of potential energy that was initially stored in the spring.

Problem 7.75

7.75. A 0.500-kg block, attached to a spring with length 0.60 m and force constant 40.0 N/m, is at rest with the back of the block at point A on a frictionless, horizontal air table (Fig. 7.44). The mass of the spring is negligible. You move the block to the right along the surface by pulling with a constant 20.0-N horizontal force. (a) What is the block's speed when the back of the block reaches point B, which is 0.25 m to the right of point A? (b) When the back of the block reaches point B, you let go of the block. In the subsequent motion, how close does the block get to the wall where the left end of the spring is attached?

Figure 7.44 Problem 7.75.



Muzzle Velocity for an Object Shot Straight Upwards

Note that as the ball is shot out of the cannon vertically upwards, it has a certain initial (muzzle) velocity, which causes it to have a certain kinetic energy. The ball decelerates uniformly, until at the apex of its flight, all of its kinetic energy is converted to potential energy. Using this principle (Conservation of Energy), the muzzle speed of the ball may be calculated to be:

a.) $\sqrt{gh}$ b.) $\sqrt{2gh}$ c.) mgh d.) $\left(\frac{mgh}{2}\right)$ e.) $\sqrt{\frac{gh}{2}}$

Total Time of Flight for an Object Shot Straight Upwards

What is the total time of flight for an object of mass m shot straight upwards at an initial speed v_0?

a.) $\left(\frac{mv_0}{g}\right)$

b.) $\left(\frac{v_0}{g}\right)$

c.) $\left(\frac{2v_0}{g}\right)$

d.) mgv_0

e.) $\left(\frac{v_0 g}{m}\right)$

Total Time of Flight of a Projectile

Recall that only the vertical component of motion is influenced by gravity, and that the vertical and horizontal components of motion can be considered independently of each other. If a projectile of mass m is launched with an initial speed v_0 (with components v_{0x} and v_{0y} along the horizontal and vertical directions, respectively), its total time of flight (assuming launch height = final height) is:

a.) $\left(\dfrac{2v_{0y}}{g}\right)$ b.) $\left(\dfrac{v_{0y}}{g}\right)$ c.) $\left(\dfrac{2v_0}{g}\right)$ d.) $\left(\dfrac{mv_{0y}}{g}\right)$ e.) $\left(\dfrac{v_0}{g}\right)$

Horizontal Range

Using the diagram shown, predict an expression for the horizontal range R (displacement along the horizontal direction) of a projectile:

$$\sin\theta\cos\theta = \frac{1}{2}\sin(2\theta)$$

a.) $\left(\dfrac{v_0\sin\theta}{g}\right)$ b.) $\left(\dfrac{v_0^2\sin^2\theta}{2g}\right)$

c.) $\left(\dfrac{2v_0\sin\theta}{g}\right)$ d.) $\left(\dfrac{v_0^2\sin(2\theta)}{g}\right)$

e.) $\left(\dfrac{v_0^2\sin\theta}{2g}\right)$