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King Saud University
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PHYS 103 (GENERAL PHYSICS)

CHAPTER 7: ENERGY AND ENERGY TRANSFER

LECTURE NO. 11

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Lecture Outline

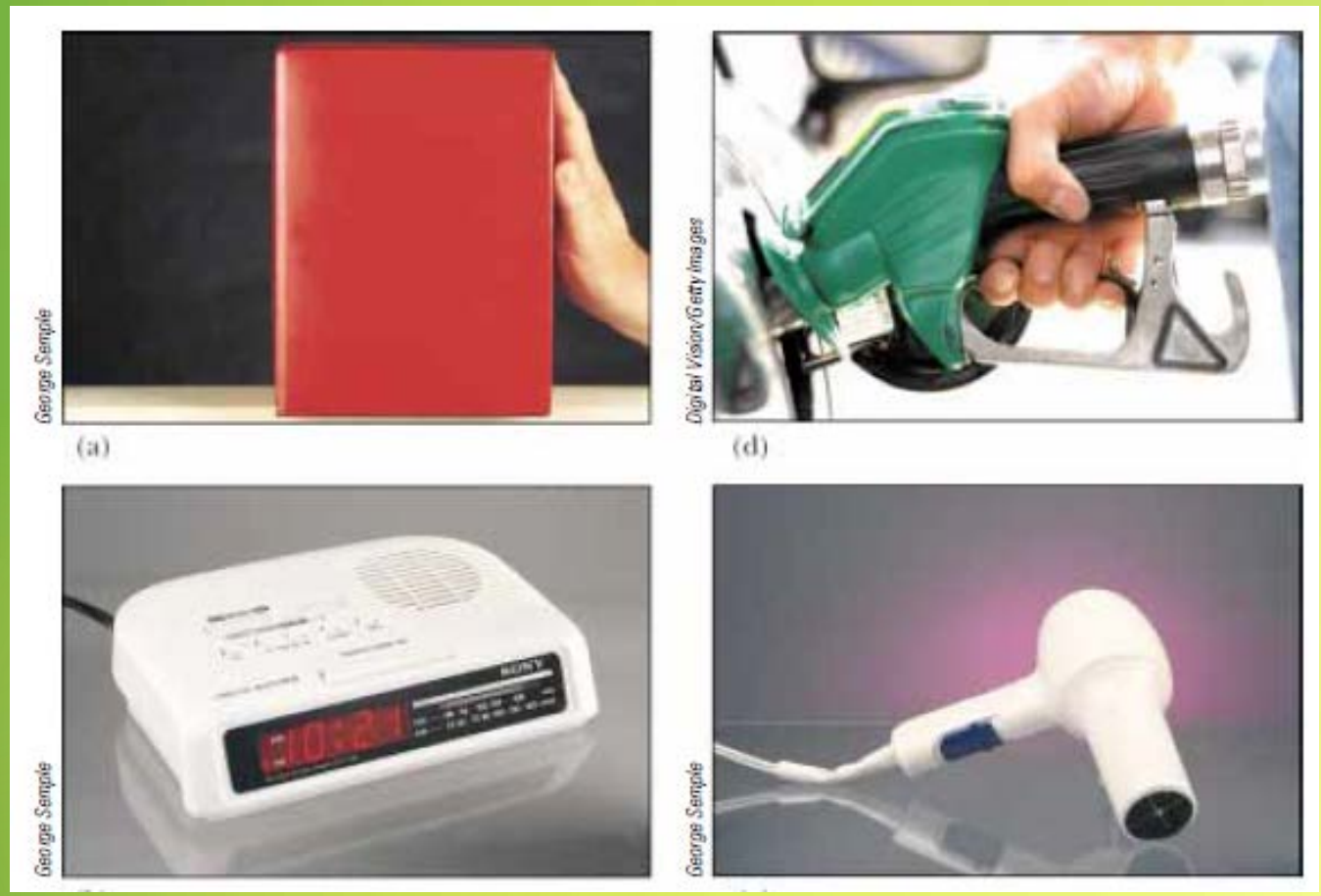
- Here is a quick list of the subjects that we will cover in this presentation. It is based on Serway, Ed. 6

- *7.6 The Nonisolated System-Conservation of Energy*
- *7.7 Situations Involving Kinetic Friction*
- *Example 7.10 (Conceptual)*
- *7.8 Power*
- *Quiz 7.12*
- *Example 7.12 (Elevator motor)*
- *End of Presentation*

7.6 The Nonisolated System-Conservation of Energy

- A particle, that is acted on by various forces, resulting in a change in its kinetic energy is an example of nonisolated system.
- Another example: when a body slides on a surface, heat will be generated although kinetic energy of the surface has not changed.
- Methods of Energy Transfer:
  - Work
  - Mechanical Waves
  - Heat
  - Matter transfer
  - Electrical Transmission
  - Electromagnetic radiation

7.6 The Nonisolated System-Conservation of Energy



7.6 The Nonisolated System-Conservation of Energy

- ***we can neither create nor destroy energy—energy is always conserved. Thus, if the total amount of energy in a system changes, it can only be due to the fact that energy has crossed the boundary of the system by a transfer mechanism such as one of the methods listed above. This is a general statement of the principle of conservation of energy.***

$$\Delta E_{system} = \sum T \qquad (7.17)$$

- Change in the total energy of the system
  = the amount of energy transferred across the system boundary by some mechanism

7.6 The Nonisolated System-Conservation of Energy

Quick Quiz 7.7 By what transfer mechanisms does energy enter and leave (a) your television set; (b) your gasoline-powered lawn mower; (c) your hand-cranked pencil sharpener?

Quick Quiz 7.8 Consider a block sliding over a horizontal surface with friction. Ignore any sound the sliding might make. If we consider the system to be the *block*, this system is (a) isolated (b) nonisolated (c) impossible to determine.

Quick Quiz 7.9 If we consider the system in Quick Quiz 7.8 to be the *surface*, this system is (a) isolated (b) nonisolated (c) impossible to determine.

Quick Quiz 7.10 If we consider the system in Quick Quiz 7.8 to be the *block and the surface*, this system is (a) isolated (b) nonisolated (c) impossible to determine.

7.7 Situations Involving Kinetic Friction

- Change in Kinetic energy is linked to the work done by a frictional force as:

$$-f_k d = \Delta K \qquad (7.20)$$

or :

$$\Delta E_{\text{int}} = f_k d \qquad (7.22)$$

- *the result of a friction force is to transform kinetic energy into internal energy, and the increase in internal energy is equal to the decrease in kinetic energy*.

Example 7.10 (Conceptual)

- A car traveling at an initial speed v slides a distance d to a halt after its brakes lock. Assuming that the car's initial speed is instead $2v$ at the moment the brakes lock, estimate the distance it slides

- ***Solution***:

$$\because -f_k d = \Delta K = \frac{1}{2} m v^2$$

$$-f_k d_1 = \frac{1}{2} m v^2$$

$$-f_k d_2 = \frac{1}{2} m 4 v^2$$

$$\rightarrow \frac{-f_k d_2}{-f_k d_1} = \frac{\frac{1}{2} m 4 v^2}{\frac{1}{2} m v^2}$$

$$\therefore d_2 = 4 d_1$$

7.8 Power

- Average power is defined as:

$$\bar{p} = \frac{W}{\Delta t} \qquad (7.23)$$

- instantaneous power is:

$$p = \frac{dW}{dt}$$

$$\because dW = \boldsymbol{F}.d\boldsymbol{r}$$

$$\rightarrow p = \frac{\boldsymbol{F}.d\boldsymbol{r}}{dt} = \boldsymbol{F}.\frac{d\boldsymbol{r}}{dt} = \boldsymbol{F}.\boldsymbol{v} \qquad (7.23)$$

- instantaneous power is: *Applied force* × *velocity*
- The SI unit of power is joules per second (J/s), also called the watt (W)
- *Or horsepower: 1hp = 746 W*

7.8 Quiz

Quick Quiz 7.12 An older model car accelerates from rest to speed v in 10 seconds. A newer, more powerful sports car accelerates from rest to $2v$ in the same time period. What is the ratio of the power of the newer car to that of the older car?
(a) 0.25 (b) 0.5 (c) 1 (d) 2 (e) 4

- Since final kinetic energy is 4 times for the new car, then work done is 4 times. Accordingly, the new car provided 4 times as large work at the same time. Then ration is 4.

- What is the kWh? It is the energy transferred in 1 h at the constant rate of 1000 J/s

$$1\ \text{kWh} = (10^3\ \text{W})(3600\ \text{s}) = 3.60 \times 10^6\ \text{J}$$

Example 7.12 (Elevator motor)

- An elevator car has a mass of 1 600 kg and is carrying passengers having a combined mass of 200 kg. A constant friction force of 4 000 N retards its motion upward.
- What power delivered by the motor is required to lift the elevator car at a constant speed of 3.00 m/s?
- ***Solution***:

$$\because p = \boldsymbol{F}.\boldsymbol{v}$$

$$\therefore p = \boldsymbol{T}.\boldsymbol{v}$$

for upward motion:

$$T = f + Mg = (4.00 \times 10^3)\ (1.80 \times 10^3\ kg)(9.80)$$

$$= 2.16 \times 10^4\ N$$

$$\therefore p = (2.16 \times 10^4)(3) = 6.48 \times 10^4\ \text{W}$$


THE END!