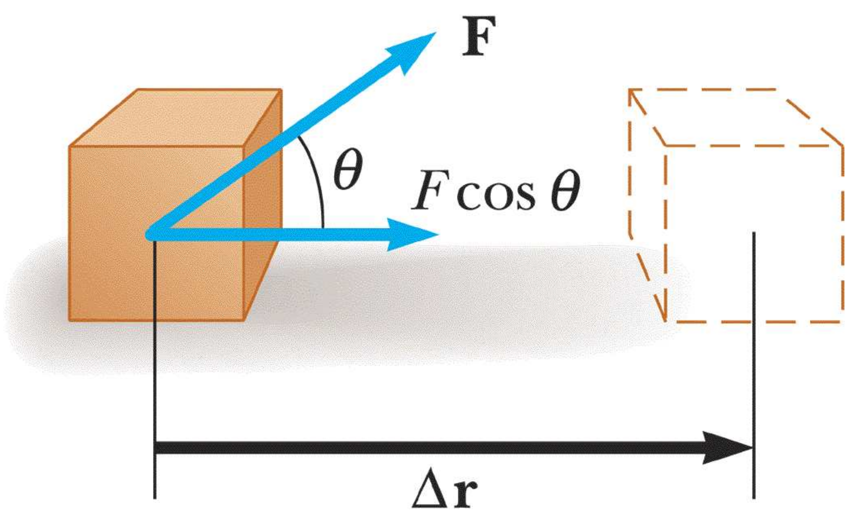
Work

Work Done by a Constant Force

$$W = F\Delta r \cos\theta$$

The unit of work is the joule (J) (1 J = 1 N·m)

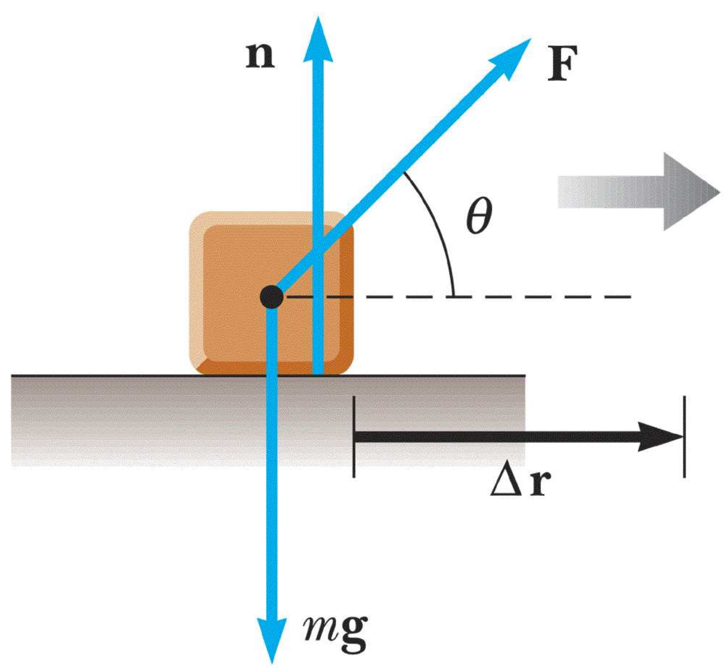
Serway/Jewett; Principles of Physics, 3/e
Figure 6.1



Forces Perpendicular to the Motion Do No Work

When an object is displaced horizontally on a flat table, the normal force **n** and the gravitational force $\mathbf{F}_g$ do no work since $\cos\theta = 90^\circ = 0$

Serway/Jewett; Principles of Physics, 3/e
Figure 6.2



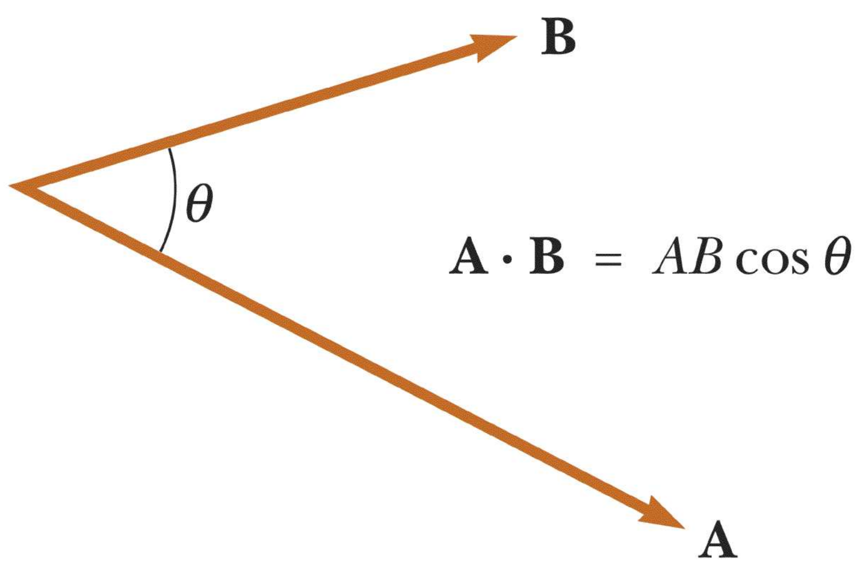
The Scalar (or Dot) Product of Two Vectors

The scalar product of two vectors $\mathbf{A}$ and $\mathbf{B}$ is defined as

$$\mathbf{A} \cdot \mathbf{B} = AB\cos\theta$$

where θ is the angle between $\mathbf{A}$ and $\mathbf{B}$

Serway/Jewett; Principles of Physics, 3/e
Figure 6.6



Properties of the Scalar Product

- The scalar product is commutative

$$\mathbf{A} \cdot \mathbf{B} = \mathbf{B} \cdot \mathbf{A}$$

- The scalar product obeys the distributive law

$$\mathbf{A} \cdot (\mathbf{B} + \mathbf{C}) = \mathbf{A} \cdot \mathbf{B} + \mathbf{A} \cdot \mathbf{C}$$

- The scalar product of the unit vectors gives us

$$\mathbf{i} \cdot \mathbf{i} = \mathbf{j} \cdot \mathbf{j} = \mathbf{k} \cdot \mathbf{k} = 1$$

$$\mathbf{i} \cdot \mathbf{j} = \mathbf{i} \cdot \mathbf{k} = \mathbf{j} \cdot \mathbf{k} = 0$$

- The scalar product can also be written in terms of the components of **A** and **B** as

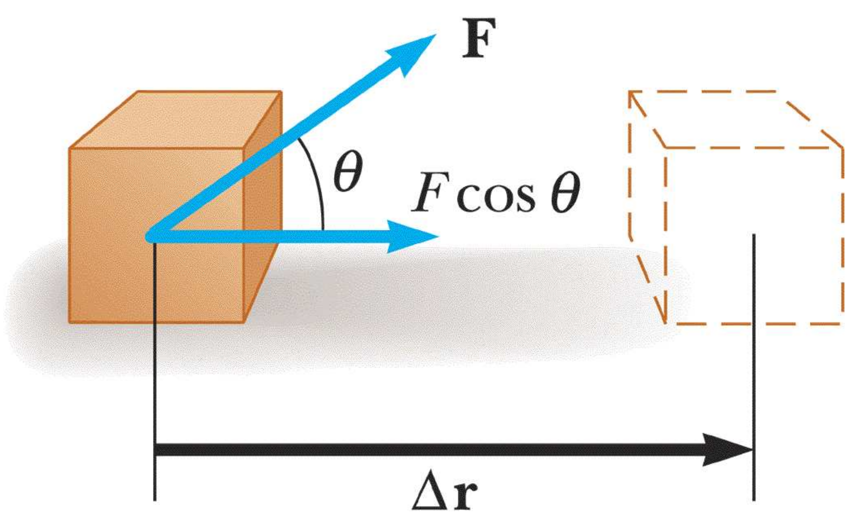
$$\mathbf{A} \cdot \mathbf{B} = A_x B_x + A_y B_y + A_z B_z$$

Work is a Scalar (or Dot) Product

The work done by a constant force is the scalar product of the force and displacement vectors

$$W = \mathbf{F} \cdot \Delta\mathbf{r} = F \Delta r \cos\theta$$

Serway/Jewett; Principles of Physics, 3/e
Figure 6.1

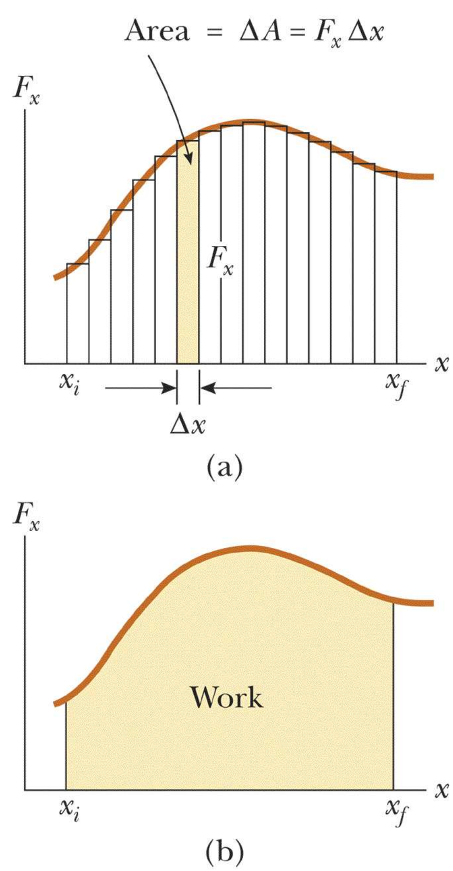


Work Done by a Variable Force

- Consider a particle being displaced along the x axis under the action of a force of magnitude F_x in the x direction
- The work done by the force as the particle moves a distance Δx is approximately

$$W_1 \approx F_x \Delta x$$

Serway/Jewett; Principles of Physics, 3/e
Figure 6.7



Work Done by a Variable Force (cont'd)

- The total work done as the particle moves from x_i to x_f is approximately

$$W \approx \sum_{x_i}^{x_f} F_x \Delta x$$

- The total work can be found by taking the limit as Δx goes to zero

$$W = \lim_{\Delta x \to 0} \sum_{x_i}^{x_f} F_x \Delta x = \int_{x_i}^{x_f} F_x dx$$

- The most general definition of the net work done on a particle is

$$W_{net} = \int_{\mathbf{r}_i}^{\mathbf{r}_f} \left(\sum \mathbf{F}\right) \cdot d\mathbf{r}$$

Work Done by a Constant Force Example

(a) How much work must be done by a force **F** directed along a 30° frictionless incline to push a block of mass 10 kg up the incline a distance of 5.0 m? (b) How much work would you have to do if you just lifted the block up to the final position?

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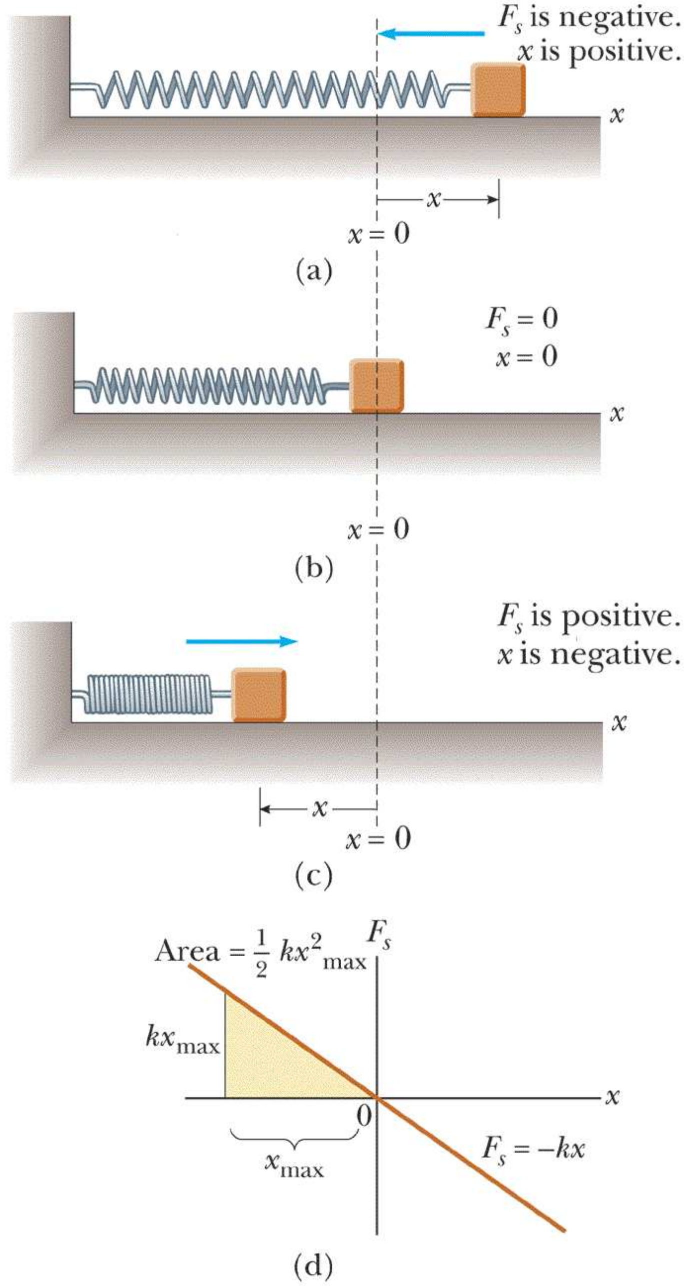
Work Done by a Spring

Serway/Jewett; Principles of Physics, 3/e
Figure 6.9



Homework Set 10 - Due Mon. Oct. 4

- Read Sections 6.1-6.4
- Answer Questions 6.2 & 6.4
- Do Problems 6.2, 6.4, 6.7, 6.11 & 6.16