

Work

$$W = F \times D \times \cos(\text{angle})$$

$$\text{N m} = \text{J}$$

Work done on an object

- What is done by the action of a force when it acts on an object as the object moves through a displacement.
- Work done on an object is the product of the magnitude of the Displacement times the component of the force parallel to the Displacement.
- $W = F \times D \times \cos(\text{angle})$ $\text{N m} = \text{Joule}$

Example

- Work done when the Force and the Displacement are in the same direction
- $W = F \times D \times \cos(\text{angle}) = F \times D \cos(0) = F \times D$

If you push a loaded grocery cart a Displacement of 50 m by exerting a horizontal force of 30 N on the cart, you do 1,500 Nm of work on the cart.

Example

- You hold a heavy bag of groceries in your hands at rest, you do no work.
- You push against the bumper of your father's car but it does not move, you do no work.

Example

- If you carry a heavy bag of groceries as you walk horizontally across the floor at constant velocity.
- $W = F \times D \times \cos(\text{angle}) = F(\text{lift}) \times D \times \cos(90)$
- $= F(\text{lift}) \times D \times 0 = 0$
- Therefore, horizontal carrying accomplishes zero work !!!

Example

- Can centripetal force ever do work on an object?
- $W = F \times D \times \cos(\text{angle}) = F \times D \times \cos(90)$
- $= F \times D \times 0 = 0$
- Centripetal Force does no work.

Group Activity for $W = F \times D \times \cos(\text{angle})$

- As Alex pulls his red wagon down the sidewalk, the handle of the wagon makes various angles with the pavement. If Alex exerts a force of 100 N along the direction of the handle, how much work is done when a Displacement of 20 m has been achieved?
 - 1. 30 degrees
 - 2. 40 degrees
 - 3. 50 degrees
 - 4. 60 degrees

Answers for Group Activity

- $W = F \times D \times \cos(\text{angle})$
- $W = 100 \text{ N} \times 20 \text{ m} \times \cos(\text{angle})$

- 1. 30 degrees: 1732 J
- 2. 40 degrees: 1532 J
- 3. 50 degrees: 1286 J
- 4. 60 degrees: 1000 J