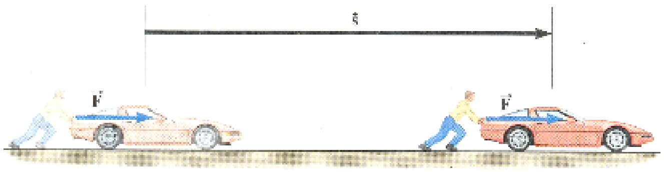
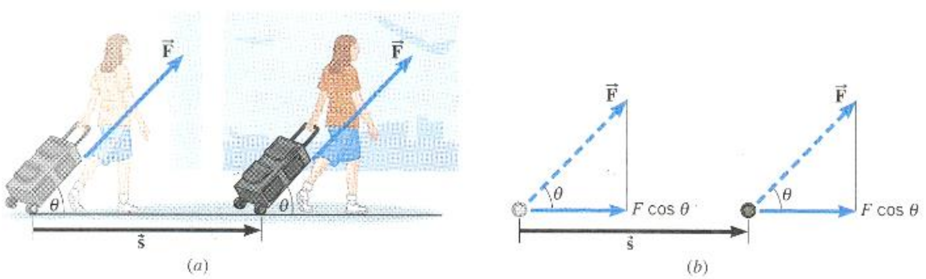
6.1 - Work Done by a Constant Force

Tuesday, January 2, 2018 9:34 PM

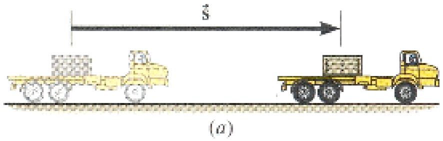
- **Work** - transferring energy (ex. Pushing a car)
- Two essential elements: **force** and **displacement**

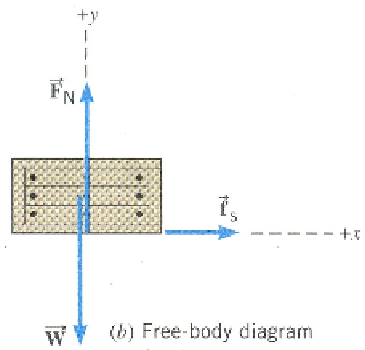


  - Diagram shows constant pushing force, $\vec{F}$
  - Displacement, $\vec{s}$ points in same direction
  - Customary to use *s* instead of *x* when dealing with displacement and work.
  - In this case, work is defined as magnitude *F* of the force times the magnitude *s* of the displacement. $W = Fs$
- Work **is the same regardless of direction**, i.e. it's a scalar quantity.
- **Units**: unit of force times the unit of distance -> newton times meter.
  - SI: Nm -> Joule (J)
  - CGS: erg
  - BE: ft * lb
- If the object does not move, the force acting on the object does no work.



- What if the force *isn't* the same direction as the displacement?
  - In the image, displacement is parallel to floor but force is applied at an angle relative to the ground, θ.
  - In this case, only the component of F that's the **same direction** as displacement is doing work. That's F_x, in this case the angle is adjacent to the horizontal, so we use cosine (*SOH CAH TOA*).
  - Therefore, the equation is $W = (F\cos\theta)s$
- To do work, there **must** be a force *and* a displacement.
  - Suppose there's a perpendicular force. If there's no displacement in the perpendicular direction, the force does no work. Makes sense: cos(90) = 0, so W = 0!
- Work can be either positive or negative.
  - Positive work: force and displacement go in the **same** direction.
  - Negative work: force and displacement go in **opposite** directions.
  - Example: lifting weights.
    - When pushing weight up, angle between force and displacement is 0. cos(0) = 1, so W = Fs
    - When lowering the weight, angle between force and displacement is 180, because they're opposite. cos(180) = -1, so W = **-**Fs (note the negative!)





(b) Free-body diagram for the crate

- What about static friction? Oh boy.
  - The crate doesn't slip when the truck is moved, so that means static friction is playing a role.
  - W and F_n are perpendicular to the displacement, so they do no work.
  - Static friction is in the same direction as the displacement. This is the net force, so to find the net work, all we have to do is solve for that!
  - $f_s = ma = (120kg)(1.5\ m/s^2) = 180N$
    $W = (f_s \cos 0)(65m) = 1.2 * 10^4 J$